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Before the

Subcommittee on Research and Technology
Committee on Science, Space and Technology
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on

"America's Seed Fund: A Review of SBIR and STTR"

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Chairwoman Stevens, Ranking Member Baird, and Members of the Subcommittee on Research and Technology, Committee on Science, Space and Technology:

It is an honor and a privilege to submit this written statement and to join you today to discuss how the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs play a critical role in translating Federally funded research into commercial development; create high-tech jobs, build new industries, and fuel economic growth; help federal science and defense agencies meet their respective missions; help maintain the position of the United States as the preeminent global leader in technology innovation; and protect the health, safety, and security of every American citizen.

I will first provide an overview of my experience as a tech entrepreneur with the SBIR/STTR program, framed by my personal interactions with six SBIR/STTR-funded companies launched out of the University of Michigan (U-M), including my own current venture, Endectra LLC. I will discuss some strengths and weaknesses which I have observed in the various programs and comment on variations in administration between different agencies. Finally, I will offer some ideas for potential improvements to the SBIR/STTR program and U.S. innovation policy in general, including specific observations concerning the *The Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2019*.

I offer these observations through a unique lens, having professionally mentored and helped to seed finance—often through SBIR/STTR awards—over 30 university spinouts, several student-initiated startups, and two university spinouts of my own over the last 12 years. I have managed successful SBIR and STTR projects representing over $2.7M in critical seed-stage funding for my own ventures, and helped to secure over $5M in SBIR/STTR funding for other student- and faculty-led startups. These proposals and funding have spanned the National Science Foundation (NSF), National Institutes of Health (NIH), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), and Department of Defense (DoD - Army, Navy, Air Force, Defense Threat Reduction Agency, and Defense Advanced Research Projects Agency), giving me firsthand experience with the administrative variations between many of the SBIR/STTR-awarding agencies. The SBIR/STTR funding I've helped to secure has in many cases led to follow-on angel, venture capital, and/or strategic investments and commercialization of technologies that now meet important "dual use" civilian and military needs and keep the U.S. at the forefront of technological innovation globally (see in particular the stories of H3D and SkySpecs below).

I have also served as a Mentor-in-Residence (MIR) for the U-M Office of Technology Transfer, as an Entrepreneur in Residence for Invest Detroit Ventures, and as a program advisor and MIR for the Michigan Economic Development Corporation's statewide "Tech Transfer Talent Network" (T3N) program. Through these diverse experiences, I've accumulated numerous lessons learned and more than a few "useful scars" concerning university sponsored research, intellectual property, startup formation, tech transfer, venture capital, and the SBIR/STTR program. It is my hope that my experience and observations will be highly complementary to the views offered by the other distinguished professionals providing testimony today.

Intralase Corp.

Federally-funded research at the University of Michigan has led to a number of high profile innovations and companies, and one of the most successful was Intralase, which commercialized the blade-free laser technology used in LASIK eye surgery (Figure 1). This project was well before my time in Ann Arbor, with the company spinning out[1] in 1997 (and the basic university research going back as far as 1992), but I reference it here because it is an SBIR success story, and one which has had a profound effect on my life—I had a very successful LASIK procedure in 2006—and one which has benefited many millions of Americans, perhaps including some attendees of this hearing.

Fig. 1: LASIK (Laser-Assisted in Situ Keratomileusis) is a type of refractive surgery for the correction of myopia, hyperopia, and astigmatism in which a laser is used to reshape the eye's cornea to improve visual acuity.

The Intralase team, under the technology leadership of Dr. Gerard Mourou, utilized SBIR funding to develop the ultrafast femtosecond laser technology that is used to create the corneal flap required in LASIK surgery. The laser technology has many additional applications, which I will return to later, but the Intralase team leveraged SBIR funding specifically to develop a method for automated refractive eye surgery. The team secured **5 Phase I SBIRs and 3 Phase II SBIRs between 1992 and 2002, for a total of approximately $2.2M in seed funding** from three agencies: Dept. of Health and Human Services (DHHS), DoD/USAF, and NSF. Their innovation created a smoother, more accurate, and more secure corneal flap than was possible with a metal blade, yielding consistently better visual acuity after surgery and enabling many patients with thin corneas to benefit from LASIK surgery who otherwise might not be candidates. Intralase went public via IPO in 2004 and was then acquired by Advanced Medical Optics (AMO) for $808M in 2007. AMO combined the Intralase technology with its a complementary laser technology for reshaping the cornea, making "all laser LASIK" possible; AMO was then acquired by Abbott Laboratories for $2.9B in 2009, and Abbot Laboratories was in turn acquired by Johnson & Johnson for $4.3B in 2017. Dr. Mourou shared the Nobel Prize in Physics in 2018 for his method of generating high-intensity, ultra-short optical pulses.

