SBIR TURNS 40: EVALUATING SUPPORT FOR SMALL BUSINESS INNOVATION

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

OF THE

HOUSE OF REPRESENTATIVES

ONE HUNDRED SEVENTEENTH CONGRESS

SECOND SESSION

APRIL 6, 2022

Serial No. 117–52

Printed for the use of the Committee on Science, Space, and Technology

Available via the World Wide Web: http://science.house.gov

U.S. GOVERNMENT PUBLISHING OFFICE

47–331PDF WASHINGTON : 2023

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C O N T E N T S

April 6, 2022

SBIR TURNS 40:
EVALUATING SUPPORT FOR SMALL BUSINESS INNOVATION

WEDNESDAY, APRIL 6, 2022

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to notice, at 10:18 a.m., 2318 of the Rayburn House Office Building, Hon. Haley Stevens [Chairwoman of the Subcommittee] presiding.

U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON RESEARCH & TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HEARING CHARTER

SBIR Turns 40: Evaluating Support for Small Business Innovation
Wednesday, April 6, 2022
10:00 a.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, April 6, 2022, the Subcommittee on Research and Technology of the Committee on Science, Space, and Technology will hold a hearing to review the role of the Small Business Innovation Research (SBIR) Program and Small Business Technology Transfer (STTR) Program in translating Federally funded research into commercial development, generating new economic growth, as well as in assisting federal science agencies in meeting their respective missions. The Subcommittee will also consider recommendations for improvements to the SBIR and STTR Programs and receive testimony on *Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021.*

WITNESSES

- **J. Stephen Binkley Ph.D.**, Acting Director, Office of Science, Department of Energy
- **Dr. Ben Schrag**, Program Director and Policy Liaison, SBIR/STTR Program, Directorate for Technology, Innovation and Partnerships, National Science Foundation
- **Dr. Maryann Feldman,** S.K. Heninger Distinguished Professor of Public Policy, Department of Public Policy; Professor of Finance, Kenan-Flagler Business School; Research Director, Kenan Institute of Private Enterprise; The University of North Carolina at Chapel Hill
- **Mr. George Caravias,** Chief Executive Officer, Geofabrica Inc.
- **Dr. Nigel Reuel,** Associate Professor, Jack R. and Carol A. Johnson Faculty Fellow, Director of Graduate Education, Iowa State University

OVERARCHING QUESTIONS

- What role does, or could, SBIR and STTR play in U.S. innovation policy? What is the value of the SBIR and STTR programs for start-ups and early-stage entrepreneurs?
- What do the data and assessments tell us about the SBIR and STTR programs' successes and/or challenges? Are there any policy recommendations for the current reauthorization process?
- What are additional ways to increase commercialization of federally funded university research and to achieve the goals of the SBIR Program?

- How do the SBIR and STTR programs fulfill their mission to "Foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons."? What additional authorities or directives would better enable agencies to fulfil this mission?

SBIR and STTR

Congress established the Small Business Innovation Research Program (SBIR) in 1982 and the Small Business Technology Transfer (STTR) Program in 1992 [hereafter referred to as "SBIR" collectively unless otherwise noted] as a way to encourage and facilitate small business participation in the federal research mission and to support transfer of federally funded research into market-ready technologies. The law governing these programs is found under Section 9 of the Small Business Act (15 U.S.C. 638). SBIR awards are made using a competitive and merit-based selection process. The key distinction between the programs is that STTR requires collaboration with universities or federally funded research and development centers.

The Small Business Administration (SBA) administers the SBIR program; however, the program is funded from set-asides in extramural research and development (R&D) accounts at each agency required to participate in the Program. Each agency with an annual extramural R&D budget over $100 million is required allocate 3.2% of its budget for SBIR grants and contracts[1] and each agency with an annual extramural R&D budget of $1 billion or more must allocate an additional 0.45% of its extramural budget to STTR.[2] The five agencies required to participate in STTR account for over 97% of the overall SBIR program's expenditures, which totaled approximately $3.3 billion for SBIR and $429 million for STTR in FY19, the most recent year for which data is available.

Agencies award SBIR and STTR grants and contracts in three designated phases. In Phase I, agencies may award funding up to $150,000 for six to 12 months. These funds are to be used for determining technical and scientific merit and feasibility of ideas. During Phase II, agencies may make awards up to $1,000,000 for up to two years, which are to be used for further development activities and for determining commercial potential.[3] Phase III of the program is for commercialization and is funded by non-federal sources for most agencies. One benefit of the program for awardees is the possibility of direct purchasing power by the Federal government.

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[1] Eleven agencies are required to have SBIR programs, these include: Department of Agriculture; Department of Commerce – National Institute of Standards and Technology; Department of Commerce – National Oceanic and Atmospheric Administration; Department of Defense; Department of Energy; Department of Health and Human Services (the National Institutes of Health); National Aeronautics and Space Administration; U.S. Department of Education (DoEd), Department of Transportation, Department of Homeland Security, Environmental Protection Agency, and National Science Foundation.

[2] Five agencies are required to have STTR programs, these include: Department of Defense; Department of Energy; Department of Health and Human Services (National Institutes of Health); National Aeronautics and Space Administration; and National Science Foundation.

[3] Agencies are authorized to make awards up to 50 percent greater than the award guidelines without seeking a waiver from the SBA. Phase I can be up to $256,000 and Phase II can be up to $1.7 million.

The program gives any agency the authority to directly purchase SBIR-funded technology; however, an agency must use non-SBIR federal funds to fund Phase III. In FY 2019, Phase III procurements were made by DOD, NASA, DOE, and DHS.[4,5]

The Science Committee shares SBIR jurisdiction with the House Small Business Committee (SBC). The House passed a bipartisan SBIR reauthorization bill in 2018; however, it was not taken up by the Senate. The current authorization expires on September 30, 2022. The *America COMPETES Act* includes a program extension through 2027 to minimize the risk of disruption to the program. In June 2021, Congressman Baird and Chairwoman Stevens introduced H.R. 4033, "*The Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021.*" The bill is largely based on the 2018 House-passed bill. SBC is in the process of developing their own legislative proposal. This hearing is an opportunity to receive recommendations for additional improvements Congress should consider for the SBIR program as it moves toward a more comprehensive reauthorization.

SBIR Program Flexibility

As administrator of the overall SBIR program, the SBA issues, and periodically updates, SBIR policy directives for the general conduct of the SBIR program. However, each Federal agency required to participate in SBIR implements the program to fit its own mission and existing processes. Each agency determines the categories of projects, solicitation schedule, review process, and final decisions on proposals, and makes other decisions in the administration of the SBIR program. As a result, the SBIR program varies significantly across agencies. For example, one goal of the program is increasing private sector commercialization of Federally funded research through awards to small businesses, including existing businesses and new businesses created around the awarded topic. NSF SBIR recipients are often young businesses, or start-ups, exploring high-risk, high-reward technologies that use the program to de-risk the technology to attract follow-on investments for commercialization. NASA often uses SBIR to fund innovative work in a niche area to produce a new technology necessary for a future mission. Mission-based awards enable small businesses to develop a technology with an intended government customer while also advancing their technological capacity to possibly enter new commercial markets. In DOE's case, they may not be the ultimate customer, but they are seeking to meet a niche R&D need for the energy sector.

Congress has continued to amend the statutory authorities over time to reflect the diversity in mission needs. This has included the creation of pilot programs to encourage participation and improve commercialization outcomes, as well as granting exceptions to make the SBIR program more flexible to suit the needs of the participating Federal agencies. For example, NIH, DOD, and DoEd have a pilot authority to offer "Direct to Phase II" awards. If the small business meets the merit and feasibility qualifications required for Phase I, these agencies may provide a Phase

[4] Phase III acquisitions for FY 2019: DOD, $1,183 million; NASA, $30.8 million; DOE, $18.8 million; DHS, $4.1 million

[5] Small Business Administration, 2019 SBIR and STTR Annual Report

II award on a project that has not received Phase I support. H.R. 4033 would expand this authority to all SBIR awarding agencies.

ADDITIONAL ISSUES

Entrepreneur Training and First-time awardees

Moving an idea from lab to prototype to customer draws on a range of skills and know-how beyond technical and scientific expertise. SBIR applicants often unsuccessfully apply for SBIR support multiple times before successfully receiving an award. The lack of success may be due to a mismatch with the solicitation, poorly demonstrated route to commercialization, or mistakes in the application process. Once successful, young businesses that are first-time recipients are often able to leverage the SBIR support for a larger impact on commercialization over repeat award winners.[6,7,8]

Several programs attempt to better prepare academics for entrepreneurship or the SBIR application process. The 2011 SBIR reauthorization established a Phase 0 Proof of Concept Partnership pilot program at NIH. Specifically, it allowed NIH to use $5 million of its STTR funds to make awards to universities and research institutions to make grants to individual researchers for technical validations, market research, clarifying intellectual property rights, and investigating commercial or business opportunities.[9]

In 2012, NSF launched the Innovation Corps, or I-Corps program, which is supported separately from SBIR, but whose mission complements that of the SBIR program. The I-Corps program provides funding and mentorship to help assess the viability for possible commercialization of nascent technological ideas developed through research funded by NSF.[10] In order to help SBIR awardees better navigate commercialization, NSF has adapted the I-Corps curriculum to create the "Beat-the-Odds Boot Camp" for all Phase I awardees to participate in. I-Corps may be considered another approach to "Phase 0" for SBIR and additional resources in support of the I-Corps program may strengthen the overall SBIR outcomes. H.R. 4033 would make the Phase 0 program a permanent part of SBIR and expand the authority to all agencies with STTR programs.

Participation of Socially & Economically Disadvantaged Persons and Businesses

Encouraging participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons is among SBIR's program goals[11].

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[6] The National Academies Press "Assessment of the SBIR and STTR Programs at the National Institutes of Health," 2022

[7] The National Academies Press "Review of the SBIR and STTR Programs at the Department of Energy," 2020

[8] Howell, Sabrina T, Financing Innovation: Evidence from R&D Grants (July 23, 2016).

[9] NIH implemented the Research Evaluation and Commercialization Hubs (REACH) to develop best practices to translate university innovations into real-world drugs, devices, and diagnostics. NIH has funded eight hubs that provide support for innovators at more than 70 institutions across the United States.

[10] NIH and DOE have created their own I-Corps programs modeled after the NSF program. NASA, DOD, and DHS partner with NSF to provide I-corps training.

[11] SBIR and STTR Programs Mission, www.sbir.gov/about

SBA tracks SBIR/STTR participation by women-owned small businesses (WOSB), socially and economically disadvantaged small businesses (SDB), and small businesses located in Historically Underutilized Business Zones (HUBZone). In FY 2019, WOSB, SDB, HUBZone awards made up 10%, 4%, and 4%, respectively, of all Phase II awards at civilian agencies.[12] However, four agencies, USDA, DOC, DOT, DoEd, funded no Phase II awards to businesses classified as SDB.[13] A 2022 National Academies report of SBIR at NIH found that efforts to increase participation of underrepresented groups have not been successful.[14] Additionally, they found that the STTR collaborations with Historically Black College and Universities (HBCU) and Hispanic Serving Institutions (HSI) were infrequent and had not increased over the past two decades.[15] NAS has repeatedly recommended steps for SBIR participating agencies to improve agency outreach efforts and develop new benchmarks and metrics to improve participation by underserved populations.

Award Timelines

The delay in timing from ideation to application to award notice through funding disbursement can pose a challenge for small businesses with no revenue streams. To address this, in 2019 SBA issued a Policy Directive requiring all agencies (except NIH and NSF) to make award decisions within 90 days of the solicitation closing.[16] In the FY 2019 NDAA, Congress directed the Government Accountability Office (GAO) to report annually on award timeliness. GAO reports that while agencies have adopted practices to address the timelines, significant variability persists across the agencies.[17] The National Academies have also identified the significant time between application and award disbursement at NIH as a barrier to achieving the SBIR program's objectives.[18]

Commercialization via Technical and Business Assistance (TABA)

To help improve SBIR's effectiveness in the later stages of the innovation lifecycle, Congress has authorized agencies to support commercialization assistance programs for SBIR awardees at defense and civilian agencies. Agencies may enter into agreements with vendors to contract with SBIR awardees to provide technical and business assistance.

Unsatisfactory Performance Record

While many small businesses do use SBIR awards as a springboard to private sector funding and commercialization of their business, there are some companies that receive SBIR awards year after year and never fully commercialize. To address this issue, the 2011 reauthorization required agencies to establish a way to measure the rate of commercialization for a small business,

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[12] Small Business Administration, 2019 SBIR and STTR Annual Report
[13] Ibid.
[14] The National Academies Press "Assessment of the SBIR and STTR Programs at the National Institutes of Health," 2022
[15] Ibid.
[16] 15 U.S.C. §§ 638(j), (p); Small Business Administration, SBIR/STTR Policy Directive (May 2, 2019).
[17] GAO-22-104677, Small Business Research Programs: Agencies Should Further Improve Award Timeliness, Oct. 2021
[18] The National Academies Press "Assessment of the SBIR and STTR Programs at the National Institutes of Health," 2022

establish a minimum performance standard, and track commercialization success of the small business and its progress to Phase II and Phase III. If a small business does not meet these performance goals, they are ineligible to receive a Phase I or Phase II award for one year.

Administrative Fee

Congress authorized an administrative pilot program ("administrative fee") that allowed agencies to use 3% of their SBIR funds for new activities that go toward achieving six program goals including: outreach activities; commercialization; streamlining and simplification; prevention and detection of fraud, waste, and abuse; reporting; and administration and implementation of the reauthorization.

Evaluation

Congress has required quadrennial reviews of each agency's SBIR program by the National Academies of Science, Engineering, and Medicine. The current round of reviews in ongoing. Reports on DOE and NIH have been published.[19,20]

GAO reports every four years on fraud, waste, and abuse in the SBIR program and agency adoption of minimum requirements for prevention set out by SBA. The most recent report was published in 2021.[21] In addition to the annual timeliness report, GAO is also directed by Congress to report on agency use of a flexibility to issue SBIR award to companies funded by venture capital, hedge fund, or private equity. However, GAO has repeatedly reported that most agencies do not use the authority or do so only for a small portion of their overall portfolio.[22]

[19] The National Academies Press "Assessment of the SBIR and STTR Programs at the National Institutes of Health," 2022
[20] The National Academies Press "Review of the SBIR and STTR Programs at the Department of Energy," 2020
[21] GAO-21-413, Small Business Innovation Research: Agencies Need to Fully Implement Requirements for Managing Fraud, Waste, and Abuse
[22] GAO-21-223R, Small Business Innovation Research: Three Agencies Made Awards to Businesses Majority-Owned by Investment Companies and Funds

Chairwoman STEVENS. This hearing will come to order. Without objection, the Chair is authorized to declare recess at any time.

Good morning. Thank you to our witnesses. Thank you to Members for bearing with us. We are here in the Science Committee room doing what was supposed to be a hybrid that has now turned into a Zoom hearing due to technical difficulties of the hybrid functionality which we have been successfully using all term, but for some reason today the sound was out, so we will be doing this hearing on Zoom.

People, Members should remember the conduct of a Zoom hearing. You will be responsible for your own microphone. You will need to mute at your own convenience when you're not speaking. And Members should keep their video feed on as long as they're present for the hearing. And of course if Members have any documents they wish to submit for the record, please email them to the Committee Clerk, whose address was circulated prior to the hearing.

So, again, welcome to today's hearing of the Subcommittee on Research and Technology to discuss the very important merits and challenges of the Small Business Innovation Research, or SBIR for short, and the Small Business Technology Transfer (STTR) programs. Starting a little bit late, but so necessarily given the importance of this hearing topic and for the overall success of the U.S. economy for technology, research, and other development enterprises.

We're going to welcome our distinguished panel of witnesses. I want to thank them for joining remotely. I also want to just mention a very special witness for—to me, Mr. George Caravias, the Chief Executive Officer of Geofabrica based in my home State of Michigan, based in my district actually just around the corner and a place that I had a chance to go visit.

And many of you know I do a program called Manufacturing Monday. It's the fly out day, go visit a manufacturer on the Monday of the fly out. I've had a chance to visit with Mr. Caravias and his staff and just have a lot of fun geeking out with their technologies and what they're producing. And this Manufacturing Monday program really is just a showcase of the innovation economy for Michigan. And so seeing them at the tail end of last year was just a real treat, and obviously it's very exciting to have him here with us today for this important hearing. And we obviously look forward to hearing the comments of everyone on SBIR and how this program can be strengthened to provide opportunities to encourage small businesses take risks and pursue innovative research for technology commercialization.

So for what's bringing us here today, SBIR's impact on our communities, it continues to be a very timely topic. It is in alignment with the ongoing conversations about how to sustain America's scientific and manufacturing leadership, the manufacturing economy, which is so robust, exciting, and engaging throughout our country and certainly in the hotbeds across the Midwest.

We know about the *America COMPETES Act,* which contains important provisions from this very Subcommittee seeking to reinvest in America's future, supporting innovative small companies and an essential part of our vision for America's innovative future. The

Small Business Innovation Research program is a vehicle to take discoveries made in the lab and explore how they can be transformed into a product. Many brand-new businesses use the program to de-risk their ideas and springboard them into private investment.

But not all SBIR recipients are startups. We know that. And the program is also a tool for small manufacturers to de-risk innovation and enter new markets or—it's also a tool for other science-based companies to de-risk, science and technology-based companies. So over the last 5 years the SBIR program has awarded small businesses just as an example because this isn't all about Michigan, although I would love for it to be all about Michigan but just as an example of Michigan has been awarded $348 million in funding for R&D (research and development). Geofabrica, as I mentioned at the beginning, is just one of so many stories in Michigan alone. And SBIR funding to small companies in my home State has also led to the development of handheld technology that enables farmers to accurately detect nitrates in their own fields, saving farmers money and protecting our freshwater systems from toxic algal blooms and the testing of ligand for PET imaging of the brain during clinical trials for new memory disorder drugs.

So, overall, 11 agencies support small business innovation through the SBIR program. It's important to recognize the diversity of missions and needs across those agencies when considering reauthorization.

At the end of the spectrum is the National Science Foundation (NSF), which uses the program to support innovation and new businesses broadly. At the other is the Department of Defense (DOD), which uses SBIR largely to generate mission-critical technologies. So we got these 11 agencies, you got NSF on one side and DOD on the other. We don't have a lot of these interagency initiatives. This is one of them, and it's working very well, we think. We're here to learn more, and we want to foster improvements to the program while maintaining flexibility. Flexibility is very key, especially in this COVID age to meet each agency's requirements.

Despite its many strengths, the SBIR program has some, you know, challenges, and here's where I believe Congress can help. I'm hoping to hear ideas today about how we can better prepare first-time entrepreneurs, how we can bring in and support more women- and minority-owned small businesses. I've heard from minority small—minority-owned small businesses in Michigan's 11th District, some who are tapping into SBIR and some who would be greatly benefited to learn more about the opportunity of SBIR and also for how agencies can be more responsive to the needs of small businesses. In short, we want to ensure that all communities and would-be entrepreneurs can participate in the program and that businesses with great ideas are prepared to succeed.

I was very proud to cosponsor a bipartisan bill last June with Congressman Baird to further strengthen the SBIR and STTR programs. H.R. 4033, the *Small Business Innovation Research and Small Business Technology Transfer Improvement Act of 2021.* What an honor to do this alongside my dear friend Congressman Jim Baird. The bill seeks to address some of these programmatic challenges. We must use all of the tools we have to tackle the soci-

etal challenges of today and tomorrow, including the challenge of creating safe, sustainable technologies of environmental remediation, of creating revolutionary new approaches to medicine, and much more. As an investment in a vibrant entrepreneurial ecosystem in our country, the SBIR is a premier and resounding tool.

