



Testimony of

Dr. Dawn Tilbury, Assistant Director
Engineering Directorate
National Science Foundation

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Hearing on “From Lab to Market: A Review of NSF Innovation Corps”

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Chairwoman Comstock, Ranking Member Lipinski, and distinguished Members of the Subcommittee, thank you for inviting me to participate in today’s hearing on the National Science Foundation’s (NSF’s) Innovation Corps, or I-Corps. My name is Dawn Tilbury, and I am the Assistant Director for Engineering (ENG) at NSF.

The NSF I-Corps program started in 2011 through the convergence of several trends in the economy, in the understanding of startup formation, and through NSF’s experience with seeding startups through the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) programs.

These trends strongly resonated with NSF’s experience. Our data showed that of the new startups in the SBIR/STTR programs, many of which were academic spinouts developing cutting edge, state of the art deep technologies, the greatest challenge to success was more typically market failure, not technical failure that they had to overcome. We wanted to work with these trends to try something new that might better support translating cutting-edge innovations from the lab to the market.

Against the backdrop of the Great Recession, the economy was seeing a longer-term decline in startup formation at the same time research was showing that startups were needed as the largest contributor to net new jobs. A decline in startups – the drivers for net new economic activity and jobs – was a worrying trend.

Through the work of Steve Blank and others in the Lean Startup movement emerged a body of knowledge about what practices might lead to a higher probability of startup success. Instead of generating static, multiyear business plans, it is better to think of startups as a search for a viable

business model. Active customer discovery can guide this search and create a framework to communicate it to the company, investors and other stakeholders.

I-Corps was developed and adapted from Steve Blank's Lean Launch Pad course at Stanford University, with the goal of providing Lean Startup training to NSF scientists and engineers so they could quickly determine whether their technology or product has commercial potential.

Each I-Corps Team consists of an Entrepreneurial Lead (EL), an I-Corps Team Mentor (IM) and a Technical Lead (TL). The EL could be a post-doctoral scholar, graduate or other student or other personnel with relevant knowledge of the technology and a deep commitment to investigate the commercial landscape surrounding the innovation. The IM will typically be an experienced entrepreneur with proximity to the institution and experience in transitioning technology out of Academic labs. The I-Corps Teams' IM must be a third-party resource and may be recommended by the proposing institution. The TL will typically be a faculty member, senior research scientist or post-doctoral scholar with deep and direct technical expertise in the actual core technology about which the I-Corps team is exploring commercial potential.

Each I-Corps Team participates in a curriculum designed to provide real-world, hands-on, immersive learning about what it takes to evaluate commercial opportunity around the innovation. The curriculum consists of an approximately seven-week program that involves an in-person entrepreneurial curriculum immersion Kickoff, a weekly online curriculum, and an in-person Lessons Learned report-out. The Kickoff and Lessons Learned are both held on-site at the cohort location. The weekly online sessions are a combination of instructor and team presentations and active interactions between the teams, instructors and other teams in the cohort. In addition to scheduled cohort events, the main activity of the program is customer discovery where the Team leaves the lab to evaluate potential product-market fit and the wider business model. At the end of the curriculum, Teams are expected to have performed at least one hundred (100) face-to-face interviews with potential customers and potential partners from their proposed target market(s). The Team's progress in customer discovery will be shared with the entire cohort to facilitate group learning.

Teams that come to a "Go" decision at the end of the program have been deemed to have significant commercial viability. Of equal benefit are the teams that get to a "No Go" decision at the end of the curriculum, who recognize that their technology was not addressing market needs or perhaps needed additional development at the university before being considered for a spin out. We wanted to stop the cardinal sin of startups, "Developing something nobody wants."

NSF I-Corps is managed within NSF's ENG Directorate Division of Industrial Innovation and Partnerships (IIP), but is an agency-wide program. NSF has seen over 450 companies develop out of I-Corps teams. These companies have collectively raised over \$250 million in seed capital. Traditionally, these types of companies take 5-10 years to fully develop into commercial successes. Early fundraising and improved success rates in SBIR/STTR programs are a testament to I-Corps' value in improving the preparation of early stage startups.

