



Testimony of

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SBIR Turns 40: Evaluating Support for Small Business Innovation

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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 (TABAs), 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.