INNOVATION CORPS: A REVIEW OF A NEW NATIONAL SCIENCE FOUNDATION PROGRAM TO LEVERAGE RESEARCH INVESTMENTS

FIELD HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

MONDAY, JULY 16, 2012

Serial No. 112–96

Printed for the use of the Committee on Science, Space, and Technology

Available via the World Wide Web: http://science.house.gov

U.S. GOVERNMENT PRINTING OFFICE

79–436PDF WASHINGTON : 2012

For sale by the Superintendent of Documents, U.S. Government Printing Office
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U.S. HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Northwestern University School of Law, Chicago, Illinois

The Subcommittee met, pursuant to call, at 10:00 a.m., at Lincoln Hall, Levy Mayer 104, 375 East Chicago Avenue, Chicago, Illinois, Hon. Mo Brooks [Chairman of the Subcommittee] presiding.

HALPH M. HALL, TEXAS
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U.S. HOUSE OF REPRESENTATIVES

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Subcommittee on Research & Science Education Hearing

Innovation Corps: A Review of a New National Science Foundation Program to Leverage Research Investments

Monday, July 16, 2012
10:00 a.m. to 12:00 p.m.
Northwestern University School of Law
Chicago, Illinois

Witnesses

Dr. Thomas Peterson, Assistant Director, Directorate for Engineering, National Science Foundation

Mr. Steve Blank, Lecturer, Stanford University and the University of California at Berkeley

Mr. Neil Kane, President, Illinois Partners Executive Services, LLC

Dr. Gabriel Popescu, Assistant Professor, Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign

Dr. Andrew Mazar, Director, Program for Developmental Therapeutics and Entrepreneur-in-Residence Innovation and New Ventures Office, Northwestern University

U.S. HOUSE OF REPRESENTATIVES
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SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

HEARING CHARTER

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Monday, July 16, 2012
10:00 a.m. – 12:00 p.m.
Lincoln Hall, Levy Mayer 104
Northwestern University School of Law
375 East Chicago Avenue
Chicago, Illinois

1. Purpose

On Monday, July 16, the Subcommittee on Research and Science Education of the House Committee on Science, Space, and Technology will hold a hearing to examine the new National Science Foundation Innovation Corps program and assess its value to the American taxpayer and its potential contribution to the Nation's future prosperity.

2. Witnesses

- **Dr. Thomas Peterson**, Assistant Director of the Directorate for Engineering, National Science Foundation
- **Mr. Steve Blank**, Lecturer, Stanford University and the University of California at Berkeley
- **Mr. Neil Kane,** President, Illinois Partners Executive Services, LLC
- **Dr. Gabriel Popescu**, Assistant Professor in the Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign
- **Dr. Andrew Mazar,** Director of the Program for Developmental Therapeutics and Entrepreneur-in-Residence, Innovation and New Ventures Office, Northwestern University

3. Overarching Questions

- What was the genesis of the Innovation Corps (I-Corps) program? What are the objectives of the program and how was it designed to achieve those objectives? In what ways is the I-Corps program a public-private partnership? What is the benefit of the I-Corps program to the American taxpayer?

- Is the I-Corps program an appropriate role for the federal government in general and for a basic research agency like the National Science Foundation (NSF) in particular? How is it distinct from the many innovation programs and activities at other federal agencies? Given the self-interest of both the private sector and research universities in commercializing university research, why is a federal program such as I-Corps necessary?

- What, if any, are the outcomes from the first round of I-Corps awards? What did the principal investigators and their students and/or post-docs learn and achieve through the program? What did the mentors learn and achieve through the program? What if any lessons did NSF learn and apply from the first round to the second and going forward? What are NSF's plans for the I-Corps program over the next few years, including any plans for continued expansion of the program?

4. The I-Corps Program

The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..." **With a current annual budget of $7 billion,** NSF is the primary source of federal funding for non-medical basic research, providing approximately 40 percent of all federal support, and serves as a catalyst for science, technology, engineering, and mathematics (STEM) education improvement at all levels of education. In addition, NSF is the funding source for over 20 percent of all federally supported basic research conducted by America's colleges and universities. It supports the fundamental investigations that ultimately serve as the foundation for progress in nationally significant areas such as national security, technology-driven economic growth, energy independence, health care, nanotechnology, and networking and information technology.

Through its new Innovation Corps (I-Corps) program, launched in 2011, NSF seeks to develop and nurture a national innovation ecosystem that builds upon the fundamental research it already supports. The goals of the I-Corps program are to spur translation of fundamental research, to encourage collaboration between academia and industry, and to train students to understand innovation and entrepreneurship. Only researchers who already receive NSF support are eligible to apply for the I-Corps program. The program is designed to provide additional support - in the form of mentoring and funding - to accelerate the translation of knowledge derived from fundamental research into emerging products and services that can attract subsequent third-party funding.

Specifically, the purpose of an NSF I-Corps grant is to give the project team access to resources to help determine the readiness to transition technology developed by previously-funded or currently-funded NSF projects. The outcome of the I-Corps projects will be threefold: 1) a clear go/no go decision regarding viability of products and services, 2) should the decision be to move the effort forward, a transition plan to do so, and 3) a technology demonstration for potential partners. The go/no go decisions are made by the I-Corps team in consultation with the I-Corps Cognizant Program Directors.

An I-Corps award is for $50,000 and has a 6-month duration. Awards are made to teams of three individuals: a Principal Investigator (PI), an Entrepreneurial Lead, and an I-Corps Mentor. The Entrepreneurial Lead could be a Post-Doctoral scholar, graduate or other student with relevant knowledge of the technology and a deep commitment to investigate the commercial landscape surrounding the innovation. In rare circumstances, it also could be the PI. The Entrepreneurial Lead should also be capable and have the will to support the transition of the technology, should the I-Corps project demonstrate the potential for commercial viability. The I-Corps Mentor will typically be an experienced or emerging entrepreneur with proximity to the institution and experience in transitioning technology out of Academic labs. The I-Corps Mentor must be a third-party resource and may be recommended by the proposing institution or may be a member of the NSF-supported I-Corps network which is being put together at this time.

All teams must make a commitment to participate in a fixed curriculum. The curriculum is based on a course recently developed in the Engineering School at Stanford University, *Technology Entrepreneurship and Lean Startups*. The I-Corps curriculum is necessarily shorter, but also narrower in scope than the Stanford course. It is described in the NSF solicitation as a hypothesis-validation approach to identify and mitigate gaps in knowledge in the following seven areas: Value Proposition of the proposed product or service; Customer/User use-case and pain point; Demand Creation; Channel Development; Revenue Model; Partnership Strategy; and Resource Requirement. The I-Corps institute has just been expanded to two additional sites at the University of Michigan and Georgia Institute of Technology.

NSF made awards to 21 teams in September 2011 and an additional 25 teams in March 2012. The total anticipated funding level for I-Corps in fiscal year 2012 (FY12) is $5 million. The agency has requested $19 million for FY13. Among the witnesses for this hearing, **Neil Kane** is a mentor from the first cohort, **Gabriel Popescu** is a PI from the second cohort, and **Steve Blank** is the lead instructor for the I-Corps institute at Stanford and is helping the University of Michigan and Georgia Institute of Technology set up their own institutes.

5. Role of Universities and the Private Sector

Perhaps the two U.S. institutions best known for their entrepreneurial successes are the Massachusetts Institute of Technology (MIT) and Stanford University. In 2009 two professors at the MIT Sloan School of Management wrote a report on *Entrepreneurial Impact: The Role of MIT*[1]. They found that the 25,800 currently active companies founded by MIT alumni [as of 2003] employ about 3.3 million people and generate annual world sales of $2 trillion, producing the equivalent of the eleventh-largest economy in the world. In addition, they found that an estimated 6,900 MIT alumni companies with worldwide sales of approximately $164 billion are located in Massachusetts alone and represent 26 percent of the sales of all Massachusetts companies. MIT alumni-founded firms are also found in California, the Washington-Baltimore-Philadelphia belt, the Pacific Northwest, the Chicago area, southern Florida, Dallas and Houston in Texas, and the industrial cities of Ohio, Michigan, and Pennsylvania. In total, nearly 60 percent of the MIT alumni companies are located outside the Northeast. Stanford, in the heart

[1] http://www.kauffman.org/uploadedFiles/MIT_impact_brief_021709.pdf

of Silicon Valley, can tell a similar story. Among the thousands of companies founded by Stanford faculty and alumni are several Fortune-500 companies, including Cisco Systems, eBay, Google, and Nike.[2]

MIT faculty are able to take advantage of resources provided by the Deshpande Center, which operates something like an I-Corps program but for MIT faculty only.[3] Since 2002, the Deshpande Center, which is supported by private donors, has funded more than 90 projects with over $11 million in grants. The Stanford School of Engineering has the Stanford Technologies Ventures Program, which also brings in private support but is focused more on entrepreneurial education and training.[4] Stanford has many other entrepreneurial-focused groups and organizations on campus tied together by a formal network.[5] The Ewing Marion Kauffmann Foundation also supports entrepreneurial education and training activities at university campuses across the country, including the University of Illinois at Urbana-Champaign.[6] Many universities, such as Northwestern University, are using their own resources to broaden their outreach and entrepreneurial support for their faculty beyond the traditional legal role of university technology transfer offices.

The I-Corps program, itself a public-private partnership with some initial support from the Desphande Center and the Kauffman Foundation, is attempting to take some of the best practices at MIT, Stanford, and other very successful entrepreneurial research universities and build similar capacity at research universities of all sizes in regions across the country. Awards to date have been made to faculty at such diverse institutions as the University of North Texas, SUNY at Stony Brook, the University of Pennsylvania, and the University of Arkansas. Two-thirds of the awards made to-**date have been made to PI's at public universities.** Based on informal discussions with a number of I-Corps awardees, staff have learned of efforts by several awardees from the first and second cohorts to bring what they have learned from the I-Corps institute back to their own campuses. NSF officials and I-Corps awardees speak of this in terms of leveraging the $50,000 awards to build entrepreneurial capacity well beyond the teams themselves. This leveraging effect **is part of NSF's long**-term vision for the I-Corps program. Nevertheless, with private sector and university resources also supporting similar efforts, it remains a point of debate as to what the most appropriate and effective role is for each of the university, industry, and government partners.

[2] http://facts.stanford.edu/research.html
[3] http://web.mit.edu/deshpandecenter/index.html
[4] http://stvp.stanford.edu/about/
[5] https://sen.stanford.edu/
[6] http://www.kauffman.org/

Chairman BROOKS. The Subcommittee on Research and Science Education will come to order.

Good morning; welcome to today's hearing, Innovation Corps and review of a new National Science Foundation Program to Leverage Research Investments. The purpose of today's hearing is to examine the new National Science Foundation Innovation Corps program and assess its value to the American taxpayer and potential contribution to the Nation's future prosperity. In front of you are packets containing the written testimony, biographies and truth-in-testimony disclosures for today's witnesses.

Chairman BROOKS. Ranking Member Lipinski, first and foremost, it is a pleasure to join you here in Chicago this morning for what will be the first, minority field hearing held by the Science, Space and Technology Committee in this Congress.

This is your hearing, on your turf. The Chair recognizes you first, Mr. Lipinski, for an opening statement.

Mr. LIPINSKI. Thank you, Mr. Chairman, and thank you for waking us up with the gavel this morning. I thank you for coming here and, well, first of all, scheduling this hearing in Chicago, traveling here to hold it. I didn't even realize it was the first one that—field hearing for the, uh,—for the Democrats. I especially appreciate that. I know your time here in Chicago is short, but I hope you enjoy your visit as much as I enjoyed my time down in Huntsville when I traveled there for our STEM education hearing a couple months ago. I'd also like to thank Northwestern for hosting us. I'm a proud graduate of Northwestern, and received my Bachelor's Degree of Mechanical Engineering at Northwestern. Although, it was up in Evanston. I actually did get into Northwestern Law School and decided not to become an attorney, for whatever that means. I know Chairman—Chairman won't think anything bad about me. And, finally, I want to thank our witnesses——

Chairman BROOKS. You know, we are in a law school.

Mr. LIPINSKI. Yeah. I'd like to thank our witnesses for taking the time to share your insights and experience with National Science Foundation Innovation Corps Program.

And I would like to thank everyone else who has joined us for the hearing.

Very briefly, I–Corps is an NSF education program which helps federally funded research innovations transition from the university lab into a profitable company. It is based on the Lean LaunchPad course developed by successful Silicon Valley serial entrepreneur Steve Blank, and essentially applies the scientific method, which is well-known by researchers, to developing a startup.

I strongly believe that the I–Corps program embodies NSF's original mission of both promoting the progress of science and advancing the national prosperity. Let's not forget that second part, especially when we are looking to maximize the efficiency of our federal government. When Vannevar Bush talked about the need for a National Science Foundation in 1945, he was concerned about getting the U.S. back to full employment. Back then he wrote, "We do not know yet how we shall reach that goal, but it is certain that it can be achieved only by releasing the full creative and productive energies of the American people."

More recently, the *America COMPETES Act* Reauthorization that passed last Congress stipulates that the Broader Impacts criterion used in evaluating NSF grant proposals must include the, "Increased economic competitiveness of the United States,"; and, "Increased partnerships between academia and industry." Now, as Chairman of this Subcommittee at that time, I included those two additional components in the bill in order to reinforce the original mission of the NSF as we see innovation and the role of our research institutions becoming increasingly critical to job creation. We will hear today from our witnesses how educational programs like I–Corps fit perfectly into the mission of the NSF.

Although it's only about one-quarter of one percent of NSF's budget, I think this program will yield disproportionate benefits. By giving scientists who have already been awarded NSF research grants the education needed to push their work outside of the ivory tower into the marketplace, we are helping turn NSF's research investments into jobs. I'm encouraged by the many stories I've heard from awardees in the first and second cohorts, including two of the witnesses here today. In May I had the opportunity to sit in on the final presentations of the second I–Corps cohort at Stanford. I was very impressed, not only by the innovations presented, but also by the stories about what the participants learned through the program.

For anyone who hasn't looked at this program in depth, it is important to note that we are talking about a stage of commercialization before private sector financing gets involved. The goal of I–Corps is to educate scientists, to help them establish the viability of an idea before forming a startup. What I am especially excited about is not just the promise of the new technologies being explored by the teams fortunate enough to participate in I–Corps, it is also the exponential leveraging effect that is already happening. I–Corps participants are taking what they have learned and are working with their new private sector connections and their university administrators to create opportunities on their own campuses to educate students and faculty on the basics of entrepreneurship. Many are from institutions in communities and regions without a significant record of entrepreneurship. So, they are becoming, in a sense, missionaries carrying the best practices of Silicon Valley back to their own communities and figuring out how to localize these best practices.

Despite the tremendous promise of the I–Corps program, some of my colleagues may be skeptical that this is an appropriate use of funds for the National Science Foundation. I explained briefly how I see I–Corps fitting into NSF's core mission, but I welcome all of our witnesses today to help us understand how NSF is filling an unmet need, and why you believe it's appropriate for the NSF. I also welcome your thoughts on how the I–Corps program can be improved. And, finally, I challenge you to share your thoughts on what more the private sector and universities themselves can be doing in this space. I invited Dr. Mazar to testify about his role as an Entrepreneur-in-Residence at Northwestern University. Northwestern is just one of many universities around the country who have taken their own initiative and either their own funds or pri-

vate sector donations to bolster entrepreneurial activity on their campuses.

The way I see it, this is not a situation where either universities do this on their own, or the private sector does it, or the federal government steps in. This is a partnership among all three, and all three have a role to play, resources to contribute, and benefits to reap. We have good representation here from all of the partners, and I look forward to an interesting and thoughtful discussion about the new NSF I–Corps program and where we take it from here. Once again, I thank all of the witnesses for being here this morning and I look forward to your testimony.

PREPARED STATEMENT OF RANKING MEMBER DANIEL LIPINSKI

Thank you Chairman Brooks for scheduling this hearing in Chicago and traveling here to hold it. I know your time here is short, but I hope you enjoy your visit as much as I enjoyed my time in Huntsville when I traveled there for our STEM Education hearing. I would also like to thank Northwestern University for hosting us here today; I am a proud graduate of Northwestern having received my bachelors degree in mechanical engineering. And finally I want to thank our witnesses for taking the time to share with us your insights and experiences with the National Science Foundation's Innovation Corps Program and everyone else who has joined us for this hearing.

Very briefly, I-Corps is an NSF education program which helps federally funded research innovations transition from the university lab into a profitable company. It is based on the Lean LaunchPad course developed by successful Silicon Valley serial entrepreneur Steve Blank and essentially applies the scientific method—which is well-known by researchers—to developing a start-up.

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a sense, missionaries carrying the best practices of Silicon Valley back to their own communities and figuring out how to localize these best practices.

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The way I see it, this is not a situation where either universities do this on their own, or the private sector does it, or the federal government steps in. This is a partnership among all three, and all three have a role to play, resources to contribute, and benefits to reap. We have good representation here from all of the partners, and I look forward to an interesting and thoughtful discussion about the new NSF I-Corps program and where we take it from here. Once again I thank all of the witnesses for being here this morning and I look forward to your testimony.

Chairman BROOKS. Thank you, Mr. Lipinski. I now recognize myself for five minutes for an opening statement.

The National Science Foundation funds basic research, which is oftentimes too costly and too risky for industry alone to undertake, but has many times proven to be groundbreaking and economic successes in the end. For example, current nanotechnology initiatives marked by a transformative technology which allows scientists to manipulate matter at the atomic and molecular levels, was preceded by scientists funded by NSF who were learning how to detect activity at the scale of individual atoms. Now, companies are making plans to utilize this pioneering technology to produce nanoscale products which will enter the marketplace.

