



*Written Testimony of  
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House Committee on Small Business  
Subcommittee on Innovation and Workforce Development  
Hearing on  
“The Innovation Pipeline: from Universities to Small Businesses”  
February 11, 2020*

**Introduction**

Chairman Crow, Ranking Member Balderson, and members of the subcommittee, good morning and thank you for the opportunity to testify. It is an honor to be with you today—on National Inventors’ Day—to discuss the University-Small Business Innovation Pipeline.

My name is Sheila Martin and I am the Vice President for Economic Development and Community Engagement at the Association of Public and Land-grant Universities (APLU). APLU is a research, policy, and advocacy organization dedicated to strengthening and advancing the work of public universities in the U.S., Canada, and Mexico. The association's membership consists of 242 public research universities, land-grant institutions, state university systems, and affiliated organizations.

APLU's mission is to expand access and improve student success to deliver the innovative workforce of tomorrow; advance and promote public impact research and discovery to improve society, foster economic growth, address global challenges; and build healthy, prosperous, equitable, and vibrant communities locally and globally.

The subject of today’s hearing is important to public and land-grant universities. Public universities work with small businesses to improve their success and competitiveness in three ways:

- **Talent:** Probably the most important source of technology transfer occurs when companies hire our graduates. When our students participate in federally funded research, they benefit in many ways: they learn about scientific discovery, they participate in cutting-edge research, and they learn how to work in teams. They carry that knowledge and experience to the companies that employ them. They often participate in internships and capstone classes that provide direct experience within companies, including small companies, and these efforts provide businesses the opportunity to solve problems with pioneering techniques that our students are learning from their faculty.
- **Innovation:** The second way universities work with small businesses is through research and discovery that brings new products, greater productivity, and entirely new industries to our

economies, while solving important societal problems. This kind of public impact research isn't just about science and technology. Innovation happens not just in scientific discovery, but also in new business models, new marketing models, and new methods for product delivery. Small businesses of all kinds benefit from these discoveries and their application.

- **Place:** Universities are also important to improving the quality of life in their local communities. They generate more prosperous economies, offer a rich cultural life, enrich civic life of their communities, and partner with their local governments and other organizations to address important community problems like transportation, housing, and public health. Thriving regions are a magnet for the talent that small businesses need to innovate and flourish.

### **University Innovation: The Long View**

We used to think of universities as primarily conducting basic research – uncovering the mysteries of nature that applied researchers build on to generate new products, processes, and businesses. With vital support from federal agencies, it is certainly true that universities conduct a great deal of this basic research and discovery.

Importantly, basic research often leads to unexpected but significant public impact. We don't always know where areas of basic research will lead. For example, consider the two American winners of the 2019 Nobel prize for Chemistry, Stanley Wittingham, of Binghamton University, SUNY and John Goodenough from the University of Texas at Austin. Their basic research into the properties of superconducting materials and magnets led eventually to the development of lithium-ion batteries—an invention that each of us is carrying in our pocket—because it powers our phones and our laptops, fuels electric vehicles, and enables the small business community to easily use the internet to expand their businesses.

The National Science Foundation funded the research that led to the development of these batteries over a span of 30 years.<sup>1</sup> The agency did not know their funding would revolutionize power electronics, but that is the nature of scientific discovery. It is not always possible to predict what kinds of basic research will yield innovations that have economic value; furthermore, that value often comes years, or even decades, after the research investment has begun.

Because the benefits of basic research are so diffuse and long-term, few private sector companies are willing to fund it on their own. Yet without it we would not have the scientific basis for today's economy. Therefore, it makes economic sense that basic research is funded by federal agencies such as the NSF, NIH, NASA, DOD, DOE, and the USDA. Maintaining or increasing the funding to these agencies is essential to ensuring that the font of scientific knowledge that feeds the innovation pipeline to small businesses continues to flow.

Once the value of that research has become more apparent, the private sector leverages federal investment in basic research and invests its own funds to further develop it into innovative new products and industries. Universities collaborate with the private sector to make that happen.