Another, often overlooked, outcome of I-Corps is the opportunity cost of teams that decide after only seven weeks that their cutting-edge technology cannot be wrapped into a viable business

model and so do not start a company. Failing fast is the mantra of Silicon Valley and a tenet of I-Corps. As much as we relish the successes of startups emerging from I-Corps, we applaud the teams that declare a “No Go” in the program and decide to either adapt their technology or product back at the university, or decide to pursue another innovation altogether. NSF has programs, such as the Partnerships for Innovation (PFI), that are particularly well suited to support technology development that needs additional time and support at the university prior to commercialization. Similarly, the NSF SBIR/STTR program is focused on primarily supporting deep technology startups, many of whom were the “Go” teams emerging from I-Corps Teams.

I-Corps has its genesis in many of the Foundation’s long-standing innovation ecosystem programs. Those existing NSF innovation research alliances include consortia such as Engineering Research Centers (ERC), Industry University Cooperative Research Centers (IUCRC), PFI, Science and Technology Centers (STC), Nanoscale Science and Engineering Centers (NSEC) and Materials Research Science and Engineering Centers (MRSEC). They are also exemplified by the Grant Opportunities for Academic Liaison with Industry (GOALI) program, and the SBIR/STTR program. Many of these programs have been part of the NSF investment portfolio for decades. For example, SBIR is a government-wide program initiated at the NSF in 1976. These programs complement our other significant investments in fundamental scientific and engineering research by offering multiple pathways to moving discovery to innovative technologies.

Most closely related to I-Corps is the PFI program in the ENG Division of IIP which also started in FY 2011. The PFI program:

- encourages the translation of the numerous, technologically-promising, fundamental discoveries made by NSF researchers, while drawing upon and building the entrepreneurial spirit of the researchers and students; and
- fosters connections between existing NSF innovation research alliances.

Both I-Corps and PFI are designed to strengthen the U.S. innovation ecosystem.

To build a national “culture of innovation” we not only need sustained research investment but also skillful and deliberate catalysts to hasten the application of scientific discoveries. A robust innovation ecosystem could also help us conceive novel research questions and shift Science and Engineering knowledge paradigms altogether. That, in effect, is what we seek to accomplish through the I-Corps program.

There are four distinct components of the I-Corps program today:

- Teams – These are the actual teams that participate and are funded to go through the NSF National I-Corps Teams Program. The teams are comprised of at least three members, including a technical lead, the scientist or engineer as entrepreneurial lead, and the industry Mentor. This is an entrepreneurship program for scientists and engineers to learn how to evaluate market opportunity created by their technology. I-Corps does not fund the R&D itself. It funds the validation, or invalidation, of the product (or technology)-market fit.
- Nodes – These are regional hubs for education, infrastructure, and research that engage academic scientists and engineers in innovation regionally. Nodes provide the backbone

to support the Teams program and work to adapt the training to new partners and audiences.

- Sites – These are awards to single academic institutions intended to catalyze the engagement of local teams in technology transition and strengthen local innovation ecosystems.
- National Innovation Network. - Collectively our Nodes, Sites, Teams, other agency partners and others comprise a network to work cooperatively to build, utilize, and sustain the national innovation ecosystem.

I-Corps Highlights:

- 8 Nodes involving 28 universities
- 86 Sites
- 1000+ Teams funded by NSF (Since 2011)
- 450+ startups created
- 9 MOUs with other Federal Agencies. I-Corps programs have been adopted and adapted in partnerships with a growing number of Federal agencies, including the National Institutes of Health (NIH), Department of Energy (DOE), Department of Defense (DOD), National Security Agency (NSA), United States Department of Agriculture (USDA), Department of Homeland Security (DHS), Advanced Research Projects Agency – Energy (ARPA-E), National Aeronautics and Space Administration (NASA), and the Small Business Administration (SBA).
- The I-Corps model has been adopted by the state of Ohio.

Additional primary outcomes for the I-Corps program center on those tangible measures that relate directly to the societal application realized from NSF’s investments in basic research. For example, successful completion of the I-Corps grant would be expected to contribute to one or more of the following:

- New start-up businesses;
- Licensing;
- SBIR/STTR proposals;
- A business opportunity suitable for review by third-party investors;
- Students prepared to be entrepreneurially competitive; and
- Researchers able to evaluate market potential and better able to align research directions with commercial opportunity.