I could list other examples, but I think my point is clear; that NSF has contributed to America's economy and competitiveness in invaluable ways. Unfortunately, today the United States faces unsustainable budget deficits which limit the spending in Congress, and what it is able to appropriate. While I am thankful to chair a Subcommittee which oversees such important research and development activities, it is the role and responsibility of Congress to work to prevent overspending, ensure that federally funded programs do not impede the work of the private sector, and provide the best return on the taxpayer dollar. The question we must address is which activities fall under this purview.

NSF created a new Innovation Corps program, I–Corps, to assess the readiness of emerging technological concepts for transitioning into new products through a public-private partnership. According to NSF, the program will, "bring together the technological, entrepreneurial, and business know-how to bring discoveries ripe for innovation out of the university lab,"; and, "increase the number of entrepreneurs emerging from university laboratories."

While this certainly sounds like a worthwhile endeavor, I have a number of questions, including the degree to which the federal government should determine which companies succeed and which fail, which are entitled to I–Corps assistance and which are not, but, if so, whether it is appropriate for this kind of decision-making to be made by an agency whose primary mission is basic research, at a time when businesses are struggling to compete with big gov-

ernment, and funding is already scarce, and at a time when there are already a number of questions arising over the federal government picking commercial winners and losers.

And rather badly, I might add, in the case of Solyndra, roughly a 535-million-dollar cost to the United States taxpayer; Abound Solar, potentially a 400-million-dollar loss to U.S. taxpayers, who went bankrupt after receiving 70 million dollars from U.S. taxpayers; and Beacon Power, nearly a 70-million-dollar cost to U.S. taxpayers, 43 million in Department of Energy loan guarantees, and more than 25 million in other Department of Energy grants. I need to better understand how and why NSF is best equipped to make these similar types of decisions for university research.

I look forward to hearing from our witnesses today, to working with my colleagues, to further explore I–Corps and determine its viability as a program funded by taxpayer dollars.

PREPARED STATEMENT OF CHAIRMAN MO BROOKS

The National Science Foundation funds basic research which is oftentimes too costly and too risky for industry alone to undertake, but has many times proven to be groundbreaking and economic successes in the end. For example, current nanotechnology initiatives, marked by a transformative technology which allows scientists to manipulate matter at the atomic and molecular levels, was preceded by scientists funded by NSF who were learning how to detect activity at the scale of individual atoms. Now, companies are making plans to utilize this pioneering technology to produce nanoscale products which will enter the marketplace.

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I look forward to hearing from our witnesses today and to working with my colleagues to further explore I–Corps and determine its viability as a program funded by valuable taxpayer dollars.

If there are other Members who wish to submit additional opening statements, your statements will be added to the record at this point. I know we have an audience here, Congressman Lipinski and I are the only two Members who are here today. We have a good number of others who are Members of the Subcommittee, and at this point, that is when they would be permitted to offer statements.

At this point, I yield to Mr. Lipinski to introduce our witnesses.

Mr. LIPINSKI. I thank the Chairman, especially thank you for the opportunity to do this, to let me go first in opening statement and to introduce our witnesses. I'm not used to that, after, you know, being the minority. So, thank you, I appreciate that.

Dr. Tom Peterson is Assistant Director of the National Science Foundation Directorate for Engineering. Prior to joining the NSF, he served on a faculty at the University of Arizona, beginning in 1977, serving as head of the Chemical and Environmental Engineering Department from 1990 to 1998, and as dean from 1998 until 2009. Good to have you, Dr. Peterson.

Next we have Steve Blank. Steve Blank is currently a Consulting Associate Professor at Stanford University, and adjunct at U.C. Berkeley Haas Business School. In 21 years as a Silicon Valley entrepreneur he created eight companies in various computer-related fields. So, a serial entrepreneur for those familiar with the term. Although he formally retired in 1999, he became very busy as an educator, teaching courses at Stanford, U.C. Berkeley and Columbia. During this time he developed the Lean LaunchPad course NSF uses for the Innovation Corps Program. And I want to add that Steve waited, he had his plane delayed for three, four hours last night; they cancelled it; he drove all the way from Richmond, Virginia, to Dulles last night to take a six a.m. flight, which was then cancelled. From there he went to Washington Reagan National to get out here. So, I especially appreciate all the effort that he's gone through to be here today.

Next we have Neil Kane. Neil Kane is the President and founder of Illinois Partners Executive Services. Most recently he was the CEO with Advanced Diamond Technologies, a company he cofounded in 2003, by licensed technology at Argonne National Lab. Mr. Kane is a former co-Executive Director of the Illinois Technology Enterprise Center at Argonne. He was Entrepreneur-in-Residence at the Research Park at the University of Illinois at Urbana-Champaign. Good to have you.

Next we have Gabriel Popescu. Dr. Gabriel Popescu is an Assistant Professor in the Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, and holds a full-faculty appointment with the Beckman Institute for Advanced Science and Technology. Before joining the UIUC faculty in 2007, Dr. Popescu received a Ph.D. in optics in 2002, from the University of Central Florida. Dr. Popescu received an I–Corps grant earlier this year for quantitative phase imaging solutions, for materials in life sciences. Good to have you, Dr. Popescu. And I have to say that as it came down to going—between Northwestern and Illinois to go to undergraduate engineering, and I chose Northwestern, but mainly, probably that it's closer to home. No, it's a great university, University of Illinois.

And, finally, we have Dr. Andrew Mazar, who serves as the Entrepreneur-in-Residence and the Managing Director for the Center for Developmental Therapeutics in the Chemistry of Life Processes Institute at Northwestern University. He has spent 23 years working on drug discovery, development and commercialization at the interface of academia and industry. Dr. Mazar is a member of sev-

eral cancer journal editorial boards and has published over 90 papers in peer-reviewed journals. Good to have you, Dr. Mazar.

Now, this next line, I think the Chairman—did you tell them how much time they have.

Chairman BROOKS. Ah, there it is.

As our witnesses should know, spoken testimony is limited to five minutes, after which the Members of the Subcommittee will have five minutes each to ask questions.

I now recognize our first witness, Dr. Peterson, for five minutes.

STATEMENT OF DR. THOMAS PETERSON, ASSISTANT DIRECTOR FOR ENGINEERING, NATIONAL SCIENCE FOUNDATION

Dr. PETERSON. Chairman Brooks. Ranking Member Lipinski. Thank you for inviting me to participate in this field hearing focusing on NSF's Innovation Corps, or I–Corps. I'm very pleased to have the opportunity to discuss this very exciting program with you.

NSF is recognized and respected worldwide for identifying and supporting fundamental research and education in science and engineering, through a peer-review evaluation of the merits of the ideas that are proposed. That process, both by definition and by construction, selects the best and most creative ideas, those that offer the greatest promise for success. We invest more than seven billion dollars annually in these efforts. Our grantees are the winners in this process, but so, too, are the taxpayers who have invested in this research through the NSF.

I–Corps has as its genesis many of the foundation's long-standing innovation ecosystem programs. Those existing NSF innovation research alliances include consortia, such as the Engineering Research Centers, the Industry University Cooperative Research Centers, and the Science and Technology Centers, as well as the Academic Liaison with Industry program, and of course the Small Business Innovation Research program. These programs complement our other significant investments in fundamental science and engineering research by offering multiple pathways to moving discovery to innovative technologies.

Many of these programs have been in the NSF portfolio for decades. For example, the SBIR program is a government-wide program that was initiated at NSF in the early '80s. The Centers programs that I mentioned all began at NSF in the late 1980s.

To build a national culture of innovation we need not only sustained research investment, but also skillful and deliberate catalysts to hasten the application of scientific discoveries. A robust innovation ecosystem also helps conceive novel research questions, and it shifts the science and engineering knowledge paradigms altogether. That, in effect, is what we seek to accomplish through the Innovation Corps program.

The goals of I–Corps are as follows: First, to build on NSF's investment in fundamental research; second, to offer academic researchers and students an opportunity to learn firsthand about technological innovation and entrepreneurship, and thereby fulfill the promise of their discoveries; and third, to prepare students for real-world experience through curricular enhancements, and pro-

vide them with opportunities to learn about and participate in the process of transforming scientific and engineering discoveries to meet societal needs.

We accomplish these goals in I–Corps by providing three elements. Namely, financial support to the teams to assist the development of a prototype or a proof of concept; a specific structure for the I–Corps team, comprised of a principal investigator, an entrepreneurial lead, and an innovation/entrepreneurial mentor; and finally, a strong education component focusing on a hypothesis-driven approach to developing a methodology for evaluating both the technical merits, as well as the marketability of the concept that's being proposed.

Every directorate in NSF participates in I–Corps. The structure of I–Corps mirrors the NSF Director's vision of OneNSF, working together seamlessly in well-integrated and efficient ways across organizational and disciplinary boundaries.

Teams that advanced their efforts towards commercializing technologies were facilitated by inclusion of public and private sector experts to provide guidance by participation in tailored curriculum and by funds to evaluate the commercial readiness of technology ideas. Some exciting new technologies that have emerged from the first I–Corps cohorts include photocatalysis to help clean up contaminated water, a new technology for semiconductor-based hydrogen and hydrocarbon sensors, and production of graphene film.

I–Corps presents a new model for public-private partnerships that leverages our significant investment in basic research with relatively smaller I–Corps funding, thus offering a bigger bang for the buck.

In the first two cohorts over 4,000 discussions took place between I–Corps teams and potential partners, customers and stakeholders. As of today there a total of 100 teams, and there are 100 mentors that joined these teams, plus over 70 additional mentors who have been identified as already willing to join other teams.

In summary, 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. For those 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 come here today to tell you about it. I'd be happy to answer any questions.

[The prepared statement of Dr. Peterson follows:]

Testimony of

Dr. Thomas Peterson, Assistant Director
Engineering Directorate
National Science Foundation

Before the

U.S. House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Research and Science Education

Field Hearing
Northwestern University
Evanston, Illinois

I-Corps

July 16, 2012

Chairman Brooks, Ranking Member Lipinski, and distinguished Members of the Subcommittee, thank you for inviting me to participate in this field hearing here at prestigious Northwestern **University, on NSF's Innovation Corps, or I-Corps.** I am pleased to have the opportunity to discuss this exciting program with you.

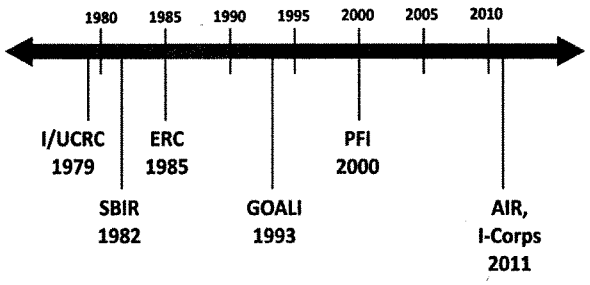
NSF is recognized and respected worldwide for identifying and supporting fundamental research and education in science and engineering, through peer review evaluation of the merits of the ideas proposed. That process, by definition and by construction, selects the best and most creative ideas, those that offer the greatest promise for success. We invest more than $7 billion annually in these efforts. Our grantees are the winners in this process, so too are the taxpayers who have invested in this research through the NSF.

Let me illustrate one way, through our recently launched I-Corps program, the American taxpayer benefits from NSF investments. Important discoveries that expand our knowledge of the universe, our natural world and our human-made environment are made every day by NSF-

funded researchers. Those researchers have been chosen for financial support from NSF through NSF's merit review process, the gold standard world-wide for competitively choosing the best research and education ideas. Some of that research addresses our most fundamental and basic curiosities, such as the origins of the universe. And some of that research leads to advancement in science in technology that can directly benefit the world in which we live, such as a better understanding of the environment, methods for generating energy, or the benefits of certain materials properties. It is good stewardship, we believe, if we can assist those current and past NSF-funded researchers to identify the realistic potential for developing their ideas into a product or process of societal benefit.

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 (I/UCRC), Partnerships for Innovation (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 of course the Small Business Innovation Research (SBIR) program. These programs complement our other significant investments in fundamental scientific and engineering research by offering multiple pathways to moving discovery to innovative technologies.

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 the early 1980's.



Timeline for Inception of Current NSF programs Supporting the Innovation Ecosystem

Most closely related to I-Corps is the Accelerating Innovation Research (AIR) program in the Directorate for Engineering (ENG) also started in FY 2011. The AIR 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 AIR 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 S&E knowledge paradigms altogether. That, in effect, is what we seek to accomplish through the Innovation Corps program.

Goals

The goals of the I-Corps program are:

- to build on NSF's investment in fundamental research;
- to offer academic researchers and students an opportunity to learn firsthand about technological innovation and entrepreneurship, and thereby fulfill the promise of their discoveries; and
- to prepare students for real-world experience through curricular enhancements, and provide them with opportunities to learn about and participate in the process of transforming scientific and engineering discoveries to meet societal needs.

The I-Corps program is comprised of three elements, namely:

- Financial support to the team to assist the development of a prototype or a proof of concept;
- A specific structure for the I-Corps team, comprised of a principal investigator, an entrepreneurial lead, and an innovation/entrepreneurial mentor; and
- A strong educational component focusing on a hypothesis driven approach to developing a methodology for evaluating both the technical merits and the marketability of the concept being proposed.

Because the hypothesis-testing approach of the customer development process used in I-Corps is so similar to the Scientific Method, it is easily accepted by the scientists and engineers we touch with I-Corps. This approach is proving to be instrumental in helping teams to take a practical look at what is involved in going to the next step. Also, because the teams proceed together in cohorts of approximately 25, the peer-to-peer environment greatly enhances the effectiveness of the overall effort; independent teams help, encourage and drive one another. Finally, the business model canvas which is employed in the curriculum puts a straightforward go/no go assessment and commercialization plan in place during the effort. Together, these elements enable the teams to effectively assess the commercial viability of the proposed innovations. At this stage of the effort, the teams do not need to focus on business plans per

se, rather they need to focus on the nature of the commercial opportunity enabled by the proposed innovation and fleshing out the gaps in knowledge required to be successful. What they take away are the skills and tools that they will need to move forward to become great entrepreneurs.

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.

NSF participation in I-Corps includes every directorate and NSF's Offices of Cyberinfrastructure and Polar Programs. The structure of I-Corps mirrors the NSF Director's vision of OneNSF, working together seamlessly in well-integrated and efficient ways across organizational and disciplinary boundaries. The internal review structure for the program involves a core of cognizant program officers in partnership with topic-specific program officers in each of the seven directorates and the Offices of Cyberinfrastructure and Polar Programs.

The I-Corps award mechanism includes 'seed/pre-seed' funding, 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.

I-Corps targets the critical gap that occurs just before researchers have advanced their ideas sufficiently to apply for Small Business Innovation Research funding. In that sense this is a 'pre-seed' investment. The phrase "jumpstart" is used to describe the needed push. NSF investments will strategically strengthen the innovation ecosystem by addressing the challenges inherent in the early stages of the innovation process.

In FY 2012, the I-Corps program will support up to 100 projects, at $50,000 each, for six months.

In FY 2013 I-Corps will support up to 250 awards. Going forward, some adjustments may be made to the program, possibly including:

- The duration of the award;
- The number of team members required/allowed to participate in all aspects of the educational elements of the program; and
- The geographic distribution of the providers of the educational content of the program.

We plan to retain the current model of a hypothesis driven approach to evaluating technical and market viability. This approach has proven to be very successful and experience to date indicates it provides significant "value added" to the principal investigators (PIs) and their teams. While this curriculum is currently offered to the teams by one university (Stanford University), other universities are being invited to leverage and integrate it into similarly productive curricula, including Georgia Tech and the University of Michigan. We anticipate, in FY 2013, to offer opportunities to other universities to further develop the curriculum, using the lessons learned in the execution of the I-Corps program in FY 2011 and FY 2012. We also anticipate the establishment of regional I-Corps nodes, wherein the hypothesis driven innovation educational offerings for PIs and their teams would be developed and provided by the universities involved in these nodes.

Teams that advanced their efforts toward commercializing technology were facilitated by inclusion of public- and private-sector experts to provide guidance, from, participation in tailored curriculum, and funds to evaluate the commercial readiness of technology ideas. These first technologies include photocatalysis to help clean up contaminated water, a new technology for semiconductor-based hydrogen and hydrocarbon sensors, and production of graphene film. I-Corps presents a new model for public-private partnerships that leverages our significant investment in basic research with relatively smaller I-Corps funding thus offering a bigger bang for the buck.

In the first two cohorts, (21 + 24), over 4000 discussions took place between I-Corps teams and potential partners, customers and other stakeholders. As of today, there are a total of 100 teams. There are 100 mentors with these teams, plus over 70 additional mentors who have been identified as ready and willing to join teams.

While evaluation and assessment of the progress towards achieving the prescribed goals is important for *all* NSF programs, it is particularly so for the I-Corps program. As such, I-Corps is the subject **of one of NSF's three Priority Goals for FY 2012 and FY 2013. Progress towards** Priority Goals is assessed quarterly by agency senior management and will be reported on the website Performance.gov. The relevant priority goal is to *increase the number of entrepreneurs emerging from university laboratories*. Specifically, the Priority Goal states that by September 30, 2013, 80 percent of teams participating in the Innovation Corps program will have tested the commercial viability of their product or service.

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 proposals;
- A business opportunity suitable for review by third-party investors;

- Students prepared to be entrepreneurially competitive; and
- New curriculum development or improvement in current curricula focusing on entrepreneurship and innovation.

These outcome indicators will become critical to monitor as the program matures, and establishing a realistic timeline over which these measures will change is critical. It will take more than a single one-year cycle to see real and substantive changes in these measures. .

In the meantime, we are monitoring process measures such as level of interest,number of proposals, completion rates, and the ability to expand the mentor network. Being very analytical, but also realistic, about the measures of success and when it will be appropriate to use each particular metric, a projected timeline is:

- FY 2012: Up to 100 awards at $50,000 each – The Foundation will establish baseline activities "Pre ICorps" and begin data collection of the metrics described above.
- FY 2013: Up to 250 awards at $50,000 each– The Foundation will initiate evaluations utilizing the metrics developed in FY 2012.
- FY 2014-FY 2016: NSF will continue with regular evaluations of the previously described metrics, developing a chronological database that allows for more detailed historical analysis of program success.