### **Universities Innovations Drive Small Company Success**

University researchers are anxious to see their discoveries put into practice. They are passionate about public impact research and have turned that passion into launching their own businesses or working

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<sup>1</sup> <https://www.nobelprize.org/prizes/chemistry/2019/press-release/>

with existing businesses to further develop and implement those technologies. According to the Association of University Technology Managers, (AUTM), from 1995 to 2018, entrepreneurs have used university research to launch 14,021 companies.<sup>2</sup> Before good ideas reach the market, though, someone must invest in the additional research, design and process engineering, as well as marketing and business models that turn them into a new product, a new process, a new business, or an entirely new industry.

At this stage, there is still a great deal of risk involved in that process—risk the private sector is often loath to shoulder without incentives, despite the potential for economic returns and positive public impacts. That is why programs like the Small Businesses Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programs are so important. They provide funding to help companies work through some of the more difficult technical risks, evaluate the market potential, and take ideas to the point where the private sector is ready to invest.

Public and land-grant universities are important sources of both ideas and talent for the companies that benefit from SBIRs and STTRs. A survey by the National Research Council found over half of respondents reported some university involvement in SBIR projects. Of those companies, more than 80 percent reported that at least one founder was previously an academic.<sup>3</sup> Furthermore, studies show direct, systematic evidence that a university connection to an SBIR project, as either the source of the technology or involvement of a university researcher in the company, increases the probability that the SBIR grant will lead to a successful commercialized technology.<sup>4</sup>

There are many challenges to getting great ideas from the laboratory into the marketplace. AUTM estimates that over 380,000 innovations were disclosed to research institutions in the past 25 years. Many of these innovations will never become companies or products. And many companies that are launched don't survive for very long. Of the 14,021 companies formed from university innovations from 1995 to 2018, only 6,518 are still operational.<sup>5</sup> The costs of patenting and perfecting a technology for the market, the technical challenges at early development stages, the lack of early stage capital, and the shortage of market and business expertise among scientists all stand in the way of a successful product and business. But with the help of public research funding and programs like the SBIR and the STTR, universities and their partners are tackling these challenges.

While there are countless examples of companies that have received SBIR funding based on university technologies, I will highlight a few here.

### ***Powering A Clean Energy Future***

Innovative technologies based on university research are helping to move our economy toward cleaner, more sustainable energy sources. Solid Power is a great example. Solid Power is a Louisville, Colorado company that spun out of the College of Engineering and Applied Sciences at the University of Colorado at Boulder. It is developing solid state battery technology for the electric vehicle market. Solid state

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<sup>2</sup> <https://autm.net/surveys-and-tools/tech-transfer-infographic>

<sup>3</sup> National Research Council 2008. An Assessment of the SBIR Program. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11989>.

<sup>4</sup> Link, A. N., & Ruhm, C. J. (2009). Bringing science to market: Commercializing from NIH SBIR awards. *Economics of Innovation and New Technology*, 18(4), 381–402. <https://doi.org/10.1080/10438590802208166>

<sup>5</sup> Association of University Technology Managers. <https://autm.net/surveys-and-tools/tech-transfer-infographic>

batteries are safer than standard liquid electrolyte designs, and they provide approximately double the run time—a significant factor in the demand for electric vehicles. Solid Power received Phase I and II SBIR awards from NSF, DOD, DOE, and NASA. They are now backed by strategic investors including Hyundai, BMW, and Samsung. Federal investment has laid the groundwork for societal impact and private sector competitiveness.

Xpeed Turbine Technology (XTT) of Piscataway, NJ was launched with technology developed at Rutgers University by co-founders Arturo Villegas and Javier Diez. XTT's mission is to improve the efficiency of wind turbines. They have developed a deflector that can be deployed on existing wind turbines to make them up to 4 percent more efficient for a small investment with a one-and-a-half to three-year return on investment. XTT received a \$150,000 Phase I SBIR from NSF in 2016 and a Phase II \$750,000 Phase II grant in 2017 to further develop this technology, which will help our wind energy industry become more economically sustainable.

