

**Testimony to U. S. House Committee on Science, Space and Technology/
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AMERICA'S SEED FUND: A REVIEW OF SBIR AND STTR

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I would like to thank Congressman Baird for the opportunity to speak to you today about the Small Business Innovation Research (SBIR) program. I hope you will find that my own experience with SBIR provides compelling evidence of the value of this very important program.

As you know, the SBIR program benefits certain businesses whose roots are usually in university research projects. At the research stage, those projects have typically received federal agency funding, and business from the research is started, if at all, usually by the researchers who are conducting that research. Indeed, SBIR is intended to facilitate and accelerate the commercialization of research, enabling it to contribute to economic growth that benefits the nation, and thereby increasing the return on federal agency research investment. Specifically, SBIR grants cover the very early part of the commercialization runway, where promising ideas are still too risky for conventional venture capital investment.

Successful commercialization is the expected outcome for an SBIR grant. In my case, a total of approximately \$1.5M in SBIR phase I, II, and IIB grants helped my startup, Spensa Technologies, go on to be named by Forbes as one of the Top 25 Most Innovative Ag-Tech Startups in 2017. Spensa created jobs, hiring over 70 technical and business professionals. Its products helped growers reduce the labor cost associated with insect control and make more timely and judicious spray decisions. On average, Spensa doubled its annual revenue in each of the last five years before it was acquired by DTN, which continues to operate the business from the Purdue Research Park where Spensa was founded.

But the numbers do not account for the full value of the SBIR program. An injection of money into any startup may be necessary but it is almost never sufficient for the startup to succeed. That is especially true when the entrepreneurs are academics.

Following the traditional path of a newly minted Ph.D., I became a Purdue professor, pursuing my research interest in robotics, machine learning and wireless networks. Then in 2008, I received a USDA grant to develop technologies that could automate key labor-intensive activities in agriculture. Although it involved basic research, the project was intended to address a compelling industry need. Adopting that outward perspective was a transformational move for me. I became very interested in agriculture as a sector that could truly benefit from my research. In fact, the challenges faced by agriculture and the related struggles of rural America moved me deeply. I became determined to use my expertise to find solutions that would support and advance rural development.

As it turned out, the first opportunity I had to make a difference occurred precisely at the nexus of research and entrepreneurship. My work for the USDA project focused on automating insect monitoring in high-value specialty crops such as tree fruits. The problem was that the spraying that helps growers reduce losses due to pests is most efficiently, cost-effectively, and safely performed when growers have data about the actual insect populations in their orchards and fields. But the pheromone-baited paper traps that were considered to be state-of-the-art pest monitoring technology required manual inspection involving locating traps, counting the number of target pests captured in the trap, and replacing the sticky bottom as it became covered with insects and other debris. The expense of such a labor-intensive process was the primary hindrance to widespread adoption of data-based spraying.

After about a year of research and development, my team demonstrated the feasibility of automatically monitoring insect populations with a wireless network of highly specialized sensors. Because of the potential for this IoT technology to dramatically impact the financial model of farming, Spensa was born in order to commercialize our research.

But though we had moved into development of our prototype, we had not reached the point of market-ready product. For example, we still had issues with the sensors robustly detecting target insects under harsh and highly varying environments across different agricultural fields. Ensuring that the devices could communicate data reliably throughout the entire growing season was also a difficult challenge that needed to be resolved. Indeed, with several problems not fully resolved, we were too high a risk for most venture capital. We needed much more time to get to market than I had originally anticipated.

At this point, the SBIR program became critical to the survival of Spensa. Because the program is affiliated with federal agencies that fund research, the SBIR program staff understand and are patient with the research timeline. They also understand the tendency of research-driven projects often requiring major changes of direction. SBIR grants, in conjunction with a tolerance for the research paradigm, bought Spensa the runway it needed to develop its product to the point that venture capital could also participate. Notably, another benefit of the SBIR grants is the prestige that comes along with the award. SBIR grants are highly competitive, so the fact that Spensa was awarded SBIR grants helped attract additional investments as well as customers.

But more than a long and well-funded runway was needed for Spensa to succeed. The fact that university researchers start with basic scientific research affects more than the length and complexity of the road to commercialization. It means that the researchers must perform a 180-degree turn in thinking and methodology in order to become entrepreneurs. In a sense, both the scientific method and the development of a product for market depend on formulating and testing hypotheses based on prior knowledge. But if the goal is science, or knowledge, the researcher will follow the path wherever it leads in order to bring a phenomenon to light. The entrepreneur doesn't really care about phenomena per se, and sometimes not even at all, unless such knowledge contributes to meeting a customer need profitably. Proverbially, humans invented, built and sold boats long before Archimedes formulated the principle that underlies flotation. But it is unlikely that they would have been able to invent submarines without that scientific discovery. Basic science is not replaced by entrepreneurial thinking: in fact, they need to co-exist.