Intralase provides an excellent example of the many benefits and long term value creation that can be catalyzed through SBIR/STTR investment: high tech job creation; wealth creation (which is plowed back into universities and local entrepreneurial ecosystems); global technological leadership (a Nobel Prize, plus over 40 million LASIK procedures performed worldwide); increased economic growth (including Federal tax revenues); and military benefits (NASA and DoD eventually approved LASIK for most personnel). In this case the DHHS, DoD, and NSF all also met their respective missions and received an outstanding return on their SBIR investments. Furthermore, as noted above, the ultrafast laser technology,

[1] In university tech transfer, a new company is generally considered "spun out" or "launched" when it signs a license agreement for the university technology on which it is based; companies operate prior to that point under an "option agreement."

which was substantially advanced both within Intralase and at the University of Michigan through SBIR funding and follow-on private investment, also has other applications. As is typical of many "platform" innovations developed at universities and national labs, U-M licensed the ultrafast laser technology to Intralase for a specific field of use (ophthalmic medical devices), retaining the right to license out additional applications such as materials processing, advanced manufacturing, high precision military ranging, and remote sensing of air pollutants.[2] Dr. Mourou is even working on a technique to transmute nuclear waste into new forms of atoms which are no longer radioactive.[3] These are truly remarkable economic and societal dividends for a $2.2M SBIR seed investment.

The Intralase story is also illustrative of the challenge of commercializing what I call "hardtech"—physical science innovations with far-reaching impact, often based on many years of prior basic and applied R&D at universities and national labs, that require substantial scientific, engineering, and technical expertise, large teams, numerous rounds of investment by "patient" capital, and 5-10 years to reach maturity. Provided of course that they first find a way to cross the daunting "chasm" that exists between the laboratory and marketplace, a chasm which is far larger in the physical sciences than in software; consider the hard constraints of fundamental physics, biology, and Moore's law versus the infinite scalability of information technology, or the cost and time required to protoype a battery versus that required to host a weekend hackathon. Imagine the challenge, in 1992, to map a pathway for a laboratory laser to eventually gain FDA approval and patient/ophthalmologist acceptance for cutting into and reshaping a human eye! The prevailing "fail fast" mantra is also problematic for the university professor who has made a hardtech innovation his or her life's work, and university tech transfer professionals and mentors, representing the fiduciary duty and societal mission of the university, cannot allow Federally-funded research with valuable applications to end up on the proverbial university shelf merely because they need time to mature. The SBIR/STTR program is one of the most powerful and flexible tools we have to address these hardtech challenges, and I offer the following five additional SBIR/STTR-funded hardtech companies to further illustrate this point.

H3D, Inc.

H3D (www.h3dgamma.com) is a 2013 spinout from the U-M Nuclear Engineering and Radiological Sciences (NERS) program. Over the past decade, the H3D team, led by CEO Dr. Willy Kaye and his former professor Dr. Zhong He, have successfully commercialized a novel gamma radiation imaging technology for nuclear power plants, defense, and homeland security applications (Figure 2). I had the pleasure of working with H3D first as a U-M MIR, then as a private consultant, and finally as a collaborator on a DTRA SBIR. In 2010, the technology had already received over 10 years and $16M in Federal funding for basic and applied research, and we were able to articulate a robust, "dual use" path to commercial deployment in nuclear power plants and through direct sales to DOE, DHS, and DOE. Using a subaward from a Federal grant to U-M NERS, a small cash award from the 2011 Accelerate Michigan Innovation Competition, and employing four recent NERS PhD graduates, H3D managed an extremely lean launch in 2013 and then scaled with a combination of SBIR support and revenues from the early adoption of its "Polaris-H" detectors in U.S. nuclear power plants. The H3D team secured **6 Phase I SBIRs and 2 Phase II SBIRs between 2014 and 2019, for a total of approximately $2.15M in seed and early-stage funding** from three agencies: DOE, NIST, and DoD. Today H3D has approximately 35 employees and its gamma imaging spectrometers have been widely adopted for radiological monitoring of nuclear power plants, nuclear materials security and safeguards, and defense applications. 70% of the U.S. nuclear power plant fleet now uses H3D detectors.