### ***Melding Engineering and Life Sciences to Address Health Care Needs***

Biomedical technologies are improving the quality of life for many who face physical challenges. Point Designs is addressing the needs of partial hand amputees, including many veterans. The Lafayette, Colorado company spun off from the Biomechatronics Development Lab at the University of Colorado. The lab is led by Professor Richard Weir, who still serves on the company's board of advisors. Dr. Weir has received many research grants from the NIH and the VA for development of prosthetics. He has also worked side-by-side with the founder of the company, Levin Sliker. The idea for their flagship product, the Point Digit, came from repeated requests from industry clinicians for a durable ratcheting full-finger prosthesis. After two years of development, many iterations, and feedback from prosthetists and end users, they launched the Point Digit in early 2017. Their two SBIR awards, a Phase I award and Phase II fast track award, have both resulted in commercial products that are now being used to improve quality of life for amputees.

Actuated Medical, Inc., located in central Pennsylvania, was incorporated by two graduates of Penn State University with a vision to improve patient outcomes and reduce healthcare costs by integrating electronically controlled motion into medical devices. The SBIR program provided the early-stage capital needed to bring their medical devices to patients. Their first product, the TubeClear system, was funded with a National Science Foundation SBIR. It clears clogged feeding tubes while the tube remains in the patient and works at bedside. The National Institutes of Health (NIH/NICHHD) SBIR funded a pediatric model that is in clinical testing at the Children's Hospital of Philadelphia. TubeClear is a faster, more effective method that works on more types of tubes and types of clogs than current practice. With repeat sales in several large US hospitals, the TubeClear system is enabling patients to receive medication, nutrition, and hydration therapies optimally and on schedule. Without the SBIR program, the TubeClear system would not be available to help these critically ill patients. Actuated Medical has since received private investment and developed strategic partnerships to help fund their growth. Actuated Medical has generated 22 issued U.S. patents and over 40 pending U.S. and international patent applications. Additional devices are working their way through development and regulatory approvals to revolutionize areas like neural implant treatments and pain management.

In 2017, Kansas State University graduate Austin Pfannenstiel founded Precision Microwave, a start-up company in Manhattan, Kansas. Precision Microwave is developing and commercializing new microwave ablation (MWA) technology spun out of the Kansas State's Biomedical Computing and Devices Lab. MWA procedures offer cost-effective, minimally invasive treatment options for localized tumors and other diseases. These treatments are especially important to the large population of cancer patients who are poor candidates for surgery or other physically demanding therapies. Yet currently available MWA systems may damage critical healthy tissues or result in disease recurrence if not placed precisely. Precision Microwave received an NSF STTR Phase I grant to pursue technical R&D of a directional microwave ablation (MWA) applicator. If successful, the resulting proposed technology will facilitate both procedural and technical simplification of MWA treatments, saving time and critical resources in hospitals, and ultimately improving quality of, and access to, cancer treatment for a broad range of patients.

### ***Entrepreneurship that Serves National Security***

The SBIR program also plays an important role in national security. The program helps meet the procurement needs of the Department of Defense by encouraging companies to develop technologies they view as essential to keeping the nation safe. Technology from public universities has been instrumental in meeting these needs. For example, ARCS Aviation of Cookeville, Tennessee develops eLearning modules that employ virtual-reality and augmented-reality for aviators. This cutting-edge technology allows them to build interactive courses where students can do such things as a tip-to-tail walkthrough of an aircraft without ever leaving the classroom. Not only does this give students more hands-on learning time, it allows for simulations to run with complete safety. With help from the University of Tennessee's Procurement Technical Assistance Center and its Center for Industrial Services ARCS Technology secured an SBIR grant from the Air Force—expanding the technology the Air Force employs to train pilots, flight dispatchers, and maintenance, and safety workers.

In 2011, a Kansas State University nuclear and mechanical engineering research associate began a Manhattan-based start-up company, Radiation Detection Technologies, to commercialize innovative, compact, and lightweight radiation detection/monitoring sensors for the defense, homeland security, and health physics sectors where reduced power consumption and compact packages are critical to mission success. RDT addresses a gap in the radiation detection industry that is particularly noticeable because of the lack of a transition of many novel technologies reported in academic literature to the commercial sector. RDT is focused on commercializing technologies such as those developed in two Kansas State University laboratories: The Semiconductor Materials and Radiological Technologies (SMART) and Laboratory and the Electronics Design Laboratory (EDL). Through a series of SBIR grants the company, in partnership with these labs, has successfully transitioned university-grown technologies to its industry partners to deliver innovative, low-power, and compact sensors to the Department of Energy, the Department of Defense, and private industry partners.