The approach will be similar to that taken with the very successful Engineering Research Centers and Industry/University Cooperative Research Centers programs since 1985.

Summary

Initial anecdotal indicators suggest that 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. For those 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 come here today to tell you about it. I would be happy to answer any questions.

Chairman BROOKS. Thank you, Dr. Peterson.

I now recognize our second witness, Mr. Blank, for five minutes.

STATEMENT OF MR. STEVE BLANK, LECTURER, STANFORD UNIVERSITY AND THE UNIVERSITY OF CALIFORNIA AT BERKELEY

Mr. BLANK. Thank you, Chairman Brooks and Ranking Member Lipinski; and thank you for the opportunity to discuss the National Science Foundation Innovation Corps. And I hope to address Chairman Brooks' questions directly, because I think they're appropriate questions for the country, given the set economic climate.

I just have to note that, in volunteering my services to the National Science Foundation, my career has gone full circle. I started my government service volunteering for my country during Vietnam for four years in the air force, with a year and a half in Southeast Asia. So, I'm glad to be doing this type of government service again.

I think Dr. Peterson described the role of the Innovation Corps and the SBIR and STTR program. But it's just important to note that what we have here is an education program that bridges the basic research that this Committee authorizes the NSF to do, and commercialization that we fund through the SBIR and STTR program. For 30 years we've been writing checks, but not having any educational process to assure that the recipients of those checks actually understood how to take best advantage of those scholars.

The Innovation Corps is the first successful STEM education program to bridge this gap between NSF-funded researchers who want to commercialize their technology and the needs of private capital. The data from the first 50 teams show the effectiveness of this program.

By the way, there's been two other key consequences, completely unexpected, that we had no idea would happen. The first has been the leveraging effect, as these Principal Investigators went back to their own universities and took this methodology and actually started teaching it to their own students in their own universities. And the second, I think important for this Committee and this Congress, is the effect and the applicability of this program to small business innovation and job creation on "Main Street", as well as in technology startups. That is, the same process can be used for the other 99 percent of businesses in the United States, not just for technology startups.

So, what's new about the Innovation Corps? We now know that startups are not smaller versions of large companies.

In fact, we now know that researchers who used to believe that the entire company was about their idea, is now learning that their idea and their technology is just one small piece of all the things they need to know about how to build a successful venture. They need to know—to understand customers, they need to understand pricings, they need to understand distribution channels. None of those things are visible inside the laboratory.

And so, what the class is about, this education program, is getting these scientists and engineers out of their labs, for some of them the first time in 20 years since they've seen daylight. And, actually, having them talk to people they've never talked to in their

entire lives. An average team talks to a hundred customers in eight weeks. A hundred. Let me tell you, if Solyndra was doing that, we wouldn't have been writing these checks.

Now, in fact, if we were looking for a program to avoid waste in the United States, this is the program to do that. And it's a uniquely American program. Because we've talked about hypothesis testing, we've talked about how scientists understand how to test hypothesis, but we sometimes forget that in America we don't punish failure, we actually understand that failure is part of the scientific method.

But we actually now teach the same in getting out of the building and talking to customers, and we now understand that when this wasn't the right customer, it's okay to now inexpensively look over here. If this wasn't the right pricing, look over here. If these aren't the right features, look over here. And it's only in the United States that we actually are able to take these risks and integrate quickly.

The last thing I want to mention is why is this program necessary. And I think a lot of this discussion is about a fallacy of the role of private capital. I think you know I taught this class from day one with venture capitalists sitting in the class as instruction. We brought private capital in on day one. And their take was the same as mine, none of these guys were fundable at all. They weren't. It was great science, great technology, great whatever, but they didn't have a clue about the business. It's not the role of private capital to actually go identify where the technology fits. It's actually the role of the technologist to get out of the building, have some discussions, and take the business to the next step so they can present it to private capital. And that's what this class has been doing.

I–Corps is an educational program that's a bridge to private capital, not as a replacement. And I think, I'm proud to say, that a lot of these teams will get funded by private capital, only because they've been through this class.

The other comment that I just want to make is picking winners and losers. As I said, this doesn't replace private capital with government's funds. Its goal is to get research in the country that we've already paid for, to a point where a team can attract private capital in the shortest period of time.

Now, I'm happy to take questions. And I just should, would like to close, that I think the results were pretty spectacular, and I'm just proud to have been part of it.

What we've seen is a government program designed, built, and tested and scaled within a year. Amazing. This is like the early days of NASA. With just one-quarter of one percent we've leveraged the country's entrepreneur commitment to research, its partnership of private capital, and its tolerance for failure in a uniquely American way. It's an extraordinarily efficient use of taxpayer money, and it will pay us back with jobs and a competitive edge on a global scale. Thank you.

[The prepared statement of Mr. Blank follows:]

INNOVATION CORPS: A REVIEW OF A NEW NATIONAL SCIENCE FOUNDATION PROGRAM TO LEVERAGE RESEARCH INVESTMENTS

Statement of
Steve Blank
Architect and Author of the National Science Foundation
Innovation Corps Curriculum
Consulting Associate Professor Stanford University,
Adjunct U.C. Berkeley Haas Business School and Columbia University

Before the

Subcommittee on Research and Science Education Committee on Science, Space, and Technology U.S. House of Representatives

July 16, 2012

Testimony to the Congressional Committee on Science, Space, and Technology – Subcommittee on Research and Science Education

Innovation Corps: A Review of a New National Science Foundation Program to Leverage Research Investments

Chairman Brooks, ranking member Lipinski, and other members of the subcommittee, thank you for the opportunity to discuss with you the National Science Foundation Innovation Corps.

My name is Steve Blank. I am a Consulting Associate Professor at Stanford University, and an Adjunct at U.C. Berkeley Haas Business School. I am the architect and author of the National Science Foundation Innovation Corps curriculum. In volunteering my services to the National Science Foundation my career has gone full circle. I started my government service with 4 years in the U.S. Air Force during Vietnam – serving a year and a half in Southeast Asia. I've spent the last 34 years in Silicon Valley, 21 years as an entrepreneur in 8 startups and the last 11 years as an educator teaching at Stanford, U.C. Berkeley and Columbia University.

I'm here today to offer my thoughts on the benefits of the NSF Innovation Corps (I-Corps) program to the U.S. taxpayer, share with you some of the results of the class and to describe my role in the program.

Summary

The National Science Foundation's funding of America's research universities "have been the critical assets that have laid the groundwork—through research and doctoral education—for the development of many of the competitive advantages that make possible the high American standard of living. Business and industry have largely dismantled the large corporate research laboratories that drove American industrial leadership in the 20th century (for example, Bell Labs), but have not yet fully partnered with research universities to fill the gap."[1]

Over the last three decades the SBIR/STTR programs were created to bridge this gap by increasing private-sector commercialization of proposed innovations derived from Federal research and development funding and stimulate technological innovation while meeting federal research and development needs.

Yet in the decades since the inception of the SBIR/STTR programs, there has not been a formal education process to help these federal research innovations transition from the university lab into a profitable company.

The NSF Innovation Corps is the first successful STEM education program to bridge the gap between NSF funded researchers who want to commercialize their technology and the

[1] http://www7.nationalacademies.org/ocga/testimony/Research_Universities.asp

needs of private capital. Data from the first 50 I-Corps teams confirm the effectiveness of the program. We believe the result will be new jobs and increased competitiveness of American industries.

There have been two other consequences of this program. The first has been the leveraging effect as Principal Investigators take what they learned from I-Corps back to their home institutions and develop workshops and similar opportunities on their own campuses. The second has been the applicability of the program to small business innovation and job creation on "Main Street" as well as in technology startups.

What's New About the I-Corps?

The I-Corps capitalizes on new insights we have about reducing the failure rate of new startups. We now know that *startups are not smaller versions of large companies.*

- Until now classes for entrepreneurship assumed that techniques learned in business school (i.e. how to write a business plan, 5-year forecasts) were applicable to new ventures. We now know that's wrong.
- We now know that new ventures are a series of untested hypotheses (guesses).
- While researchers believe that a company is just about their invention, the I-Corps program teaches them that *their technology idea alone is not a company.*
- A company is the sum of their technology idea *plus* customers, distribution channels, pricing, partners, etc.
- Therefore, a new startup requires deep understanding of all these other parts to be successful. (We call the sum of these parts of a company *a business model.*)
- The program emphasizes that this deep understanding can not be found inside research labs or libraries, but instead the researchers need to get out and talk to potential customers. (An average team meets at least 100 customers during the class.)
- The program teaches researchers a methodology called *Customer Development*, a process of rapidly and *inexpensively* testing their business hypotheses.
- Since hypotheses' testing is an integral part of the scientific method, scientists grasp this concept of testing business hypotheses immediately.

Companies have adopted the customer development process because it consumes less cash, wastes fewer resources and allows them to bring products to market rapidly.

I-Corps - A Uniquely American Program

One of the unique parts of the class is applying the scientific method to building startups. Teams start with a hypothesis – in this case about some part of their business (who are their customers, partners, etc.), they design experiments to test those guesses, get out of the lab and run the test. With the data in-hand they attempt to derive insight from the data and either verify or disprove the hypothesis.

But much like in science, in business most experiments fail. Teams pick the wrong customers, or the wrong pricing, or the wrong partners or even the wrong features for their product. But the customer development process says *failure is an integral part of the processes.* If you're hypotheses are incorrect you *pivot* – that is you make a substantive change a try something different.

By running the process of hypothesis testing and pivots at an extraordinary high rate of speed, startups rapidly converge on a potential solution to "how do I turn a technology into a company."

This process is uniquely American. At its heart *it embraces failure*. We don't punish it we don't give up when it happens we just simply recognize that Americans understand that failure is part of the startup (and science) culture. Careers don't end if experiment didn't work or your company fails – you do another one. This tolerance for risk in our society is what enables us to fund basic research. It's why Silicon Valley investors fund startups *when over 90% of startups fail.*

We have a special word for failed entrepreneurs in the U.S. that visitors to this country have a hard time understanding – *experienced.*

Why is this Program Necessary?
One would think that private investors would be flocking to advanced technology coming out of our universities. Yet the reality is that proposed technology innovations are just one part of what makes a fundable company. A *mistaken assumption is that it's the role of private capital to assess technology and determine whether there exists a viable fundable company.* In fact, ***it's the role of the company to investigate the business opportunity*** of the technology *and present it to potential investors.*

The job of the I-Corps program is to teach our top scientists how to develop the many other essential components that make up an investable business (customers, pricing, sales channel, partners, marketing, manufacturing, etc.) and present them to private capital in a form that that articulates how investors can make money. And to do so in weeks, not in years.

I-Corps is an *educational program* that is a bridge to private capital - *not a replacement* for private capital. Venture capitalists co-teach the class to prepare the teams so they can become fundable. Almost none of the entrants to the I-Corps cohorts could have attracted private capital. Upon graduation 92% of the I-Corps graduates stated they were going to go out and raise money – either from the NSF or with private capital - to build companies and put Americans to work. Given that most of them didn't know what a startup was coming in, this was a bit astonishing. Every new company that gets funded means new jobs are being created.

Picking Winners and Losers
The I-Corps program does not pick winners and losers. It doesn't replace private capital with government funds. Its goal is to *get research the country has already paid for to the point where a team can attract private capital in the shortest period of time.* (It's why we teach the class with experienced Venture Capitalists.) Every team has volunteered for the program. The marketplace, not the government, will decide whether their new venture will win or lose.[2]

[2] http://www.nsf.gov/news/newsmedia/i-corps/team_summaries.pdf

While many government agencies use the Technology Readiness Levels[3] to measure a project's *technical* maturity, there are no standards around *business* maturity levels. The output of the NSF I-Corps class provides a proxy for a minimum level of business maturity.

Our goal is get the science out of the labs and into use by U.S. corporations. For the first time, private capital now can look at "business ready" technology.

Why is a Federal Program Necessary?
The NSF I-Corps class has different goals then the same class taught in a university or incubator. In a university, the class teaches a methodology the students can use for the rest of their careers. In an incubator, the class develops angel or venture-funded startups.

When taught for the NSF I-Corps, the goal of the class is to teach NSF-funded researchers how to move their technologies from university labs into the commercial world. Unlike a traditional incubator where a successful outcome is an angel or venture-funded startup, for the I-Corps the expected outcomes for teams include:

New startups funded via:
- a NSF SBIR Phase I grant (over 25% of the teams apply)
- Angel/VC funding (over 90% of the teams will seek additional funding)
- Patent or technology license to a U.S. company

If the teams pursue a SBIR Phase I grant ($150K), the NSF looks at the I-Corps projects and asks: 1) is this teams product viable? Go/no go? 2) **If it's a go, what's the transition** plan to do so?, and 3) can this be a technology demonstration for potential partners?

Principal Investigators managing research at their university labs cannot take three months off to attend a class at Stanford without interrupting their teaching and research. Therefore the classes need to be offered at multiple sites in the U.S. with the majority of the coursework performed at the teams University. Only the Federal government can provide the funding and logistics for the hundreds of I-Corps teams seeking the opportunity to commercialize their research.

Innovation Corps Status
Beginning in 2011 we taught two I-Corps cohorts: 21 teams ending in December 2011 and 24 teams ending in May 2012. As we speak, in July 2012 we are teaching 54 more teams – 27 at Georgia Tech and 27 at the University of Michigan. We plan to educate another 50 teams in October. Each 3-person team consists of a *Principal Investigator, an Entrepreneurial Lead* and a *Mentor.*

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[3] http://www.hq.nasa.gov/office/codeq/trl/trl.pdf

The *Principal Investigator* (average age of ~45) is faculty member who runs his or her own research lab and has had an active NSF grant within the last 5 years. The Principal Investigator forms the team by selecting one of his graduate students to be the Entrepreneurial Lead.

The *Entrepreneurial Lead* is a graduate student or post doc (average age ~ 28) who works within the Principal Investigator's lab. If a commercial venture comes out of the I-Corps, it's more than likely that the Entrepreneurial Lead will take an active role in the new company. (Typically Principal Investigators stay in their academic role and continue as an advisor to the new venture.)

Mentors (average age ~50) are experienced entrepreneurs who are located near the academic institution and have experience in transiting technology out of academic labs. Mentors are recommended by the Principal Investigator (who has worked with them in the past) or they may be a member of the NSF I-Corps Mentor network. Some mentors may become an active participant in a startup that comes out of the class.

Teaching Objectives
Few of the Principal Investigators or Entrepreneurial Leads had business startup experience, and few of the mentors were familiar with either Business Model design or Customer Development.'

Therefore, the teaching objectives of the I-Corps class are:

1) Help each team understand that a successful company was more than just its technology/invention by introducing all the parts of a business model (customers, channel, get/keep/grow, revenue models, partners, resources, activities and costs.)
2) Get the teams out of the building to test their hypotheses with prospective customers. The teams in the first cohort averaged 80 customer meetings per team; the second cohort spoke to an average of 100.
3) Motivate the teams to pursue commercialization of their idea. The best indicators of their future success were whether they a) found a scalable business model, b) had an interest in starting a company, and c) would pursue additional funding.

My Role in the I-Corps Program
The I-Corps class was derived from my 21 years of startup experience. Those years gave me the freedom to give back to my country and community to teach entrepreneurship. It allowed me to explore a totally different way to think about and teach new venture formation. I'm proud that startups in Silicon Valley and other entrepreneurial clusters in the U.S. and the world have rapidly adopted the Lean Startup and Customer Development methods. But its embrace by our country's leading scientists that make me most proud. We've cracked the code on entrepreneurship. We now know how to make startups fail less.

Scaling the I-Corps Program
I taught the first two I-Corps classes alongside venture capitalists I asked to volunteer their services to the country. None of us received any compensation for our efforts.

Other regions in the U.S. around research universities have a robust entrepreneurial culture (what they lack is a robust venture capital culture.) The program was designed from inception to scale in those research universities with entrepreneurial curricula. It is built around a formal methodology of business model design and customer development. The rigor of the framework allows entrepreneurship faculty in other universities to come up to speed quickly. In fact, in March we trained the first set of instructors from other universities. As we speak, the I-Corps is being taught simultaneously in Georgia Tech and the University of Michigan. And the NSF will be announcing its plans to scale it further to other universities.

Results

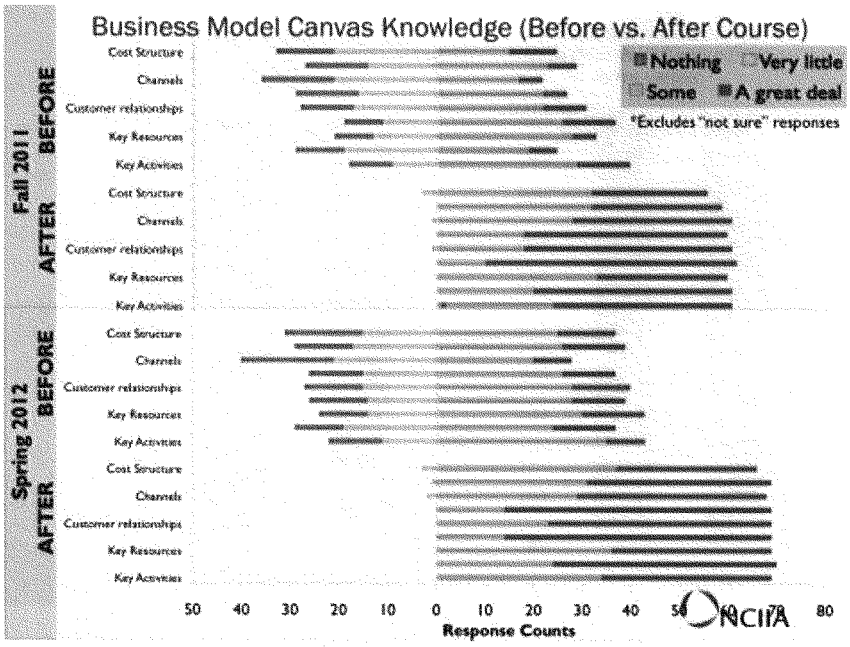
The National Science Foundation worked with NCIIA[4] to establish a baseline of what the students knew *before* the class and followed it up with a questionnaire *after* the class.