[2] *IntraLase to develop, market laser systems for eye surgery.* 29Jan2007. https://news.umich.edu/intralase-to-develop-market-laser-systems-for-eye-surgery/

[3] *Zapping Nuclear Waste in Minutes Is Nobel Winner's Holy Grail Quest.* 02Apr2019. https://www.bloomberg.com/graphics/.2019-nuclear-waste-storage-france/

Fig. 2: H3D currently sells seven different gamma imaging spectrometers based on Cadmium Zinc Telluride (CZT) for use in nuclear power plants and border security. Additional military-grade systems are in various states of technology insertion.

While H3D was very unique in "crossing the chasm" without initial SBIR/STTR support or other seed investment, the team credits SBIR funding with driving much of the subsequent growth of the company. The total dollar value of the company's SBIR funding is relatively small versus the company's aggregate revenues 2013-2019, but according to Dr. Kaye, SBIR funding has driven the innovation of the H3D technology platform more than any other funding source. DOE has provided the most substantial SBIR funding to date, including a Phase II SBIR effort to develop a handheld device for the characterization of radiological sources inside a nuclear facility. This device answered a specific need articulated by the DOE program office—enhancing fuel cycle safeguards—but it also enabled H3D to enter other adjacent markets such as radiation chemistry and waste processing with the same underlying technology.

However, the most important contribution of this DOE SBIR research effort to the company's growth was the fact that some of the core technology required to accomplish the SBIR effort also improved the entire H3D product line. This greatly enhanced the company's core product offering and helped H3D achieve such rapid and deep market penetration in domestic nuclear power plants. For an early-stage company there are almost always aspects of a product that could be greatly improved but which would be risky to undertake for a small company with limited funds. SBIR/STTR funding allows company researchers to focus on higher risk and higher reward activities with large commercial potential, which even if not entirely successful, often yield new manufacturing techniques, cost reductions, and other beneficial innovations that can be applied enterprise-wide across a company's entire product portfolio. H3D's rapid penetration of a conservative industry such as nuclear power would not have been possible without the technological enhancements it developed with SBIR funding.

H3D technology, advanced with SBIR funding, has also reached customers on four continents and in more than 15 countries worldwide. The International Atomic Energy Agency (IAEA) has purchased multiple gamma-ray imaging spectrometers developed through the SBIR program and is investigating a next-generation spectroscopic handheld device with technical specifications that were derived directly from the results of several DOE/H3D SBIR projects. H3D technology is also being integrated into a vehicle-based imaging system under the DoD Joint Program Executive Office for Chemical, Biological,

Radiological and Nuclear Defense (JPEO-CBRND). The company hopes to participate in an even larger sensor suite upgrade program to create a standard CBRNe payload for the entire US military. This is an excellent example of how the SBIR/STTR program creates innovation that often reaches beyond our borders and across agencies to achieve exponential impact.

Every company with which I've worked has submitted promising, compelling SBIR and STTR proposals that have not been funded. H3D is no exception, but it is particularly illustrative of the fact that the very exercise of thinking through the SBIR/STTR technical scope of work for an innovative product, assessing the market, developing a sound business plan, and securing collaborators is often a worthwhile process even if the proposal is not funded. The same agency may reopen the same opportunity in future years if the need is not properly addressed, and sometimes other agencies may ultimately decide they want to fund the work. I worked with H3D on one particular SBIR proposal that was rejected by NIH, but later much of the work was rolled into a funded NIH R01 grant in a collaborative effort between H3D and the University of Maryland. Likewise, some of the DOE Phase I SBIR efforts that did not receive Phase II funding were deemed so valuable that H3D internally funded the Phase II R&D using commercial profits. This is yet another example of the power of the SBIR/STTR program; even when companies "fail" in the process (or elect not to proceed, as in the example below), it still tends to catalyze valuable technical and business innovation.