[The prepared statement of Chairwoman Stevens follows:]

Good morning and welcome to today's hearing of the Subcommittee on Research and Technology to discuss the merits and challenges of the Small Business Innovation Research, or SBIR for short, and Small Business Technology Transfer programs. I'd also like to welcome our distinguished panel of witnesses joining us remotely.

I would like to give a special warm welcome to Mr. George Caravias, Chief Executive Officer of Geofabrica, based in my home state of Michigan. Since I was elected to Congress, I devote time every Monday to visit a manufacturer or business in my district—Michigan's 11th District -that showcases southeastern Michigan's innovation economy. In December, I had the privilege of visiting the team at Geofabrica to hear from Mr. Caravias of about his company's exciting DOD-funded SBIR work. I am looking forward to hearing more from him on how the SBIR program could be strengthened to provide opportunities that encourage small businesses to take risks and pursue innovative research for technology commercialization.

As for what bring us here today—SBIR's impact in our communities -continues to be a very timely topic. It is in alignment with the ongoing conversations about how to sustain America's scientific and manufacturing leadership. The *America COMPETES Act,* which contains important provisions from this very subcommittee, seeks to reinvest in America's future. Supporting innovative small companies is an essential part of that vision of our innovation future.

The Small Business Innovation Research program is a vehicle to take discoveries made in the lab and explore how they can be transformed into a product. Many brand-new businesses use the program to de-risk their ideas and springboard them to private investment. But not all SBIR recipients are start-ups. The program also is a tool for small manufacturers to de-risk innovation and enter new markets.

Over the past five years, the SBIR program has awarded small businesses in Michigan more than $348 million in funding for R&D. Michigan's Geofabrica is just one of so many stories in Michigan alone. SBIR funding to small companies in my state have also led to the development of a hand-held technology that enables farmers to accurately detect nitrates in their own fields, saving farmers money and protecting our freshwater systems from toxic algal blooms; and the testing of a new ligand for PET imaging of the brain during clinical trials for new memory disorder drugs.

Overall, eleven agencies support small business innovation through the SBIR program. It's important to recognize the diversity of missions and needs across those agencies when considering reauthorization. At one end of the spectrum is the National Science Foundation, which uses the program to support innovation and new businesses broadly. At the other is the Department of Defense, which uses it largely to generate mission-critical technologies. We hope to foster improvements to the program while maintaining the flexibility to meet each agency's requirements.

Despite its many strengths, the SBIR program has some ongoing challenges, and here's where I believe that Congress can help. I'm hoping today to hear ideas for how we can better prepare first-time entrepreneurs, how we can bring in and support more woman- and minority-owned small businesses, and for how agencies can be more responsive to the needs of small businesses. In short, we want to ensure that all communities and would-be entrepreneurs can participate in the program and that businesses with great ideas are prepared to succeed.

I was proud to cosponsor a bipartisan bill last June with Congressman Baird to further strengthen the SBIR and STTR programs. H.R. 4033, The *Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021.* This bill seeks to address some of these programmatic challenges.

We must use all of the tools we have to tackle the societal challenges of today and tomorrow, including the challenge of creating safe, sustainable technologies, of environmental remediation, of creating revolutionary new approaches to medicine, and much more. As an investment in a vibrant entrepreneurial ecosystem in our country, the SBIR program is one such tool.

I want to thank the witnesses for being here today. I greatly look forward to hearing your expertise, your experiences, and your feedback on our legislation and any additional ideas Congress should consider for improving the SBIR Program.

Chairwoman STEVENS. So we're going to hear from the witnesses shortly. I believe that Ranking Member Feenstra is with us on Zoom. We are now fully Zoom although I am in the hearing room using the headphones. Mr. Feenstra, would you like to give your opening remarks? OK. We're going to pause because technology is not on our side today. So I'm going to move to the intros and then—OK. That's—yes, I'm moving to the intros. Is Mr. Feenstra here, Mr. Feenstra from Iowa, my good friend? He's from a northern district in Iowa.

Mr. FEENSTRA. Yes, I am here.

Chairwoman STEVENS. Here we go.

Mr. FEENSTRA. I'm here.

Chairwoman STEVENS. OK. We can hear you. It's great. Thank you, sir.

Mr. FEENSTRA. All right. Thank you, Chairman Stevens, and thank you for our witnesses for joining us today to share your expertise—expert testimony on Small Business Innovation and Small Business Technology Transfer programs. SBIR and STTR are the Federal Government's largest source of early stage technology development and commercializing funding for small businesses. Our witness panel today represents a variety of perspectives which will be valuable to our Committee as we think about SBIR, STTR, and reauthorization.

With the programs set to expire at the end of September, we have to—work to do to ensure that we can continue to make these investments in small businesses that can propel American innovation moving forward. The programs provide an opportunity for small businesses to be involved in Federal research and development and to help transfer federally funded R&D into innovative products and services.

It is for this reason that these programs are sometimes referred to as America's seed fund, investing in research and emerging tech ideas that are too risky to raise capital in private—in the private sector. The programs are funded from set-asides of the extramural research budgets at Federal agencies, 3.2 percent from SBIR grants and just less than .05 percent from STTR. These set-asides sound small, but they add up to about $3.3 billion for both of these programs.

The—this is a huge taxpayer investment, so it is important for Congress to ensure that the programs are working efficiently as we consider reauthorization. My esteemed colleagues, Dr. Baird and Chairwoman Stevens, are leading a bipartisan bill which would improve these programs by enhancing accountability, providing agencies flexibility, and prioritizing successful policies. This bill, H.R. 4033, presents a path forward for both of these programs' reauthorization, and I look forward to working with both Dr. Baird and Ms. Stevens on this legislation.

If America wants to maintain its competitive edge in technologies of the future, we must make sure that Federal investments in R&D are made across the country, not just in Silicon Valley. These programs provide a unique opportunity for middle America small businesses to become more involved in Federal R&D. States like Iowa have recognized the opportunity for these programs and what they provide for our State economies. Last year, Iowa received our most

award year ever to date for a total of $11 million federally invested in Iowa's small business through these programs.

One of our witnesses today, Dr. Nigel Reuel, a professor from Iowa State University located—is located in my district. Iowa State is doing a great work to foster the entrepreneurial spirit on campus. This hard work is paying off. The Princeton Review recently ranked Iowa State 11th in the Nation for student entrepreneurship. I am thrilled to have Dr. Reuel with us today to discuss Iowa State's work and to share his own SBIR stories.

I'm also looking forward to hearing from Dr. Binkley and how the Department of Energy's (DOE's) national labs like Ames Laboratory are utilizing both of these programs. Investing in both of these—investing in these basic research help NSF, DOE, and NASA (National Aeronautics and Space Administration) and other agencies to create scientific breakthroughs, and investments like SBIR and STTR are key to supporting jobs and retaining talent and leveraging State and private funding in America's heartland.

I am proud to work with my colleagues to encourage innovation and to give our businesses the resources they need to thrive. We must take every opportunity to strengthen investment in R&D so we can continue breaking boundaries and moving forward in our economy.

Thank you, Madam Chair, for hosting this event, and I yield back.

[The prepared statement of Mr. Feenstra follows:]

Thank you, Chairwoman Stevens, and thank you to our witnesses for joining us today to share your expert testimony on the Small Business Innovation Research and Small Business Technology Transfer programs.

SBIR and STTR are the Federal Government's largest source of early-stage technology development and commercializing funding for small businesses. Our witness panel today represents a variety of perspectives which will be valuable to our Committee as we think about SBIR and STTR reauthorization. With the programs set to expire at the end of September, we have work to do to ensure they can continue to make investments in small businesses that can propel American innovation forward.

The SBIR and STTR programs provide an opportunity for small businesses to be involved in federal research and development, and to help transfer federally funded R&D into innovative products and services. It is for this reason that these programs are sometimes referred to as America's seed fund, investing in research and emerging tech ideas that are too risky to raise capital in the private sector.

The SBIR and STTR programs are funded from set-asides of the extramural research budgets at federal agencies—3.2% for SBIR grants and just less than half a percent for STTR. These set asides sound small, but they added up to around $3.3 billion for SBIR and $429 million for STTR in 2019. This is a huge taxpayer investment, so it is important for Congress to ensure the programs are working efficiently as we consider reauthorization.

My esteemed colleagues, Dr. Baird and Charwoman Stevens, are leading a bipartisan bill which would improve these programs by enhancing accountability, providing agencies flexibility, and prioritizing successful policies. This bill, H.R. 4033, presents a path forward for SBIR and STTR reauthorization, and I look forward to working with both Dr. Baird & Ms. Stevens on the legislation.

If America wants to maintain its competitive edge in the technologies of the future, we must make sure federal investments in R&D are made across the country, not just in Silicon Valley. These programs provide a unique opportunity for middle America small businesses to become more involved in federal R&D.

States like Iowa have recognized the opportunity SBIR and STTR provide to their state economies. Last year, Iowa received our most awards year to date for a total of around $11 million federally invested in Iowa small businesses through these programs.

One of our witnesses today is Dr. Nigel Reuel, a professor from Iowa State University located in my district. Iowa State is doing great work to foster the entrepre-

neurial spirit on campus. This hard work is paying off—the Princeton Review recently ranked Iowa State 11th in the nation for student entrepreneurship. I am thrilled to have Dr. Reuel with us today to discuss Iowa State's work and to share his own SBIR story.

I'm also looking forward to hearing from Dr. Binkley about how the Department of Energy's National Labs, like Ames Laboratory, are utilizing the SBIR and STTR programs.

Investing in basic research at NSF, DOE, NASA and other agencies has led to key scientific breakthroughs. And investments like SBIR and STTR are key to supporting jobs, retaining talent, and leveraging state and private funding in America's heartland. I am proud to work with my colleagues to encourage innovation and give our businesses the resources they need to thrive.

We must take every opportunity to strengthen investment in R&D so we can continue breaking boundaries and moving our economy forward.

Thank you, again, Madam Chair for hosting this hearing. I look forward to hearing from our witnesses and I yield back the balance of my time.

Chairwoman STEVENS. Great. If there are other Members who wish to submit additional opening statements, your statements are going to be added to the record at this point.

[The prepared statement of Chairwoman Johnson follows:]

I want to thank Chairwoman Stevens and Ranking Member Feenstra for holding this hearing on the SBIR and STTR programs. I would also like to welcome our witnesses to today's hearing and thank them for sharing their expertise with us on these important programs.

Even as the United States faces increasing global competition in science and technology, we remain the envy of the world for our culture of discovery and innovation. That culture begins with our nation's talent, including the entrepreneurs who move scientific advances along the challenging path from lab to market. But as brilliant as they may be, these entrepreneurs cannot achieve their goals without financial and other kinds of support.

Private sector investors are risk averse. They want to see clear proof-of-concept and market viability before they invest. That is where the Federal government, and specifically the SBIR program, comes in. Just a modest amount of early stage support for new ideas can propel them forward and open the door to significant private sector investment and commercial success.

The SBIR program authorization expires at the end of this fiscal year, after having been extended 5 years without a comprehensive review of policy. The *America COMPETES Act* has a provision to extend the program again for 5 years, without any policy changes. It is my intention to keep that provision on the table for conference as a backstop. However, it is Congress's responsibility to take up a full reauthorization with due consideration given to all potential program improvements, and I am hopeful we can do that this year, in collaboration with our colleagues on the Small Business Committees.

To that end, a few years ago, the Science, Space, and Technology Committee developed bipartisan legislation to reauthorize the SBIR program. I want to thank Rep. Baird and Rep. Stevens for reintroducing that legislation this Congress as H.R.4033, the *"Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021."* H.R. 4033 reflects long-standing priorities of this committee, including flexibility for the agencies to meet their respective missions, efforts to diversify the applicants and awardees, and support for various pilot programs that were developed over time and have proven their value.

Specifically, H.R. 4033 would support making the 3 percent administrative fee a permanent feature of the program, and it would also extend Phase 0 and Direct to Phase II authority to all relevant program agencies. In general, we support the agencies continuing to experiment with evidence-based approaches to improve the outcomes of the program and want to ensure the authorizing statute gives them such flexibility. Through hearings such as this and other forms of oversight, we can track how agencies are doing and to what extent their efforts are strengthening the program.

I look forward to an informative hearing, and I appreciate the witnesses being with us to share their insights and legislative recommendations.

Thank you, and I yield the balance of my time.

Chairwoman STEVENS. I now would like to introduce our phenomenal witnesses, and thank you so much again for being with

us this morning and for slightly bearing with us as we conduct this hearing now on Zoom platform.

Our first witness is Dr. J. Stephen Binkley. Dr. Binkley is the Acting Director and Principal Deputy Director in the Office of Science at the U.S. Department of Energy. In this capacity, Dr. Binkley is the senior career science official in the Office of Science, which is the third-largest sponsor of basic research in the United States of America. Prior to his experience in various leadership positions in the Department of Energy, Dr. Binkley has held senior positions at the Department of Energy's Sandia National Laboratories, a favorite of this Committee, and the Department of Homeland Security.

Our next witness is Dr. Ben Schrag. Dr. Schrag is an SBIR/STTR Program Director and Policy Liaison at the National Science Foundation. He joined NSF as a Program Director in 2009, leading the advanced materials and instrumentation portfolios. Prior to NSF, he was the Director of Research and Development at Micro Magnetics and served as a visiting scientist at Brown University.

Our third witness is Dr. Maryann Feldman. Dr. Feldman is the Heninger Distinguished Professor in the Department of Public Policy and Professor of Finance at the Kenan-Flagler Business School at the University of North Carolina. We see that Congresswoman Ross is clapping vehemently, hailing from North Carolina herself. From 2014 to 2017 she held the joint appointment at the National Science Foundation as the Science of—the Science of Science and Innovation Policy Program Director. Dr. Feldman co-chaired the National Academies of Sciences, Engineering, and Medicine's recent assessment of the SBIR/STTR programs at DOE and the NIH (National Institutes of Health).

Our next witness is Mr. George Caravias. He is the Chief Executive Officer of Geofabrica, Inc., in Michigan. Mr. Caravias is an experienced Chief Executive with an almost 40-year career in engineering and applied technology. He must've started as a child. He began his career developing computer-aided manufacturing/computer-aided design systems in the defense industry and successfully managed multiyear, multimillion dollar projects for manufacturing in information technology applications. Prior to establishing his current business, Geofabrica, Mr. Caravias founded and helped to lead two technology ventures, one which grew to over $200 million in sales.

Our final witness is Dr. Nigel Reuel, and I would like to recognize my colleague Congresswoman Feenstra to introduce Dr. Reuel.

Mr. FEENSTRA. Thank you, so much, Madam Chair. I am very pleased to welcome Dr. Nigel Reuel, Associate Professor of Chemical and Biological Engineering at Iowa State University to testify before our Subcommittee today. In addition to being a professor, Dr. Reuel is also a Jack R. and Carol A. Johnson Faculty Fellow and Director of Graduate Education at the College of Engineering Entrepreneurial Fellow. In his time at Iowa State, Dr. Reuel has been involved in the national I-Corps program and also participated in three separate Iowa State I-Corps site cohorts. Additionally, Dr. Reuel has contributed to several successful IBR, SBIR, and STTR award applications. One of these successful awards helped ensure the realization of a startup called Skroot Laboratory

established in 2018 and initially incubated in Iowa State's Roy J. Carver Co-Lab on the north side of the campus. Additionally, Dr. Reuel has been involved with SBIR-awarded small businesses—a small business that was recently acquired through the Biotechnology, Inc. He maintains that the progress and ability to connect to this acquisition partner was made possible through SBIR funds. I want to thank Dr. Reuel for taking the time out of his busy schedule to join us today, and we are looking forward his testimony. I yield back the balance of my time.

Chairwoman STEVENS. Great. And as our witnesses should know, you're each going to have 5 minutes for your spoken testimony. We can't wait to hear it. Your written testimony is included in the record for the hearing as well. And then when you've completed your spoken testimonies, we'll begin with questions, and each Member is going to have 5 minutes to question the panel.

We will start with Dr. Binkley.

TESTIMONY OF J. STEPHEN BINKLEY, PH.D., ACTING DIRECTOR, OFFICE OF SCIENCE, DEPARTMENT OF ENERGY

Dr. BINKLEY. Thank you, Chairwoman Stevens, Ranking Member Feenstra, and Members of the Subcommittee. I am pleased to join you today to discuss the Department of Energy's programs for Small Business Innovation Research and Small Business Technology Transfer and how legislation like the proposed *Small Business Innovation Research and Small Business Technology Transfer and Improvements Act of 2021* can contribute to the Department's innovation and technology transition goals.

The SBIR/STTR programs are an important Federal contribution of our Nation's innovation enterprise. They address a critical stage of technology development where innovations may stall because of a lack of access to funding, particularly for those where commercialization times can be long. SBIR/STTR funding enables small businesses to prove feasibility and demonstrate successful working prototypes after undergoing scientific peer review.

The programs help to catalyze relationships. Small businesses build with research institutions, larger businesses, and the investment community. DOE uses its SBIR/STTR program to address innovation opportunities in its mission areas such as clean energy and scientific instrumentation to support discovery science.

Within DOE, the Office of Science has managed the SBIR/STTR program since they were first authorized in 1992. The programs work collaboratively with research and development program offices throughout the Department to leverage their technical expertise and identify opportunities for small business innovation that are aligned with the DOE missions. ARPA-E (Advanced Research Projects Agency—Energy) independently manages its own SBIR/STTR programs.

In Fiscal Year 2021, DOE obligated $353 million for SBIR and STTR programs, issued 465 phase I awards, 229 phase II awards, and the awards were made to small businesses across 44 States and the District of Columbia.

Over the last 10 years, Congress has made important changes to SBIR/STTR programs that have allowed DOE to improve commer-

cialization outcomes of its awardees, including the introduction of second phase II awards authorized in 2012 and third phase II awards enabled by the Commercialization Assistance Pilot Program authorized in 2019. In addition, the 2019 expansion of technical and business assistance (TABA) provided more funds and greater flexibility in using these funds to support commercialization. Finally, the Administrative Funding Pilot Program has enabled DOE to offer Energy I-Corps training to its phase I awardees.

Past evaluation of the programs by the National Academy of Science, Engineering, and Medicine have found the DOE does—needs to do more to improve participation by underrepresented groups. Our first major initiative in this area was the introduction in 2014 of our phase 0 application assistance program targeted at underrepresented groups, women-owned small businesses, socially and economically disadvantaged small businesses, and small businesses from underrepresented States. We have since expanded this program to include all first-time applicants, but 2/3 of the participants in this program continue to come from underrepresented groups.

The programs have focused attention on underrepresented groups during the award selection process in Fiscal Year 2021 and implemented diversity promoting policy factors in Fiscal Year 2022, leading to consistent improvement in the percentage of awards going to underrepresented groups. In Fiscal Year 2021, women-owned small businesses and socially and economically disadvantaged small businesses each made up more than 10 percent of our phase I awardees up from close to 5 percent in 2013. We recognize—with all that said, we recognize that we need to do much more to encourage women and socially and economically disadvantaged individuals to explore entrepreneurial STEM careers.

From a broad policy perspective, we note that the strength of SBIR/STTR programs has been the flexibility provided to agencies to adapt the programs to serve their respective missions, and we encourage Congress to continue to provide agencies with such flexibility.

Chairwoman Stevens, Ranking Member Feenstra, and Members of the Subcommittee, thank you again for the opportunity to speak about DOE's SBIR/STTR program and for your continued efforts to enhance the Nation's ability to apply innovative discoveries to Federal agency missions. I look forward to discussing the program further.