### **Meeting the Challenge of Early Stage Risk**

While the SBIR program has been very helpful in getting great ideas to market, there are other innovative ideas that never make it to that stage. Even before they form a company—and therefore become eligible for SBIR—researchers need help understanding the potential for commercial applications of their discoveries.

The National Institutes of Health is working with universities to test new approaches to early-stage risk with its Research Evaluation and Commercialization Hub (REACH) program. REACH funds what are called

Phase 0 projects that focus on the evaluation of discoveries for their commercial potential and, once identified, advances them to the point where the scientists can launch a company, making them eligible for SBIR. The University of Colorado Anschutz Medical Campus is using its REACH award to support translational research projects and their product development efforts.

Colorado REACH is leveraging another important program that offers public university researchers the entrepreneurship skills they need to be successful. Programs such as NSF's I-Corps complement SBIR, STTR, and REACH. I-Corps provides real-world, hands-on, immersive learning about what it takes to successfully transfer knowledge into products and processes that benefit society and reduce the time to translate a promising idea from the laboratory to the marketplace.

AEIOU Scientific of Athens, Ohio provides an example of this successful combination of SBIR and I-Corps launch methodology. AEIOU is a startup company based on a technology for measuring bone strength developed at Ohio University. Three Ohio University researchers joined forces to develop a technology that accurately estimates bone strength—a radical improvement over current diagnostic technologies. After seed funding from Ohio University, they participated in I-Corps@Ohio, a state-sponsored program modeled after NSF's I-Corps. This technology will enable researchers to better understand osteoporosis and other bone diseases and has the potential to help doctors more accurately identify patients at risk of bone fracture. The company is a client of Ohio University's innovation Center incubator, allowing it to manufacture the technology and grow its businesses in southeast Ohio.

#### **Diversifying the Talent Pipeline: Supporting Female, Minority, and Student Entrepreneurs**

Public universities are working tirelessly to improve the success of female, minority, and student entrepreneurs in the SBIR program. One example is the ADVANCE program at The Ohio State University. The mission of Ohio State ADVANCE is to impact the recruitment, retention, and advancement of women faculty in the STEMM disciplines (Science, Technology, Engineering, Mathematics and Medicine), with a focus on building research leaders. REACH for Commercialization is a signature program of the ADVANCE grant; it develops the entrepreneurial capacity of women faculty. With funding from the National Science Foundation, ADVANCE fosters institutional change through support, increased representation, and advancement of women faculty in academic STEM careers.

The Ohio State University has successfully nurtured women to start companies that have been successful with SBIR and beyond. One example is Core Quantum Technologies. The company's founder and Chief Scientific Officer is Professor Jessica Winter from Ohio State's College of Engineering. The technology uses quantum dots, which can fluoresce in multiple colors, to allow laboratories to check for multiple cancer biomarkers at the same time, speeding diagnosis and identification of cancer treatment options. The company's COO, Kristie Melnik, is a graduate of The Ohio State University—another beneficiary of Ohio State's commitment to diversity in STEM fields.

The talent pipeline of entrepreneurs is further enriched by programs that nurture student entrepreneurship. Public universities not only offer formal degree programs in entrepreneurship, but also informal clubs, pitch competitions, and supportive environments like Ohio University's Center for Entrepreneurship and Iowa State University's Student Innovation Center. Universities also partner with organizations like the Lemelson Foundation, which funds Invent Oregon, to mentor students and provide them the resources they need to take their inventions from ideas to working prototypes. From there, they can start working with the services we've already mentioned to get assistance launching a

company. Precision Microwave, mentioned earlier, is a great example: the founder benefited from winning Kansas State's Launch a Business Competition.

### **Strengthening American Manufacturing**

American universities have an important role to play in the development of new technologies that are transforming American manufacturing. University research, often in partnership with industry, advances technology in digitization, the use of smart sensors, robotics, simulation technologies, advanced materials, nanomanufacturing, and additive manufacturing techniques.