SkySpecs, Inc.

Federal funding to university labs produces a great deal of technological innovation, but it also produces talent in the form of brilliant undergrad and graduate students who go on to become outstanding inventors and entrepreneurs across multiple ventures. SkySpecs (www.skyspecs.com), an autonomous drone company that is revolutionizing wind farm inspections, is a prime example of this (Figure 3).

Fig. 3: A SkySpecs drone conducts an automated inspection on a wind turbine at a wind farm.

I first met the co-founders in 2011 when they were aerospace engineering and computer science grad students at U-M. I was still focused on mentoring several companies spinning out of the U-M Office of Tech Transfer, but I quickly recognized a unique combination of market opportunity, passion, and technical capability and so decided to try mentoring my first student startup team. The team launched SkySpecs in 2012 after winning the International Aerial Robotics Competition, and then won the Michigan Clean Energy Venture Challenge in 2013. I helped them close a seed round led by Invest Detroit (where I was an Entrepreneur in Residence) later that year and strongly encouraged them to seek additional SBIR/STTR funding. In July 2014, SkySpecs was awarded an **NSF Phase I SBIR for an additional $150,000 in seed funding.** Today, SkySpecs has nearly $10M in annual revenue, 50 employees spanning five countries, and has completed over 30,000 wind turbine inspections in 19 countries. The company closed a Series C financing of $17M in late 2019, for a total of $29.3M capital invested.

The focus of the SkySpecs Phase I SBIR was to develop sense and avoid capabilities for small unmanned aerial systems to help the Federal Aviation Administration safely integrate drones into the national airspace. While the project did not proceed to Phase II—the company won $500,000 at the Accelerate Michigan Innovation Competition in November 2014 and decided to forego the effort—SkySpecs is similar to H3D in that the act of executing the Phase I SBIR scope of work still led to innovations which benefited the company's entire technology platform. Furthermore, developing the organizational discipline required to execute the technical scope of work of the SBIR, comply with the programmatic

rules that apply to federal grant recipients, and be responsive to external stakeholders like Federal Program Managers was invaluable in preparing the company for its rapid growth. This "positive organizational side effect" of the SBIR/STTR program is something I have repeatedly observed in numerous early-stage companies; SBIR/STTR funding is often the first capital into these companies and it comes with a number of rigid rules, deadlines, and reporting requirements that engender individual and organizational growth, radically accelerate company and technology development, and prepare the startup team for bigger future challenges. The two very early-stage companies below are excellent examples of this phenomenon.

Enertia Microsystems, LLC

Enertia Microsystems is developing an ultra-high-precision Micro Electromechanical Systems (MEMS) gyroscope called the birdbath resonator gyroscope (Figure 4). The BRG can enable autonomous vehicles to operate on inertial navigation alone for up to 15 minutes. The basic and applied research behind the BRG was funded by DARPA over many years, and the team has subsequently secured an **NSF Phase I SBIR, a DoD/USAF Phase I subaward, and a NASA Phase II subaward, for a total of $580K in seed funding.** The company is pre-revenue with four part-time employees, but is hoping to grow rapidly in 2020 with a pending NSF Phase II award and numerous strategic relationships. In negotiating and managing subaward contracts across two different agencies, the technical founders, who are also presently the management team, have had to develop substantial new contracting and compliance skills and make the transition from conducting R&D within a major research university to doing so in a minimally-resourced startup, sometimes with sponsored research agreements. This exercise of managing SBIR/STTR grants and contracts is not for everyone, and while some technical founders positively flourish in the process, such as Dr. Kaye at H3D and Dr. Cho at Enertia Microsystems, it can be an invaluable experience in encouraging others to partner with professional management talent.