[The prepared statement of Dr. Binkley follows:]

Testimony of Dr. Steven Binkley
Principal Deputy Director
Office of Science
U.S. Department of Energy

Before the
Committee on Science, Space and Technology
Subcommittee on Research and Technology
United States House of Representatives
Hearing entitled: SBIR Turns 40: Evaluating Support for Small Business Innovation

April 6, 2022

Thank you, Chairwoman Stevens, Ranking Member Feenstra, and Members of the Subcommittee. I am pleased to join you today to discuss the Department of Energy's (DOE or Department) programs for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) and how legislation like the proposed *Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021* can contribute to the Department's innovation and technology transition goals.

The SBIR/STTR programs are an important Federal contribution of our Nation's innovation enterprise. They address a critical stage of technology development where innovations may stall because of a lack of access to funding, particularly for those where commercialization times can be long. SBIR/STTR funding enables small businesses to prove feasibility and demonstrate successful working prototypes, after undergoing scientific peer review. These achievements assist them in obtaining further investment to scale and manufacture the technology. Small businesses also serve an important networking role in the innovation ecosystem because of their need to partner to achieve success. The SBIR/STTR programs help to catalyze the relationships small businesses build with research institutions, larger businesses and the investment community.

Currently, innovations funded through SBIR/STTR programs serve Federal R&D needs. DOE utilizes its SBIR/STTR program to address innovation opportunities in its mission areas such as clean energy and scientific instrumentation to support discovery science. The opportunity exists to further explore whether the current technology focus areas of Federal SBIR/STTR programs are matched to future needs of the U.S. economy.

Within DOE, the Office of Science (SC) has managed the DOE SBIR/STTR programs since they were first authorized in 1992. The DOE SBIR/STTR programs work collaboratively with research and development program offices throughout the Department to leverage their technical expertise and identify opportunities for small business innovation that are aligned with the DOE mission. ARPA-E independently manages its own SBIR/STTR programs. In FY 2021, DOE obligated $353 million for the SBIR/STTR programs, issuing 465 Phase I awards 229 Phase II awards. The awards were made to small businesses in 44 states and the District of Columbia.

Over the last 10 years, Congress has made some important changes to the SBIR/STTR programs

that have allowed DOE to improve the commercialization outcomes of its awardees, including the introduction of second Phase II awards (authorized in 2012) and third Phase II awards enabled by the commercialization assistance pilot program (authorized in 2019). Both of these awards have enabled DOE to address longer horizon innovation opportunities for which a single Phase I and II award are not sufficient. In addition, the 2019 expansion of technical and business assistance provided more funds and greater flexibility in using these funds to support commercialization. Finally, the administrative funding pilot program has enabled DOE to offer Energy I-Corps training to its Phase I awardees.

The DOE SBIR/STTR program is complemented by other efforts within the Department that support innovation. Examples of other early-stage programs include the Energy Program for Innovation Clusters[1] and Energy I-Corps[2], both sponsored by the DOE Office of Technology Transitions, and the Lab Embedded Entrepreneurship Program[3] sponsored by the Advanced Manufacturing Office within the Office of Energy Efficiency and Renewable Energy. As part of the Department's realignment in February 2022, DOE has moved later stage commercialization support programs under the new Under Secretary for Infrastructure. Two new offices, the Office of Clean Energy Demonstrations and the Office of Manufacturing and Energy Supply Chains, will complement existing offices, such as the Loan Programs Office, to assist with demonstrating and deploying new technologies at scale.

Past evaluations of the DOE SBIR/STTR programs by the National Academies of Sciences, Engineering and Medicine have found that DOE needs to do more to improve participation by under-represented groups.[4] Our first major initiative in this area was the introduction in 2014 of our Phase 0 application assistance program targeted at under-represented groups: women-owned small business, socially and economically disadvantaged small businesses, and small businesses from under-represented states. We have since expanded this program to include all first-time applicants, but two thirds of the participants to this program continue to come from under-represented groups. In 2020, the Office of Science created the Office of Scientific Workforce Diversity, Equity, and Inclusion to address under-represented groups broadly across all of its programs, including SBIR/STTR. Through efforts initiated by this office, the SBIR/STTR programs brought attention to under-represented groups during its award selection process in FY 2021 and implemented diversity-promoting policy factors in FY 2022. These efforts have led to consistent improvement in the percentage of awards going to under-represented groups. In FY 2021, women-owned small businesses and socially and economically disadvantaged small businesses each made up more than 10 percent of our Phase I awardees, which is up from close to 5% in 2013. Since 2013, the number of phase I and II awards to small business in under-represented states has trended up, with nearly 20% of phase I and more than 15% of phase II awards going to such states in FY 2021.[5]

DOE recognizes that we need to do more to encourage women and socially and economically disadvantaged individuals to explore entrepreneurial STEM careers. To that end, we

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[1] https://www.energy.gov/technologytransitions/energy-program-innovation-clusters
[2] https://www.energy.gov/technologytransitions/energy-i-corps
[3] https://www.energy.gov/eere/amo/lab-embedded-entrepreneurship-program
[4] Past National Academies studies on the SBIR/STTR programs were in 2008, 2016, and 2020.
[5] Historical data on the award rates as a percentage of total awards for under-represented groups dating back to 2013 is provided at https://science.osti.gov/sbir/About/Diversity-Equity-and-Inclusion

implemented diversity supplements–an NIH best practice–in our FY 2020 Phase II solicitations. Diversity supplements enable SBIR/STTR Phase II awardees to hire an under-represented undergraduate or graduate summer intern to provide exposure to entrepreneurial research and development. Among the first group of eligible Phase II awardees this past year, 21% applied for and received a diversity supplement. To further extend our efforts to broaden participation in the SBIR/STTR program, we are committed to working across the Department on initiatives such as Justice40 to document and improve participation not only by disadvantaged individuals, but also disadvantaged communities.

From a broad policy perspective, we note that the strength of the SBIR/STTR programs has been the flexibility provided to agencies to adapt the programs to serve their respective missions. We encourage Congress to continue to provide agencies with such flexibility, for example, by continuing the administrative funding pilot program, and not to assume that there is one best model for executing the SBIR/STTR programs.

Chairwoman Stevens, Ranking Member Feenstra, and Members of the Subcommittee, thank you again for the opportunity to speak about DOE's SBIR/STTR program, and for your continued efforts to enhance the Nation's ability to apply innovative discoveries to Federal agency missions and accelerate their transition to market. I look forward to discussing our program further, and how the *SBIR/STTR Improvements Act of 2021* can contribute. I'd be happy to take any questions you may have.

Dr. J. Stephen Binkley
Principal Deputy Director
Office of Science
U.S. Department of Energy

J. Stephen (Steve) Binkley is the Principal Deputy Director in the Office of Science (SC) at the U.S. Department of Energy (DOE). In this capacity, Dr. Binkley is the senior career science official in the Office of Science, which is third largest Federal sponsor of basic research in the United States, the primary supporter of the physical sciences in the U.S., and one of the premier science organizations in the world.

As the Principal Deputy Director of SC, Dr. Binkley serves as the principal overall advisor to the Director on all aspects of the Office of Science. Dr. Binkley determines the financial and personnel resources needed to achieve mission objectives and support mission operations; oversees and directs the internal organization, staffing, policies, and personnel authorities required to carry out the responsibilities of the organization, including the recruitment of senior managers and technical experts necessary to ensure the success of the programs. He ensures that program activities are strategically conceived and executed to maximize the benefit to organization, the Department, and the United States. Dr. Binkley also serves as the champion for crosscutting issues that affect more than one program office and special research initiatives of priority to Director and the Department leadership.

Dr. Binkley has held senior positions at Sandia National Laboratories, the Department of Homeland Security (DHS), and the Department of Energy. He has conducted research in theoretical chemistry, materials science, computer science, applied mathematics, and microelectronics. At Sandia, Dr. Binkley managed computer science, fundamental chemistry, combustion science, and chemically reacting flow organizations. He also has served as the manager for the Office of Science's Combustion Research Facility, at Sandia's Livermore, California location. Dr. Binkley managed Sandia's Office of Science Program, comprising activities in materials science, chemistry, geoscience, magnetic fusion energy, atmospheric measurement technology, and scientific computing at Sandia's New Mexico and California locations. He also managed activities in Sandia's national security program, including distributed information systems technology.

At DOE, Dr. Binkley served as a technical advisor to the Assistant Secretary of Defense Programs (subsequently the Deputy Administrator for Defense Programs after the establishment of the National Nuclear Security Administration). At DHS, Dr. Binkley served as the deputy director for technology within the DHS Operations Directorate, where he led and managed the development of systems for monitoring and disseminating situational awareness to federal, state, and local law-enforcement organizations and for coordinating emergency response activities. Returning to DOE in 2006, Dr. Binkley served as a senior technical advisor to the Under Secretary for Science and the Director of the Office of Science.

As head of SC's Office of Advanced Scientific Computing Research, Dr. Binkley served as one of the Associate Directors for the Office of Science, and was responsible for the overall management of the ASCR program including: strategic planning; budget formulation and execution; project management; program integration with other Office of Science activities and with the DOE technology offices; and interagency integration.

Chairwoman STEVENS. Excellent. With that, we're going to move to Dr. Schrag, please.

TESTIMONY OF DR. BEN SCHRAG,
PROGRAM DIRECTOR AND POLICY LIAISON,
SBIR/STTR PROGRAM,
DIRECTORATE FOR TECHNOLOGY,
INNOVATION AND PARTNERSHIPS,
NATIONAL SCIENCE FOUNDATION

Dr. SCHRAG. Chairwoman Stevens, Ranking Member Feenstra, and Members of the Subcommittee, thank you for this opportunity to testify on the Small Business Innovation Research and Small Business Technology Transfer programs at the National Science Foundation. My name is Ben Schrag, and I'm a Program Director and Policy Liaison with NSF's SBIR/STTR program.

NSF has funded research and researchers, innovations and innovators, and infrastructure that have provided incredible benefits to the Nation. The internet, Google, Qualcomm, 3-D printing, the economic theory underpinning spectrum auctioning and kidney exchanges, and even the discovery of the enzymes at the heart of the polymerase chain reaction, the chemical reaction that enables COVID–19 tests that have been critical in the fight against the pandemic. NSF investments have been foundational to all of these.

NSF's mission is to support fundamental research across all fields of science, technology, engineering, and mathematics and all levels of STEM education. Given this unique role in supporting innovators, the agency recognized early on the potential for greater and faster commercialization of NSF-funded research. That is why in the late 1970's NSF created the SBIR program. The program is an integral part of the NSF strategy to stimulate innovation and address societal needs through the commercialization of the results of fundamental research.

Our strategy for the SBIR and STTR programs is to focus primarily on supporting early stage startup companies and especially firms new to government funding. We seek to support these firms long before private investors or customers are ready to provide financial support. This approach allows our funding to have maximum impact on each awardee and also allows our funding to impact the community of innovators and entrepreneurs as broadly as possible.

In recent years, the large majority of our phase I awardees are firms with fewer than 10 employees and that were founded in the preceding 5 years. In Fiscal Year 2021, over 85 percent of our phase I SBIR and STTR awards represented the first ever award received by the applicant's small business from any Federal agency.

We have used multiple strategies to encourage new applicants to participate and to help maximize their chances of success. For example, our project pitch is a short pre-application review covering key aspects of a potential project, giving every new applicant an accessible and fast way to get feedback on whether their proposed project is a good fit for the program. We have also changed the administrative and compliance-checking processes for phase I proposals to allow proposers to fix most administrative mistakes in their proposals. This has lowered the percentage of phase I pro-

posals that are not considered from about 15 percent, which was typical a decade ago, to about 2 to 3 percent in recent years.

NSF has also designed several supplemental funding opportunities to spur the commercial success of its SBIR companies. The flagship amongst these is the phase IIB supplements, which provides up to an additional $500,000 on top of the $1 million phase II award for a firm generating marketplace traction for the first time.

In addition to providing funding, NSF uses experiential education to help researchers gain valuable insight into starting a business or industry requirements and challenges. For example, just under 2,100 NSF SBIR and STTR phase I awardee companies have participated in a condensed version of NSF's Innovation Corps program called the Beat the Odds Boot Camp.

Although our focus is on the earliest and riskiest projects, our portfolio of awardees has had strong commercialization success in recent years. Over the past 6 years, we have seen about 200 confirmed exits where our awardee organization has had an initial public offering or undergoes a successful merger or acquisition and about $14 billion in follow-on private funding.

For over 40 years, NSF has helped startups and small businesses across the country transform their ideas into marketable products and services through our SBIR and STTR programs. NSF is always assessing its performance against the broad goals of the SBIR and STTR programs, and this process has led to new supplements, new outreach, and enhancements to other NSF programs. NSF is focused on helping these startups address all the potential risks, whether technical, market, team, or financial, that they may face in their commercial journey.

On behalf of the National Science Foundation, the SBIR/STTR programs, and our awardees, I want to thank you for your support of NSF and for this opportunity to highlight programs that provide startups and small businesses with the means to keep America on the forefront of the technological innovation. I would be pleased to answer your questions.

[The prepared statement of Dr. Schrag follows:]

Testimony of

Dr. Ben Schrag
SBIR/STTR Program Director and Policy Liaison
Directorate for Technology, Innovation and Partnerships
National Science Foundation

Before the

U.S. House of Representatives
Committee on Science, Space and Technology
Subcommittee on Research and Technology

SBIR Turns 40: Evaluating Support for Small Business Innovation

April 6, 2022

Introduction

Chairwoman Stevens, Ranking Member Feenstra, and members of the Subcommittee, thank you for this opportunity to testify on the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs at the National Science Foundation (NSF), how NSF is supporting the creation of new businesses and bringing new technologies to the public, and to provide comments on H.R. 4033, *The Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021*. My name is Ben Schrag, and I am a Program Director and Policy Liaison with NSF's SBIR/STTR program.

NSF is recognized and respected as a global leader in identifying and supporting curiosity-driven, discovery-based explorations and use-inspired, solutions-focused innovations across all fields of science, technology, engineering, mathematics (STEM) and supporting all levels of STEM education. Our process through which we select proposals based on peer review, merit-based evaluations, by definition and by construction, selects the best and most creative ideas, those that offer the greatest promise for success. NSF funding accounts for approximately 24 percent of the total federal budget for basic research conducted at U.S. colleges and universities and has been vital to many discoveries that impact our daily lives and drive the economy. In

many fields such as mathematics and computer science, NSF is the major source of federal support for academic research.

NSF has funded research and researchers, innovations and innovators, and infrastructure that have garnered incredible benefits to the nation. The Internet, Google, Qualcomm, 3D printing, the economic theory underpinning spectrum auctioning and kidney exchanges, and even the discovery of the enzymes at the heart of the polymerase chain reaction, the chemical reaction that enables COVID-19 tests that have been critical in the fight against the pandemic, have been supported by NSF investments. NSF's unique mission to support research and innovation across all fields of science and engineering places the agency at the forefront of discovery. Indeed, 253 Nobel Prize winners have been supported by NSF at some point in their careers. Our awardees are often investigating novel concepts that may have unforeseen applications or immediate commercial use. Recognizing this, NSF has made a concerted effort to support researchers who believe they have a commercially viable idea, and the SBIR and STTR programs are vital components of NSF's agenda to enable commercialization of technologies stemming from basic research.

History of SBIR/STTR

In 1977 the National Science Foundation (NSF) initiated a pilot program that became the "Small Business Innovation Research" (SBIR) program. This program solicited research proposals from profit-seeking small firms. Subsequently in 1982, Congress established the SBIR program across government to provide increased opportunities for small businesses to:

- meet federal research and development needs;
- stimulate technological innovation;
- foster and encourage participation in technological innovation by socially and economically disadvantaged persons; and
- increase private-sector commercialization of innovations derived from federal research and development.

The primary objective of the NSF SBIR program is to increase incentives and opportunities for startups and small businesses to undertake transformative, high-risk, research across all technology areas. NSF funds projects that have the potential for economic payoff and broad societal impact if the innovation is successful. Additionally, the program seeks to stimulate technological innovation in the private sector, increase commercial application of NSF-supported research, and improve the return on our investment in federally funded research for its economic and social benefits to the nation. With this goal in mind, most SBIR/STTR program officers are highly trained scientists who are also former entrepreneurs, investors, or both – and indeed, NSF is one of the only agencies with program officers dedicated strictly to SBIR and STTR.

SBIR has broad reach throughout the government, as eleven federal agencies now have SBIR programs. Government-wide, these programs set aside ~$3 billion annually and have granted ~160,000 awards. The budget is 3.2% of a research agency's extramural R&D budget – which is approximately $200 million at NSF.

The STTR program was established in 1992 and, like the SBIR program, focuses on transforming scientific discovery into products and services with commercial potential and/or societal benefit. It differs from SBIR in that a small business must partner with a university or federally funded research center to do a percentage of the R&D work. Five federal agencies have STTR programs. The budget for STTR is 0.45% of extramural R&D.

SBIR/STTR at NSF

Within NSF's mission to advance the frontiers of science and engineering, the SBIR program is an integral part of the NSF strategy to stimulate innovation and address societal needs through the commercialization of the results of fundamental research. NSF's program funds small businesses to de-risk their technology, often long before the private sector is willing to invest.

Unlike some other agencies which award SBIR contracts to meet their own procurement needs, NSF is never envisioned to be the ultimate customer of the technologies it funds. The NSF SBIR research topics are oriented to the needs of the marketplace and the nation as a whole. For example, NSF SBIR seed funding led to Symantec, which is now a global leader in cybersecurity. Symantec was founded in 1982 by Gary Hendrix who was funded by an NSF SBIR grant. Qualcomm was launched after co-founder Andrew Viterbi invented the "Viterbi Algorithm," a mathematical formula to eliminate signal interference, paving the way for widespread use of cellular technology. After receiving NSF SBIR funding during the 1980s in its early years as a small business, Qualcomm has grown to become a world leader in wireless technologies and particularly "5G," a critical technology and industry.

At NSF, SBIR grants are divided into two competitive phases. Phase I awards have a duration of six to twelve months and a maximum of $275,000. These awards provide support to conduct feasibility research into new techniques or products. All Phase I awardees are eligible to apply for a Phase II award which can be for up to $1,000,000 and two years in duration.

NSF has used multiple strategies to encourage new applicants to participate, and to help maximize their chances of success. Our Project Pitch, a short pre-application review covering key aspects of a potential project, gives a new applicant a relatively accessible and fast way to get feedback from our team on whether their proposed project is a good fit for the program. In addition, our creation in 2020 of solicitations with multiple, always-open submission windows has given applicants more flexibility in choosing a timeline to apply. Finally, we have changed the administrative and compliance-checking processes for Phase I proposals, where we now work with applicants to allow them to fix most administrative mistakes included in their

proposal, rather than rejecting the application entirely. This has lowered the percentage of Phase I proposals that are not considered from about 15%, which was typical a decade ago, to about 2 to 3% in recent years.

NSF has also designed several supplemental funding opportunities to spur the commercial success of its SBIR companies. The flagship among these is the "Phase IIB" supplement which provides up to an additional $500,000 for a firm generating marketplace traction for the first time.

Established in 1998, the Phase IIB supplement incentivizes active NSF-funded Phase II companies to attract private sector funding for further technology commercialization. The Phase IIB proposal is submitted while the company is conducting the Phase II research. The objective of the Phase IIB is to motivate companies to extend the R&D efforts to meet the product, process, or software requirements of a third-party investor, thereby accelerating commercial success of a Phase II project.

Supplements are also available to provide support for college and high school students, and for teachers and veterans to participate in research experiences with SBIR awardees; to enable awardees to form partnerships with minority-serving universities, colleges, and community colleges; and to help firms form partnerships with NSF-funded research centers, among others.