While my experience teaching *students* at Stanford, Berkeley and Columbia suggested that this class was an effective way to teach all the parts that make up a startup, would the same approach work with *academic researchers*?

Here's what we found.

Teams came into the class knowing little about what parts made up a company business model (customers, channel, get/keep/grow, revenue models, partners, resources, activities and costs.) They left with very deep knowledge.

[4] http://nciia.org/

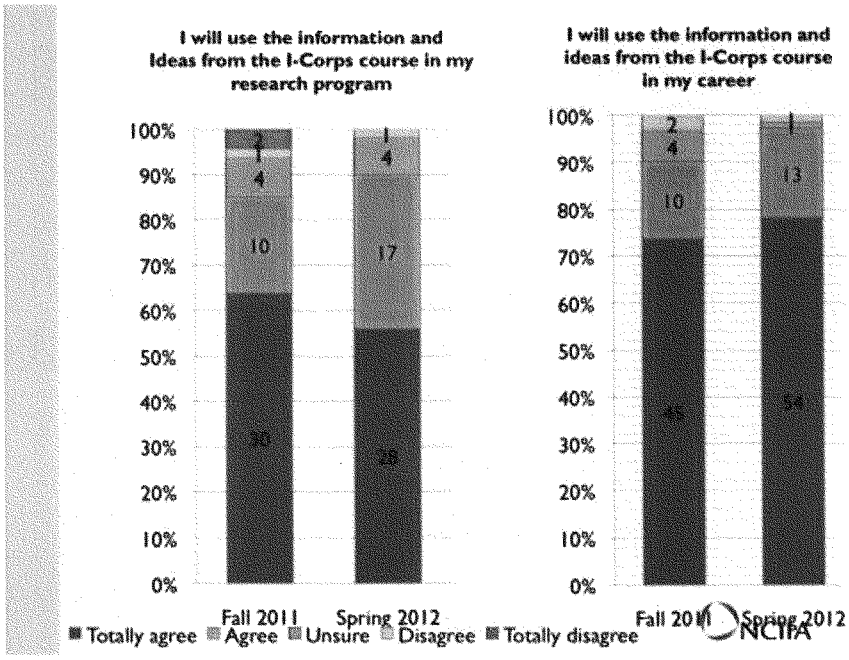


I-Corps teams spent the class refining their business model and minimum viable product.

By the end of the class:
- Over 95% believed that they found a scalable business model.
- **98% felt that they had found "product/market fit".**

The class increased everyone's interest in starting a company. 92% said they were going to go out and raise money – either from the NSF or with private capital. (This was a bit astonishing **given that most of them didn't know what a startup was coming in. These are** new jobs being created.)

One of the unexpected consequences of the class was its effect on the Principal Investigators, (almost all tenured professors.) A surprising number said the ideas for the class will impact their research, and 98% of all of the attendees said it was going to be used in their careers.



Another unexpected result was the impact the class had on the professors' own thinking about how they would teach their science and engineering students. We got numerous comments about "I'm going to get my department to teach this."

The NSF understands that the analysis doesn't end by just studying the results of each cohort. We need to measure what happens to the teams and each of the team (Principal Investigator, Entrepreneurial Lead and Mentor) over time. It's only after a longitudinal study that will take years that we'll understand the final tally on job creation. But I think we've made a start.

Results/Recommendations

Going into the I-Corps program we had a series of our own untested hypotheses:

- Would this experiential method of teaching impart a deep understanding of what it takes to build a fundable company? The data from NCIIA says yes.
- Could we make 45-year old academics work as hard as entrepreneurs in hoodies and flip-flops? Watching them get out of their labs and talk to 100 customers in 10 weeks says yes.
- Was the I-Corps curriculum scalable? Could we train other educators to teach it? The courses being taught at Georgia Tech and the University Michigan show that we can.
- Most importantly could we bridge the missing educational gap between invention and company building? Here again the results say yes.

If we are correct about the outcome of these classes it seems logical to:

1. Recommend that the National Science Foundation require participation in an I-Corps class for all teams before receiving a Phase II grant.
2. To support this, scale the I-Corps classes to ~15 universities by the end of 2013.
3. Encourage other government research organizations to offer I-Corps training as precursor to their Phase II SBIR/STTR grants.
4. Use the NSF organizational experience in building the I-Corps program to be the cognizant agency for I-Corps across all U.S. research organizations.

In closing, what we've just seen is a government program designed, built, tested and scaled within a year. With just one-quarter of one percent of the NSF budget we've leveraged the country's commitment to research, it's partnership with private capital and its tolerance for failure in a uniquely American way. It's an extraordinarily efficient use of taxpayers' money. It will pay us back with jobs and a competitive edge on a global scale.

In short, we made a dent in the universe.

Thank you.

Acknowledgements
Thanks to the team at NCIIA that provided the analytical and logistical support to run these NSF classes. And to the team at the National Science Foundation (Errol Arkilic, Babu DasGupta) who took a chance at changing the status quo.

And thanks to the venture capitalists and entrepreneurs who volunteer their time for their country; Jon Feiber from MDV, John Burke from True Ventures, Jim Hornthal from CMEA, Jerry Engel from Monitor Ventures (and the U.C. Berkeley Haas Business School,) Oren Jacob from ToyTalk and Lisa Forssell of Pixar.

Entrepreneurship Background: Cold War Spin Outs[5]

In the 1950's the groundwork for a culture and environment of entrepreneurship were taking shape on the east and west coasts of the United States. Each region had two of the finest research universities in the United States, Stanford and MIT, which were building on the technology breakthroughs of World War II and graduating a generation of engineers into a consumer and cold war economy that seemed limitless. Each region already had the beginnings of a high-tech culture, Boston with Raytheon, Silicon Valley with Hewlett Packard.

However, the majority of engineers graduating from these schools went to work in *existing companies.* But in the mid 1950's the culture around these two universities began to change.

Stanford – 1950's Innovation
At Stanford, Dean of Engineering/Provost Fred Terman wanted companies outside of the university to take Stanford's prototype microwave tubes and electronic intelligence systems and build production volumes for the military. While existing companies took some of the business, often it was a graduate student or professor who started a new company. The motivation in the mid 1950's for these new startups was a crisis – we were in the midst of the cold war, and the United States military and intelligence agencies were rearming as fast as they could.

In 1956 Hewlett Packard, then a maker of test equipment was the valley's largest electronics employer with 900 employees. But startups were rapidly spinning out of Stanford's Applied Electronics Lab delivering microwave tubes, components and complete electronic intelligence and electronic warfare systems for the U.S. military and intelligence agencies. The future of the valley was clear – *microwaves*.

1956 – SLBMS and Semiconductors
In 1956 two events would harbor the beginning of a sea-change in innovation and entrepreneurship. At the time neither appeared earthshaking or momentous. Shockley Semiconductor Laboratory, the first semiconductor company in the valley, set up shop in Mountain View. And down the street, Lockheed Missiles Systems Division, which would become the valley's most important startup for the next 20 years, moved its new missile division from Burbank to 275 acres next to the Moffett Naval Air Station in Sunnyvale.

Lockheed, an airplane manufacturer, was getting into the missile business by becoming the prime contractor to build the Polaris, a submarine launched ballistic missile (SLBM) developed by the Navy. The Polaris was unique: it would be the first solid-fuel ballistic missile used by the U.S. Solid fuel solved the safety problem of carrying missiles at sea and underwater and also allowed for instant launch capability. Polaris launched SLBM's would become the third part of the nuclear triad the U.S. built in the cold war – the Polaris, the B-52 manned bomber, and the Minuteman, and Titan land-based

[5] http://steveblank.com/secret-history/

Intercontinental Ballistic Missiles (ICBMs.)

10 years after the program started the United States had built and put to sea 41 ballistic missile submarines carrying 656 Lockheed missiles. Lockheed built close to 1000 of these missiles in those ten years. **That's 100 missiles a year, 8/month or 2 a week** flying out of Moffett Field in the heart of what would become Silicon Valley.

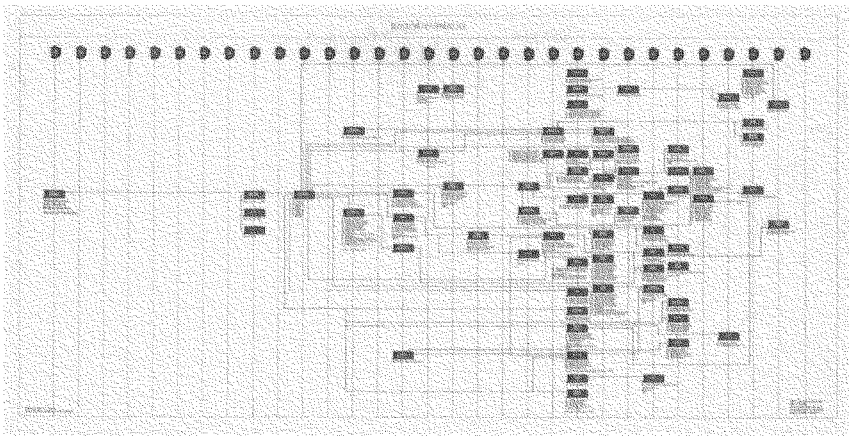
Zero to 28,000 people – We Become "Defense Valley"
By 1965 Hewlett Packard, the test and instrumentation company, had grown ten-fold. From 900 people in 1956 it now employed 9,000. Clearly it must have been the dominant company in the valley? Or perhaps it was Fairchild, the direct descendant of Shockley Semiconductor, now the dominant semiconductor supplier in the valley (80% of its first years business coming from military systems) with ~10,000 people?

Nope, it was the Lockheed Missiles Division, which had zero employees in 1956, now in 1965 *had 28,000 employees in Sunnyvale*. The best and the brightest were coming from across the country to the valley south of San Francisco.

And they were not only building Polaris missiles.

By 1965 Lockheed factories in Sunnyvale, Stanford and East Palo Alto *were building spy satellites for the CIA, NSA and NRO.* **While the 1950's had made** the area south of San Francisco **"Microwave Valley," the growth of Lockheed, Westinghouse and their** suppliers **had turned us into "Defense Valley."**

Why It's "Silicon" Valley
While 1956 was the beginning of massive government funding in what would become Silicon Valley, entrepreneurship as we now know it began to emerge in a very small and inconspicuous way. Shockley Semiconductor Laboratory, the first semiconductor company **in the valley, set up shop in Mountain View. Fifteen months later eight of Shockley's** employees (three physicists, an electrical engineer, an industrial engineer, a mechanical engineer, a metallurgist and a physical chemist) quit Shockley and founded Fairchild Semiconductor. (Every chip company in Silicon Valley can trace their lineage from Fairchild.)



The history of Fairchild was one of applied experimentation. It wasn't pure research, but rather a culture of taking sufficient risks to get to market. It was learning, discovery, iteration and execution. The goal was commercial products, but as scientists and engineers the company's founders realized that at times *the cost of experimentation was failure.* And just as they don't punish failure in a research lab, they didn't fire scientists whose experiments didn't work. Instead the company built a culture where when you hit a wall, you backed up and tried a different path. (In 21st century parlance we say that innovation in the early semiconductor business was all about "pivoting" while aiming for salable products.)

The Fairchild approach would shape Silicon Valley's entrepreneurial ethos: *In startups, failure was treated as experience* (until you ran out of money.)

Scientists and Engineers as Founders

In the late 1950's Silicon Valley's first three Initial Public Offerings (IPO's) were companies that were founded and run by scientists and engineers: Varian (founded by Stanford engineering professors and graduate students,) Hewlett Packard (founded by two Stanford engineering graduate students) and Ampex (founded by a mechanical/electrical engineer.) While this signaled that investments in technology companies could be very lucrative, both Shockley and Fairchild could only be funded through corporate partners – there was no venture capital industry. But by the early 1960's the tidal wave of semiconductor startup spinouts from Fairchild would find a valley with a growing number of U.S. government backed venture firms and limited partnerships.

A wave of innovation was about to meet a pile of risk capital.

For the next two decades venture capital invested in things that ran on electrons: hardware, software and silicon. Yet the companies were anomalies in the big picture in the U.S. – there were almost no MBA's. In 1960's and '70's few MBA's would give up a lucrative

career in management, finance or Wall Street to join a bunch of technical lunatics. So the engineers taught themselves how to become marketers, sales people and CEO's. And the venture capital community became comfortable in funding them.

Medical Researchers Get Entrepreneurial
In the 60's and 70's, while engineers were founding companies, medical researchers and academics were skeptical about the blurring of the lines between academia and commerce. This all changed in 1980 with the Genentech IPO.

In 1973, two scientists, Stanley Cohen at Stanford and Herbert Boyer at UCSF, discovered recombinant DNA, and Boyer went on to found Genentech. In 1980 Genentech became the first IPO of a venture funded biotech company. The fact that serious money could be made in companies investing in life sciences wasn't lost on other researchers and the venture capital community.

Over the next decade, medical graduate students saw their professors start companies, other professors saw their peers and entrepreneurial colleagues start companies, and VC's started calling on academics and researchers and speaking their language.

Scientists and Engineers = Innovation and Entrepreneurship
Yet when venture capital got involved they brought all the processes *to administer existing companies* they learned in business school – how to write a business plan, accounting, organizational behavior, managerial skills, marketing, operations, etc. This set up a conflict with the learning, discovery and experimentation style of the original valley founders.

Fifty years later we now know the engineers were right. Business plans are fine for large companies where there is an existing market, product and customers, but in a startup all of these elements are unknown and the process of discovering them is filled with rapidly changing assumptions.

Startups are not smaller versions of large companies. Large companies execute known business models. In the real world a startup is about the *search* for a business model or more accurately, *startups are a temporary organization designed to search for a scalable and repeatable business model.*

Yet for the last 40 years, while technical founders knew that *no business plan survived first contact with customers,* they lacked a management tool set for *learning, discovery and experimentation.*

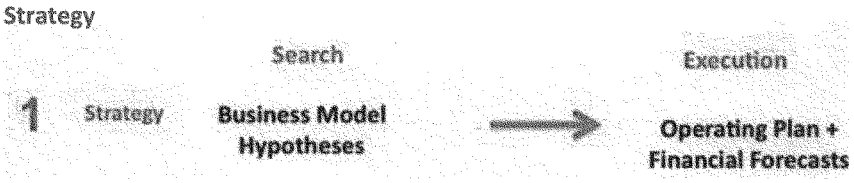
In 2011 we taught a class in the Stanford Technology Ventures Program, (the entrepreneurship center at Stanford's School of Engineering), based on my previous Stanford and U.C. Berkeley courses, to provide scientists and engineers just those tools – how to think about *all* the parts of building a business, not just the product. The Stanford Lean LaunchPad class introduced the first *management tools for entrepreneurs* built around the business model / customer development / agile development solution stack.

With the NSF Innovation Corps, *scientists and engineers now have a methodology to rapidly take commercialize their research.*

The Innovation Corps/Lean LaunchPad: Management tools for entrepreneurs

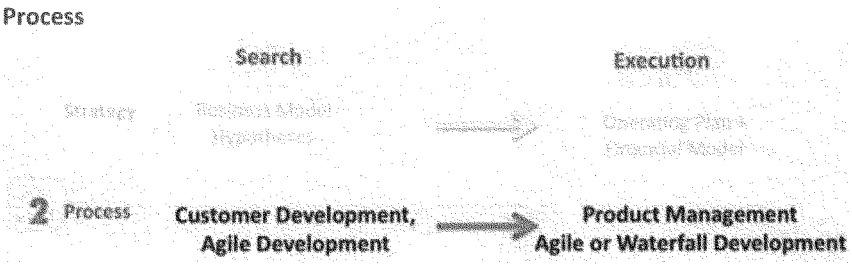
One of the things startups have lacked is a definition of who they were. For years we've treated startups like they are just smaller versions of large companies However, we now know that a startup is a *temporary organization designed to search for a repeatable and scalable business model.* Within this definition, a startup can be a new venture or it can be a *new division or business unit in an existing company.*

If your business model is *unknown*—that is, just a set of untested hypotheses—you are a startup *searching* for a repeatable business model. Once your business model (market, customers, features, channels, pricing, Get/Keep/Grow strategy, etc.) is *known*, you will be *executing* it. *Search* versus *execution* is what differentiates a new venture from an *existing* business unit.



The term "business model" first appeared around 50 years ago, but the concept didn't catch on until the 1990's. It became common vernacular to discuss business models, but without a standard framework and vernacular, confusion reigned. In 2010, when Alexander Osterwalder published his book, Business Model Generation, he provided a visual ontology and a clear vernacular that was sorely needed, and it became clear that this was the tool to organize startup hypotheses.

The primary objective of a startup is to validate its business model hypotheses until it finds one that is repeatable and scalable (it continues to iterate and pivot until it does.) Then it moves into *execution* mode. It's at this point the business needs an operating plan, financial forecasts and other well-understood management tools.



Yet as powerful as the Business Model Canvas (a template with the nine blocks of a business model) is, at the end of the day it was a tool for brainstorming hypotheses without a formal way of testing them.

The *processes* used to organize and implement the search for the business model are *Customer Development* and *Agile Development*. A search for a business model can occur in any new business—in a brand new startup new or in a new division of an existing company.