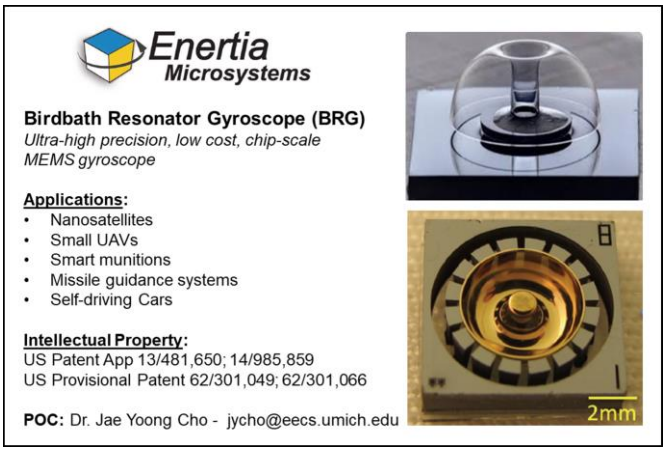

Fig. 4: Enertia Microsystems is developing the next generation of MEMS gyroscopes.

iReprogram LLC

I had the pleasure of helping to launch iReprogram out of the U-M Department of Computational Medicine and Bioinformatics in 2017 and assisted the faculty founders in winning **DoD/DARPA Phase I and Phase II STTRs for a total of $1.08M**. Building upon prior discoveries by Dr. Indika Rajapakse and his research team, the company succeeded in creating a prototype MATLAB bio-computational tool which can analyze, predict, and optimize cell conversion and differentiation (Figure 5). In addition to meeting this important technological goal for the Phase I effort and validating the tool through wet lab experiments, the SBIR also pushed the team to meet important business objectives, including establishing a well-equipped computer lab within company controlled space, hiring key employees and consultants, recruiting additional management talent and advisors, and establishing preliminary relationships with DoD transition and private-sector commercialization partners, such as MathWorks. As it evolves, the iReprogram bio-computational tool will be applicable to an extremely broad range of applications and market opportunities relating to cell-cycle progression, growth, metabolism, healing, aging, and cell death. This is yet another example of the broad "dual use" impact that SBIR/STTR awards can catalyze; iReprogram could have just as easily launched with NSF or NIH funding (and might still pursue such funding), but the outcomes and benefits to humanity will be the same.

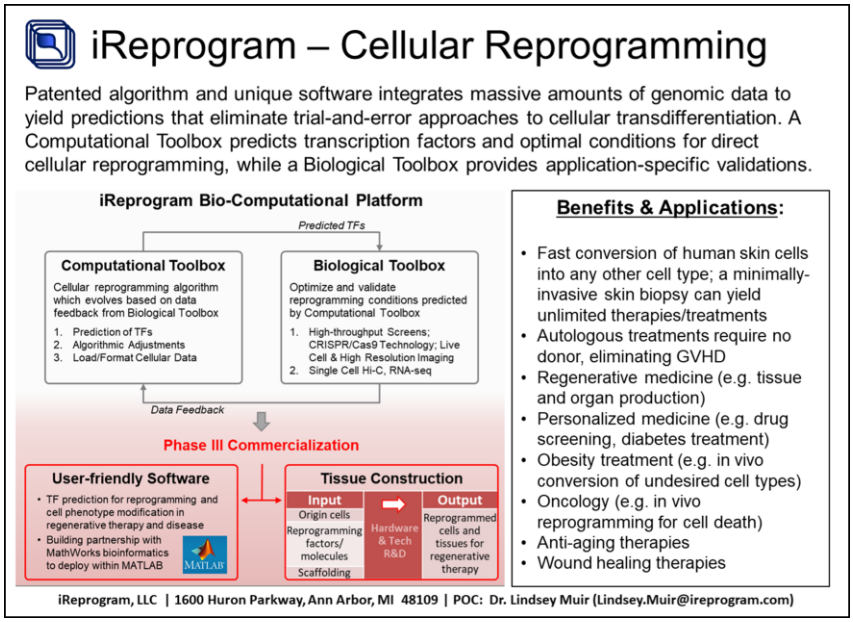

Fig. 5: iReprogram technical summary (unclassified).