In addition to providing funding, NSF uses experiential education to help researchers gain valuable insight into starting a business or industry requirements and challenges. The NSF Innovation Corps (I-Corps) program helps entrepreneurs and small businesses understand market needs and opportunities, thus increasing their chances of successfully translating new technologies. I-Corps was designed to foster entrepreneurship that will reduce the time it takes to bring technologies from the lab to the marketplace. More than 1,900 teams have participated in the program since 2011. In addition, just under 2,100 NSF SBIR and STTR Phase I awardee companies have participated over the past six years in a condensed version of the I-Corps program called the "Beat-the-Odds Boot Camp".

Within the last year, NSF announced the first awards made under the I-Corps Hubs program, a modified operational model to leverage and amplify the best practices of the program's first eight years of operation. The I-Corps Hubs program will create larger university consortia that can more easily share lessons learned. In addition, I-Corps will continue expanding its geographical reach to ensure that all the nation's communities have the opportunity to learn from and contribute to the innovation ecosystem. The Hubs model also offers a path for promising technologies funded by other federal agencies to benefit from I-Corps training, enhancing access to scientists and engineers in historically black colleges and universities (HBCUs), Hispanic-

serving institutions (HSIs), and other organizations with a rich portfolio of technologies that can potentially benefit the nation.

Another program closely related to I-Corps and similarly aimed at fostering a national innovation ecosystem is Partnerships for Innovation (PFI). The PFI program encourages the translation of promising, fundamental discoveries made by NSF researchers into products and services that benefit the nation. PFI nurtures entrepreneurial spirit by pairing I-Corps training with prototyping and advanced technology development, giving technologists and engineers in academia a set of tools to successfully transition their inventions into impact. Through I-Corps and PFI, NSF helps prepare researchers in advance of starting new firms. These programs serve as important training grounds and help researchers improve their success rates in securing SBIR and STTR funding and follow-on investments.

Together, I-Corps, PFI, and SBIR/STTR constitute a "Lab-to-Market Platform" organized under NSF's new Directorate for Technology, Innovation and Partnerships. Partnerships being critically important in moving scientific and engineering discoveries funded by NSF to the marketplace, TIP will also serve as a central resource to catalyze and scale public and private partnerships agency wide.

Frequently, NSF-funded researchers will pursue and receive grants from many of these programs in parallel, in sequence, or on a combined path. We are seeing strong interactions between these programs as well as with our SBIR/STTR program where researchers start with NSF-funded fundamental research, participate in I-Corps training to learn about the marketplace and the opportunities for new technologies to impact industry, then create technology demonstration projects in PFI before launching a new firm and pursuing SBIR and STTR funding.

Workforce Development

There are several ways in which NSF SBIR and STTR awards contribute to the development of an advanced workforce for the entire research enterprise. Firms may take advantage of the many supplements available to all NSF investigators through short-term training activities such as the Research Experiences for Undergraduates (REU), Research Experiences for Teachers (RET), Research Assistance Supplements for High School Students (RAHSS), INTERN, a graduate student supplement, and the Veterans Research Supplement (VRS) program. These NSF programs have had tremendous impacts beyond technical and economic development. They support future researchers, engineers, entrepreneurs, and educators in STEM fields as well.

Professional development of students through research experiences in a fast-paced entrepreneurial setting is an important part of NSF's SBIR and STTR programs. Undergraduates typically work ten weeks in the summer and receive an average stipend of $8,000. Throughout

NSF, REU is a critical program to creating the next generation of STEM professionals, and REU slots are hotly competed for by students.

The RAHSS program is designed to foster both opportunity and interest in science and engineering among female and minority high school students. The program provides an opportunity to work on scientific and engineering projects, and we hope fosters these students' interest in pursuing science, technology, and engineering studies in college. This program is unique to NSF and is only one element of our broader support of inclusion.

NSF remains deeply committed to providing access for all the nation's communities to participate in the economic and industrial transformation offered by technology translation opportunities. NSF's inclusion initiative built on the three pillars of affinity, community, and opportunity. NSF partners with affinity groups, such as groups focused on underrepresented STEM students, to identify young scientists and engineers interested in understanding the potential impact of their technologies. By creating models for shared leadership between the affinity group and the I-Corps community to jointly provide experiential learning opportunities, NSF accelerates the process by which enterprising researchers throughout the country learn about innovation opportunities.

The RET program brings high school teachers and community college professors to work at a small business in SBIR/STTR-funded research projects. They can then bring their experiences in engineering and technological innovation into their classrooms, and ultimately to their students.

Another supplement, INTERN, is designed to prepare highly trained graduate students for the workforce by funding a six-month internship in a non-academic setting, such as in industry, a government laboratory, or a policy think tank. INTERN provides up to $55,000 for a graduate student to work with a non-academic mentor in one of these settings.

The Veterans Research Supplement (VRS) is another supplement opportunity that NSF offers to engage former service members in the research enterprise. NSF offers up to $10,000 to awardees to engage veterans who are full- or part-time students or even serving as STEM teachers or faculty.

Together these programs enhance the capabilities of students and teachers, and synergistically foster an interest in technical innovation, engineering, and entrepreneurship in the broader community.

Comments on H.R. 4033

NSF appreciates the attention of the Congress and this Committee to these important programs and efforts to improve the opportunities for startups and small businesses to successfully enter

the marketplace. While the Administration has not taken a position on H.R. 4033, *The Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021*, let me provide here some comments on those parts of the legislation that relate most directly to NSF.

First, allow me to start with an overview of the role of these programs. The SBIR and STTR programs, now several decades old, are central to the health of our nation's economy. Startups and small businesses create jobs for Americans. Plus, companies with roots in science and engineering – and with intellectual property – present opportunity for unusually high economic and social impact. Unfortunately, the changing investment landscape makes it difficult for startups or small businesses founded around disruptive technical innovations to attract private capital. Therefore, SBIR and STTR fill a significant gap by enabling firms with significant potential to grow, addressing both technical and economic risks as they become ready for the private markets.

Sections 4 and 5 of the legislation instruct the Administrator of the Small Business Administration to ensure that, in selecting small businesses to participate in SBIR or STTR programs, federal agencies give high priority to small manufacturing companies and business concerns engaged or planning to engage in manufacturing R&D, and small business concerns that are engaged in cybersecurity, respectively. The NSF SBIR/STTR programs fund a broad set of technologies. For example, in the manufacturing space alone, we support advanced manufacturing, advanced materials, new chemical technologies, the Internet of things, nanotechnology, photonics, instrumentation and hardware systems, robotics, semiconductors, space technologies, and wireless systems. And in the cybersecurity space, we support work that spans artificial intelligence, cryptography, quantum information technologies, and distributed ledgers, among other areas.

All of these areas represent innovations important to current and future economic growth. NSF appreciates the flexibilities provided by the current authorities, which allow NSF to support activities to strengthen the nation's innovation ecosystem across all areas of research and education supported by the Foundation.

Section 6 of the legislation stipulates the issuance of Phase III awards to SBIR and STTR award recipients that developed the technology as direct follow-on awards without further competition. As mentioned earlier, NSF's Phase IIB program helps bridge the gap in funding between Phase II and ultimate commercialization. A Phase IIB Supplement of up to $500,000 is available for small businesses able to attract third-party investment. NSF has found that awardee companies that qualify for Phase IIB successfully commercialize their innovations and that the NSF funding is critical in helping these firms address the remaining technical and market risk. Many Phase IIB

firms have grown in both revenue and employment and are even ready for acquisition by larger firms.

Sec. 7 of the legislation requires increased outreach efforts to Historically Black Colleges and Universities (HBCUs) and Hispanic-Serving Institutions (HSIs). As part of the inclusion initiative described earlier, NSF has multiple outreach efforts focused on underrepresented communities in STEM. These include Accelerating Women And under-Represented Entrepreneurs (AWARE), a set of awards to recruit, educate, and retain underrepresented groups in entrepreneurship; Culturally Relevant Enterprise Development (CRED), consisting of short courses piloted with the Native American/Alaska Native (NA/AN) communities to develop entrepreneurial skills and new ventures aligned with their communities' needs and priorities; Innovative Postdoctoral Entrepreneurial Research Fellowship (I-PERF), a partnership with the American Society of Engineering Education (ASEE) to provide scientists and engineers underrepresented in innovation and entrepreneurship with postdoctoral fellowships in startups; and women's networking sessions at all SBIR/STTR Phase I workshops. These programs complement other NSF broadening participation programs to recruit and retain all STEM communities.

With respect to Section 9, NSF has many programs that address commercialization readiness and foster innovation and technology transfer. We are continually reevaluating these programs for effectiveness with then inputs of NSF Advisory Committees and Committees of Visitors, which aim to review each of NSF's programs, including SBIR and STTR, at regular intervals.

Section 12 expands SBIR Phase flexibility to NSF, which would allow us to consider new approaches to supporting a wide variety of entrepreneurs and innovators at various stages and across many industries.

Section 13 makes the administrative funding pilot permanent, which would allow us to continue to utilize this flexibility to continue our important efforts to improve the commercialization outcomes of our program, attract new and high-potential applicants to the program, and increase the participation of underrepresented groups and geographies in the program.

Section 15 calls for the extension of the commercialization assistance pilot program. NSF has in place multiple programs that accomplish the objectives of this pilot program. For example, NSF provides supplemental funding to grantees through its Technology Enhancement for Commercial Partnerships (TECP) program. The TECP supplement is intended to pave the way for partnerships with strategic corporate partners and investors as a means to increase the potential for the SBIR-STTR awardees to successfully commercialize their technology. The supplemental funding allows the small business to conduct additional research needed to meet the needs of a

corporate partner or customer that will consume the commercial outcome. The TECP supplement can be up to 20% of the original Phase II award for a maximum TECP supplement of $200,000.

Finally, NSF provides additional funding to small businesses through its Phase IIB matching funds program as described above. It has been our experience that almost all of the major commercial successes to come out of our program have required substantial follow-on funding from angel investors, venture capitalists, corporate partners to reach their ambitious goals, and the Phase IIB program ensures that awardee firms focus on preparing for the transition to the next stage of funding.

Conclusion

For over 40 years, NSF has helped startups and small businesses across the country transform their ideas into marketable products and services through our SBIR and STTR programs – programs that, without Congressional action, will expire at the end of the fiscal year.

NSF focuses on high-risk, high-impact technologies in startups – those teams and technologies that show promise but whose success hasn't yet been validated. Our goals are to foster innovation and spur businesses and job creation in the United States. Between fiscal years 2016 and 2020, America's Seed Fund powered by NSF made over 2,200 awards to startups and small businesses. During approximately the same period, fiscal years 2016 through 2021, the NSF-funded startups and small businesses (including those funded prior to 2016) portfolio subsequently raised more than $14 billion in private investments. Furthermore, an estimated 200 companies ultimately generated returns to their investors through so-called "exits," in which the awardee organization becomes a public company or undergoes a successful merger or acquisition with another company.

NSF is always assessing its performance against the broad goals of the SBIR and STTR programs, and this process has led to new supplements, new outreach, and enhancements to other NSF programs because it takes far more than the SBIR or STTR investment to translate a technical vision into a realized solution. NSF is focused on helping startups address all the potential risks – marketplace and technical risks, and even potential skills gaps – that researchers may experience in exploring the broader market. The SBIR/STTR programs anchor an extensive activity in identifying and leveraging the opportunities that new technologies offer the nation.

On behalf of the National Science Foundation, the SBIR/STTR programs and our awardees, I want to thank you for your support of NSF and for this opportunity to highlight programs that provide startups and small businesses with the means to keep America on the forefront of innovation. I would be pleased to answer any questions at this time.

Dr. Ben Schrag is an SBIR/STTR Program Director and Policy Liaison. He joined NSF as a Program Director in 2009, leading the Advanced Materials and Instrumentation portfolios. Prior to NSF, he was the Director of Research and Development at Micro Magnetics, where he led an effort to commercialize a new family of high-performance magnetic microsensor products. During this time, he also served as a visiting scientist at Brown University. Ben received his Ph.D. in Physics from Brown University.

Chairwoman STEVENS. Great. With that, we're going to hear from Dr. Feldman. We've got to unmute you. There we go.

TESTIMONY OF DR. MARYANN FELDMAN,
S.K. HENINGER DISTINGUISHED PROFESSOR
OF PUBLIC POLICY, DEPARTMENT OF PUBLIC POLICY;
PROFESSOR OF FINANCE,
KENAN-FLAGLER BUSINESS SCHOOL;
RESEARCH DIRECTOR, KENAN INSTITUTE
OF PRIVATE ENTERPRISE;
THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

Dr. FELDMAN. Great, very good. Well, thank you for inviting me to address the Committee today. I'm honored to have this opportunity to talk about my research. I realize I've spent my career studying innovation, and the SBIR/STTR programs have been very important to the American system of innovation. It has been my pleasure to serve as the Co-Chair for the National Academies' assessment of the programs, and we've organized a dream team of scholars to look at this program. And overall, we find that the programs are effective public-private partnerships, and they play an important role in the commercialization of science and in sparking the American innovation economy. The programs have been successful on a variety of different measures, and they deserve your continued support.

Now, these programs are so important to local innovative ecosystems that virtually every State has initiated programs to help win SBIR awards, and half of U.S. States provide matching funds that top off the SBIR award. But this program does much more than simply provide money. They also provide the context for developing cutting-edge technology for connecting small firms to one another, connecting them to universities, and to Federal agencies and labs.

In each of our reports, we found that the programs are effective in stimulating small business research and experimentation and innovation. For DOE, our committee found that SBIR contributes to the agencies' R&D needs and advances the national energy system. But, importantly, we found that these awards have significant technological spillovers, and that means that firms that are located in the same State actually benefit greatly when an award is given to one firm. So these are very extensive benefits.

For NIH, we've found that the program really is conducting such rigorous and commercially relevant research that contributes to U.S. leadership in the life sciences. And so in fact from 1996 to 2020, 12 percent of new drug approvals and 18 percent of orphan drug approvals were associated with SBIR/STTR awardees.

But each of our reports recommends ways the programs might be improved to improve commercialization, and I want to highlight some of these. For NIH, there's a need to reduce the timeframes used for reviewing and selecting awardees while emphasizing more on the commercial potential. And here's where Congress could act to remove the requirement that applicants are subject to the same identical scientific review as the more basic projects.

We also would encourage DOE to allow their technical and business assistance, that is TABA funding, to be used to hire in-house

experts. What we've found is that DOE firms are staffed with managers with technological expertise, but they lack management expertise that allow them to pursue and grow their companies strategically.

As far as participation by women and socially/economic disadvantaged people, what we find is that the programs could be improved, and this is specifically greater outreach to minority-serving institutions. DOE has a pipeline problem as there are fewer women and minorities in technical fields. For NIH, there are a large number of women and minorities, but their participation has not improved over time. And for both programs, you could work with the HBCUs. (historically Black colleges and universities) They're an untapped resource. Collaborations between HBCUs and small businesses are rare, and their faculty are not selected as reviewers. Now, there's also the time lags associated with getting an award, which more adversely affect women and minorities because they're less likely to get money from the private sector.

I want to address this question of mills. And so while we have many proposals to limit the amount of awards, let me just say that complex innovation requires multiple and reinforcing awards. And I've done research with my students looking at this multiple-award-recipient problem. And the firms are very actively engaged in patenting. I would caution you in trying to ferret out waste, fraud, and abuse, that we don't want to adversely affect incentives and distort the overall functioning of the innovation system.

You know, periodic evaluations that we do are great, and they can improve the operations of the program, but here's where we could use your help to ensure that the appropriate data are collected and available. For example, in the NIH assessment by the National Academies there are rigorous evaluations of the proposals, but this information is not available in all our congressionally mandated studies.

I've been trying to talk more like a New Yorker and less like a Southerner, but let me just conclude by saying over the past 40 years these programs have played a critical role in advancing the U.S. innovative ecosystem, and they have really helped small businesses contribute to U.S. competitiveness. Thank you for this opportunity.

[The prepared statement of Dr. Feldman follows:]

Statement of

Dr. Maryann Feldman
Heninger Distinguished Professor, Department of Public Policy;
Professor of Finance, Kenan-Flagler Business School; and
Research Director, UNC Kenan Institute of Private Enterprise
at the
University of North Carolina at Chapel Hill

and

Co-chair, Committee on the Review of the Small Business Innovation Research and
Small Business Technology Transfer Programs at the Department of Energy;
Co-chair, Committee on the Assessment of the SBIR and STTR Programs at NIH; and
Co-chair, Committee on the Review of the Small Business Innovation Research and
Small Business Technology Transfer Programs at the National Science Foundation
at
The National Academies of Sciences, Engineering, and Medicine

before the
Committee on Science, Space, and Technology
Subcommittee on Research and Technology
United States House of Representatives

April 6, 2022

Chairwoman Stevens, Ranking Member Feenstra, Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, thank you very much for inviting me to testify at this hearing.

I am the Heninger Distinguished Professor in the Department of Public Policy at the University of North Carolina, a Professor of Finance at Kenan-Flagler Business School and a Research Director at UNC Kenan Institute of Private Enterprise. I am appearing today in part as an expert in innovation and a scholar of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, and in part because of my role as the co-chair of several assessments of the programs that are either completed or underway at the National Academies of Sciences, Engineering, and Medicine. The National Academies assessments include two completed reports: an assessment of the DOE programs which was completed in 2020, and an assessment of NIH's programs, which was released earlier this year. The assessment of NSF's programs is underway. Additional evaluations are planned for NASA and DOD.

I will make my best effort to differentiate between comments and recommendations today that are my own, and those that reflect consensus findings and recommendations of those National Academies assessments. For a full description of the findings and recommendations in the National Academies assessments, I would refer the committee to those reports, which are available via the National Academies Press at www.nap.edu.

It is my opinion that overall, the SBIR and STTR programs demonstrate that effective public-private partnerships play an important role in promoting the commercialization of science and leveraging America's innovation economy. The programs have been extremely successful on a variety of measures and deserve Congress's continued and enthusiastic support.

Let me begin by discussing the role that SBIR and STTR play in the U.S. innovation system. In each of our released National Academies' reports, the study committees found that the programs were effective at funding small businesses that provide and stimulate research, experimentation, and innovation in the energy and health sciences sectors.

For DOE, our committee found that the programs contribute to DOE's R&D needs and advance the national energy innovation system. We found that some awarded firms have achieved significant commercialization outcomes; however, there has not been large-scale commercialization on a systemic basis by the awardees. This may be due to a lack of follow-on private sector investment.

At the same time because the vast majority of DOE awards are in response to targeted solicitations for particular technologies, we were able to assess the broader

impact of the programs on other firms in the energy innovation system, finding significant technological spillovers -- especially to nearby firms located in the same state and region.

Similarly, our study committee looking at the NIH SBIR and STTR programs found that they provide funds for U.S. small business to conduct rigorous and commercially relevant life sciences biomedical research and innovation, contributing to US leadership in life sciences innovation. Awarded firms have produced a significant number of new drugs and devices. In fact, 12 percent of new drugs and 18 percent of orphan drugs approved from 1996 to 2020 are associated with NIH SBIR/STTR awardees. However, because of data constraints, our committee was unable to establish that the receipt of NIH SBIR/STTR funding was responsible for these outcomes. NIH selected high quality firms, and other funding (from both the public and the private sectors) is available from the vibrant biomedical ecosystem. Awarded firms may have achieved the same outcomes even in the absence of NIH SBIR/STTR awards. In the NIH report, the committee noted that a significant number of awards go to firms that are new to the programs and in the first few years of their existence. The SBIR program often provides first funding.