Federal support for programs such as the Hollings Manufacturing Extension Partnership and the Manufacturing USA programs complement SBIR in providing support to small and medium-sized manufacturing businesses that work with public universities to develop and utilize these important Industry 4.0 technologies.

For example, Xact Metal is a client of the Innovation Park at Penn State University and the Pennsylvania MEP and is a member of America Makes. Xact Metal's Chief Technical Officer, Matt Woods, laid the foundation for Xact Metal when he recognized the need for additive manufacturing to offer higher performance in a sustainable way. He developed the technology at Penn State's Center for Innovative Materials Processing Through Direct Digital Deposition (CIMP-3D), a leading additive manufacturing research facility. Xact Metal is taking the essential specifications for metal powder-bed fusion and combining them with breakthrough technology to establish a new level of price and performance for additive manufacturing. This allows lower-capital firms to enjoy the benefits of the next generation of innovative manufacturing solutions powered by metal 3D printing. Although they have not received SBIR funding, this company benefits from the suite of state and federal investments that are supporting innovation in manufacturing.

### **Support for Small Business is a Team Sport**

Obviously, successful small businesses—even those in technology intensive industries—need more than technology to be successful. They also need insightful marketing and business strategy advice, assistance with financing, identification of customers, help with training, and eventually, partnerships that will help them manufacture their product and deliver it to customers. This is where other programs, such as the Small Business Development Centers, the Procurement Technical Assistance Centers, and the Hollings Manufacturing Extension Partnership (MEP) complement SBIR and STTR to support small businesses. Public and land-grant universities are very good at leveraging multiple resources to provide these businesses the support they need to achieve sustainability so they can have a greater public and economic impact.

The support that Iowa State has provided Gross-Wen Technologies provides a case study. The company is based on a technology developed at Iowa State University by the company's founders, Dr. Martin Gross and Dr. Zhiyou Wen. This technology removes nutrients and pollutants from wastewater using algae while creating a valuable product that can be turned into fertilizer and a supplement for livestock feed.

After Gross and Wen first formed their company, they met with the Small Business Development Center at Iowa State University to develop its early strategy. The company later joined the cohort of the Iowa State University Startup Factory, which helped the company refine its business model. In that same year, they received a Phase I SBIR award, which enabled the company to demonstrate the feasibility of its technology for producing a slow release algae-based fertilizer. This success led to a Phase II award the

following year to scale production, and another award to use the technology for development of a supplement to livestock feed.

In 2018, Gross-Wen secured its first customer—the city of Slater, Iowa. Applying the company’s technology saved the city over \$1,000,000 compared to the cost of constructing a conventional wastewater treatment system that would otherwise have been required to meet wastewater discharge quality standards. In the meantime, Iowa State’s Center for Industrial Research and Service, Iowa’s MEP affiliate, helped the company connect to manufacturers also in need of lower cost wastewater treatment options.

Other important resources at Iowa State were also involved in this company’s success. Iowa State’s Ivy College of Business set up student groups to assist the company with market discovery, which gives those students valuable experience while providing essential information to the company. The Pappajohn Center for Entrepreneurship provided one of the founders a scholarship that supported his research while in graduate school.

Not only did this company save a small town a great deal of money and bring the world a new, lower-cost wastewater treatment technology that also generates a beneficial byproduct, it also has created several jobs in the small town of Slater.

While Gross-Wen illustrates the importance of leveraging multiple programs across a university, it is also sometimes important to identify resources from multiple universities to support a startup. This was the case with APDM Wearable Technologies, a small company in Portland, Oregon born of technology developed in part at Portland State University. APDM is tackling the problem of balance and fall risk for people with Parkinson’s disease and other sources of movement disorders. Founded in 2007 by Portland State University Professor of Electrical and Computer Engineering, James McNames and his associates, Mateo Aboy, and Andrew Greenberg, APDM has received SBIR and STTR awards from HHS, NIH, and DOD. The company develops technologies for monitoring human movement with wearable sensors and for storing the resulting data for analysis. This supports researchers who are conducting clinical studies testing approaches to addressing these problems. APDM’s success has required collaboration among experts in embedded systems, signal processing, physical therapy, and web-based data management, and has collaborated with scientists, faculty, and clinicians at Oregon Health & Science University, Portland State University, and Oregon Institute of Technology.