Endectra

Finally we come to my own company, Endectra LLC (www.endectra.com). As with Enertia and iReprogram, my co-founders and I launched the company with Phase I SBIR funding and a $25K match from the Michigan Emerging Technologies Fund (MI-ETF), plus I had some in-kind support from Invest Detroit Ventures. We subsequently secured an **NSF Phase IB SBIR, DoD/DTRA Phase I SBIR, NSF Phase II SBIR, NSF Technology Enhancement Commercialization Partnership (TECP) supplement, and a DoD/USAF Phase I STTR for a total of $1.3M in seed funding.** Our five years of translational research have yielded a portfolio of distributed sensors for defense, medical, and industrial applications (Figure 6). We have developed a patented, compact, low cost photonic sensor module for radiation detection which can be integrated into existing handheld and mobile threat detection systems, deployed in a series of interconnected sensor nodes for stationary detection, and miniaturized for integration with small drones. We have also adapted this silicon photomultiplier-based (SiPM) technology to a Cerenkov MultiSpectral Imaging (CMSI) probe for cancer radiotherapy (NIH STTR pending), a non-invasive blood glucose meter, and an atomic absorption spectrometer for industrial metrology.

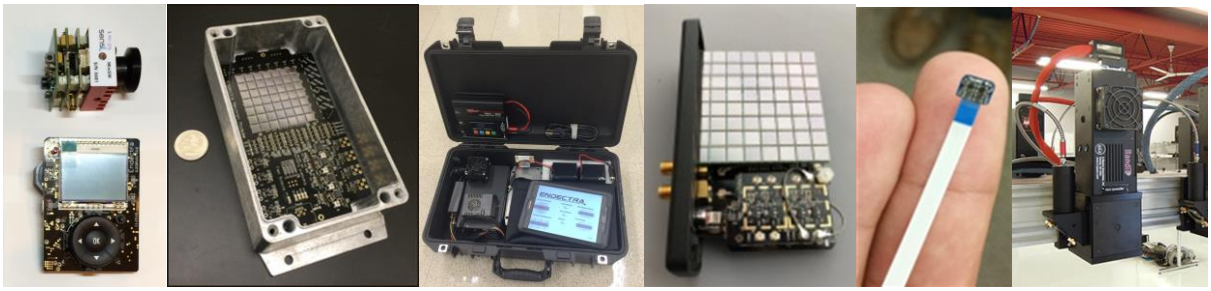

Fig 6. Endectra SBIR funded innovations, from Left to Right: (a) Endectra CBSG-2 (Cerenkov Borosilicate Glass) prototype neutron detector (Aug 2015); (b) CBSG-3 neutron detector module (Jun 2016); (c) Tri-Modal (gamma, fast neutron, slow neutron) Radioisotope Identification Device incorporating Endectra and H3D technology (Aug 2016); (d) CBSG-4 wireless radiation sensor network module (Feb 2017); (e) CMSI probe utilized in arrays of multiple on-skin probes for radiotherapy (Dec 2017); (f) Online metrology tool within which we helped integrate a SiPM-based spectrometer for a leading domestic photovoltaic manufacturer (July 2018).

Endectra has also combined the proprietary, low power network technology originally developed to interconnect our distributed radiation detectors with a unique plug-load power metering technology conceived by our CTO Dr. Sam DeBruin (who is also a co-founder of SkySpecs) to rapid prototype an extremely compact plug-load power meter (Figure 7a-c). This "uSense" system is specifically designed for large-scale enterprise energy management; the uSense plug is the smallest plug-load power meter in the world today and is far more accurate, rugged, and reliable than current consumer-oriented, commercial-off-the-shelf power meters. We also extended our network technology and embedded systems expertise to produce a small batch of networked ammonia gas sensors in a "smoke detector" form factor to facilitate industrial demonstrations by a research team at Wayne State University (Figure 7d). This led us to a new collaboration in 2019 with Michigan Technological Research Institute, Wayne State University, and Lockheed Martin to develop a palm-sized gas sniffing drone under a DoD STTR project.

Fig 7. Left to Right: (a) 3D printed model and 3 generations of uSense PCB prototypes; (b) the latest uSense 3.0 PCB incorporates a rigid-flex design derived from our CMSI radiotherapy probes to streamline assembly; (c) Endectra wireless gateways and uSense meters in Beta trials (Jan 2019); (d) WSU ammonia sensor PCB incorporating nanowire vapor sensor, battery management system, and wireless backhaul (Dec 2018).