The program has been relabeled as "America's Seed Fund." It is my personal belief that this label is misplaced as it limits the program to simply addressing a capital constraint. SBIR also provides a context for developing cutting edge technology, connecting small firms to federal agencies that can make further introductions. Most DOE SBIR/STTR awardees receive their first awards in the early years of their existence and in some cases the program provides the impetus for the formation of the firm.

Let me address the issue of SBIR "mills" – a pejorative term that implies that a significant number of awards go to a small number of small businesses who are dependent on government funding for their entire lifespan and do not end up commercializing anything. There is no generally accepted definition of what qualified a firm to be a "mill," but there is a perception that the number of awards should be limited. Here it is important to remember that innovation is complex and often requires multiple, reinforcing inventions and projects. This is especially true for energy innovation and biomedical innovation, which require a great deal of funding support and a long-time horizon to achieve commercial success.

In the DOE report, our committee noted that there are a small number of firms that receive significant awards, but these firms are often supplying specialized equipment (primarily for the national labs) where there is not a large commercial market. In the NIH report, we found that the outcomes are much higher for the firms who win the largest number of awards.

My own research on multiple award recipients indicates that firms at the extreme tail of the distribution defy this label – they patent extensively, sell commercial products and engage in government procurement. Often overlooked in discussing the "mills" is the fact that awards are made to specific Principal Investigators, who go on to start new firms or join other companies, both large and small, or go on to academic jobs. Applying for an SBIR award requires familiarity with the program; firms that win multiple awards function as incubators for human capital and ideas.

As part of its charge, each of these National Academies' reports has recommended ways that the programs could be improved to increase commercialization of federally funded research, and I will highlight some of those now.

In the case of NIH, although the combined NIH SBIR/STTR budget is over $1 billion per year, each institute or center operates as a smaller life sciences program. There is significant variation across the institutes with its own approach to outreach, selection, and support of awardees and applicants.

- Commercialization outcomes would be significantly improved by adopting processes and procedures that reduce the time frames that NIH uses for reviewing and selecting awardees, and by placing more emphasis on the commercial potential and the steps needed to achieve a technology's commercial potential expertise. These would include making sure that reviewers and staff have adequate experience with the needs of innovative small businesses. Improvements along this dimension are likely to need action by Congress to remove the requirement that SBIR applications are subject to the identical scientific review as academic and more basic projects.
- There are other needed commercialization improvements. Our committee found that many of the commercialization programs offered within NIH for SBIR/STTR awardees are duplicative and fragmented across the institutes and centers, as well as duplicating programs offered by regional and local life sciences incubators and accelerators. Focusing on building bridges to the national and local biotech ecosystem would be better than duplicating the resources that are already available.
- Additionally, in the DOE report, the committee noted that the technical and business assistance is required to be subcontracted to outside vendors in order to receive the congressionally allotted funds – a requirement that may be detrimental to commercialization and business development of the firm. The vast majority of DOE SBIR/STTR funded small businesses are founded by the technical expert, and the management structure is heavily weighted toward technical – rather than business – expertise. Allowing firms to use TABA funds for in-house expertise would encourage a more diversified top management, and such diversity is associated with more growth potential among small firms.

Research has found that the SBIR program serves to certify that firms are high quality and deserving of further investment. The program is important to seeing local entrepreneurial ecosystems. The program is so important that virtually every state has initiated programs to help firms win SBIR awards and half of states provide matching funds to top off SBIR awards and further incentivize firms.

As far as achieving their goal to foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons, in both DOE and NIH, the committee found that the programs could be significantly improved by better outreach, especially to minority-serving institutions. DOE's progress may be constrained by a shortage of women and minorities in the relevant fields: for example, the vast majority of electrical engineers are white men. Diversity of the pipeline, including improving the diversity of employment at the national labs, may be needed to help improve the diversity of applicants and awardees in DOE's SBIR and STTR programs. The bulk of DOE's SBIR/STTR reviewers come from either national labs or universities, and there is a lack of gender and racial diversity in those institutions.

However, pipeline issues are likely not the cause of NIH's lack of progress on this goal. More than half of PhDs in biology are awarded to women. Notably, although a significant share of historically black colleges and universities have medical schools, collaborations between these institutions and small businesses are rare. While NIH has made significant improvements in the share of abstracts and awards addressing health issues for women and minorities, the share of applications and awards to businesses owned by women or underrepresented minorities has not improved in the last 20 years.

Women and minorities may be facing funding constraints that white male business owners do not, and those constraints are compounded by long processes for selecting and awarding applicants. Additional funding does not seem to improve the situation for NIH – additional funding supplied by the Recovery Act led to an increase in acceptance rates for small businesses owned by men, not women. And the larger institutes and centers at NIH do not have higher application or award rates for women and minorities.

I would like to say something about the lack of available data to assess the SBIR and STTR programs' successes and/or challenges. Assessments of how the programs are doing is difficult to do without information on potential awardees, such as those who apply to the program but are not selected or how peer review scores affect the selection of awardees. Periodic assessment of the programs is important, and Congress needs to ensure that the appropriate data are collected and available to perform these assessments. Otherwise, there is little information about whether changes in processes and procedures have led to the desired outcomes.

NIH's RePORTER and PubMed databases have improved our ability to evaluate NIH funding, but significant improvements are needed to the collection and reporting of

this information. And the only information on DOE's awardees was available from the Small Business Administration. We were able to identify significant gaps and errors in the Small Business Administration's public database on SBIR and STTR awards by comparing it to the RePORTER database, but a comprehensive database of DOE awards is not available. Significant improvements in the collection and reporting of data would improve our ability to perform such assessments.

Additionally, I would like to note that we only have information on small business partnerships with research institutions for STTR awardees, not for SBIR awardees. It is likely that a significant amount of federally funded university research is associated with SBIR awards, but we have little information on this topic. Conversations with university tech transfer experts indicate that universities use both SBIR and STTR programs. Because the pool of money is larger for SBIR, it is likely that this program is more attractive to university researchers. Additionally, during both the DOE and NIH assessments, our committee members interviewed program managers in all parts of the organizations, and program managers did not indicate a separate use for SBIR versus STTR. The distinction between these programs seems to be artificial.

At the same time, the agencies have to allocate different amounts of money to each of the different programs and each part of each organization. Which means that for some parts of DOE and NIH, an institute or office may be unable to offer Phase II STTR awards. Congressional action is needed to allow agencies more flexibility within SBIR and STTR, or across the different institutes or offices, which could improve the outcomes from the programs. In both DOE and NIH, because the funding is a fixed percentage of extramural research and development, there is little incentive for the agency to allocate awards to advance its broader missions, rather than the needs of a particular office or institute.

In conclusion, we know that over the past 40 years, these programs have played a critical role in advancing the innovation ecosystem and have helped small businesses contribute significantly to U.S. competitiveness. Many people want to talk about return on investment, but when dealing with innovative small businesses, we must recognize that there will be many failures but also a few "home runs" that essentially pay for the whole program. Innovative outcomes are skewed with a few billion-dollar valuations. Many small firms fail, but people and their ideas recirculate to make the innovation system more vibrant.

Thank you for the opportunity to testify. I look forward to the opportunity to address your questions.

Dr. Maryann P. Feldman is the Heninger Distinguished Professor in the Department of Public Policy and Professor of Finance at the Kenan Flagler Business School at the University of North Carolina. Her research and teaching interests focus on the areas of innovation, the commercialization of academic research, and the factors that promote technological change and economic growth. From 2014 to 2017, Dr. Feldman held a joint appointment at the National Science Foundation as the Science of Science and Innovation Policy (SciSIP) Program Director. Dr. Feldman's early work revealed that universities were necessary, but not sufficient, for technology-based economic development. These findings launched a new area of investigation into university technology transfer. She has written extensively on processes and mechanisms to commercialize academic research, areas germane to the SBIR/STTR programs. She co-chaired the National Academies of Sciences, Engineering, and Medicine's recent assessments of the SBIR/STTR programs at DOE and NIH, and she is currently co-chairing the on-going assessment of SBIR/STTR at NSF. She earned her Ph.D. in economics and management from Carnegie Mellon University.

Chairwoman STEVENS. Nice. That's great, thank you.

And with that, we'll hear from Mr. Caravias. We've got to unmute you. There we go.

TESTIMONY OF MR. GEORGE CARAVIAS,
CHIEF EXECUTIVE OFFICER, GEOFABRICA INC.

Mr. CARAVIAS. Well, there we go. OK. Thank you, Chairwoman Stevens, Ranking Member Feenstra, and Members of the Subcommittee on Research and Technology. It is an honor and a privilege to join you today to testify on the SBIR and STTR programs. My name is George Caravias. I am the Chief Executive Officer of Geofabrica, Inc., a small technology business based in Michigan that develops and builds manufacturing systems.

Before I begin, allow me to tell you how highly I regard the SBIR and STTR programs. They are gems among government programs for small businesses. I appreciate all that you do to make them possible. So on behalf of Geofabrica and the many other SBIR/STTR awardees, I thank you.

Geofabrica is known for its work in additive manufacturing, otherwise known as 3-D printing. We're currently pursuing two major efforts. One is the development of an expeditionary manufacturing systems, transportable 3-D printers that can operate at forward operating bases, at disaster sites, and on ships and trucks. We're also pioneering large-scale additive manufacturing. That involves making 3-D printers to build parts that are as large or larger than the chairs and desks that you are sitting at today. We've performed many phase I and phase II SBIRs and are in the midst of completing a phase III SBIR funded by one of the suppliers to the DOD.

The following is an abbreviated list of my recommendations for these programs. First, I suggest creating incentives to buy and use the prototypes resulting from the R&D. I suggest that SBIR/STTR programs create incentives for Federal agencies, DOD program offices, and large corporations to buy and use the beta prototypes resulting from phase II efforts. Built-in beta users would go a long way to helping firms overcome the valley of death at the end of an SBIR or STTR.

Two, accelerate the pace of SBIR/STTR project development. These projects take 4 to 6 years from conception to commercialization. Six years is an eternity in terms of technology lifecycles. Six years is too long to wait for a solution. In 6 years, too many market opportunities have vanished.

Three, opportunities should be expanded for open-topic calls. The Air Force and the NSF have increasingly solicited very open or very broad topic calls. I believe this is a good trend that should be encouraged across all agencies.

Four, expand access to companies owned by women and socially or economically disadvantaged persons. I applaud the efforts of this Committee to foster SBIR/STTR participation by women and socially or economically disadvantaged persons.

And fifth, I encourage innovation in manufacturing. I strongly support the act's language encouraging manufacturing innovation and prioritization of manufacturing in the United States. Support for manufacturing innovation should be expanded across all agen-

cies. Federal funding should give high priorities to companies demonstrating a commitment to building products in the United States.

Small businesses are at the heart of our economy and are vital participants in our rich culture of innovation. Small companies are nimble, innovative, and willing to make bold moves to commercialize new technologies. The SBIR/STTR programs are one of the better ways of supporting small business technologists across a range of geography, demographics, and experience levels. I thank you again for your work and for your continued support of the SBIR and STTR programs. I will be pleased to answer any questions you may have.

[The prepared statement of Mr. Caravias follows:]

Testimony of

Mr. George D. Caravias
Chief Executive Officer
Geofabrica Inc.

Before the

U.S. House of Representatives
Committee on Science, Space and Technology
Subcommittee on Research and Technology

SBIR Turns 40: Evaluating Support for Small Business Innovation

April 6th, 2022

Introduction

Chairwoman Stevens, Ranking Member Feenstra, and members of the House Committee on Science, Space, and Technology, Subcommittee on Research and Technology:

It is an honor and a privilege to join you today to testify regarding the Small Business Innovation Research (SBIR) program's and Small Business Technology Transfer (STTR) program's role in translating Federally funded research into commercial development, in generating new economic growth, and in assisting federal science agencies in meeting their respective missions.

My name is George D. Caravias. I am the Chief Executive Officer, one of the founders, and an owner of Geofabrica Inc., a small technology business based in Michigan that develops and builds manufacturing systems.

I will first briefly describe Geofabrica for context and will provide an overview of my experience with SBIR awards. I will then offer some observations and recommendations for improvements to the SBIR and STTR Programs. Finally, I will comment on *Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2021*. All my comments will be from my perspective as a small business owner and recipient of SBIR awards.

Before I begin, allow me to tell you how highly I regard the SBIR and STTR programs. They are a gem among government programs for small businesses in our country. These programs support new business creation and help make small technology businesses successful. They create high-paying jobs, and deliver new technologies that help accomplish government agency missions. They make important, and sometimes essential, contributions to the sustainability, economic prosperity, and quality of life in the United States.

The Government program managers, contract officers, management, and support staff are accomplished professionals. They are driven to support their agencies' missions, and they work hard to get results. Behind them are all of you. Legislators, advisors, and Government professionals that make these marvelous programs possible. So, on behalf of Geofabrica, and I believe also on behalf of the many small company beneficiaries of SBIR and STTR awards, I thank you.

Geofabrica Inc.

I often introduce Geofabrica by explaining that customers come to us saying, "*I've designed this widget. Can you build me a machine that will manufacture the widget faster, cheaper, lighter, on a ship, on a ship in high seas, or in the battlefield*?" Our staff of 31 engineers, scientists, technicians, and business professionals are good at inventing and delivering new manufacturing technologies. I would say we are *really* good. I can't tell you how proud I am to work with each and every one of our talented staff.

Geofabrica has a small but distinguished reputation for its work in additive manufacturing, otherwise known as 3D printing. We have built 3D printers to make plastic, metal, and more recently composite material parts. Geofabrica's team is currently pursuing two major development efforts. One is the creation of expeditionary manufacturing systems – that is, transportable 3D printers and similar systems that can operate at military forward operating bases, at disaster sites, and on mobile platforms like ships and trucks. We are also pioneering large-scale additive manufacturing technology. That involves making 3D printing systems that can build big parts; parts that are as large or larger than the chairs and desks you are sitting at today.

Geofabrica has successfully completed multiple Phase I and Phase II SBIRs and is completing a Phase III SBIR to deliver a device for sealing sensitive electronics to a supplier to the U.S. Department of Defense. We are also finalizing a Rapid Innovation Fund project. "RIF" projects help companies transition SBIR-stage R&D to program-ready systems for DOD agencies. Our RIF project involved adapting 3D printing technology to reduce the time and the cost of fabricating metal replacement parts for legacy weapons systems sustainment.

Experience with the SBIR Program

Geofabrica would not have undertaken a fraction of its technology development if it were not for the SBIR and STTR programs. It is hard for a small company to access the funding for building new technologies, particularly if the development involves risk. Small company profits and overhead do not provide enough funding for major R&D initiatives.

Venture and growth capital is plentiful in the United States, but it is difficult to raise outside of the technology centers like the California Bay Area or Cambridge, Massachusetts. It is not often available for focused development of one aspect of a company's technology or for Federal agency-specific product R&D. Venture capital for technology development is also expensive. By that I mean that investors demand large ownership interests in small companies in exchange for their funding. Further, institutional and private investors are unforgiving. If the technology development is delayed or unsuccessful, the small company seldom gets a second chance and sometimes goes out of business. That dynamic creates disincentives for small companies to undertake high-risk projects, or create technologies tailored to government applications.

SBIRs and STTRs fill this gap. Funding is awarded to companies across all regions of the United States. Support is available for high-risk/high-reward R&D, and if successful, SBIRs offer a pathway to an initial customer. These programs create nation-wide economic development.

That is not to say that it is easy to win an SBIR or STTR award. I wrote at least 8 unsuccessful applications before being awarded our first SBIR project, and I began as an experienced proposal writer that had won multimillion-dollar commercial projects prior to my first SBIR submission. I suspect that inexperienced technology entrepreneurs, especially those staffed by socially or economically disadvantaged persons, struggle to find the formula for writing successful proposals.

Proposals require a lot of work. We spend hundreds of hours crafting each submission. Many members of our company contribute to our proposals, and our senior management is very involved. That does not include the time and cost of meeting with agency representatives to understand technology directions, or the time working on proposals that are never submitted. Even a company that is very good at writing proposals will probably only be awarded 20% of its Phase I SBIR/STTR submissions. In total, that represents a high investment for a small company like Geofabrica. Small companies also face a significant opportunity cost in dedicating resources to SBIR/STTR proposals.

Every R&D effort is different, and Phase I projects allocate funding differently to Phase II efforts. But in rough numbers, the money we receive from SBIRs is spent as follows:

- About 45% of the funding goes toward the salaries of the engineers and scientists working on the project. Effective R&D is not the product of a lone brilliant scientist. It is the result of a well-coordinated team in which men and women, each with different skills, contribute to the evolution of a concept. Every team member at Geofabrica plays an important role, from our Chief Technology Officer who has a Ph.D. in Physics and over 20 years of experience in developing and commercializing technology products, to one of our welding specialists whose career is based on vocational training and on-the-job experience. It is difficult to form these teams. Not only must small companies find talented staff, but they must help the team learn to work together efficiently.
- About 10% of the money is used for materials and supplies.

- 0-5% is used to buy equipment. In general, established small businesses have the equipment needed to perform SBIR R&D, but startups and companies with limited resources are more likely than not to need equipment. Money that is spent on equipment reduces the funding that is available for staff. That places more pressure on efficient project execution, which is hard, especially for inexperienced teams.
- 10% to 35% of the funding is spent to subcontract project partners. Small companies rarely have the expertise to perform all aspects of a development. Subcontracted partners are often other small businesses, which means that one SBIR award can benefit multiple small businesses. Subcontractors, of course, are universities in the case of STTRs. While Geofabrica has never received an STTR award, I think they are excellent mechanisms for transitioning academic R&D into viable commercial products. Finally, subcontractors can be large companies. This arrangement is effective when the large company is a potential first user of the new technology and helps to guide the development towards high-priority needs.
- About 25% is used for indirect costs such as rent, utilities, and insurance.
- 5% to 8% of the award goes to the company as fees. I suspect that fees or profits are often misunderstood within government agencies, and I'm surprised by the number of funding instruments that prohibit profits. Lack of profits wreck small company financials and make it difficult or impossible to get bank loans. The small company entrepreneurs I know do not pay themselves large bonuses or use profits for frivolous expenditures. For the most part, profits are important contributions to companies used to:
  - Create a cushion of funds to cover cash flow (money that is used to pay for a company's expenses before collecting payments from a customer.)
  - Pay for patents and unallowable costs.
  - Establish savings for a rainy day; for instance, to pay for salaries, rent, and utilities during a Covid shutdown, when revenue from customers slows to a trickle.

Some states provide matching funds to SBIR and STTR awards. These are good programs that amplify the benefits of SBIRs and STTRs. I recommend that Federal programs encourage their expansion. These matching funds help pay for websites, trade shows, legal costs associated with initial customer contracts, product certification, and a host of product launch costs. I also recommend that states limit the restrictions on the use of these funds. Technologies and applications vary widely, and it is simply too difficult for government programs to regulate the best use of matching funds.

RECOMMENDATION: Structure SBIR/STTR programs to involve end users from the start

In my experience, successful SBIR projects are those that have a clear vision of a market need, and those in which customers or end users are engaged in the project from the start. Engineers and scientists are inherently problem solvers, but they seldom understand issues facing users in the field. Geofabrica's staff is inventive and good at finding ways to make 3D printers work in freezing, dusty, or humid conditions. But our engineers do not know what replacement parts a US Marine infantryman will need for a Humvee after a firefight. We know how to protect a 3D printer from power fluctuations, but we have very little information about the performance of electric generators at military forward operating bases.