Next Steps

Training scientists and engineers to evaluate market opportunity and to get out of the lab to speak with potential customers and stakeholders in industry is the main contribution of the I-Corps program. We are excited to move the program forward into its next phase. NSF has pilot programs currently underway to lay the groundwork for this expansion. In collaboration with the NSF SBIR/STTR program we have launched the I-Corps for Phase 0 pilot. Through this pilot we are supporting non-academic teams of very early startups or pre-startups that are developing game-changing technologies. These Phase 0 Teams will receive national I-Corps training as well

as participate in a follow-on curriculum called “I-Corps Go” that addresses some of the more common issues in startup formation, including incorporation, licensing and negotiation of intellectual property, and fundraising. “I-Corps Go” will allow NSF to work with startups on more than just the problem of “Developing something nobody wants.”

As we look ahead to the next five years of I-Corps, we see the continued motivation for the program. Startup rates are still down in the United States. With NSF-supported researchers continually innovating and developing cutting edge technology, we see the I-Corps Program as a key tool to help with our broader goals to:

- Leverage NSF’s investments and broaden the impact of NSF-funded research,
- Prepare scientists and engineers to expand their focus beyond the laboratory into entrepreneurship and commercialization,
- Promote the commercial success and societal benefit of new technologies funded by the US Government,
- Turn ideas into companies,
- and Change the lives of researchers and the cultures of academic institutions.

Summary

NSF’s primary mission is to advance the frontiers of science and engineering through basic research. The I-Corps program is an integral part of the NSF strategy to stimulate innovation and address societal needs through the commercialization of the results of fundamental research. I-Corps uses customer discovery and business model development to validate commercialization opportunities, and I-Corps projects with product market fit will be well positioned for business formation.

I-Corps is designed to create a national network of scientists, engineers, innovators, business leaders, and entrepreneurs to accelerate and strengthen our national innovation ecosystem. I-Corps taps into the American entrepreneurial spirit to identify opportunities. The idea is not to take money away from basic research, but rather to look at research already completed that can be leveraged with a little nudge into translational activities of potential commercial benefit. I-Corps targets the critical gap that occurs just before researchers have advanced their ideas sufficiently to determine whether they have a product with market fit that justifies the formation of a company that will request SBIR/STTR funding. In that sense, this is a ‘pre-seed’ investment. NSF investments strategically strengthen the innovation ecosystem by addressing the challenges inherent in the early stages of the innovation process.

NSF participation in I-Corps includes every Directorate of the Foundation. The I-Corps Team award mechanism includes funding for the team to go through the rigorous entrepreneurship training, mentorship, and focused instruction in a hypothesis-driven approach to evaluating potential commercial viability of completed scientific and engineering research. Academic institutions are key partners in the I-Corps national network, as is the private sector. Technology developers, business leaders, venture capitalists, and experienced entrepreneurs serve as mentors, providing critical support by sharing knowledge and experience. This network operates to

enhance the ability of NSF-supported researchers to turn scientific results into potentially successful technologies. I-Corps also provides students with opportunities to participate.

The I-Corps program has been a significant positive addition to the NSF investment portfolio. Even though it constitutes less than one-third of one percent of the NSF budget recent data shows I-Corps teams have collectively raised over \$250 million in seed capital. For the teams who have participated, it has been truly transformational to thinking in a more entrepreneurial way. An enormous and significantly underutilized storehouse of creative ideas with potential economic benefit exists in our nation's colleges and universities, and I-Corps is simply a way to help unlock and unleash some of those ideas generated by current and previous NSF investments. I thank the committee for their interest in this exciting program, and for giving me the opportunity and the privilege to testify before you today. I would be happy to answer any questions.

Dr. Dawn M. Tilbury

Dawn M. Tilbury received the B.S. degree in Electrical Engineering, *summa cum laude*, from the University of Minnesota in 1989, and the M.S. and Ph.D. degrees in Electrical Engineering and Computer Sciences from the University of California, Berkeley, in 1992 and 1994, respectively. In 1995, she joined the Mechanical Engineering Department at the University of Michigan, Ann Arbor, where she is currently Professor, with a joint appointment as Professor of EECS. Her research interests lie broadly in the area of control systems, including applications to robotics and manufacturing systems. In June of 2017, she became the Assistant Director for Engineering at the National Science Foundation, while maintaining her position at the University of Michigan. She has published more than 150 articles in refereed journals and conference proceedings. She was elected Fellow of the IEEE in 2008 and Fellow of the ASME in 2012, and is a Life Member of SWE.