Every company I have highlighted is a great example of university-derived hardtech: they required (or likely will require) millions of dollars in follow-on funding, a decade or more to reach full commercialization and/or an exit, a large and highly educated team, and a great deal of persistence. The SBIR/STTR program plays a critical role in the viability of these ventures, providing seed funding sufficient to refine the technology and de-risk the venture until it becomes attractive to investors or organically achieves sustainability on revenues. Endectra is no different, with the exception that our first attempt to commercialize our radiation detection technology collided head on with external forces beyond our control and necessitated that we pivot and opportunistically pursue other related technology applications. We would not have survived this experience without the flexibility of the NSF SBIR/STTR program, which unlike other agencies' programs tends to focus more on the development of the company than a specific technology. I now recommend that newly forming university spinouts first pursue NSF funding before appealing to the other agencies under a tech-specific topic, or to consider submitting differentiated proposals in parallel (e.g. submitting a strictly military tech proposal to DoD and a dual-use civilian tech proposal to NSF).

Additional Observations and Recommendations

- I cannot overemphasize the importance of the SBIR/STTR program with respect to "hardtech" commercialization. The venture capital community has prospered for over 25 years by investing primarily in infinitely scalable, software-enabled ventures and there is relatively little "patient capital" for early-stage ventures facing a 7-10 year development path. It is so bad that companies are even "lying about their age" in order to look like the Next Big Thing.[4] The bottom line is that hardtech has a longer, bigger chasm to cross, but the outcomes are often in the strategic interest of the United States and its taxpayers. Therefore maintaining the SBIR/STTR program is absolutely essential.

[4] "Dating Game Helps Them Stay Forever Young - Resetting the clock, startups pick and choose later 'founding' dates to suit their agenda." The Wall Street Journal, 07Aug2017.

- It is a cliché that "business needs certainty" from the Federal Government, but it is particularly true for fragile, early stage companies which are already facing substantial tech and market risk. Greater certainty in the SBIR/STTR process could be achieved in many ways, including keeping to publicized (and preferably faster) timelines for proposal review and funding decisions; providing transparency with respect to expected selection rates and funds available for Phase II projects; transitioning contract-based awards away from small payments/tranches to the larger up-front payments made under grant-based awards (this is particularly important to very early stage companies with limited working capital); and standardizing, as much as possible, the proposal processes of each agency.
- The NIH should be explicitly encouraged to follow the NSF model of seeking "high risk, high return" research in Phase I, with emphasis on proof of concept in Phase I and translation in Phase II. I have relatively limited experience with NIH, but in my experience and that of many colleagues, the NIH is tending toward a very risk-averse approach to Phase I SBIR/STTR proposals.
- All agencies should redouble efforts to screen panelists for conflicts of interest. I am aware of at least two instances in which a competitor gained confidential and sensitive information about an SBIR applicant, and one in which an excluded individual negatively influenced a marginal funding decision. No entrepreneur wants to spend the personal capital or risk having his or her company "blacklisted" to resolve such an issue, and it is in the best interests of the government to ensure the absolute integrity of the SBIR/STTR program.
- The NSF recently increased its baseline SBIR/STTR Phase I funding level to $225K and the NIH has routinely obtained SBA waivers for Phase I awards as high as $400K. I believe that all agencies should be encouraged to follow suit; it can be extremely difficult to complete a quality Phase I project on $150K, especially when it is the first capital into a new company with little or no prior working capital. I recognize that in some situations this might limit the number of topics and/or awards, but I believe that the net outcome would be positive in most cases.
- All agencies need to address the "success to the successor" problem, wherein new startups (1-10 employees) and established/scaling companies (11-50 employees) are beaten out for Phase II funding by relatively large, established companies that have a long track record of SBIR/STTR success and/or an incumbent technology, yet still meet the SBA SBC size standard. In my experience, opportunities have been missed for the Federal Government to help establish an alternative domestic technology vendor (to ensure healthy economic competition and create jobs in new parts of the country) or finance an alternative technological solution to a particular problem, because an award panel or Program Manager chose the "sure thing" over the fledgling startup. In many cases, the established company was merely making incremental improvements to an existing offering, while the smaller company was attempting to deliver a new, more advanced technology into the market. I believe the latter is more consistent with the spirit and intent of the SBIR/STTR program. This often happens when Program Managers are forced to downselect from several projects to a single Phase II award, so creating more flexibility in SBIR/STTR budgeting and funding mechanisms is one solution.
- With the exception of NSF, which already has very broad topic areas, all agencies should be encouraged to solicit "open topics" to capture innovations relevant to their mission areas which otherwise do not fit their technology topics. The Air Force piloted just such a program last year to increase the efficiency, effectiveness, and transition rate of their SBIR program, and this might be a useful model.[5]
- Endectra and many of the companies with which I have worked have significantly benefited from participation in the NSF I-Corps program, which is designed to reduce the time and risk associated with translating promising ideas and technologies from the laboratory to the marketplace, identify viable paths to market, and prepare tech entrepreneurs for participation in the SBIR/STTR program. I