Some agencies have begun requiring user commitments a prerequisite to funding an SBIR. But they put the onus of securing a letter of support on the small business. I believe this is a mistake that causes many good development efforts to be missed. Small technology firms seldom have the necessary access to end users. Not having connections with government program offices has nothing to do with small company's abilities in technology. This is particularly true for the small companies in locations that are far from government facilities or industrial centers.

The responsibility for engaging end users and solving agency needs should lie with the Government SBIR/STTR program managers that create and manage the topics. Program managers should certainly welcome unanticipated ideas and end user partners brought forward in the proposal processes. But SBIR projects are best framed as initiatives to create a tool in response to a need. An SBIR government program manager's primary responsibility should be ensuring that an end user's need is met as thoroughly and as quickly as possible. Valuable SBIR funds are wasted while small businesses guess at program office requirements, agency intent, or customer priorities.

RECOMMENDATION: Create incentives for agencies and large users to buy and use SBIR/STTR prototypes

I also recommend that SBIR/STTR programs should establish incentives, funding, and possibly minimum requirements for federal agencies, DoD program offices, and large corporations to buy and use the beta products that result from SBIR/STTR Phase II efforts. It is difficult to convey how hard it is for a small company to bring a product to market. Built-in beta users would go a long way to helping firms overcome the "Valley of Death" at the end of an SBIR or STTR.

Fewer product launch failures mean more effective use of Federal funding, more economic development across the United States, and more rapid advancement of Federal agency missions.

Beta customers are invaluable. They help their small businesses refine their minimum viable products into mature products that reliably deliver value to end users and they provide reference sites for other customers. Beta products also benefit federal agencies. These early versions of products allow agencies to access new technology directions. I recently met with a program office that told us they would not consider any additive manufacturing equipment until the need was written into their acquisition requirements. In my view, that is the wrong time to begin learning about a potentially valuable new technology. End users need to experiment with new technologies before making major investments. I suspect that federal agencies, program offices, and large corporations would welcome buying and using SBIR/STTR prototypes – particularly if they have had a hand in guiding the development from the start of the project.

RECOMMENDATION: Accelerate the pace of SBIR/STTR project development

In the case of many agencies, SBIR/STTR proposal opportunities are only open a few times per year. Most Funding Opportunity Announcements or Broad Agency Announcements have 2-month prerelease/release cycles. Application evaluation, selection and contracting requires a subsequent 6 months, in preparation for a 6 to 9-month Phase I project. After completing Phase I, small businesses often wait for another 6 months to learn whether a Phase II project is awarded and placed under contract. Phase II efforts are scheduled over 18 to 24-months. That totals 3 to 4 years from the identification of a need to the introduction of a minimum viable product. When time is added for Government development of the SBIR/STTR topic concept, and the company's maturation of the product after the Phase II, the period stretches to 6 years or more. 6 years is an eternity in terms of technology lifecycles. 6 years is far too long for a user to wait for a solution. In 6 years, many market opportunities have vanished.

Direct-to-Phase II projects are one good way to address this issue. I encourage their expanded use across all agencies. I realize that the Phase I / Phase II structure creates an opportunity for exploring solutions from a variety of firms, and the opportunity to down-select to the most promising technology, so I do not advocate abandoning this approach. However, there

are many cases in which getting a solution to market quickly through the Direct to Phase II authority outweighs the advantages of a more careful, competitive process.

RECOMMENDATION: Avoid funding interruptions and funding uncertainty

Funding interruptions are incredibly problematic for small companies. You can't put a team on a shelf while waiting for funding. Small companies do not have the resources to pay for staff that do not bring in revenue. Businesses therefore assign staff to other projects when SBIR/STTR funding stops, or in extreme cases, they must lay off staff. It is difficult to reassemble teams for a follow-on phase of a project, particularly when the unfunded period is long. New teams must therefore be formed, and these staff members require time to become acquainted with the project, reducing resources for the R&D.

Funding uncertainty is also problematic. New technology development resources are golden opportunities for small technology companies. They therefore assign their most talented staff to SBIR/STTR projects. If funding to finish a development becomes uncertain, it means that their best staff may be working on a dead-end effort. Small companies do not have a lot of room for error. So, they must continually optimize the use of their scarce resources. If there is uncertainty about whether a follow-on phase or option will be exercised, companies tend to commit fewer of their most talented staff to the current phase of an SBIR or STTR, potentially reducing the quality of the result.

RECOMMENDATION: Expand opportunities for open topic calls

The Air Force and the NSF have increasingly solicited open or very broad topic calls. I believe this is a good trend and should be encouraged across all agencies. While I do not believe open calls should supplant calls for specific agency needs, the inclusion of open calls helps capture valuable new concepts and technology solutions that might not be obvious to the agency program managers.

RECOMMENDATION: Favor high quality innovation and do not under-rate the capacity of businesses with few employees

Early in its development, Geofabrica was not selected for an SBIR project because the reviewers felt that we did not have the company size and economic resources to commercialize the result of the R&D. This was despite receiving high praise for the innovativeness and thoroughness

of our solution. The project went to a larger firm that eventually produced – in my view – a rather mundane system.

Do not prioritize the perceived strength of a larger firm over the technical quality of a small hungry startup. I assure you that good entrepreneurs are resourceful. Small companies that produce good results are also very likely to find ways to commercialize their results. Technologies can be licensed, products can be manufactured with partners, and sales agents can be hired. The purpose of SBIR/STTR programs is to stimulate technological innovation. Inferior technology has reduced technical advantage and seldom survives the ravages of the market.

In the same vein, I encourage Federal agencies to support more high-risk/high-return SBIR and STTR projects. Funding for such projects is difficult or impossible to source from commercial investors so SBIR and STTR funding may be the only opportunities small companies have to attempt bold technical advancements.

Observations and Recommendations about the Program and the Act

RECOMMENDATION: Expand the access of SBIR/STTR funding, especially to women and socially or economically disadvantaged persons

I applaud the efforts of this committee and changes in the Act to foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons. I would add that expanding the geographic diversity of SBIR/STTR awards and access to companies that have not previously received SBIR/STTR awards helps the national economy. Many capable small technology businesses operate in regions where access to development capital is extremely limited. SBIR/STTR projects may therefore be their only source of technology development funding.

It is hard to teach small companies how to write proposals or administer projects. While assistance programs such as the DOD's Discretionary Technical and Business Assistance (TABA), or DOD Phase 0 projects are a step in the right direction, I believe more could be done. I recommend that some number of awards be set aside for first-time proposal submitters and socially or economically disadvantaged persons. Give them experience performing an SBIR or STTR,

even if their proposals are not up to standard, and help them learn by doing. As part of such projects, I recommend that program managers speak with their awardees and explain what they would have preferred to have seen in the proposal, what changes they recommend to the project plan, and what factors might increase the new performer's success in continuing to subsequent phases. Government SBIR/STTR managers are close to the projects and are likely to offer project-specific suggestions that produce meaningful results.

Winning an SBIR or STTR project, especially a Phase II award, gives a small business a huge boost. It not only provides much-needed funding for developing new technologies, but also gives customers and investors greater confidence in a business. While I do not advocate funding proposals that are based on bad science and seriously flawed project plans, I do believe that offering an easier path for some number of awards to socially or economically disadvantaged persons would teach these firms how to succeed with future proposals and improve their chances of succeeding in the commercial marketplace.

A footnote to this recommendation is that I do not advocate penalizing multiple recipients of SBIRs and STTRs. I do not like "SBIR mills" – companies that exist only to do SBIR and STTR projects. But companies become more efficient at performing SBIR development projects with each one they complete. The result is that these firms produce better innovations, achieve more valuable economic results, and more effectively contribute to the missions of Federal agencies.

RECOMMENDATION: Encourage innovation in United States manufacturing

I strongly support the Act's language encouraging manufacturing innovation and prioritization of manufacturing in the United States. Recent supply chain disruptions have shown the vulnerabilities in our economy that have been created by the deterioration of our manufacturing industries. Support for manufacturing innovation should be expanded across all agencies. Federal funding should also give high priority to companies demonstrating a commitment to building products in the United States.

Conclusion

Thank you for inviting me to testify today. Small businesses are at the heart of our economy and are vital participants in our rich culture of technology innovation. Small companies are nimble, innovative, and willing to make bold moves to commercialize new technologies. The SBIR and STTR programs are one of the better ways of supporting small business technologists across a broad range of geography, demographics, and experience levels. I hope that my comments are useful to the Subcommittee. If so, I am very happy to have been of help.

As I mentioned at the beginning of my testimony, the SBIR and STTR programs are gems among federal programs, and I am encouraged by the many economic and technical advancements that these programs create. I thank you for your work and for your continued support of the SBIR and STTR programs.

I will be pleased to answer any questions you may have.

George Caravias

Chief Executive Officer, Geofabrica Inc.

Mr. Caravias is an experienced Chief Executive with a 39-year career in engineering and applied technology, including a decade in the defense and telecommunications industries, followed by 29 years in the development of products and services at early-stage technology ventures. He began his career developing computer aided manufacturing / computer aided design systems in the defense industry and successfully managed multi-year, multi-million-dollar projects for manufacturing and information technology applications. Mr. Caravias founded and helped to lead two technology ventures, one of which grew to over $200 million in sales prior to establishing his current business, Geofabrica. In addition to building technology firms, Mr. Caravias spent almost a decade working for venture capital firms.

Experience

- Current CEO, co-founder, and owner of Geofabrica, a manufacturing technology development company.
- CEO and one of the founders of Grid Logic, a developer of advanced manufacturing systems.
- CEO and one of founders of Alta, acquired by Interpath Communications, which was ultimately acquired by ATT.
- Senior Manager and one of founders of Axicorp, acquired by Primus Telecommunications and ultimately acquired by other telecommunications companies.
- Early-stage technology venture experience as a manager and as a member of venture capital teams.
- Early career in engineering, project management, marketing, and sales in defense and telecommunications.

Education

Columbia Business School, MBA

California Institute of Technology, BS Engineering & Applied Science (Mechanical Engineering)

Whitman College, BA Mathematics and Physics

About Geofabrica

Geofabrica is a manufacturing technology development company specializing in additive manufacturing (3D printing) systems for mobile and high-mix production. We build innovative solutions to unlock the economic potential of 3D printing and additive technologies for metal, plastic, and composite applications. We create application-specific devices and processes to help customers overcome the limitations of current technologies and help them achieve a competitive advantage within the evolving digital manufacturing landscape.

Chairwoman STEVENS. Excellent. With that, we'll hear from Dr. Reuel.

TESTIMONY OF DR. NIGEL REUEL, ASSOCIATE PROFESSOR, JACK R. AND CAROL A. JOHNSON FACULTY FELLOW, DIRECTOR OF GRADUATE EDUCATION, IOWA STATE UNIVERSITY

Dr. REUEL. Great. I appreciate this opportunity to speak to you today. I wear an interesting little hat here in this role of both as an academic member at Iowa State University where my graduate students and I develop the initial seeds of these technologies and then seek for supportive SBIR funds to take them out of the lab.

Today, I've helped over the last 3 years three separate entities start, and each of their start's initial funding was SBIR funds. And in some cases they've moved very quickly, one just last month [inaudible] is done with these funds.

So I want to take my oral testimony just to highlight some of the things that I've detailed further in my written testimony, and it's mainly riffing off of this analogy of a seed. So coming from Iowa, it's an apt image of things that grow, and building things in my academic laboratory. It is a young tender seed that needs a lot of support in order to make it, survive the drought and winds that occur when it leaves the controlled environment of a lab.

And there are three specific aspects of the SBIR program that I want to highlight, and namely—and these have already been highlighted today but I'll further reinforce. So first, you need purposeful training. Dr. Schrag mentioned aspects of that at NSF. Second is funding to test feasibility, which is unique. Private funds are very scared of touching that, and so SBIR provides a critical role in supporting that. And then third is this validation to external State—stakeholders.

So first with purposeful training it's already been mentioned that some programs think about this very intently, so we've had the privilege of working through the National Science Foundation and multiple boot camps where the team are trained in customer discovery and in some cases, for example, Frugi Biotechnology, Inc., they started with an idea in mind of their technology of what market need it would fill, and when they went out and did customer discovery, they found actually that need wasn't as apparent but there was another burning need. And so they pivoted due to this training that the National Science Foundation had them go through through the SBIR program. And that pivot turned them to drug discovery customers, and that eventually was the company out in San Francisco that acquired Frugi. And so that was all done through customer discovery.

In addition to that, they get training on their commercialization plan that's very data-driven. They have consultants that meet weekly to provide insight, training on IP (intellectual property), all those aspects that give resilience to this young tender seed to grow.

And so then going to the next one, the funding to test feasibility, that, again, is something that I've seen with my companies. I, out of graduate school, had my very first startup attempt, went to a premier business incubator out in Boston and quickly found that my needs as a science-minded entrepreneur were very different. I

needed more than a desk and a phone. I needed more than just a mockup, a cardboard model. I needed to test feasibility, and that takes sufficient funding and required capital in order to do that. And so with SBIR funds for my three companies that have—are growing and employing 11 individuals today, all of that funding goes to that testing and feasibility. And that allows them to get that critical data to then stand before a private investor and provide a convincing pitch of what they can do. So that's very important.

And last is this validation to external stakeholders. So it's a stamp of approval that you've gone through a scientific review, you're found meritorious, and it allows you to again strengthen that recommendation to seek fundraising.

So last, I do just want to echo my gratitude to Members of the Subcommittee and for not only the long-standing support of SBIR but also communicating it your constituents, that it's very important to have this innovation ecosystem. Also wearing my academic hat, I want to thank for fundamental tests—fundamental funding, which incubates those seeds. And I think we need to strive as we grow this pot and continue to expand to keep that parity of providing fundamental research to keep the pipeline of seeds alive to then incubate into businesses, to expand diversity in order to have better regional representation, as well as amongst people. So, with that, I look forward to questions.

[The prepared statement of Dr. Reuel follows:]

STATEMENT OF

DR. NIGEL REUEL

ASSOCIATE PROFESSOR, JACK R. AND CAROL A. JOHNSON FACULTY

FELLOW, DIRECTOR OF GRADUATE EDUCATION, DEPARTMENT OF

CHEMICAL AND BIOLOGICAL ENGINEERING,

IOWA STATE UNIVERSITY

BEFORE THE UNITED STATES HOUSE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

HEARING ON:

"SBIR TURNS 40: EVALUATING SUPPORT FOR SMALL BUSINESS INNOVATION"

APRIL 6, 2022

10:00 A.M.

ONLINE VIA VIDEOCONFERENCING AND 2318 RAYBURN

Statement of Dr. Nigel Reuel

Iowa State University

INTRODUCTION

Chairwoman Stevens, Ranking Member Feenstra, and members of the United States House Committee on Science, Space, and Technology Subcommittee on Research and Technology, thank you for this opportunity to testify on such an important topic.

I am Dr. Nigel Reuel, Associate Professor, Jack R. And Carol A. Johnson Faculty Fellow, and Director of Graduate Education, in the Department of Chemical and Biological Engineering at Iowa State University and founder of three, SBIR funded companies.

Let me begin by saying that Small Business Innovation Research (SBIR) programs are well-known for their tagline "America's seed fund." Seed is an apt image that resonates well in an agriculture powerhouse state like Iowa, which was the first state in the nation to officially accept the provisions of the Morrill Act 160 years ago. That decision created our state's land-grant institution, which later became known as Iowa State University.

A young tender plant can only emerge from a tiny seed if it is given the proper resources — soil, water, light, and nutrients — and time and expert care to grow. Only after the plant has emerged, deepened its roots and strengthened its stalk is it able to stand on its own against the daily hazards that threaten to dry it, drown it or knock it down.

In the last four years, I have seen this metaphor play out for each of the three companies that I have spun off from my research at Iowa State University. Each started as a seed of a business, a promising idea from my academic laboratory made possible by the longstanding foundational support our nation has provided to nurture fundamental research. My university has its own tagline — "Innovate at Iowa State" — that provides great resources across campus to support and encourage the promising ideas of faculty and student entrepreneurs. But my firsthand experience is that, without the $1.8 million of SBIR funding my companies have received to date, these ideas would have remained dormant seeds. Without SBIR, these start-up companies may have limped along for a few months, then withered and died like a neglected plant. Without this critical funding, we would not have been able to grow the crop that these companies represent today – employing 11 individuals, attracting external investors and acquirers, and — most importantly — launching products and services that I believe will revolutionize the way cell therapies are manufactured, antibodies are discovered, and enzymes are optimized for the benefit of human health.

So, today my goal is relate to you three key aspects of the SBIR program that I have experienced in the past few years — and to encourage expansion of SBIR and of fundamental research funding that further strengthens our country's competitive edge in innovation, science, and technology.

The three areas of SBIR support for science and technology-oriented start-ups are:

1. Unique, purposeful training
2. Funding to test feasibility
3. Validation to external stakeholders

1) SBIR TRAINING

Many SBIR programs purposefully support the nurturing and growth of the young start-up. Also, SBIR training programs offer a distinct complement to the training opportunities provided by my own innovation-minded university — opportunities that encourage creative thinking and the creation and "seeding" of new businesses.

Iowa State University provides me with an excellent innovation ecosystem. As I stated, we are a land-grant university whose motto, or tagline, historically has been "Science With Practice." Iowa State currently is ranked 11th in the nation by the *Princeton Review* for student innovation and is in the top 100 worldwide universities granted U.S. patents for our science and technology achievements. Iowa State's emphasis on innovation and entrepreneurship has earned the Association of Public and Land-Grant Universities (APLU) recognition with its 2020 Innovation and Economic Prosperity (IEP) Innovation Award and 2021 IEP Place Award. Iowa State's passion for inspiring young people to explore innovation and entrepreneurship is illustrated by the recent dedication of the Student Innovation Center: 140,000 square feet of modern, open collaborative space for students from all majors and disciplines to work, learn, and be inspired by each other. The facility is equipped with the latest technology and provides students with access to nationally known business and industry professionals, who share personal stories and lessons from their entrepreneurial successes. Iowa State offers our students training programs, such as those provided by our Pappajohn Center for Entrepreneurship, that help prepare them with entrepreneurial skillsets and resources to help student teams distill their ideas into business plans. We have accelerator programs like the ISU Startup Factory, a17-week incubator focused on helping researchers and inventors develop a roadmap to realize the societal and economic impact of their high-tech innovations, ideally stemming from university commercialization efforts. Additionally, "CyStarters" offers undergraduate to Ph.D. students, as well as recent graduates, the opportunity to participate in an immersive summer accelerator program to help kick start the launch of a new business venture. Combined, these two programs have jumpstarted more than 120 new companies over the past four years. Within our "Innovate at Iowa State" ecosystem, students learn the fundamentals of team building, accounting, fundraising, and perfecting their business plans and pitches.

These kinds of programs and facilities are extremely useful in planting the seed of a business, and in our experience at Iowa State, germinating viable businesses — especially those with proven business models and low capital needs. I am giving you this background on our campus's innovation environment because it's important to understand that, in addition to these excellent programs, there is a need for specialized support for companies like mine that, at their core, are creating practical applications for new, cutting-edge science and technology. I saw this firsthand in my first start-up experience right out of graduate school, a company that was launched in one

of the premier business accelerators in Boston. I had great visibility and general training, but my company needed more than a desk and phone — it needed a specialized lab to prove the promise of the technology and it needed training specific to a strongly science-oriented start-up.