Indeed, the SBIR program taught me how to navigate between the paradigms of scientific research and entrepreneurship. For Spensa, the result was, first and foremost, a product that met a critical and costly need for growers. But the SBIR-guided experience had a much more profound and long-lasting effect, because along with funding, SBIR passed along some very important DNA. Perhaps the biggest lesson I learned was the sheer power of research in conjunction with an entrepreneurial model to effect meaningful and substantial change. Spensa was founded with the vision of serving as a storehouse (*spensa* means storehouse in Latin.) The purpose of a storehouse is not to keep its resources to itself, but to serve as a base to deploy those resources strategically and judiciously so as to generate the most value to stakeholders, especially customers. The DNA that I inherited from SBIR informs my understanding of entrepreneurship as a customer-centered innovation that accelerates change through the strategic, value-sensitive, and nimble deployment of resources. And “resources” includes not only financial capital and intellectual property, but also the team’s talents, time and passion. The entrepreneurship model is thus a resource engine. As each new asset comes to fruition, it becomes the basis for new deployment and generation of value.

As I mentioned earlier, Spensa was ultimately acquired. But my current role as CEO of the Wabash Heartland Innovation Network (WHIN) is an even greater and truly unique opportunity to put research and entrepreneurship together to meet the needs of rural America. WHIN benefits tremendously from lessons learned from Spensa. I believe its story illustrates how the SBIR program in action with Spensa continues to generate economic growth, especially for rural America.

WHIN was originally funded in 2017 with a \$40 million grant from Lilly Endowment, Inc. (LEI). The funding followed a lengthy process of self-discovery by a ten-county region in north-central Indiana that is anchored by Tippecanoe County, home of Purdue University. LEI’s goal was to enable the region to leverage its many assets, especially Purdue University, Ivy Tech Community College, and strong manufacturing and agricultural sectors, not only to increase core competitiveness, but also to identify new drivers of innovation to improve the region’s economic prospects.

The strategy that evolved in the proposal was to utilize a Purdue research strength in the Internet of Things (IoT) to make the region a global epicenter of digital agriculture and next-gen manufacturing, powered by IoT technology.

Because of the technical aspects of the project, Purdue wrote the grant on behalf of the CFGL. Grant resources are heavily tilted toward research, with about half of the grant designated to sponsor Purdue IoT research, education and engagement, as well as to enable the Lafayette campus of Ivy Tech Community College to enhance IoT workforce development. A small portion of the grant provides for its region to be a “living laboratory,” with the original idea being for Purdue researchers working with regional farmers and manufacturers to test Purdue technology in real applications. The grant includes sponsored funding for university outreach to increase awareness and utilization of Purdue IoT in the region.

The grant also provides for a Regional Cultivation Fund that re-grants funds to encourage and support place-making projects throughout the region.

But LEI had a stipulation. At the end of the five-year grant period, WHIN, which is a community-based organization, had to be sustainable. As WHIN's only real activity was to regrant funds to others, primarily for research activities, sustainability was an enormous problem. Indeed, LEI had no expectation that WHIN would raise future funds simply to regrant them to others. The original grant was essentially for capacity-building. LEI wanted something new to emerge.

Notably, the sustainability stipulation can be seen to be analogous to a federal agency's aspiration that the basic research it sponsors be commercialized. And according to that analogy, the next step would involve building on and leveraging that capacity. The WHIN Board hired me in 2018 to figure it out.

The grant included a lot of foci. Its own DNA involved research, engagement, place-making, community development, economic development, IoT, technology adoption, agriculture and manufacturing. But boiled down, the grant relied on university research, with a little help from engagement, to transform the region. The Spensa experience, along with my work as an academic, had taught me that is a very long-term project, and so it was proving to be with WHIN. Eighteen months into the grant, the region had not adopted any IoT. In fact, that was WHIN's real problem: adoption. That is the only way the region could benefit from research. It had to actually use IoT, and on a scale, and at a speed, large enough to be transformational.

But WHIN is committed to research in a fundamental and non-negotiable way. It is a 501c3 nonprofit organization whose charitable purpose is research and education. And it is presently supported by LEI, whose own 501c3 status restricts the use of its funds to charitable purposes.

WHIN's research DNA looked a lot like an impediment to sustainability. But WHIN is, after all, a community organization and the role of the community in the grant's research component was basically to be a research subject. Instinctively falling back on the entrepreneurship DNA that we had inherited from SBIR, we asked, what does the research paradigm produce that is needed by a customer, besides a new piece of intellectual property? In particular, what do experimental subjects produce? The answer, of course, is data. Data is exactly what a living lab contributes to research. And in the knowledge economy, data is in demand. It has enormous value. Data could be WHIN's product.