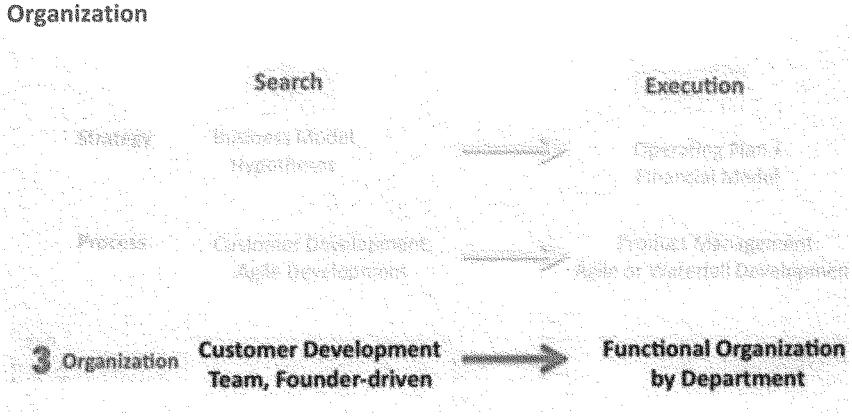
The Customer Development model breaks out all the customer-related activities of an early-stage company into four easy-to-understand steps. The first two steps of the process outline the **"search" for the business model. Steps three and four "execute" the business model that's been developed, tested, and proven in steps one and two. The steps:**

- *Customer discovery* **first captures the founders' vision and turns it into a series of** business model hypotheses. Then it develops a plan to test customer reactions to those hypotheses and turn them into facts.
- *Customer validation* tests whether the resulting business model is repeatable and scalable. If not, you return to customer discovery.
- *Customer creation* is the start of execution. It builds end-user demand and drives it into the sales channel to scale the business.
- *Company-building* transitions the organization from a startup to a company focused on executing a validated model.

In the "search" steps, you want a process designed to be dynamic, so you work with a rough business model description knowing it will change. The business model changes because startups use customer development to run experiments to test the hypotheses that make up the model. (First testing their understanding of the customer problem and then solutions.) Most of the time these experiments fail. *Search embraces failure as a natural part of the startup process.* Unlike existing companies that fire executives when they fail to match a plan, *we keep the founders and change the model.*

Once a company has found a business model (it knows its market, customers, product/service, channel, pricing, etc.), the organization moves from search to execution.

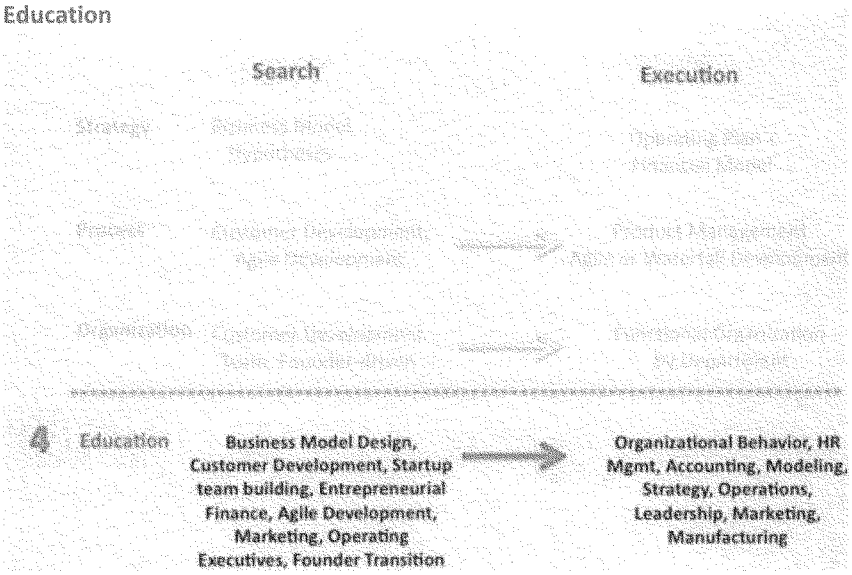
The product execution process—managing the lifecycle of existing products and the launch of follow-on products—is the job of the product management and engineering organizations. It results in a *linear process* where you make operating plans and refine them into detail. The more granularity you add to a plan, the better people can execute it: a Business Requirement document (BRD) leads to a Market Requirements Document (MRD) and then gets handed off to engineering as a Functional Specifications Document (FSD) implemented via Agile or Waterfall development.



Searching for a business model *requires a different organization* than the one used to execute a plan. *Searching* requires the company to be organized around a *customer development team* led by the founders. It's only the founders who can make the strategic decisions to iterate and/or pivot the business model, and to do that they need to hear customer feedback directly. In contrast, execution (which follows search) assumes that the job specifications for each of the senior roles in the company can be tightly authored. Execution requires the company to be organized by function (product management, sales, marketing, business development, etc.)

Companies in execution suffer from a "fear of failure culture," quite understandable since they were hired to execute a known job spec. Startups with Customer Development Teams have a "learning and discovery" culture for search. The fear of making a move before the last detail is nailed down is one of the biggest problems existing companies have when they need to learn how to search.

The idea of not having a functional organization until the organization has found a proven business model is one of the hardest things for new startups to grasp. *There are no sales, marketing or business development departments when you are searching for a business model.* If you've organized your startup with those departments, you are not really doing customer development. (It's like trying to implement a startup using Waterfall engineering.)



Entrepreneurship curricula are only a few decades old. First taught as electives and now part of core business school curricula, the field is still struggling to escape from the bounds of the business plan-centric view that startups are "smaller versions of a large company." Venture capitalists who've watched as *no startup business plan survived first contact with customers* continue to insist that startups write business plans as the price of entry to venture funding. This continues to be the case even as many of the best VCs understand that ***business "planning,"*** and ***not the "plan"*** itself, is what is important.

The trouble is that over time, this key message has gotten lost. As business school professors, many of whom lack venture experience, studied how VCs made decisions, they observed the apparently central role of the business plan and proceeded to make the plan, *not the planning*, the central framework for teaching entrepreneurship. As new generations of VCs with MBAs came into the business, they compounded the problem ("that's how we always done it" or "that's what I learned (or the senior partners learned) in business school.")

Entrepreneurship educators have realized that a plan-centric curriculum may get by for teaching incremental innovation but won't turn out students prepared for the realities of building new ventures. Educators are now beginning to build their own *E-School* curriculum with a *new class of* management tools built around "search and discovery." Business Model Design, Product/Service Development, Customer Development, Startup Team-Building, Entrepreneurial Finance, Marketing, Founder

Transition, etc., all provide the startup equivalent of the management tools MBAs learn for execution.

Entrepreneurial education is also changing the focus of the class experience from case method to hands-on experience. Invented at Harvard, the case method approach assumes that knowledge is gained when students actively participate in a discussion of a situation that may be faced by decision makers.

But the search for a repeatable business model for a new product or service is not a predictable pattern. An entrepreneur must start with the belief that all her assumptions are simply hypotheses that will undoubtedly be challenged by what she learns from customers. Analyzing a case in the classroom removed from the realities of chaos and conflicting customer responses adds little to an entrepreneur's knowledge. Cases can't be replicated because the world of a startup too chaotic and complicated. The case method is the antithesis of how entrepreneurs build startups—it teaches pattern recognition tools for the wrong patterns—and therefore has limited value as a tool for teaching entrepreneurship.

The replacement for the case method is not better cases written for startups. Instead, it would be business model design; using the business model canvas as a way to 1) capture and *visualize the evolution* of business learning in a company, and 2) see what *patterns*

match real world iterations and pivots. It is a tool that better matches the real-world search for the business model.

In addition, teaching for the Lean LaunchPad class is typically done with a "flipped classroom." Here, the lectures are homework (as interactive videos) and the homework (testing hypotheses in front of customers) is the classroom discussion as all teams present. To keep track of the students' customer discovery progress, we use an on-line tool (LaunchPad Central) to record the week-by-week narrative of their journey.

An entrepreneurial curriculum obviously will have some core classes based on theory, lecture and mentorship. There's embarrassing little research on entrepreneurship education and outcomes, but we do know that students learn best when they can connect with the material in a hands-on way, personally making the mistakes and learning from them directly.

As much as possible, the emphasis ought to be on experiential, learner-centric and inquiry-based classes that help to develop the mindset, reflexes, agility and resilience an entrepreneur needs to search for certainty in a chaotic world.

I-Corps Lean LaunchPad Pedagogy – Experiential Learning and a Flipped Classroom

The Lean LaunchPad is a hands-on program that immerses teams in testing their business model hypotheses outside the classroom. Inside the classroom, it deliberately trades off lecture time for student/teaching team interaction.

The Lean LaunchPad uses the Customer Development process and the business model canvas to collapse the infinite possibilities of a startup into a solvable problem.

Experiential Learning
Experiential learning has been around forever. Think of the guilds, apprentices, etc. Mentors were the master craftsmen. That's the core idea of this class.

The I-Corps class uses *experiential learning* as the paradigm for engaging the participants in discovery and hypotheses testing of their business models. From the first day we meet, the teams get out of the classroom and learn by doing.

This is very different from how a business school, "how to write a business plan" class works. There, it assumed a priori a valid business model. In this Lean LaunchPad class, the teams are *not* building a business (yet). Information they learn from customers will validate/invalidate their hypotheses (thesis), and the teams will modify the business model (iterate or pivot). This results in the teams bringing market needs forward. Then they can decide if there's a business to be built.

What this class does not include is execution of the business model. In this course, implementation is all about discovery outside of the classroom. Once discovery has

resulted in a high degree of confidence that a viable business model exists, it is time to create an execution plan. If the teams continue with their companies, they will assemble the appropriate operating plans (financial models, revenue plans, etc.)

The Flipped Classroom
Rather than classroom lectures by an instructor in the weeks we are remote and online, the lectures have now become homework. Students will watch a lecture on each component of the business model canvas, take a short quiz and have access to a class forum for questions. Their homework for that week assumes they will use that new knowledge to test that specific part of the business model.

Innovation Corps - Course Logistics

In week 1, students attend 3 days of on-site training at a NSF-designated university. Half the days are team presentations and critiques plus in-person lectures, and the other half consists of getting out of the building and talking to customers.

For the next 5 weeks, back at their universities, teams spend 10-15 hours a week talking to customers.

In addition, each week, teams spend two hours on-line as they present their findings via WebEx and hear their peers' presentations

During the week, they watch an interactive lecture on a portion of the business model canvas

In Week 8, they reconvene at the same at a NSF-designated university for one day of presentation training, and another for the final "Lessons Learned" presentations.

Classes
For each weekly class session, there are:
- Pre-class readings
- A pre-recorded on-line lecture with quizzes
- An in-class team 10-minute presentation
- Weekly assignment to get out of the building and test one of the business model components with 10+ customers

Each week's class session is organized around:
- Team presentations on their "lessons learned" from talking with customers and iterating or pivoting their business models.
- Lectures:
  - For the first week, three in-person business model lectures;
  - Online, in weeks 2-6, lectures are assigned as homework with quizzes

Week	Location	Lecture	Topic
Week 1	On-site	Lecture 1	Intro, Business Models, and Customer Development
	On-site	Lecture 2	Value Proposition
	On-site	Lecture 3	Customers
Week 2	On-line, self paced	Lecture 4	Channels
Week 3	On-line, self paced	Lecture 5	Customer Relationships Get/Keep/Grow
Week 4	On-line, self paced	Lecture 6	Revenue Model
Week 5	On-line, self paced	Lecture 7	Partners
Week 6	On-line, self paced	Lecture 8	Resources and Costs
Week 8	On-Site	Lecture 9	Presentation Skills Training
	On-Site	Lecture 10	Lessons Learned Presentations

Innovation for the 99%

While we're excited by the results of the NSF Innovation Corps, we've realized that this program just solves the problem for the 1% of new ventures that are technology startups. The reality is that the United States is still a nation of small businesses. 99.7% of the ~6 million companies in the U.S. have less than 500 people and they employ 50% of the 121 million workers getting a paycheck. They accounted for 65 percent (or 9.8 million) of the 15 million net new jobs created between 1993 and 2009. And while they increasingly use technology as a platform and/or a way of reaching and managing customers, most are in non-tech businesses (construction, retail, health care, lodging, food services, etc.)

While we were figuring out how to be incredibly more efficient in building new technology startups, three out of 10 new small businesses will fail in 2 years, half fail within 5 years. The tools and techniques available to small businesses on Main Street are the same ones that were being used for the last 75 years.

Therefore, our remaining challenges are *how to make them fail less* – and how can we make the Lean LaunchPad approach relevant to the rest of the 99% of startups.

Business plans are obsolete for Main Street
Our first insight was that the traditional "how to write a business plan" *was as obsolete for Main Street as it is for Silicon Valley.*

In most communities building a successful venture that generated nice cash flows – not IPO's – were the big win. To his students these were not "small businesses", but 'their businesses', their livelihoods and their opportunities to create wealth and independence for themselves and their families.

While the teachings of the Lean LaunchPad directly applicable and effective to small businesses, there is a mismatch in the size of the end goal (a great living versus a billion dollar IPO) and the details of the implementation of the business model (franchise and multilevel marketing versus direct sales, profit sharing versus equity for all, family and

SBA loans versus venture capital, etc.)

We can easily adjust *the NSF Innovation Corps class to bring 21st century entrepreneurship techniques to 'Main Street'*. To do this we needed to do is change the end goals and implementation details to match the aspirations and realities that these new small businesses face.

We called this Main*stream* Entrepreneurship.

Mainstream Entrepreneurship
Mainstream Entrepreneurship recognizes that with the Lean LaunchPad class we now have a methodology of making small businesses fail less. That accelerating business model search and discovery and using guided customer engagement as a learning process, we could help founders of mainstream businesses just like those starting technology ventures. For the rest of the afternoon, Steve and I brainstormed with Alex about how he could take his 20 years of entrepreneurial small business experience and use the Business Model Canvas and Customer Development to create a university entrepreneurship curriculum and vocabulary for the mainstream of American Business.

Chairman BROOKS. Thank you, Mr. Blank. And thank you for your extraordinary efforts to get here.

The Chair next recognizes our third witness, Mr. Kane, for five minutes.

STATEMENT OF MR. NEIL KANE, PRESIDENT, ILLINOIS PARTNERS EXECUTIVE SERVICES, LLC

Mr. KANE. Chairman Brooks, thank you; I'd also like to thank Ranking Member Lipinski and the other Members of the Committee for the opportunity to speak here today. I'm the token mentor on the panel, and the team that I mentored was in the first I–Corps cohort, and we attended Steve's class at Stanford in the fall of 2011.

I'm a serial entrepreneur, and I've spent the last 12 years helping professors and researchers commercialize their research. I've been involved in eight university spinoffs, and in five of them I was the CEO. Along the way I've encountered every small business and tech transfer issue there is. I've also developed a deep appreciation for the role that NSF can play in helping to get these companies down the runway and airborne.

Shortly after the I–Corps program was announced last summer, Professor Yi Lu from the University of Illinois asked me to be a mentor to his team. He had just published a paper on an innovative method for turning a personal glucose meter, the kind that diabetics use, like this, into a general purpose point of care medical diagnostic device that could be used to detect viruses, toxins and infectious diseases. And for any of you who'd like to have your blood glucose checked today, I'd be happy to oblige. While the science is exceptionally innovative and creative, the I–Corps program would allow us to deal with the challenge of figuring out how to bring it to market.

The goal of I–Corps is not to make entrepreneurs out of professors. The curriculum allows academics to develop an awareness and appreciation for what elements need to be present for innovation to have a chance to succeed in the market. It is more often poor market fit, in my opinion, rather than poor technology, which causes startups to fail. People who have never commercialized technology always underestimate the time and effort required. A startup is a perpetual open-book test where you're not graded on a curve. Its challenge is academics, because for the first time in many of their careers being the smartest person in the room does not guarantee success.

When technology has an obvious need, like a cure for cancer, arguably I–Corps is not needed. This falls into the category of, "If I build it, they will come." Instead, the purpose of I–Corps is to answer the question, "If I build it, will they come?" NSF's other traditional programs address the question, "Can I do it."

I–Corps is a teaching program with a considerable amount of skills transfer that will increase the effectiveness of research programs when measured on commercial impact.

I am currently also working on another startup, this one at Northwestern University, and even though that project did not go through I–Corps, like any good disciple, I have brought teachings to that project. There's a lot of leverage now that you have a wave

of mentors who have been trained in this methodology. And I have passed the torch to several Kellogg MBA students, one of whom has his own startup.

Based on our experience with I–Corps, we formed a company in Champaign called GlucoSentient, and I became the founding CEO. We got a Phase I SBIR from NSF, which is critical toward our ability to translate the technology from the university setting into the commercial world. A few months ago our company was not venture ready. We hope it will be after the SBIR is done. Several of the graduate students who worked on the technology in their research programs at the university will have full-time jobs in the company to continue its development.

Entrepreneurship is the link between scientific innovation and economic development. I'm going to repeat that. Entrepreneurship is the link between scientific innovation and economic development. Instead of discouraging I–Corps, Congress should encourage it. It's a low-cost program that adds fuel to NSF's research mission. I–Corps will pay a handsome return some day for taxpayers with job creation and wealth building, not to mention enhancing the global competitiveness in the United States.

When I was an undergraduate engineering student at the University of Illinois in Champaign, there was no entrepreneurship curriculum. Basic business courses, like marketing and finance were taught in the business school so far across campus from the engineering quad that we couldn't have taken courses there even if we had wanted to. Today it's cool for engineers, scientists and programmers to become entrepreneurs and learn business skills.

The dislocations in the economy over the past few years have taught us that even STEM students need business skills to succeed professionally. I–Corps helps prepare a new generation of researchers for the realities of today's economy, regardless of whether they become entrepreneurs or not. The professors who go through the program develop a deeper appreciation for the relevance of their research, which improves their ongoing effectiveness. And NSF is investing in a network of mentors who can help to materially move the needle in improving the outcomes of the commercial entities that become the stewards of the NSF-funded research.

Thank you.