That's where SBIR plays a critically important role. Many SBIR programs, such as those that I have been a part of supported by the National Science Foundation (NSF), provide such training and resources. At the start of the SBIR program, entrepreneurial scientists go through a boot camp that provides a condensed version of the I-Corps training; NSF's Innovation Corps (I-Corps™) program provides experiential education to help researchers gain valuable insight into entrepreneurship and how to start a new business. As evidence of this programs impact, the Iowa State's University's local I-Corps Site program embeds a stronger and more pervasive culture of entrepreneurship and innovation across the entire campus community and provides a great starting point for validating the business potential of the technology or basic research idea. Since becoming an I-Corps site in the fall of 2017, the I-Corps program at Iowa State has generated roughly $6 million in commercialization grants and investment funding and has provided training to over 100 teams involving 300 students, postdocs, faculty, and staff, launched 14 new companies; and advanced 12 teams to the national program. This training at the SBIR kick off meeting pushes the team to put lectures on these topics into practice. It requires us to meet established metrics and cohort reporting. It forces us to get out of our labs and out of our buildings to learn about real challenges voiced by real people in target markets. Innovation truly is the seed, but at the start we put that aside briefly to understand the environment and real conditions to determine where the seed will best thrive.

In many cases, including my own start-ups, this critical training reveals the need to pivot from a perceived initial problem to something more pressing. The NSF SBIR program also pairs the founder team up with a consulting group to provide market research and weekly trainings. The program highlights the unique aspects of intellectual property, or IP, required for high tech firms. It emphasizes how to put together a commercialization plan or an enhanced business plan supported by real data, interviews, IP analysis, and technical findings. The program directors that my team and I have worked with are also an incredible resource for practical training. These professionals bring with them a wealth of experience and are accessible for discussion or review of current results. At some agencies, like the NSF, there are also supplemental awards that encourage the team to secure external investments. Finally, in most SBIR programs, the companies are part of a cohort. Being part of a cohort is incredibly important because you can provide practical advice to each other — advice that is aligned with the unique needs of growing that seed of a technology and science-oriented company.

2) FUNDING TO TEST FEASIBILITY

As I briefly mentioned, my first start-up company needed more funding and resources than the modest support offered by business plan competitions and accelerators. We needed a different level of support to gather critical feasibility data. My needs were obviously different from others in the accelerator cohort. Some members of my cohort simply needed a little space and some high-speed connectivity to enable the launching of an online or digital service or product. But this was not the case for my product or my innovation. 3D printers and maker spaces could help

me mockup my scientific invention, but not to test its functionality. The initial development and proof of concept for these inventions are often done in academic labs, where fundamental research funding makes possible bringing the idea to life and conducting the very first tests of viability.

But while these first steps are appropriately accomplished in a controlled environment like a campus lab, the next steps of growth require much more testing and building before an innovation can be customer-facing in the real, end-use world. This is where the SBIR support has maximum impact. SBIR funds help make possible the research necessary to produce feasibility data and, eventually, to place the invention in the hands of the end user. The SBIR support is at the funding level and duration where it can really start to make a difference.

I want to tell you the impact this kind of support has had on one of my companies — Skroot Laboratory, Inc. This company strives to be a lead process analytical technology or sensor developer for manufacturers of cell and protein therapies. The seed of Skroot Laboratory started as a project in my Iowa State laboratory in 2018. The initial tests looked promising, so we filed for a patent through the Iowa State University Research Foundation. We then founded the company and applied for SBIR support. When the SBIR Phase I award arrived in 2019, we moved into a small research space in the Iowa State University Research Park. The Iowa State University Research Park is a key asset in the "Innovate at Iowa State" ecosystem. It is home to 119 companies — an incubator for start-ups and a collaborative space for multinationals — plus research centers, and affiliates. At the Research Park, we used the Phase I award to test feasibility and do early-stage testing with end-users. The result was successful, strengthening the validation of market need through our boot camp training and commercialization plan preparation. Armed with these results, we applied for and earned an SBIR Phase II award. This has allowed us to expand customer-facing and internal testing of the product, make a few pivots, and move closer to full launch. Without SBIR funding, we might have been able to attract a few brave angels to invest in us, but it would not have been sufficient to take the idea through feasibility testing to end users. SBIR funding provided the validation and funding package necessary to attract stakeholders, which I will address next.

3) VALIDATION TO EXTERNAL STAKEHOLDERS

Receiving SBIR funds has emerged as one key vetting attribute by external stakeholders. It reflects a stamp of approval that a company's approach has been peer-reviewed in a competitive selection and found meritorious. In the experience of my companies, this has enabled us to get the necessary angel investor attention and ability to attract and retain qualified talent. For example, the SBIR-supported customer discovery we did for one of my companies, Frugi Biotechnology Inc., enabled us to get on the radar of a rapidly accelerating antibody engineering company. The result was that my firm was acquired by this company, and our innovation continues to accelerate to meet customer needs. None of this would have happened without the support and validation that comes from the SBIR program.

CONCLUSION

The 40-year track record of the SBIR program makes it clear: SBIR is a support mechanism enabling the growth of new technology-based firms that would otherwise struggle to survive past the initial innovation stages. SBIR has been key to the success of my companies. The growth of new technology and science companies directly impacts economic development and competitiveness in my state of Iowa, in our nation and in our world. Can the SBIR program be improved? Like all programs, there are numerous opportunities to improve implementation and efficient operations. I believe that specific SBIR trainings and resources for companies like mine can certainly be continuously improved and standardized across funding agencies. I believe that continuing to incrementally increase award amounts will allow companies like mine to maintain their economic impact and further the application of science and technology to pressing challenges we face. Increasing the overall investment in SBIR awards will allow new companies to grow. That is important; however, this must not come at the risk of minimizing investment in fundamental research. This brings me back to my seed analogy: It is not prudent to provide more soil and nutrients and care if there are no viable seeds to nurture. As a nation, we must continue our commitment and further increase our support to funding fundamental research, account for regional disparities and promote a more equitable and diverse pool of talent. Every day at Iowa State University I see how that fundamental support for innovative research produces viable seeds. These fundamental projects are the innovation pipeline – they are the crop — that, by applying SBIR funding, can produce an abundant harvest for us all.

Let me close with my own personal message of gratitude for the many members of Congress who, over the past 40 years, have had the foresight to set up and support this unique SBIR program and who have communicated to their constituents the importance of using public funds to support the growth of new companies. It is an investment that benefits our nation. New companies are formed. Jobs are created. Life-changing products are introduced to the marketplace. The return on investment is amazing; we are able to expand a new, robust tax base and we are able to create new, enduring industries. I am excited to see what the next 40 years of the SBIR program brings. I am excited to see how SBIR nurtures the future companies I will get to create with my talented students at Iowa State University.

BIO: Nigel F. Reuel is an Associate Professor of Chemical and Biological Engineering at Iowa State University and is a Jack R. and Carol A. Johnson Faculty Fellow and College of Engineering Entrepreneurial Fellow. He received his PhD in Chemical Engineering at MIT in 2014 under the guidance of Prof. Michael Strano. After graduating, he attempted to commercialize his PhD work in a startup, Volvox Biologic Inc. (Boston), and then consulted at a larger life science tool company that obtained the startup IP (Maryland). He then worked as a Research Investigator (PI) at DuPont's historic Central Research and Development campus (Wilmington, DE) for two years on projects ranging from wireless power transfer, sensors, and precision agriculture. He was then promoted as the corporate technology scout, where, for 8 months, he traveled to universities and incubators to find technology for the CTO office at DuPont. Although this was an exciting role at a large company, he quickly realized that making technology is more stimulating than finding it and was pleased with the opportunity to come to ISU and become an entrepreneurial-minded professor. Currently his group has over 15 active technology disclosures at ISURF, two granted ISU patents, and three startup company offshoots (Skroot Laboratory Inc., Frugi Biotech Inc. (acquired by BigHat Bioscience Inc.), and Zymosense Inc. which have earned numerous SBIR awards. Dr. Reuel's work has been recognized by the NSF Career Award (2021), NIH Outstanding Early Investigator Award R35 (2020), 3M Nontennured Faculty Award and BMES Advanced Biomanufacturing Junior Investigator Award (2020).
See more at www.reuelgroup.org or follow @reuelgroup on Twitter

Chairwoman STEVENS. OK. That's great. We're now going to move to 5 minutes of questions, and I'm—the Chair is going to recognize herself for 5 minutes.

Dr. Schrag, you were—in your testimony you're talking about accessibility, and I'm just wondering, could you shed some light on how people find out about SBIR/STTR opportunities?

Dr. SCHRAG. Thank you for that question, Chairwoman. Yes, the NSF portfolio we found that there's a number of different routes. We obviously—the NSF has a very high name brand among scientists and engineers, and a lot of times those folks are involved in inventing the technology and so they may know about our programs. But more recently we have tried to really create new routes to visibility for our program, and that includes a pretty coordinated digital marketing campaign, especially to underrepresented entrepreneurs and innovators and a lot of outreach events. Our program directors are full-time dedicated to this program and they attend and present at well over 100 outreach events per year, especially to again target communities where maybe our visibility is not as high. So we've tried to really create multiple different ways that people can find out about us.

The other thing I would say is that our portfolio companies are great ambassadors, and so if we give them the good experience, if they find that they're supported and the NSF is adding value to their company, they are the best referrals that we can get——

Chairwoman STEVENS. Oh, sure.

Dr. SCHRAG [continuing]. Because they can talk to entrepreneurs in their network and get the word out that way.

Chairwoman STEVENS. Yes, those ecosystems are really important. And the—we have TechTown in Detroit, for instance, and that's sort of an accelerator because what happens—you know, we got a lot of university people here, and those are great hotbeds, but then people leave the university and they're years into their career and they're tinkering around in the garage or the basement and then they forget all about these opportunities like SBIR/STTR. And this is why frankly as Members of Congress, you know, we share these opportunities, we look to unearth this.

And, Dr. Feldman, I want to get at—your testimony was just fantastic. And you're talking about this linkage about what's going on at the HBCUs and SBIRs. And obviously there's some challenges to nontraditional and underrepresented firms, which we've talked about. But could you just—could you just shed a little bit more light on exactly what you shared in your testimony about why HBCUs tend to not be as plugged into technology transfer or SBIR/STTR opportunities?

Dr. FELDMAN. I want to say that it is just an artifact of the data and so, we don't know are they applying and then not getting the funding, right? We are just observing who received the funding. And so our recommendation, our committee recommendation, we see all the HBCUs have engineering schools. Many of them have medical schools. And their faculty, graduate students also—because many times we see that companies are started, academic companies are started by postdocs or Ph.D. students. And so an important way that people learn about the program and also what makes a high-quality proposal is in participating in a review panel.

Chairwoman STEVENS. Yes.

Dr. FELDMAN. And so that is something we need to do. We need to do scientific review anyway. And by sort of broadening the list of participants, more people would know about the program and would know what a good proposal looks like.

And I also love the idea of involving more small businesses in the evaluation of these proposals. Now, specifically at NIH it's an issue because NIH's SBIR and STTR awards go through the same evaluation as an R01 award. And so that is being evaluated on its scientific merit.

Chairwoman STEVENS. Yes, and we have a—there's a lot with the evaluation component. And, you know, I'm just wondering, Dr. Schrag, have you spent time going to these HBCUs with the NSF yet, I mean, you personally or anyone in your shop? Because I'm wondering if we should do something like that if you—I mean, I know it's been 2 years of a pandemic, but do you—have you spent time over there?

Dr. SCHRAG. So we've actually approached those communities in multiple ways. The main focus of our outreach has actually been through organizations that support critical masses of underrepresented innovators and entrepreneurs like the National Society for Black Engineers and SACNAS (Society for Advancement of Chicanos/Hispanics and Native Americans in Science) and——

Chairwoman STEVENS. Yes.

Dr. SCHRAG [continuing]. A number of organizations. And so we find that's—those have a little bit of a greater scale nationally where we can get kind of in front of more folks at one time.

Chairwoman STEVENS. Yes.

Dr. SCHRAG. But I think it's absolutely a great thing to explore. I think it's a great idea.

Chairwoman STEVENS. Yes, I was over at Groves High School sending off a group of 125 students. It was a Black empowerment education tour to about a half a dozen HBCUs, and, you know, I'm just thinking about how, you know, we go and visit the national labs as Members of Congress, and our Chairwoman, Congresswoman Eddie Bernice Johnson, has been involved with this *MSI STEM Achievement Act,* which passed the House as part of *COMPETES,* and I think that would further assist, too.

We're going to move to the next questioner, but I do want to put a pin in Dr. Feldman's great points on data collection and how we manage that. That's come up with our AmeriCorps program as well. And if we could do a second round, maybe we can get into that.

But with that, why don't I yield back and get to Mr. Feenstra for 5 minutes of questions.

Mr. FEENSTRA. Well, thank you so much, Madam Chair. And I want to thank everyone for their testimony.

As I mentioned in my opening statement, one of the great aspects of SBIR and STTR programs are the ability to spark innovation in middle America not just on the coast. Dr. Reuel, your story provides a great model for entrepreneurs. Can you further expand upon the advantage of building a startup in a State like Iowa, and then also how has Iowa State supported and helped to foster this entrepreneurial spirit on campus in Ames and across the State?

Dr. REUEL. Thanks, Representative Feenstra, happy to. So, yes, my first startup experience was in a much more expensive climate on one of the coasts where funding did not go as far. One of the benefits I've found in Iowa, especially with the entrepreneurship ecosystem that's being built here at Iowa State University, there are many incubators that are not only available and provide functional space but they come at a cost point that is very affordable in terms of usage of SBIR funds. So we can use those funds to lease space, to get the personnel that we need. And being close to a university is also—gives us great access to talented people. And a shout-out to the Midwest. It's nice in the fact that people love it here and they want to stay here, so in terms of employee retainment, that's been a nice thing as well. They don't drift off and go to different companies.

Mr. FEENSTRA. Well, that's great to hear. I mean, I'm just so impressed with what you do. I've got a further question for you, Dr. Reuel. As Congress is considering reauthorization of the SBIR and the STTR programs, the I-Corps program model is one that we have been looking at closely as a method to encourage SBIR success. What has been your experience with the I-Corps program, and do you think it's worthwhile for all SBIR and STTR applicants to be involved in this program? And would you consider any improvements that would be beneficial?

Dr. REUEL. Thank you again for that question. Yes, definitely. It provides critical feedback when you need it at the very beginning of your journey. So often the founding team is very much in love with their technology and they think they know what its prime application can be. However, this forced training, this experiential training makes you put it aside for a bit and go out and talk to others and not talk about your technology but talk about their needs. And then that allows you to really match where those funds are going to go so now you're not burning them toward a destination that doesn't make sense but you're using them to really bring your product to a market that has a need that can be met.

Mr. FEENSTRA. Yes, thank you. I greatly appreciate those thoughts and ideas.

Dr. Binkley, I'm very proud to have Ames National Lab located in my district, and I want to ask you about the important facet of DOE's SBIR program partnerships with national labs. Can you discuss how the SBIR partnership with a national lab generally works? And then how does DOE utilize these partnerships to further capitalize on R&D in its mission areas?

Dr. BINKLEY. Thank you, Representative Feenstra, for those questions, very, very good questions. We use a significant fraction of our SBIR funds in a mode that helps us advance instrumentation and experimental capabilities that can directly be folded back into our science programs. And Ames Lab is an example of one of the places where we do this. And we find that that approach to advancing instrumentation and other features related to the scientific mission of the Department is really important. I'll stop there.

Mr. FEENSTRA. Well, I appreciate, you know, those comments, and what you do. I mean, I think of all the witnesses that we have, I mean, we're making great strides in these different areas, and I

appreciate all your comments and thoughts. And with that, Chairman Stevens, I yield back.

Chairwoman STEVENS. OK, that's great. And we'll turn to Dr. Bill Foster for 5 minutes of questioning now. Thanks.

Mr. FOSTER. Well, thank you, Chairwoman Stevens and Ranking Member Feenstra and all the witnesses for joining us here today. I'd like to actually give you a little more chance to brag about some of the successes of the SBIR programs. Specifically there's a company called ClearFlame Engine Technologies that's based out of Geneva, Illinois, just outside my district which has widely succeeded in developing diesel engines which work with full thermodynamic efficiency on everything from corn ethanol to methanol from hydrogen hubs. And it's actually led by former researchers from Argonne National Lab and Stanford, and ClearFlame received funding from the SBIR and other sources, including everything from the corn growers in nearby States to significant assistance from the national lab and the SBIR programs. In fact, they just were able to raise $17 million from a combination of John Deere and I think Breakthrough Energy Ventures, so they've clearly vaulted across the valley of death.

And so, Dr. Binkley, how does the Office of Science mass produce successes like ClearFlame and advance translational breakthroughs in other areas?

Dr. BINKLEY. Thank you, Representative Foster. That's a very, very good question. Thank you for the opportunity for me to answer that. So the way we arrive at SBIR topics in the Department is we have a network of Federal program managers spanning the Office of Science and the applied energy programs and even parts of NNSA (National Nuclear Security Administration). And they are always on the lookout for topics that can advance the clean energy and national security missions of the Department. And it's through that network of Federal program managers that we identify topics that are folded into our funding opportunity announcements (FOAs) for phase I and phase II SBIR and STTR activities. And it's through that process that we are able to get proposals in across a very, very diverse set of activities. And it's essentially, you know, go—for the broad community input through the FOA process and, you know, there are a number of outstanding successes over time.

Mr. FOSTER. And so what I was struck with while reading through the history of ClearFlame is how it started as a bright idea at a university. The technology was essentially proven at a small scale at Argonne National Lab, and then it is now—it's now to the point where I think they had a semitruck driving around the National Mall powered by corn ethanol. And I didn't mention actually one of the neatest things about it is that the pollutants coming out the back end of the diesel engine that they've developed are much, much smaller, so you don't have to worry about soot and the other things that actually cost a lot of money to try to mitigate in standard diesel engines.

And so—but the pipeline from the bright ideas collected from both laboratory researchers and universities and then having some technical assistance trying to sort of get to the proof-of-principle stage and then launching into the point where venture capital will grab it or established companies like John Deere. How is that pipe-

line set up, and what are the opportunities to just have the Department of Energy do more of this? Is it—yes.

Dr. BINKLEY. Well, so the success at Argonne, I think, at least in my opinion, derived from the fact that there's close cooperation between the basic and applied programs at Argonne. So fundamental advances coming out of the chemistry and materials areas and then close coupling of those activities with the funded activities—activities at the lab funded by the applied energy offices. And I think that's a key strength in developing ideas that can be commercialized the way you described.

Mr. FOSTER. OK. In my sort of last 30 seconds here, I'd like to point out what is a real concern with me. When I look at in the Office of Science you have many ongoing construction projects at any time, and essentially all of the construction projects have just been clobbered by a combination of COVID and supply chain difficulties and, you know, the—actually the very rapid rate of wage inflation for technical personnel. And so they've ended up, you know, not making their initial budget, you know, estimates. As a result, in order to hold to the original budgets, they've cut scope, important scientific scope from these projects. And I'd like you to consider if you would and get back to us with a rough estimate of what would be involved in restoring the original scientific scope that was planned and appropriate levels of project contingency really to correct for what is, we all hope, a one-time big body punch to these—all these ongoing projects? Because that's the sort of thing I think that putting in in the startup funding for the COMPETES and other appropriations things I think would do a lot of good to making sure we get the scientific output that was planned on these very important construction projects. So if you could get back to us with some information on that, I'd appreciate it.

Dr. BINKLEY. Yes, Representative Foster, we'd be very happy to get back to you with that information. We've tracked that very closely over the lifetime of the pandemic and have a really solid financial understanding of what the impacts are and the scope impacts to the projects.

Mr. FOSTER. Yes, OK. Well, thank you. I appreciate it and I yield back.

Chairwoman STEVENS. Great. And now we're going to move to Dr. Baird for 5 minutes of questioning. Thank you so much for your patience.