### **Cultivating Place: Building Stronger Innovation Regions**

Research and innovative technologies are obviously not all that is required to assist small businesses in overcoming the challenges of getting new ideas into the market where they can have the greatest impact. They also need capital, legal expertise, mentorship, and a policy and innovation environment that is generally supportive of entrepreneurs and attracts the required talent.

Public and land-grant universities collaborate with industry, state and local government, and economic development organizations to build that supportive ecosystem. A notable example is the creation of TechAccel, a private capital development company headquartered in Overland Park, Kansas and launched by Kansas State University’s Institute for Commercialization in 2014. Addressing the shortage of venture capital that plagues many smaller metropolitan areas, TechAccel brings private capital to invest in, acquire, and advance early-stage discoveries and technologies in plant and animal agriculture,



animal health and nutrition, and related areas including food safety and quality and crop processing. TechAccel works with partners to de-risk new technologies. Supporting emerging companies in the animal and animal health sector takes on a new approach through the company's unique "Equity+" investments of capital and talent.

Complementary programs, like the Economic Development Administration's Regional Innovation Strategies program, help bring additional assets into efforts to support the innovation ecosystem. For example, AgLaunch is a nonprofit partnership launched to support the agtech industry in Tennessee. Its EDA i6 Challenge grant is creating AgLaunch i6, a farm-centric commercial validation program for agricultural-technology startups. The initiative will focus on creating a platform to commercialize technologies in agriculture and facilitate farmers' transitions into next-generation agricultural opportunities, stimulate job creation in at-risk rural and urban communities, and create a more profitable system to support AgTech investors and startups. The partnership includes a number of higher education, state government, private sector, and nonprofit partners.

Partnerships between universities, government, and the private sector can also be effective at improving the livability of a community, attracting and keeping the talent that is essential to fueling the innovation economy. The SBIR program contributes here, too, because it helps fund startups in smart cities technologies that improve community livability.

A 2018 SBIR award from the Department of Transportation to Knowledge Based Systems Inc, a small research and development company in College Station, Texas, created a unique research partnership with Texas A&M's Transportation Institute to create a public mobile application for citizens to report sidewalk and pedestrian mobility issues. Working with regional metropolitan planning organizations, pedestrian advocates, and municipal leaders, the grant enabled the creation of this new tool that is being deployed in various areas around the state. In the future, this could provide tools to decision makers in metropolitan areas, such as Fort Worth, TX, where sidewalks are an element of the Active Transportation Plan, and the tool will help identify improvements that will facilitate active transportation.

**Conclusion: Universities Strengthen the Innovation Pipeline, But More Can be Done.**

I'll conclude by stating what might seem obvious from the examples I've shared: public and land-grant universities strengthen the innovation pipeline from universities to small businesses by nurturing the talent that small businesses need; by generating the basic science and applied innovation that companies are built upon and that make them productive and competitive; and by contributing to the broader entrepreneurship and innovation ecosystem and the quality of life in their communities. This combination of talent, innovation, and place is what propels our regional economies and their small businesses forward. Creating and supporting small businesses that take innovative ideas into the marketplace is a part of our mission because it ensures that our research truly has public impact.

Still, there are many challenges to getting great ideas to the market where they can have the greatest impact. APLU and its member universities are grateful for the support of the committee for the important funding programs that fill and advance the innovation pipeline from universities to small businesses. We look forward to working with you to test and scale successful approaches to breaking down the remaining barriers.

To see for yourself how our universities are supporting this pipeline, I invite all of you to the Innovation and Entrepreneurship Showcase, sponsored jointly by APLU and the Association of American Universities, to meet some of the inventors and entrepreneurs that leverage federal research funding to create companies that sell products and processes that have important public impacts. This year, the event takes place on April 28 at 5 PM in here in the Rayburn Building, in the Cafeteria. I look forward to seeing you there.