[The prepared statement of Mr. Kane follows:]

Testimony from Neil D. Kane, President, Illinois Partners Executive Services, to the
U.S. House of Representatives' Subcommittee on Research and Science Education,
Committee on Science, Space and Technology
Field Hearing: "Innovation Corps: A Review of a New National Science Foundation
Program to Leverage Research Investments"
Delivered July 16, 2012

I'd like to thank Chairman Brooks, Ranking Member Lipinski and the other members of the Committee for the privilege and honor to speak to you today. I represent on today's panel the perspective of an Innovation Corps Mentor. Last fall our team, now known as GlucoSentient, Inc., was part of the first cohort of the Innovation Corps program.

You can think of me as the proverbial serial entrepreneur. With a degree in mechanical engineering and an MBA, I spent the first part of my career in large companies like IBM and Microsoft in a variety of engineering and customer facing roles. About 12 years ago I saw an opportunity to apply my technical and business experience to help researchers, typically from universities and federal laboratories, commercialize the fruits of their work. My involvement is sometimes as a consultant or advisor, and on more than a few occasions I have been the CEO of a startup company formed to commercialize this work. My focus tends to be on innovations derived from the engineering sciences with an emphasis on advanced materials and nanotechnology. On this journey I was the Entrepreneur-in-Residence at the Research Park at the University of Illinois at Urbana-Champaign, and earlier I was co-Executive Director of the Illinois Technology Enterprise Center at Argonne National Laboratory. Through these efforts I was involved in the launching of innovative companies such as SolarBridge Technologies, a maker of micro-inverters for photovoltaic systems; Semprius, a leading flexible electronics company; and Advanced Diamond Technologies, a pioneer in the synthesis of diamond from natural gas. Together these companies have raised over $110 million. Currently I am involved in a number of projects, all based on university research, and I hope they become as successful as these companies.

The core technology underlying Advanced Diamond Technologies (ADT) is a process, very much like processes used to make semiconductors, which converts natural gas (the stuff that heats your home) into diamond. Applications of our synthetic diamond thin films range from reducing friction on wear parts in rotating equipment like pumps to electrodes for the treatment of water in cooling towers with myriad electronic applications along the way. I co-founded ADT with two scientists from Argonne in 2003. Today we have products generating revenue in multiple markets and are exporting our technology around the world from our factory in Romeoville, IL, near Chicago. Along the way we have been recognized many times for our innovations including being named as a Technology Pioneer by the World Economic Forum. I was the CEO of ADT from its founding in 2003 until 2011. I learned firsthand that the road from the laboratory to the marketplace is a long one, especially for complex technologies, and particularly for those that are derived from academic research.

At ADT we owe a debt of gratitude to NSF. It is doubtful that we would have made it were it not for the SBIR program. As Tom Peterson noted in a session a few weeks ago at Northwestern University, NSF can't take *all* the credit for their grantees' success, but they unquestionably deserve *some* of it. All of the products that ADT is selling commercially today at one time were the subjects of NSF SBIRs. We also owe a big thanks to Congressman Lipinski who has been a constant supporter of ours even before we landed in his district as a result of redistricting after the 2010 census.

Last summer Professor Yi Lu from the University of Illinois at Urbana-Champaign had just published a paper on a new innovation which was generating unsolicited inquiries from around the world. He figured out a way, using DNA technology, to repurpose a personal glucose meter (the kind used by diabetics to measure blood sugar) into a platform for dozens of diagnostic tests that could be administered as simply as a patient today measures their blood sugar levels. Imagine a library of test "strips" that could be used at home to measure infectious diseases like HIV or hepatitis, diseases like tuberculosis, poisons like lead or mercury, recreational drugs, environmental hazards or cancer all with a simple, inexpensive device and a test strip that costs a few dollars—similar to the way home pregnancy tests work. Now that glucose meters are becoming wirelessly enabled and are available as smartphone attachments, the possibilities are even more expansive. It is a transformative technology.

I had known Prof. Lu for many years due to time I spent in Champaign as the Entrepreneur-in-Residence at the Research Park. Last summer we had lunch and he made me aware of the just announced Innovation Corps program and asked if I would be the mentor for his team. He had already identified one of his students, Tian Lan, as the entrepreneurial lead. We applied and got accepted into the first class of I-Corps which was taught by Steve Blank and his team at Stanford University. Our focus was to assess the commercial potential of Dr. Lu's new DNA-sensing technology based on the personal glucose meter. We had a working hypothesis about the best market to go into. It turns out our hypothesis was wrong.

The goal of the I-Corps program is not to make entrepreneurs out of professors. Rather it is to teach the Customer Development methodology (developed by Steve Blank) and Business Model Generation technique so that professors and other academics develop an awareness and appreciation for what elements need to be present in an innovation for it to have a chance to succeed in the marketplace. In my experience it is more often poor market fit, rather than poor technology, which causes startups to fail. People who have not experienced what it takes to commercialize a new technology always underestimate the time and effort required. Here is a quote from my 2010 testimony on the subject of technology transfer:

> I've learned over the past ten years that *the real challenge is not transferring the technology out of the laboratory—it's transferring the technology into the marketplace*. If we do everything right except get products to market, we've accomplished nothing. A professor friend of mine [who had started a company] said, "When the technology leaves the lab, it's 5% done."

A professor's reputation is tied up in the quality of their research. As an entrepreneur, I see things through a different lens. In my world view, technologies have limited value unless they are applied. And for jobs to be created and the tax base to go up, somebody, *eventually*, needs to make a profit. In the 12 years I have been working with university professors, their work almost always takes the form of a "technology in search of a solution". Often times the work coming out of academia is scientifically interesting but completely unproven for commercial purposes. I learned firsthand that the I-Corps demonstrably improves a startup's chances for success by helping to remove market risk and business model risk—two areas where scientists typically don't have much experience.

As a thought experiment, consider two potential outcomes of the I-Corps program:

1) A professor attends the program and determines that his/her idea has no commercial merit and does not pursue a startup.

2) A professor attends the program and receives customer feedback that is highly encouraging.

The first outcome is good because they will avoid spending fruitless years or wasted money in pursuit of a goal that isn't going to be fulfilled. It's far better for all concerned that they spend their time on something else. The second outcome may catalyze the momentum for forming a startup company, and now the company is getting started based on good information with the wind at their backs. In both cases the NSF has trained a professor to think differently in the future about how to structure his/her research programs. While the I-Corps program in no way guarantees the success of a startup, it diminishes the risk and increases the likelihood of success. Even without a startup, the I-Corps experience moves the needle in getting researchers to think about the commercial significance of their research programs which is a beneficial effect for all concerned.

If a new technology is developed in academia, and it is clear how it should be applied (such as a cure for cancer), then I-Corps is not needed. When it is obvious that "If I build it, they will come," the I-Corps program has little value. Rather the purpose of I-Corps is to diminish or mitigate what are known as market risk and business model risk. In other words, it answers the question "If I build it, *will* they come?" NSF's other traditional programs address what is known as invention risk which answers the question, "*Can* I build it?"

I-Corps is a teaching program with a considerable amount of skills transfer that, over time, will increase the effectiveness of research programs across the country when measured on a new dimension, commercial impact. We learned in I-Corps to "get out of the building" because only in the marketplace can we find the answers we are seeking. We would never find them in our conference room. As a business professional I have been trained in customer interview techniques, but the technical team members needed to be pushed outside of their comfort zones to learn not only how to do this, but to acknowledge its value despite its simplicity. In the case of our entrepreneurial lead for whom English is not his native language, I think he found making cold calls on prospective customers particularly stress inducing.

Entrepreneurship is the link between scientific innovation and economic development. Instead of discouraging I-Corps, Congress should encourage it. It's a low cost program, and although the benefits won't be calculated for several years, it adds fuel to NSF's research mission. I-Corps will pay a handsome return for taxpayers through job creation and wealth building not to mention enhancing the global competitiveness of the United States.

Initially, a lot of the feedback we got from talking to market participants about our DNA technology by "getting out of the building" was inconclusive. We heard many opinions and received many responses but nothing was converging. Then we spoke to a major pharmaceutical company who saw how our technology could be applied in a way that added a lot of value to their operations. With that insight we pivoted away from our original hypothesis and focused on a new set of customers for a different application. Only then did we decide to start a company. What we learned in I-Corps was how to assess the market need and fit for our innovations.

As an aside, we are nearing agreement on a test plan with that pharmaceutical company, and we've identified another pharmaceutical company with the same need who appears even more motivated to work with us. Our future is not guaranteed, that is for sure. But had we not gone through I-Corps, we'd be wasting our time right now trying to raise money. Instead we are spending our time, albeit with

limited resources, on technical risk reduction and the development of a prototype so that when we do begin raising money, our company will be an excellent candidate for financing.

As helpful as I-Corps is, the job is only half done. I think there's another piece that's missing. Now that NSF has helped to motivate professors to start companies based on their research, I don't necessarily think it's a good idea to try to have them manage those businesses. This is not a new insight for me, and I wrote about this obstacle in 2004. Career scientists are challenged by some of the decisions that business people make which are based on incomplete and often ambiguous information, with very uncertain outcomes. I recall an academic co-founder once exclaiming that he wished there was an equation he could plug into that would give him the right answer. So there's a cultural issue as well about what it means to be the founder of a business which the I-Corps program didn't really delve into.

One way to help cross this cultural divide would be for the I-Corps program to add a module that removes some of the mystery and provides more transparency about what the startup process looks like. We went to our class at Stanford hoping to get some of that from the instructors but they deftly dodged the issue. I share this with you not being sure whether its NSF's problem to fix, but rather I'm identifying it as an impediment to the commercialization of NSF-funded research, an objective we all share.

As I noted in my testimony to this panel in 2010, another impediment to starting companies based on university technology is that the professors have no benchmark for what a "normal" deal should look like. The researchers have no calibration about what they can expect in terms of equity and compensation for participating in the formation of a startup company. When they solicit opinions from their peers, they get wildly divergent viewpoints which accentuates their anxiety. The fear among the researchers that they're not getting treated fairly has, perhaps surprisingly, been one of the biggest barriers in getting companies started. War stories are abundant, and anyone who has done this at least once has at least one story to tell. I-Corps could play a valuable role in helping to educate professors on what it means to be a founder of, but not the manager of, a company. I've seen this issue repeatedly slow down the momentum of many promising startups.

I was personally motivated to go through the I-Corps program so I could take Steve's [Blank] class. As a mentor, entrepreneur and consultant, I benefited enormously from the curriculum. Most significantly, I am working on another technology at another university that did not go through I-Corps, but I have brought the teachings of the curriculum to that project. So I have become a disciple of the methodology and there's a lot of leverage now that I've been trained in it. This "teach the teacher" outcome is a nice dividend to the investment that NSF made in the program. And I've passed the torch to several MBA students, one of whom has his own startup, through that mentoring project.

I think my academic partners got a deep appreciation for the necessity of having market feedback. And I know that my professor colleague, who is used to cramming the night before an exam and still doing well, has an appreciation for the time and commitment needed to do this right. There are no short cuts, it is not easy, and intellect does not guarantee success. This is a huge reset for people who have spent their careers excelling at academic pursuits. My teammates acknowledged what they gained from the program by offering insights such as:

> *Get out of the building and find out who the customers are and what they need before product development begins.*

Start with the customer and adapt the technology to the customer need.

Most of the time, things are not obvious. It takes a long time to find the appropriate market.

Fail fast and learn from the failures. It's a trial and error process too.

We have formed a company called GlucoSentient, Inc. to bring our innovation to market. I became the founding CEO and our entrepreneurial lead from I-Corps is the founding CTO. In his case he is an early career scientist who, we can see by the day, is growing professionally through this odyssey of being part of a startup. Since the I-Corps program ended, the students in Champaign, IL who are on our team received a $10,000 business plan prize, we were accepted into the I-Start Program which provides subsidized legal and accounting services and, most importantly, we got a Phase I SBIR from NSF. The SBIR money is critical to our advancement since our technology was not ready for venture investment a few months ago. The SBIR money gives us the critical funding needed to translate the technology from the university setting to the commercial world.

Entrepreneurship training is vital in today's economy. When I was an undergraduate engineering student there was no entrepreneurship curriculum and the basic courses of marketing and finance that were taught at the university level were in the business school, so far across the campus from the engineering quad that we **couldn't have taken courses there even if we wanted to. Now it's cool** for engineers, scientists and programmers to be entrepreneurs and learn business skills. What the recent change in our economy has taught us is that even if you are a STEM student, unless you become a career researcher or academic, you need business skills to succeed professionally. The I-Corps program helps prepare a new generation of researchers for the realities of today's economy regardless of whether they become entrepreneurs. The professors who go through the program develop a deeper appreciation for the relevance of their research which improves their effectiveness. And NSF is investing in a network of mentors who, over time, can help to materially move the needle in improving the global competitiveness of the commercial entities that become the stewards of NSF-funded research.

Chairman BROOKS. Thank you, Mr. Kane.

The Chair now recognizes our fourth witness, and I hope I pronounce this correctly, if I don't please correct me.

Mr. Popescu, for five minutes.

STATEMENT OF DR. GABRIEL POPESCU,
ASSISTANT PROFESSOR, DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING,
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Dr. POPESCU. I'd like to thank Chairman Brooks and Ranking Member Lipinski for inviting me to share my views on the NSF I–Corps program.

I am an Assistant Professor in the Department of Electrical Engineering at University of Illinois. Since an undergrad, I have been studying optics and lasers and their applications in biomedicine. I'm a believer in the fact that technology can not only generate high-quality health care, but can also help reduce its cost and, you know, help access to health care.

Engineering the tools for scientific discovery has been named by National Journal of Engineering as one of the 14 grand engineering challenges for the 21st Century. My laboratory develops the next generation of light microscope, that will help understand how cells and tissue function in both health and disease. Therefore, my research has three components: Technology development, basic science studies, and clinical application. Our technology has the potential to generate early and accurate diagnosis, new cures for devastating diseases, inexpensive blood testing for global care, and can generate billions of dollars in wealth across several different markets. Like in vitro diagnosis, biotech energy in my department.

Our research community, many of my peers asking whether they can purchase an instrument from some company. This made me realize a tremendous challenge, one that I was not well prepared to overcome. And that was, how do we go like this to a successful product that can be made available to all.

I participated in the I–Corps program as the PI for our team Phi Optics. Our participation in the I–Corps program has made a serious impact in our understanding of the commercialization process and the potential for success of our company. With the knowledge gathered during the program, and the adjustments we brought to the business model, we're now rounding up $400,000 in seed investment. We have commitments from a local venture firm and a major investor, which they both come up with a hundred thousand, each.

Recently, Phi Optics received the first order for the alpha-prototype of our microscope from a major life sciences company. The prototype will help gather internal interest for potentially investing more money in our company. This fall we will be visited by a world leading microscopy company, interested to partner and co-develop our technology into commercial products. Therefore, we are very confident about the outcome of our efforts. And much of this confidence can be traced back to the intense work during the I–Corps program.

Let me just tell you a few specific things about my experience as a I–Corps awardee. As a PI I've learned a great deal during the

program. For example, I learned that features of our technology are not synonymous with value proposition. And thank you for that. Our team learned that we must develop a clear and compelling value proposition in order to gain traction from customers.

Business models need to be flexible and allow for pivoting. Invariably, information will be gathered along the way that directs a startup to change strategy and business approach. For example, our team ended up with two different business models depending on whether we team up with a strategic partner, like a large corporation, or not.

Interacting with a hundred potential customers is an incredibly valuable experience, the results of which cannot be replicated in any other way. Prior to attending the program, I did not have a good appreciation of the two fundamental tasks in starting a business. Which is business model development and customer development.

The striking feature, to me, of this program, is that it offers a scientific approach to commercialization. Through interactions with potential customers, we have the opportunity to test certain hypothesis. For example, what is the proper set of features that our instrument should have, first; and what is the cost. This is precisely our research approach in the laboratory, where, in order to understand a certain phenomenon, we perform experimental validation of our various hypotheses.

Personally, I would like to see the I–Corps program expanded locally, if possible, on campuses throughout the country. As an alumnus, I will be very happy to help train new teams at University of Illinois.

In terms of the objectives and achievements of the I–Corps program my opinion is that it will be a very effective use of federal dollars. It combines several key elements to produce a highly catalytic environment for the launch of technology startups. Number one, top-notch entrepreneurial education from experienced, world leading instructors.

Two, significant interaction with potential users and customers of technology. We—particularly, we talked to 105 different people.

Maximum accountability to the teaching team and program peers. This combination of elements makes the I–Corps quite unique among federal programs, and should increase the odds of commercial success of the program participants.

Speaking on behalf of the Phi Optics team, I believe the program objectives were achieved.

Seems like I have run out of time, but I would like to say one thing about the benefits to the taxpayer. And that is, for decades NSF has been investing large amounts of funding in basic science, which continuously pushed the frontiers of our knowledge. The SBIR/STTR has helped commercializing some of the technology developed through this research. I do believe that the I–Corps program is an extremely useful pre-SBIR tool for training the startup teams and helping them validate the true potential for their commercialization. As large industry looks to academia and small businesses, including spin-out companies, to fill product portfolios and identify new tools for efficiency, the I–Corps program can act as a catalyzer and enhance the probability of commercial success.

The taxpayers receive a huge return from their investment. These programs provide an opportunity to validate the commercial potential before significant investments from federal and private sources are committed.

In essence, the probability of success for the projects going forward is maximized, while the losses due to the projects unlikely to succeed are minimized.

With that, I will close. Thank you very much.

[The prepared statement of Dr. Popescu follows:]

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Testimony

Gabriel Popescu

Department of Electrical and Computer Engineering
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I would like to thank Chairman Brooks and Ranking Member Lipinski for inviting me to share my views on the NSF I-Corps Program.