Mr. BAIRD. Thank you, Madam Chair. And I really appreciate you holding this session about SBIR and STTR. And I always enjoy the kind of information we get from these sessions. It really is beneficial to us making decisions on these committees.

But I was also very pleased to have you join as we introduced H.R. 4033, you know, the *SBIR and the STTR Information Transfer Improvements Act* during this Congress. So I want to thank you for that.

And you know America's leadership in science and technology is critical to our economic and national security, basic research supported with taxpayer dollars to the National Science Foundation, NASA, NIH, and DOD and even other Federal agencies has led to key scientific discoveries that are very crucial in today's world such as the internet, wireless communication, lifesaving medicine, la-

sers, and many more. So this basic research produces the scientific fuel for innovation. Risk-taking small businesses are the engines for converting this kind of knowledge into new products and services. So small businesses are the catalyst for economic growth and producing good-paying jobs in our communities.

And with that, I want to move to Dr. Schrag. And in your testimony you mentioned that H.R. 4033. So while the Administration has not really taken a position on the bill, can you expand on your comments and explain how the bill would be most directly effective for the NSF?

Dr. SCHRAG. Thank you, Representative. Yes, thank you, Representative, for that question. Yes, I don't know if there is a specific aspect of the legislation. I don't want to run you out of time but there's a number of different sections. Is there a particular area you'd like me to comment?

Mr. BAIRD. Yes.

Dr. SCHRAG. We appreciate it. I think I would refer you to my written testimony. Obviously, some of the things that stand out to us are any ability for Congress to help create a little more stability around the program as a whole and also around some of the pilot programs, which NSF uses many of to great effect, I believe, so that's all—that's all I think extremely positive. Beyond that, I'd be happy to answer any specific questions around any sections of the bill that are of interest.

Mr. BAIRD. Do any of the other witnesses care to address that issue, how effective this transfer for SBIR and STTR?

If not, Madam Chair, I yield back.

Chairwoman STEVENS. OK. That's great. Thank you. And with that, we'll move to Congresswoman Ross for 5 minutes of questioning.

Ms. ROSS. Thank you very much, Chairwoman Stevens and Ranking Member Feenstra, for holding this very important hearing. I also want to thank them for their efforts to improve SBIR and the STTR through their legislation introduced last year. These programs play an important role, as we've heard, in helping small companies take the initial steps to advance research and development and begin commercialization of exciting new discoveries. As this Committee reflects on the programs' 40 years, we should use the testimonies given today to inform how we can make improvements to ensure that we're optimizing success of Federal dollars in the small business innovation space.

And, Dr. Feldman, it is a pleasure to have you here from the University of North Carolina. For many years, the National Academies surveyed SBIR award winners in an effort to track program outcomes. But it was always a challenging task. And now your committee is taking a different approach to measuring program outcomes. Can you talk about both the challenges of surveys and how you're now trying to measure SBIR program outcomes? What are the relative advantages and disadvantages of the different approaches?

Dr. FELDMAN. Representative Ross, thank you so much for this question. So I can just talk about this all day. And really with the survey we worry about response bias. That is who is filling out the

survey and giving us information. And prior studies were only sending their questionnaire to people who received the funding.

What we've been able to do is to match from different data sources, so using patent data, looking at new product announcements, looking at follow-on funding, trying to track employment, and really triangulating across different data sources so the that we get a full picture of what's going on in the company.

And so what we find is that the programs have significant impact. For NIH we were able to look at new drug approval, new device approvals, and so on, that is using publicly validated sources to provide evidence about the program.

Let me mention one of the most exciting things that we're doing, and currently we are working on an evaluation for the National Science Foundation that is in progress. But we realize that firms get the award, but it is individual researchers who are doing the work, who have the ideas, and so we have also started looking at the individual researchers so that the firm is a way of providing resources for individual PIs (principal investigators) who actually are the inventors and have the creative ideas to move forward.

And so what are the sort of limitations? Well, I would like to know everything about a firm through its entire lifecycle. What we see is firms change their names, and so sometimes it's hard to track firms in a consistent basis. The question of are they merged or acquired, if they have an IPO, which is the gold standard, there's a lot of news about that, mergers and acquisitions less so and especially when they are publicly held companies. And so our data are only as good as all the underlying data.

Let me mention for NIH we did have the applicants who were not awarded, and so that allowed us to again have a fuller picture. But, you know, it would be great if we could trace intellectual property because even when firms do go bankrupt, those principal investigators who got the SBIR funding move on to other companies, taking their ideas and their experience with them. I wish we could do better on that front. But I do believe that we have done what is a state-of-the-art assessment of the programs.

Ms. ROSS. Wonderful. I know I only have a few seconds left, but I wanted Dr. Binkley to maybe briefly comment on the importance of matching programs. We have one in North Carolina in aiding with diversity of applicants.

Dr. BINKLEY. Thank you, Representative Ross. That's a great question. You know, we've been working very, very hard across our entire research portfolio on diversity issues, not just on the SBIR/STTR area. And so, you know, it's important to have good outreach to minority-serving institutions, HBCUs and so on.

And then the other tool that we've been using very aggressively over the last year is if you look at the Code of Federal Regulations (CFR) that govern how we do processing of grant applications, we are allowed by the CFR to have program policy factors that allow us to focus more attention on, for example, minority-serving institutions, HBCUs, EPSCoR (Established Program to Stimulate Competitive Research) States, et cetera. And so we've been using those tools in our funding opportunity announcement process overall and, you know, we'll see how this works over the next couple of years.

Ms. ROSS. Thank you very much. And thank you to the Chair for your indulgence. I yield back.

Chairwoman STEVENS. The women from North Carolina unite, and with that, we will pass it over to Congressman Meijer for 5 minutes of questioning.

Mr. MEIJER. Well, thank you, Chairwoman Stevens. Can you hear me? OK, thank you. And thank you to all our—and to Ranking Member Feenstra and to all of our panelists who are here today. I think you are hearing broad and bipartisan enthusiasm and excitement for what the SBIR and STTR programs have been able to do.

I want to just—we discussed a little bit on the underrepresented communities, and I wanted to shift that a little bit to ask to Dr. Schrag and Dr. Binkley specifically around the veterans community, how have the SBIR and STTR programs engaged the veterans community, and what obstacles have you encountered if any in working to fulfill the mission to foster and encourage participation from this population?

Dr. SCHRAG. I guess I can start, Dr. Binkley, if that's OK. Thanks for the question, Representative Meijer. I appreciate that. This is a very important issue and a focus of ours. One thing I would say is that NSF does have a specific request for supplemental funding, so an opportunity for our phase II awardees to actually request additional funding specifically to bring in and pay a veteran participant in their phase II research. And that gives the opportunity for that veteran to get kind of a boots-on-the-ground experience in deep technology startup research projects. But that's called the Veterans Research Supplement, VRS, and that's something that we've continued to offer. I think it's also been expanded throughout other parts of NSF subsequently. So that's been a great opportunity.

The broader question about outreach to veterans, that does, I think, parallel some of the other really important issues we talked about with respect to underrepresented communities and geographies with less activity. And so I think our approach really has been to really double down on doing outreach, to have our digital marketing campaign tailored to try to target these communities, including veterans.

And then the other thing is that, again, we've tried to really just create a program that is more approachable. And this is something that we hope helps everybody but specifically people who don't have as much experience with grant proposals and government funding. And part of that is the project pitch process that I mentioned, which allows folks to get immediate feedback and immediate dialog with our program directors, having a compliance that's flexible and forgiving so folks don't feel like the door is slammed in their face for bureaucratic issues, and having our program directors who are—all of us program directors at NSF are both technical experts in our fields and also have startup experience as startup founders or investors. And so for those folks, I think we have a little bit more ability to have empathy and understand where these folks are coming from and to kind of meet them where they live. So that's the kind of broader approach that we've taken to outreach to that community.

Dr. BINKLEY. OK. So, Representative Meijer, thank you for that question. I have to confess that in the Department of Energy we're not as far along as the National Science Foundation is in reaching veterans through our SBIR/STTR programs. We do have significant activities at a number of our national labs, and I think there are lessons that we can learn from NSF on how to do this in the SBIR/STTR area.

Mr. MEIJER. Dr. Binkley, I appreciate your candor there. And Dr. Schrag, I thank you for that response. I think, you know, before I came to Congress I was the Chairman of the Board of Student Veterans of America, and so for the post-9/11 G.I. Bill and what that has done for veterans' higher education, you know, that cohort is by and large—you know, what we saw in the immediate post-9/11 era, that cohort is now, you know, shifting from concentration on undergrad to a concentration in graduate programs, and so I think we're at a very opportune time to be targeting efforts, and so I appreciate that outreach as being very concentrated and that there is work to make the program more approachable. But I—you know, I think the time is right for this to be an expanded area of focus.

And just Dr. Schrag, real quickly, you know, I know in the GAO (Government Accountability Office) report it mentioned the flexibility to issue SBIR awards to companies that were venture capital or hedge fund or private equity funded and that there had been some not as rapid adoption or that there—some of the agencies had not used their full authority. Could you speak to that at all and anything we can do to encourage, you know, SBIR awards to be going to appropriate companies and not having any discrepancies in terms of their funding source?

Dr. SCHRAG. Yes, thank you for that question, Representative Meijer. Yes, so you're correct that the authority to issue SBIR awards to majority venture-backed companies is something NSF has not requested. As I mentioned, our focus is really on very early, very small companies. Typically speaking, companies will not become venture-backed until two or three rounds of private funding, and so those companies would tend to be later than the types of companies we look for.

And in general, again, our approach is to try to provide funding where there is the biggest gap in the private—the valley of death, right, in the private sector. And typically a company that's already half-owned by venture capitalists would already have had access to the private sector, and so we're less likely to fund those.

I will say though that venture capital is a very common graduation of our companies when they move out of the program to the next source of funding. Venture capital is almost always part of that path. It just happens to be that we go first and then venture capital tends to come a little later.

Mr. MEIJER. Thank you, Dr. Schrag. I appreciate that color. And, Madam Chair, my time is expired, so I yield back.

Chairwoman STEVENS. Great. And with that we're going to hear from Congresswoman Wild for 5 minutes of questioning.

Ms. WILD. Thank you, Madam Chair. I'm proud that this Committee has paid so much attention to the innovation challenges and opportunities for our country and economy in this Congress, approving a number of bills on a bipartisan basis, including my legis-

lation, the bipartisan *Regional Innovation Act,* which passed the House as part of the *America COMPETES Act,* which would invest in regional innovation strategy development and implementation for communities across the country. I think there's just as much potential in my district, the greater Lehigh Valley, as there is in the Silicon Valley, and the entrepreneurs and innovators there need a fair shot at that.

And I'm pleased to say that the Small Business Innovation Research program, or SBIR, is already supporting some of this work by local innovators in my district, Pennsylvania's 7th. [inaudible] a very proud tradition of manufacturing. It helps build the infrastructure and economic engine [inaudible] through the 20th century. And today's entrepreneurs are continuing that legacy by developing the next generation of technologies and by making them here in America.

For example, last year, one constituent's small business Amorphic Tech in Allentown, Pennsylvania, received a phase II SBIR award from the Department of Energy to build on research and pursue solutions for a device that will reduce energy use up to 40 percent from personal desalinators to municipal water treatment plants.

And another business in my district, Vaxform in Nazareth, Pennsylvania, received a phase I SBIR award from the Department of HHS (Health and Human Services) to pursue a vaccine against group A strep. These types of investments and visionary innovators will help lead my community and our entire country into a 21st century economy, ready to tackle issues like global climate change, economic opportunity, and American manufacturing leadership.

But a common refrain from aspiring SBIR awardees and entrepreneurs is that the process can be so complicated that it requires its own expertise to master. So, Dr. Schrag and Dr. Binkley, how have the Department of Energy and NSF taken the challenge of improving first-time applicants' success? And either one of you can start.

Dr. SCHRAG. Thanks for the question, Representative Wild. I'll start and try to be brief. In addition to the measures that I mentioned regarding the project pitch and the administrative compliance aspects in my opening statement, again, we have tried to change our process and our proposal format to really align more with the natural language of entrepreneurs, right? Our goal is to make SBIR not a separate offshoot of the startup and entrepreneurial process but to have it be aligned with it so that the things you're going to be doing to prepare a proposal to NSF SBIR are the same things you need to be doing anyway to build your business and your business model and your understanding of your customers, so really trying to have the commercialization focus in our format and in our review criteria, and then, again, the commercialization experience of our program directors.

The other thing I would say is that we do bring in, as was mentioned before, a number of commercial reviewers at both phase I and phase II, and those are typically entrepreneurs and investors where, again, there's an empathy between the folks who are reviewing the proposal, providing feedback, and the folks who are applying. And I think that creates more comfort in the process and

makes folks more willing to go through what is a lengthy review timeline.

Ms. WILD. Thank you. Let's switch over then to Dr. Binkley if we could on that question.

Dr. BINKLEY. OK. Thank you, Representative Wild. That's really a great question also. And in addition to reviewing our overall proposal process and trying to simplify it, you know, we have introduced I think some streamlining there.

But then more importantly we've created an application assistance program that targets first-time SBIR/STTR applicants. And we did—we actually did that in 2014, and we've been using it since then. And the focus of this application assistance program is not solely on steering small businesses through the application process in a timely fashion but similar to what my NSF colleague mentioned, it also provides critical reviews to proposers to ensure that a high-quality application can be developed and submitted.

Ms. WILD. Thank you so much. I just think it's very important that we always keep in mind that small businesses have tight operation margins, and investing the time to write a competitive application is a large investment, and we want to do everything that we can to make sure that we are assisting these small businesses.

With that, Madam Chairman—Chairwoman, I yield back. Thank you.

Chairwoman STEVENS. Yes, that's great. Thank you. Look, we're going to do a very brief round of second questions with yours truly in part because of where we were on data questioning, so that's the question I just want to get in for the record here. We've seen that critical tools in grantmaking oversight is the ability to measure the impact of the funding toward an intended goal, and the past data challenges have limited the ability for agencies to track commercialization benchmarks. But agencies were also able to identify the barriers and address those issues.

You know, I've been an NSF applicant in a previous life. I know people who've gotten SBIRs. We heard from Dr. Feldman very extensively and to great appreciation on some of this data and surveying benchmarking.

But I want to get our private sector voices in here. And I was just wondering, Mr. Caravias, if we could just start with you about how you have participated in surveys as an NSF applicant. And, by the way, congratulations on getting to phase III here. That's a really—I've looked at those phases, and that's really just tremendous to see your technology through that process. But any inputs you could make on surveying for us here?

Mr. CARAVIAS. Well, thank you, Madam Chair. I appreciate that. We have participated—we have not participated in surveys at all. We have participated—I guess we have one or I have one, an acquired company and NSF proposal, and we were very appreciative of that of phase I, which did not go to a phase II.

I'm not sure how else—is there something specifically that I could answer about surveys, you know, not having done any myself or possibly something about——

Chairwoman STEVENS. Well, look—yes, I just think in terms of what—when you're being surveyed, I know you've obviously been funded SBIR through the DOD, but are—do you feel like you're

getting the right questions asked, you know, that are contributing to these overall data benchmarks that Dr. Feldman mentioned?

Mr. CARAVIAS. Not having participated in the surveys, I think it's very difficult for me to comment on that, Madam Chair. I do——

Chairwoman STEVENS. OK. Well, has Mr.—has Dr. Reuel done a survey? Like who else here has been part of the surveys from the—I mean, obviously Dr. Schrag is sending them out, but, you know, who's been doing them?

Dr. REUEL. So I can chime in, yes. So I think surveys are often neglected. So the NSF has a much more clever tactic. So before you can get the last amount of money from your grant, you have to provide considerable feedback in a project report. And they do that on purpose so that way they can get some of these metrics in place to figure out where you are on your journey and where the funds were spent.

Dr. SCHRAG. Chairwoman, if you—do you mind if I chime in here?

Chairwoman STEVENS. Yes, that's great.

Dr. SCHRAG. OK.

Chairwoman STEVENS. Yes, we need to hear from the agencies, too.

Dr. SCHRAG. OK, no, I think this is a great, important question, and we have actually spent a lot of time trying to figure out how best to assess outcomes. There's a lot of challenges in this, as Maryann had referred to. You know, one of the main things is that when our companies become successful, it can be a decade or more, right? We had a company called Ginkgo Bioworks that was a company that went public last year for $16 billion. NSF funded them in 2007. And so the ability to kind of survey a company that you funded that long ago is difficult. You have to—you've lost contact with them in many cases and you have to find them.

And so the approach that we have taken more recently—you know, we have in the past used surveys, but more recently the approach that we've taken to tracking our companies—and again, this is focused on private sector commercialization as the outcome, so it may differ. But we use third-party tools as a primary way to do that. There are services out there like PitchBook and CB Insights that track the financial status and health of private companies. And so we can actually put a—make a list of all the companies we funded and put them in these systems and they automatically give us updates on the transactions those companies are going through, if they're acquired, if they're raising money. We get that information for free in real time without having to go and survey the company.

In addition, I do think surveys have potentially a place. We don't typically do them right now, but I think the small percentage of the companies that—you know, the big success stories which can be identified using these third-party tools, you can then go and do a deeper dive into—you know, into what makes them tick or how they've done with surveys. But obviously since we've funded 3,000 different small businesses over the last decade, doing surveys to all of them is a little bit difficult for us to manage.

Chairwoman STEVENS. Right. OK. Because—well, Dr. Feldman in her testimony said waste, fraud, and abuse, and I'm just trying

to get at what she's talking about here. Is there a concern for this? Because it seems to me—I mean, even with Mr. Caravias, I mean, he's going through the DOD, and I have worked with DOD funding before. We've seen it. It's very strict. So is there a concern for this, or is there something we're missing on the surveys here or——

Dr. FELDMAN. May I say that I was really talking about proposals to limit the number of awards that a company can apply for or can receive. And so we've heard that this is a concern, and I think it would be a bad idea in that because it's difficult to write proposals, there are economies of scale of having firms with a lot of PIs who are writing projects. And so I think that we should not limit the amount, and that's why I mentioned it——

Chairwoman STEVENS. OK.

Dr. FELDMAN [continuing]. Because I think if we want to encourage innovation, we just want to let there be as much experimentation and as many applications as possible.

Chairwoman STEVENS. Yes, because if you're limited, what happens? You know, what, do you start a new company or—you know.

Dr. FELDMAN. Right.

Chairwoman STEVENS. Yes, you know, or you're stopped in your tracks. I mean, I—just a couple weeks ago, I—we spent some time reviewing all these phases and the ways in which you get an SBIR, and it's—it is not easy, and yet it's—it really is serving a very unique purpose.

OK. So I'm over the 5 minutes for the second round of questions. We don't have any other Member who wants to do a second round of questions, so we're going to move to close.

And obviously, a huge thank you to our witnesses. Thanks for your patience at the beginning of this hearing as we moved from hybrid to all in Zoom. We did have the Zoom hybrid working yesterday, and I'll tell you the Science Committee here under my Chairmanship last term was one of the first Subcommittees to continue with Committee activity in March and April of 2020 because we know—although pandemics are long oftentimes, the work of innovation does not stop, the work of entrepreneurs and makers and dreamers and doers.

And, you know, we're really excited to have had today's kind of fact-based hearing on SBIR/STTR programs. Your expertise and your knowledge, this was very, very insightful. And I know that the colleagues who participated and who will participate following the conclusion of the hearing and the 2-week question for the record period have really appreciated your time and obviously the trajectory as we move forward with the reauthorization legislation that Dr. Baird and I introduced.

So with that, again, the record is going to remain open for 2 weeks, and the witnesses will be excused, and the hearing is now adjourned.

[Whereupon, at 11:49 a.m., the Subcommittee was adjourned.]

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