The research paradigm moved from liability to asset, enabling the grant to fully activate all of its DNA: that long list of foci for which the grant is responsible. If the ten-county living lab could be made to produce data that WHIN could license for research, every WHIN activity that supported the production of data would serve WHIN's charitable purpose. And that activity would necessarily include introducing IoT on farms and in factories throughout the region. The key to all of this, though, was to accelerate the grant by accelerating adoption of IoT.

At first glance, depending on IoT adoption to enable WHIN to fulfill its mission and sustain itself seemed like a form of circular reasoning, an infinite regress in which WHIN was established to accelerate IoT adoption, but it needed IoT adoption to be accelerated in order to accomplish its mission sustainably. But within its charitable purpose as a collector and disseminator of data for research, WHIN could simply use grant resources to incentivize adoption of IoT in order to generate that data.

The resulting model is called WHIN Alliance and it looks like this:

- Farmers and manufacturers are recruited to become members of their respective Alliances and they pay an annual membership fee.
- WHIN identifies and vets commercial and near-commercial IoT technology and services that are likely to have an immediate, significant impact on agricultural and manufacturer Alliance members. By agreement with the tech vendors (tech partners) the vetted products and services are offered to Alliance members at an initial substantial discount. The discount decreases each year the product or service is in use and, in the third year, WHIN begins to receive a percentage of the vendor's revenue for installed products and services.
- Both the farmers and manufacturers who own the IoT technology and the vendors who install it agree to grant WHIN access to their data. WHIN collects, warehouses, and structures the data, which is available at no cost for K-16 education purposes, unless such education is grant-funded and the grant allows for data licensing. The data is also licensed to university researchers who include the data licensing fee as a line item in grants. WHIN may also receive a portion of royalties for IP that is commercialized as a result of the use of its data.

The Alliance model allows WHIN to generate value for all of its stakeholders.

WHIN's living lab and the data it generates has value for research:

- The data it generates comes from real and diverse farm and manufacturing operations
- The technology that generates the data is replicated throughout the living lab, providing consistent, structured data sets
- The network that serves the data includes both conventional and novel technology
- The living lab that produces the data is very large, extending across ten counties for a total of 4,321 square miles
- The living lab is a complete representation of IoT that can be used to research both the connectivity and sensor components of IoT

WHIN's living lab directly supports IoT research, education, and innovation:

- WHIN seeks grants for specific projects related to IoT, such as installing and testing innovative rural broadband technology.
- If funding designated for the purpose is available, WHIN sponsors IoT-related research at Purdue University and educational programs at Ivy Tech Community College. WHIN collaborates with the university and Ivy Tech to secure grants related to IoT technology.

WHIN's data and living laboratory platform are valuable to the country. WHIN serves many of the same priorities as federal agencies, including contributing to economic growth in rural America:

- WHIN's model is highly amenable to public-private partnerships that advance Indiana and national research interests.
- WHIN utilizes a geographically-defined living lab to mobilize entire sectors, notably agriculture and manufacturing, to participate in relevant basic and applied research, as well as to support relevant education and workforce training. Wabash Heartland farmers and manufacturers are

learning how to use a highly disruptive technology in advance of their peers, and that learning will shape the adoption of that technology nationally.

- Likewise, the opportunity for the IoT industry to participate directly in a living lab that hosts a world-class university accelerates those benefits for that industry. The edge in competitiveness offered by the living lab benefits all stakeholders in IoT, including the U.S.

WHIN's industrial sectors, including agriculture, manufacturing and technology, benefit from being in a living lab:

- Purdue University partners with WHIN, regional industry, and global technology partners to conduct research and educate the IoT workforce.
- Ivy Tech Community College partners with WHIN to train the region's IoT workforce and participate in research projects.

WHIN's region benefits from the economic development impact of being a living lab:

- Tech partners that supply IoT to the lab are a source of jobs and investment in the region. One ag tech partner, Solinftec, recently located its global headquarters in West Lafayette because of WHIN and synergy with the research opportunities at Purdue. The company is planning to hire 334 high-wage, skilled workers by 2022.
- Because being in the living lab has measurable value to manufacturers, it is a value proposition for economic developers trying to attract and retain jobs in the region. It likewise functions to allow farms to be more competitive and to face strong headwinds.

In the long run, WHIN envisions the Wabash Heartland as the global epicenter of digital agriculture and next-gen manufacturing, powered by IoT technology. That is quite a return for \$1.5 million in SBIR grant funding to a little start up in West Lafayette, Indiana.

Thank you for your time and interest. I urge you to support the SBIR and related programs. They are delivering all you ask and more.