I am an Assistant Professor in the Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign. I have spent the past 20 years studying optics and lasers and their applications in biomedicine. Recently, I have participated in the I-Corps program as the PI of our team, Phi Optics. The team included Entrepreneurial Lead Dr. Catalin Chiritescu and Business Mentor Tim Hoerr. Our participation in the I-Corps program has made a tremendous impact in the potential for success of Phi Optics. With the knowledge gathered during the program and adjustments we brought to the business model, we are now starting to seek seed investment. Recently, Phi Optics received the first order for the alpha-prototype from a major life sciences company. This fall, we will be visited by a world leading microscopy company, interested to partner and co-develop our technology into commercial products.

PI's experience as an I-Corps awardee

As a PI, I have learned a great deal during the program. For example, I learned that features of our technology are not synonymous with "value proposition". Thus, our team learned that we must develop a clear and compelling value proposition in order to gain traction from customers.

Business models need to be flexible and allow for pivoting – invariably, information will be gathered along the way that directs a start-up to change strategy and business approach. For example, our team ended up with two different business models depending on whether we team up with a strategic partner (large corporation) or not.

Interacting with 100 potential customers is an incredibly valuable experience, the results of which cannot be replicated in any other way. Prior to attending the program, I did not have a good appreciation of the two fundamental tasks in starting a business: business model development and customer development.

Overall, the striking feature of the program is that it offers a "scientific" approach to commercialization. Through interactions with potential customers, we have the opportunity to test certain hypotheses, e.g., what is the proper set of features for our product, how much should it cost, etc. This is precisely our approach in the laboratory, where, in order to understand a certain phenomenon, we perform experimental validation of various hypotheses.

Personally, I would like to see the I-Corps program expanded locally on campuses throughout the country. As an alumnus, I will be happy to help train new teams at University of Illinois.

Objectives and achievements of the I-Corps program

The program is one of the most effective uses of federal dollars that I have encountered in my professional career. It combines several key elements to produce a highly catalytic environment for the launch of technology start-ups. Those elements are (a) top-drawer entrepreneurial education from experienced, "real world" instructors, (b) significant interaction with potential users/customers of the subject technology/product, (c) maximum accountability to the teaching team and program peers. This combination of elements makes the I-Corps quite unique among federal programs, and should increase the odds of commercial success of the program participants.

Speaking on behalf of the Phi Optics team, I believe the program objectives were achieved. We evolved our business model throughout the process, refined our value proposition, and focused our go-to-market strategy. Perhaps the team would benefit from a more extended one-on-one interaction with the teaching team. This way, problems that are specific to particular teams could be discussed in more detail.

Benefit of the I-Corps program to the taxpayer

Technology commercialization is a lengthy and challenging process. Biomedical technology in particular must face intense scrutiny such as the FDA approval mechanism, which can often temper the enthusiasm of investors. Access to the talent and capital required for the early stage commercialization process (the "valley of death") is the main obstacle in the way of translating basic research to solving commercial needs.

For decades the National Science Foundation has been investing large amounts of funding in basic science, which continuously pushed the frontiers of our knowledge. The SBIR/STTR program has helped commercializing some of the technology developed through this research. I believe that the I-Corps Program is an extremely useful, pre-SBIR tool, for training the start-up teams and helping them validate the true commercial potential of the technology. As large industry looks to academia and small business, including "spin-out" companies, to fill product portfolios and identify new tools for efficiency, the I-Corps Program can act as a catalyzer and enhance the probability of commercial success.

The program provides an opportunity to validate the commercial potential of a technology, *before* significant investments from federal and private sources are committed. In essence, the probability of success for the projects going forward is maximized, while the losses due to the projects unlikely to succeed are minimized. The taxpayers receive a huge return from their investment. Successful commercialization of a technology creates wealth and jobs, while improving the life of the society at large, e.g., by providing better health care.

Background on the PI and Technology

After Bachelor's and Master's degrees in Physics pursued in my home country of Romania, 15 years ago I came to the United States for my PhD studies in Optics, focusing on the interaction between laser radiation and biological tissue. I pursued my postdoctoral studies at M.I.T., developing new imaging technologies for studying cells and tissues. In 2007 I joined the University of Illinois faculty and established the Quantitative Light Imaging Laboratory, which I direct at the Beckman Institute for Advanced Science and Technology. In 2004 I became a U.S. permanent resident via the "National Interest Waver" and in 2009 I received the U.S. citizenship.

My work in the field of Biomedical Optics resulted in one authored book, one edited book, 76 refereed articles, 84 invited lectures, 6 book chapters, 82 conference presentations, and 24 patents of inventions (9 more disclosures are being reviewed by the University). I am Associated Editor of lead journals in optics, Optics Express and Biomedical Optics Express, serve on the Editorial board of Journal of Biomedical Optics, and organized and presided sessions at several international conferences. I am enthusiastic about teaching: I developed a new graduate course at UIUC on Modern Light Microscopy (ECE 564) and upgraded the advanced undergraduate course on Optical Imaging (ECE 460). Over the past 4 years I founded and co-organized the Biophotonics Summer School at Urbana-Champaign, a two-week program sponsored in part by NSF, which has attracted students from the U.S. and many countries.

My research group at University of Illinois consists of a postdoctoral associate, 6 PhD students, and 5 undergraduate students. Our research has three components: *technology development*, *basic science* studies, and *clinical applications*. The motivation for this work can be briefly explained as follows. Most cells from our body do not absorb light significantly and thus are transparent under visible light. In order to study them, researchers typically label the cells with contrast agents, such as fluorophores and dyes. Thus, in the life sciences, fluorescence microcopy is the most commonly used form of microscopy. However, there are significant limitations associated with fluorescence: *photobleaching* limits the temporal window of opportunity for imaging before the molecules stop emitting light (or bleach); *phototoxicity* negatively affects or kills the cells due to the high exposure required and the short wavelength of the excitation light (typically in the UV range). Existing instruments are therefore destructive, inaccurate, labor-intensive, and expensive to operate. These technical limitations result in erroneous diagnoses of disease, slow drug discovery, and poor understanding of cellular function. Improved technology will generate early and accurate diagnosis, new cures for devastating diseases, and billions of dollars in wealth across several different markets, including in-vitro diagnosis ($44B market), Biotech R&D ($20B), Biopharma ($70B).

Phi Optics, Inc. develops disruptive light microscopy technology that is accurate, nondestructive (label-free), fast, and inexpensive. The innovation with respect to the state of the art stems from using two beams of light instead of just one: a portion of the light travels through the specimen and carries the information, while the second does not, i.e., it is used as *reference*. Measuring the

superposition of the two beams, a principle known as *interferometry*, is extremely sensitive to subtle structural details in the sample, without the need for invasive contrast agents. As a result, the specimen preparation is greatly simplified and studies can be performed indefinitely, without limitations due to photobleaching and phototoxicity.

Our technology, referred to as *quantitative phase imaging (QPI)*, has been aggressively protected by the University of Illinois' Office of Technology Management: there are 15-20 disclosures, pending, and issued patents on this technology. The main patent, which protects the core Phi Optics technology, has been recently issued (Patent No. US 8,184,298, May 22, 2012).

Our QPI technology will improve human health at several different levels and contribute toward maintaining the US edge in the area of high-tech biomedicine. Specifically, if successfully commercialized, our new class of instruments will enable the following highly significant applications:

- Novel cancer drug discovery by accurate, label-free monitoring of cell response to treatment
- Automatic cancer diagnosis of biopsies and blood testing
- Basic understanding of cell function: differentiation, proliferation, and death
- Semiconductor testing with nanoscale accuracy

Due to its full automation, our diagnosis instrument can operate in areas with limited access to trained personnel and provide the digital data necessary for remote diagnosis. Our images are *quantitative*, meaning that there is no calibration necessary when operating the instrument at different sites. These features recommend our technology for applications of *global coverage*, such as screening for malaria in under-served populations of Southeast Asia and Africa.

Linage of the innovation

Our technological innovation is, to a large extent, the result of funding from the National Cancer Institute and two NSF grants. The brief description of these two research proposals are presented below.

2009 NSF CAREER Award: CBET 08-46660 "Quantitative phase imaging of cells and tissues" ($400K, 5 years).

The proposed research focuses on extending the boundaries of quantitative phase imaging (QPI) developed by the PI to high-impact applications, including neuroscience, cancer imaging, and cell membrane biophysics. QPI has the unique ability to quantify subtle changes in both structure and dynamics of cells and tissues, without using contrast agents. Imaging thin tissue slices, we are able to measure directly their refractive index distribution over broad areas, i.e. covering the entire organ. For the first time, we extracted a refractive index map at the organ scale which will serve the double purpose of both providing input parameters for modeling light-tissue interaction and also detect and monitor disease. Thus, the refractive index information will be correlated with the onset and development of breast cancer in a mouse model. QPI is a very powerful method for quantifying motions in cells at the nanometer scale. QPI sensitivity to nanoscale motions generated by minute refractive index changes in live neurons are exploited to understand how they function and communicate. Essentially, we treat the neurons in culture as a (complicated) circuit board and apply our non-contact, full-field, motion sensors to understand how the circuits work. All these research activities are developed in a highly collaborative manner with scientists from different departments on our campus and beyond, as indicated in the collaboration letters attached.

2010 NSF Major Instrumentation Grant from NSF: CBET 1040462 "Development of spatial light interference microscope (SLIM) for Materials and Life Sciences", ($2M including campus matching, 4 years).

This project aims at establishing a QPI facility for shared use at the Beckman Institute for both materials and life sciences. SLIM is a novel, highly sensitive QPI method, which promises to enable unprecedented structure and dynamics studies in biology and beyond. SLIM combines Zernike's PC method by revealing the intrinsic contrast of transparent samples, with Gabor's holography by rendering quantitative phase maps across the sample. Because of the extremely short coherence length of this illumination light, approximately 1.2 μm, SLIM provides label-free optical sectioning, allowing a three-dimensional view of live cells, which reflects the scattering potential distribution. Taken together, SLIM's features advance the field of quantitative phase imaging by several accounts: i) provides speckle-free images, which allows for spatially sensitive optical path-length measurement (0.3 nm); ii) uses common path interferometry, which enables temporally sensitive optical path-length measurement (0.03nm); iii) renders 3D tomographic images of transparent structures; iv) due to the broad band illumination, SLIM grants immediate potential for spectroscopic (i.e. phase dispersion) imaging;

v) is likely to make a broad impact by implementation with existing phase contrast microscopes; vi) and inherently multiplexes with fluorescence imaging for multimodal, in-depth biological studies. This quantitative phase imaging instrument will benefit diverse research efforts in the materials and life sciences. In particular, it will enable: (1) non-destructive inspection of nanostructures, semiconductor devices, and new materials such as graphene and carbon/semiconductor nanotubes, (2) observation of the dynamics of live cells and transport in neurons, and (3) exploration of new cancer detection techniques.

Working on these projects, especially on the QPI shared facility, the PI has been faced with many of the challenges associated with commercialization (e.g., ease of use, friendly user interface, computer-control automation). Most of these obstacles have been overcome and now we have in the lab a working prototype that can provide quantitative phase data over broad spatial and temporal scales using computer control.

The Phi Optics Team

In March 2012, the Phi Optics team was selected to participate in the I-Corps program. Our I-Corps team that traveled to Stanford for the Lean Launchpad course combines complementary expertise in biomedical imaging (PI), materials science (Entrepreneurial Lead), and business management (Business mentor), as follows.

Entrepreneurial Lead: Catalin Chiritescu. Dr. Chiritescu is a University of Illinois Ph.D. graduate from the Materials Science and Engineering Department (2010). He has a M.Sc. in Mechanical Engineering from University of Rochester, NY (2001) and one in Physics from University of Bucharest, Romania (1999). His past experience includes the UIUC Materials Research Laboratory in Urbana, IL (2002-2010), the Laboratory for Laser Energetics - OMEGA facility in Rochester, NY (2000-2001), the Institute for Laser, Plasma and Radiation Physics in Bucharest, Romania (1997-2000), and the Institute of Physics and Chemistry of Materials – CNRS in Strasbourg, France (1999). The majority of his research is in the field of nanoscale materials science and ultrafast optical spectroscopy and was published in 14 peer-reviewed and 3 conference papers. He served as reviewer for the Journal of American Chemical Society and the Journal of Applied Physics.

As a materials engineer Dr Chiritescu worked on applied research contracts with customers from the academia (Purdue University, UCSB, University of Manchester-UK), research labs (LANL, LLBL), and defense (ONR, AFOSR). Dr. Chiritescu joined Phi Optics Inc. in 2011 and serves as CTO by spearheading the development of QPI and related technology applications in the nanotechnology and materials science fields. He is also responsible for the day-to-day operations of the company.

Business Mentor: Tim Hoerr is a seasoned business executive with over 28 years of experience spanning a variety of industries. Tim is the Managing Partner of Serra Capital and CEO of Serra Ventures, LLC, a professional services firm offering assistance in business strategy, capital formation, transitional executive leadership, and organization development. He also serves as transitional CEO of Cbana Labs, a start-up technology venture located in the University of Illinois Research Park, Champaign, Illinois. Tim serves the University of Illinois technology community in the role of Entrepreneur-in-Residence at EnterpriseWorks business incubator in the Research Park. In February, 2009, Tim received the Entrepreneurial Excellence in Management Award at the Innovation Celebration ceremony sponsored by the University of Illinois and Champaign County Economic Development Corporation.

For nearly seven years, from mid-2001 through 2008, Tim served in the capacity of Co-Founder and CEO of iCyt, a rapidly growing bioscience technology firm located in the University of Illinois Research Park. iCyt provides state of the art instruments, reagents and service to global clients in the field of cytometry, the science of cell measurement. iCyt has won numerous awards including Best Places to Work in Illinois (2007, 2008) and the Frost & Sullivan Emerging Technology Award (2008). iCyt was acquired by Sony Corporation in late 2009.

Since 1983 he has assisted over 400 organizations to achieve high performance by providing

strategic, operational and leadership consulting. Tim spent nearly all of the first 15 years of his professional career with RSM McGladrey, the fifth largest international CPA and Consulting firm. He served in offices located in Illinois and San Diego, leading teams of consultants focused on serving middle market clients. In his capacity as Consulting Partner with McGladrey, Tim provided leadership on a regional and national level. He also served on two national committees for the American Society of Certified Public Accountants (Business Valuation and Emerging Services).

Principal Investigator: Gabriel Popescu.

Chairman BROOKS. Thank you, Dr. Popescu.

I now recognize our final witness, Dr. Mazar, for five minutes.

STATEMENT OF DR. ANDREW MAZAR, DIRECTOR, PROGRAM FOR DEVELOPMENTAL THERAPEUTICS AND ENTREPRENEUR-IN-RESIDENCE INNOVATION AND NEW VENTURES OFFICE, NORTHWESTERN UNIVERSITY

Dr. MAZAR. Thank you, Chairman Brooks and Ranking Member Lipinski, for the opportunity to testify today. Northwestern University and I appreciate your interest and support for science and technology issues. My name is Andrew Mazar, I'm the Director of the Center for Developmental Therapeutics at Northwestern, and also the Entrepreneur-in-Residence. My perspective that will be a little bit different today, it's not from the NSF perspective, I'm coming from the perspective of therapeutics development.

But I think a lot of the challenges that I'm discussing are applicable, also, to the I–Corps program, and we all face a similar challenge with trying to commercialize bipartisan into technology.

So, today, as I said, I'm representing the perspective of the Entrepreneur-in-Residence, or EIR. Northwestern created this position within the Chemistry of Life Processes Institute, also referred to as CLP, to address the unique challenges encountered when advancing novel therapeutic projects through development in an academic setting.

A critical component of this mission is the capacity to move discoveries from the laboratory bench into the hands of society, which is facilitated by the EIR position, which works in tandem with Northwestern's Innovation and New Venture Office, also referred to as INVO. So, this is our next generation of transfer, but it's much more than that, and really focused on commercialization aspects of our technologies.

As the EIR, I partner and collaborate on many different projects with faculty members across all the different Northwestern schools. In this role I have now helped found seven companies over the past couple years, and also founded the Center for Developmental Therapeutics, which provides actual hands-on assistance with the development of new therapeutic projects, both of them in the scientific development side, as well as the commercialization and fundraising side.

So, my EIR position was the first of its kind created at Northwestern, although there have been additional EIR positions created across the university since then.

I believe that the collaborative interaction that I enjoy with INVO has also been spurred on by the success of Lyrica, which is a drug marketed by Pfizer that was invented at Northwestern, and really a tremendous success story with the University. Lyrica is a tremendous example of leveraging the federal investment in basic research to develop a new drug that is benefiting millions of people, as well as generating a revenue stream for Northwestern that is being re-invested to create new programs. This type of royalty stream and re-investment by the university is especially important in today's challenging funding environment as it provides a complementary source of capital that can be used to build transformative and constructive programs in the academic setting, such

as CLP and the EIR, something that is not always possible through traditional grant mechanisms.

Further, I believe that the success of Lyrica has bolstered what was already a very entrepreneurial culture for Northwestern, and taken it mainstream across the entire campus. The number of people thinking about their research in terms of translation and commercialization has grown exponentially since the EIR was put in place.

Let me now speak to the challenges. One of my major challenges has been overcoming the perception that discovering and developing new drugs is somehow inferior to more basic knowledge-generating research. I believe that academic drug discovery and development is one of academia's most important missions. Drug development creates new knowledge and technology for every new product that is developed, and new models for collaborative research across departments and schools involving multiple investigators. Further, drug discovery and development is highly entrepreneurial, and is, therefore, consistent with the entrepreneurial nature to which most universities aspire.

Finally, commercialization of new therapeutics helps the U.S. grow its economy and maintains its global competitiveness.

Another major challenge is funding. I believe that it is possible to discover and develop new drugs in the academic setting, and that large research-driven institutions with medical schools, such as Northwestern, could become quite good at this if funding was available. Today we do not have a fund that can provide the capital required for these types of activities.