[5] https://www.afwerx.af.mil/sbir.html

recommend that other federal agencies leverage the work that NSF has done to create a Nationwide Innovation Network focused on finding those critical first markets for emerging technologies.

- To increase the number of hardtech SBIR/STTR success stories like those I have highlighted above, all agencies should increase engagement with the university engineering and biomedical programs training the next generation of PhD scientists and engineers for entrepreneurial careers. Programs like the Center for Entrepreneurship in the U-M College of Engineering, where I teach entrepreneurial leadership, have a key role to play in instilling an entrepreneurial mindset in our tech communities.
- All agencies should also consider adopting the new "Project Pitch" recently piloted at NSF. From the entrepreneur's perspective, this is an excellent way to minimize the time spent on a process with an uncertain outcome and to de-risk that process. From the agency perspective, it is a way to reduce the number of poor quality or off-target proposals and increase throughput of high quality research.
- I have observed a large influx of foreign capital targeting tech transfer over the past decade (in fact, one of my prior companies was negatively impacted by it), which is yet another reason why we must preserve and strengthen the SBIR/STTR program. Our university innovators need this perfect bridge funding to cross the chasm, or else there are international sources of funding just waiting to fill the gap and harvest valuable American innovations. The SBIR/STTR program helps to ensure that our groundbreaking technologies get developed here and capitalized by domestic financiers who will return any wealth created to our own economy.
- I have also noted that research universities and state governments are increasingly stepping up to help the Federal Government provide this bridge. Many universities are doubling down on their innovations using donor and endowment money. For example, U-M now has the Michigan Investment in New Technology Startups (MINTS) fund, the Michigan Biomedical Venture Fund (MBVF), and the recently launched Accelerate Blue Fund to provide seed capital to nascent U-M startup companies. Many universities have also adopted MIR programs to build and support companies before and during SBIR/STTR projects. Meanwhile the State of Michigan and the SBDC offers the aforementioned MI-ETF matching fund for SBIR/STTRs.
- Concerning *The Small Business Innovation Research and Small Business Technology Transfer Improvements Act of 2019*, I applaud the decision to prioritize small manufacturing companies, SBCs engaged in cybersecurity R&D, and minority and Hispanic research institutions. We have a long way to go to rebuild our domestic manufacturing base and counter the cyber threats of the coming years, and we need to leverage the diversity of our nation to produce the very best science and innovation. I would suggest that in the future we also prioritize SBCs developing low carbon energy and climate mitigation technologies in order to address the existential threat of global warming. I strongly approve of the Commercialization Assistance Pilot Program, wherein an SBIR Phase II awardee may receive a subsequent Phase II award with a 1:1 external funding match. This seems like an enhancement to the NSF Phase IIB Supplement, which has been widely successful in giving awardees a valuable extra "push" into the marketplace.

Conclusion

The SBIR/STTR program helps to fill the large gap between laboratory research and commercialization and is an essential component in our nation's innovation ecosystem. The very best universities and national labs are only as good as the innovations they deliver and the real-world problems they solve for humanity, and the most impactful innovations sometimes require the most patience, talent, and investment. Innovations funded under the SBIR/STTR program have a long record of creating American jobs, improving our lives, and meeting national needs, and I am grateful to have personally benefited from such innovations and to be an active participant in inventing and commercializing new ones. Thank you for the opportunity to testify today and for your continued support of the SBIR/STTR program. I will be pleased to answer any questions you may have.