A few academic institutions have been able to raise small gap funds, usually through philanthropy, but in most cases these have not provided adequate resources to really move projects forward. However, several examples of gap funds, Michigan and Harvard, that were allowed to invest sufficient capital in promising projects do exist, where returns on investment have already been observed within a few years after the initial investment was made. Thus, I believe the gap-funding model to support commercialization will work if utilized properly.

I believe that the I–Corps program, from what I understand, is trying to do exactly this, and it should be expanded. Without programs like I–Corps the basic research investment will be wasted. If gap funding is not available and if venture capital is no longer investing in early-stage projects, which it is not, then basic research ends up sitting on a shelf in the tech transfer office.

The most important thing I'd like to see from the I–Corps program is to make more funds available for each project. Each project should be evaluated for what milestone or inflection needs to be met next, and sufficient capital should be provided to support this. The milestones may be scientific, commercial, or a combination of the two, but providing insufficient funds is as bad as providing no funds at all.

Given that there are limits on how much money is available for this program, I would favor making a larger meaningful bet, rather than trying to fund as many projects as possible and none of them moving forward. And it's not to say that the federal government should bear the costs of these types of programs alone. It is pos-

sible to leverage the federal investment with private funding, and, in fact, the federal investment can be viewed as a de-risking strategy that attracts private funding that would not otherwise be available. The I–Corps program is already doing something like this by requiring identification of potential customers for each technology funded, and I believe that if I–Corps funding is increased, this approach can be expanded to seek out actual commitments of funds that can match or exceed the government investment. This drastically lowers the barriers for entry into commercialization, and in my opinion, spurs entrepreneurship and economic growth.

Mr. Chairman, thank you for providing me an opportunity to provide testimony at this field hearing on the Innovation Corps. This concludes my remarks. I would be happy to answer questions.

[The prepared statement of Dr. Mazar follows:]

INVO
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Testimony of

Andrew P. Mazar, Ph.D
Entrepreneur-in-residence
Northwestern University

Before the

Committee on Science and Technology
Subcommittee on Research and Science Education
U.S. House of Representatives

July 16, 2012

Innovation Corps: A review of a New National Science Foundation Program to Leverage Research Investments

Thank you Chairman Brooks, and Ranking Member Lipinski, for the opportunity to testify today. Northwestern University and I appreciate your interest and support for science and technology issues. My name is Andrew Mazar, Director of the Center for Developmental Therapeutics and Entrepreneur-in residence. My research interests focus on mechanisms of cancer metastasis and progression and the development of new cancer drugs. Today, I am representing the perspective of an Entrepreneur-in-Residence, or EIR. Northwestern created this position to address the unique challenges encountered when advancing novel therapeutic projects through development in the academic setting. The traditional description of an EIR is a senior levels leader who has founded and run a start-up company successfully and is looking for that next opportunity. This EIR generally sits within a venture investment firm and oversees the development of a particular project to some pre-defined milestone, at which point the EIR and technology are spun-out into a stand-alone start-up company concomitant with a funding commitment from the venture firm and possibly a syndicate of co-investors. Although certain aspects of this vision have been built into our vision of the university EIR, there are a number of unique attributes that make the phenotype of this position align closely with the academic mission.

Northwestern first created the EIR position within the Chemistry of Life Processes Institute (CLP). CLP is an "institute without walls" that provides the infrastructure necessary to help articulate and explore emerging research questions across the disciplines of physics, chemistry, biology, engineering, medicine, and computational science. The Institute acts as an umbrella for a variety of centers, facilitates collaborations and helps bridge these different cultures. The Institute draws its membership from thirty-six faculty members in four schools within Northwestern University and integrates the activity of more specialized Centers on campus.

The Chemistry of Life Processes Institute at Northwestern provides a robust ecosystem for basic and translational research that transcends disciplinary boundaries. This ecosystem is built upon a custom designed physical environment for transdisciplinary research in the Richard and Barbara Silverman Hall for Molecular Therapeutics and Diagnostics, which functions as a nexus for interaction and collaboration between the physical, engineering and life science researchers. Seven state-of-the-art core research facilities devoted to various areas of therapeutic and diagnostic development are based in Silverman Hall, and there is also space for future expansion.

A critical component of this ecosystem is the capacity to move discoveries from the laboratory bench into the hands of society. The Institute provides researchers with the tools needed to translate their discoveries through the EIR program to bridge academic and commercial environments, and works in tandem with Northwestern's Innovation and New Ventures Office (INVO). As the EIR, I partner and collaborate on many different projects with faculty members across all the different Northwestern schools. In doing so, we have formalized a Northwestern therapeutics pipeline; currently, there are more than 30 projects active in this pipeline. I bring something different to each project depending on that project's needs: in some cases, I take a hands-on role as a collaborator and co-investigator to carry out certain studies needed to develop a new therapeutic. In other cases, I provide advice and mentorship or facilitate connections to colleagues in the pharmaceutical and biotechnology space or to investors. In fact, several non-Northwestern faculty have also sought my collaboration in setting up new start-ups and helping develop their therapeutic projects to the clinic. I have now helped found seven companies (Tactic Pharma, Valence Therapeutics, Modulytics, Vascular Solutions, Inc., Lung Therapeutics, Inc. (LTI), Remedyon, Zephyrus) in the past two and one half years since assuming my role as EIR. I have also founded a Center for Developmental Therapeutics at Northwestern that I now direct, which provides hands-on assistance with the development of new therapeutic projects. I have helped obtain a NCI NExT award for a Tactic Pharma project; a SMARTT award for a LTI; seed capital from the Horizon Fund at the University of Texas for LTI; and a venture investment from HealthCap Ventures into another Tactic project that was spun out into a new company called Wilson Therapeutics AB. I have ongoing discussions with a pharmaceutical company who is interested in partnering on a different Tactic project as well as angel investors who want to provide seed funding to Remedyon and Zephyrus. I have also directly assisted several of these start-up companies prepare STTR/SBIR application (Modulytics, Valence, Vascular Solutions). Thus, I think we are demonstrating that we can bridge the academic-commercial divide and build value by advancing therapeutic projects further than was historically done in the academic setting given the proper culture and support that allows these types of activities to thrive.

This environment also nurtures the next wave of transdisciplinary researchers through multiple training and fellowship mechanisms that build upon the unique aspects of the CLP research programs and facilities. The Institute provides a robust training program for undergraduates, graduate students, and postdoctoral fellows in transdisciplinary biomedical research, including summer and academic year laboratory research programs that provide NU undergrads with their first experience in cross-disciplinary research. The Institute also developed a unique postdoctoral fellowship program that fosters highly collaborative, transdisciplinary research and entrepreneurial training to foster the development of independent scientists that possess the skills needed to address the "big questions" facing biomedical researchers in the 21st century.

My EIR position was the first of its kind created at Northwestern, although there have been additional EIR positions created across the university since then. The position was created as part of a new model of interdisciplinary collaboration to bring new perspectives to solving unmet medical needs. We recognized that in order to do this successfully, we would need to facilitate moving these ideas toward commercialization. The development of new therapeutics requires enormous resources, and, therefore, by definition, CLP had to be "outward facing." The EIR had to be someone that had both an academic as well as a therapeutics commercialization pedigree and could work at this interface and facilitate a flow of projects from the university to the outside community. In addition, in conjunction with the creation of the EIR, Northwestern revamped its technology transfer office, now known as the Innovation and New Venture Office, or INVO, to encourage greater collaborations and synergies between the CLP EIR and the INVO team. I work very closely with the INVO team and try to help them build value to projects that they then partner. I also identify projects with a therapeutic focus before INVO sees them (what we refer to as pre-IP or before an invention disclosure if submitted) and try to not only get these projects on the INVO radar but also help guide how they are developed early on with an eye towards putting together the strongest IP protection possible.

I believe that the collaborative interaction that I enjoy with INVO has also been spurred on by the success of Lyrica, which is a drug marketed by Pfizer that was invented at Northwestern. Lyrica is a tremendous example of leveraging the federal investment in basic research to develop a new drug that is benefiting millions of people (societal benefit) as well as generating a revenue stream for Northwestern that is being re-invested to create new programs. In fact, the inventor of Lyrica, Professor Richard Silverman, made Silverman Hall possible through a generous donation of a portion of his Lyrica proceeds and he is part of the CLP faculty. This type of royalty stream and re-investment by the university is especially important in today's challenging funding environment as it provides an alternative source of capital that can be used to build transformative and disruptive programs in the academic setting such as CLP and the EIR, something that is not always possible through traditional grant mechanisms. Further, I believe that the success of Lyrica has bolstered what was already a very entrepreneurial culture in some of the Northwestern Colleges and taken it mainstream across the entire campus. The number of people thinking about their research in terms of translation and commercialization has grown exponentially since the EIR was put in place and I think has helped inform a revamping of the approach that the university now takes to technology transfer.

Historically, tech transfer has been very passive, i.e. someone from the outside community sees a project they are interested in, or a faculty member that they want to work with, and that is how a relationship is forged. This approach can prove challenging for individuals in the community to really understand the technologies that a university has available for license, their stage of development, and therefore their valuation. Northwestern's approach to encourage collaboration between the EIR and INVO has made the university much more proactive. We now try to build value to projects before they are partnered by finding ways to advance them in the academic setting (i.e. through the centers and cores of CLP). We identify and get involved in projects earlier so we can improve how they are developed and protected (this comes out of my expertise in discovering, developing and taking into the clinic a number of drugs, a skill set which is not typically found in academia). In this way, we prepare better patents and can be more selective in making the investment in IP. We now also work with faculty to form and nurture start-up companies and take an active role in this process, marketing projects proactively instead of just waiting for people to come to us. Our faculty benefit from this because they now have mentorship in commercialization and people that they can go to for help. Hopefully, this will lead to an increase in the

number of projects being partnered or spun-out. For the first-time entrepreneur, these are tremendous benefits and form a nurturing entrepreneurial community. In turn, this allows the university to recruit better faculty with these same attributes.

Let me now speak to the challenges. One of my biggest challenges is human resources. As more people become interested in working with me on translating their ideas to the clinic, my capacity has been constrained. My biggest fear is that people will lose interest or fall through the cracks if I am unable to connect with them quickly. Historically, faculty have been wary of tech transfer offices because they felt that they were not responsive to their needs, thus both my office and INVO have made tremendous efforts to be responsive and meet with people to get them into the pipeline.

A second challenge has been to overcome the perception that discovering and developing new drugs or diagnostics is not part of the university mission or that somehow this type of scientific pursuit is inferior to more basic knowledge-generating research. I believe that academic drug discovery and development **is one of academia's most important missions. Drug development creates new knowledge and** technology for every new product that is developed. Drug development is inherently cross-disciplinary and creates new models for collaborative research across departments and schools internally, as well as externally with other institutions. Contrary to popular belief, most studies performed as part of a drug development project (e.g. animal model studies) are published, consistent with maintaining academic freedom. Further, drug discovery and development is highly entrepreneurial (one creates something that did not exist before) and is therefore consistent with the entrepreneurial nature to which most universities aspire. Finally, commercialization of new therapeutics helps the US grow its economy and maintains its global competitiveness. Again, this is aligned with the mission of a university.

The last major challenge that I would like to comment on is funding. I believe that it is possible to discover and develop new drugs through early proof-of-concept studies in the academic setting and that large research-driven institutions with medical schools such as Northwestern could become quite good at this if funding was available. Today, we do not have a fund that can provide the capital required for these types of activities. Thus, I have to access grants and development resources at NIH and DoD that can pay for pre-clinical development that will support an Investigational New Drug (IND) application. This requires that I be a co-investigator or principle investigator on these applications and drive their preparation and submission. This takes time away from my other activities and, unfortunately, there are not enough of these programs available and the application process is slow. Other academic institutions have been able to raise small gap funds, usually through philanthropy, but in most cases these have not provided adequate resources to really move projects forward. There are some examples (Michigan, Harvard) of gap funds that were allowed to invest sufficient capital in promising projects, and returns on investment have already been observed just a few years after the initial investment. Utilized properly, a gap-funding model can support drug discovery and development. In addition, by making these funds **self-sustaining (or "evergreen"), an initial investment** can provide a capital base that potentially generates a program capable of perpetual funding.

One way that government could accelerate commercialization of academic technologies (and I believe that this is in keeping with the mission of the I-Corps program) such as new drug and diagnostics, would be to invest in these gap funds regionally, so that non-grant capital that can be put to work rapidly would be available to support commercialization activities such as drug development. Currently, it may take me several years to go through the grant application process to secure support on a project by project

basis. For example, I mentioned the SMARTT award on which I am a Co-PI. The implementation, application and subsequent start of that program was something that took several years to get into place. If I had access to gap funding, I could have had that project to the end of a phase I trial in the time it took to secure that award. Patients would have already had access to a new drug and if it showed signs of clinical activity, the university could have already realized a return on this project. The caveat is that at least $2-3M would have had to be committed to that project and the tendency with many existing gap funds is to put in small amounts of money into many projects. I think there is still room for that kind of support but there also has to be sufficient capital to make a few large bets each year because these will be the value drivers for potential pharma partnerships, investments, and returns in the near term.

I believe that the EIR program can be replicated at other institutions if their culture is open to new models of academic entrepreneurship. There are many flavors of possible EIRs (traditional venture EIR, my EIR model at NU, others in between) and these could be molded to fit the specific needs of each institution. One idea would be to create a national academic EIR program. It would be even more interesting if that program could also provide a gap fund for each EIR. This gap fund could be provided locally for each EIR, or there could be a central gap fund to which all the EIRs could have access. Projects would be selected for funding competitively through an independent external review committee and each EIR could champion his/her institutions own programs for this funding. In some ways, this is the model that is being advanced through the National Heart, Lung and Blood Institute (NHLBI) Centers for Accelerated Innovation (CAI) (RFA-HL-13-008). Thus, the beginnings of a national entrepreneurial ecosystem are starting to form and this should be nurtured and developed.

Historically, good researchers have not been considered to be good business people and venture backed start-ups developing drugs rarely had a scientist CEO. However, this is now changing in the drug development space. When an IPO was the preferred exit strategy, selling the story was most important and traditional CEO's with a business background were the logical choice to lead these efforts. Now, the exit strategy is to find a pharma partner to either license or buy a new drug asset and thus, the metrics have changed. There now has to be very solid science and research behind each product, otherwise it will never survive the due diligence process. This has created an opportunity for scientist CEO/entrepreneurs to guide start-up companies and has created a need for mentoring and training these individuals. Most of Northwestern's entrepreneurship training has been geared toward students and not faculty. However, this is changing. Northwestern's Farley Center for Entrepreneurship and Innovation provides faculty support in entrepreneurial activities. The Levy Institute at the Kellogg Business School runs an Entrepreneurship and Innovation Program that is open to faculty. Northwestern, along with the University of Illinois at Chicago and the University of Chicago, have instituted the Chicago Innovation Mentor (CIM) program that forms mentorship teams to work with faculty inventors from all three schools to advance commercialization of their therapeutic, diagnostic and device ideas. iBio also has the Propel program that matches entrepreneur mentors with faculty interested in forming start-up companies I also partner with individual faculty to mentor them in translation of new therapeutics, as described above, and I believe there will be more such programs launched in the future. For example, the CAI described above will have a training component to mentor faculty in translation and commercialization of new therapeutics, diagnostics and devices in areas of interest to the National Heart, Lung and Blood Institute (NHLBI). Additional programs like this funded through government agencies would also boost these activities.

Chicago is a very unique area in terms of commercializing new therapeutics. Despite the academic intellectual firepower, many early stage academic therapeutic projects with commercial potential, and several large pharmaceutical companies in the vicinity, there is a paucity of investment in biotechnology spin-out companies and not many larger venture firms that invest in that space are located in the area. When technologies are spun-out, they end up going somewhere else geographically. Not having a large group of venture investors in the area definitely hurts our ability to create spin-outs because investors just don't think about Chicago when they think about investing. Baxter has a program with Northwestern where they provide small grants for Northwestern early stage projects but these are typically small and insufficient to support translation. However, it is my understanding that Baxter would like to begin supporting projects with true translational potential in the future so this situation may change. Similarly, the Chicago Biomedical Consortium has also provided a lot of early stage basic science support and is also looking to move more into the translational space, another good sign for Northwestern and the Chicago area.

I believe that there is a real opportunity for the government to provide funding that would be truly disruptive and transformative by creating a national EIR program that comes with a gap fund, as described above, and could also encompass a hands-on training component for faculty. For example, faculty that submit a project that receives funding from the gap fund component of such a program could have the option to actually see their project through to some inflection such as a partnership with a pharmaceutical company or forming a spin-out company and closing on financing for that company. This type of funding could help transform the Chicago drug translation and entrepreneurial ecosystem, which is burgeoning, but needs the injection of funds to push it over the top. All the pieces are already here, we just need the resources to connect the dots. I believe that if federal funds were available, these could be leveraged through a variety of local sources to form private-public partnerships to support the types of entrepreneurial programs described above. This could replicated throughout the country.

I believe that I-Corp program is trying to do exactly this and should be expanded. My understanding is that there is concern that this is not a basic enough academic mission for the NSF to fund but I have provided some examples of how entrepreneurial activities are absolutely aligned with the basic mission of a university in terms of knowledge generation, economic growth, and contributing to the benefit of society. Without programs like I-Corp, the basic research investment will be wasted. If gap funding is not available and if venture capital is no longer investing in early stage projects, which it is not, then basic research sits on a shelf somewhere and all these marvelous basic discoveries never see the light of day. Or, someone sees that information in a publication in a country outside of the US, they invest in its development, and we lose the economic benefits of developing this technology ourselves. The most important thing that I would like to see from the I-Corps program is to make more funds available for each project. Each project should be evaluated for what milestone or inflection needs to be met next, and sufficient capital should be provided to support this. The milestones may be scientific, commercial or a combination of the two but providing insufficient funds is as bad as providing no funds at all. Given that there are limits on how much money is available for this program, I would favor making a few meaningful bets rather than trying to fund as many projects as possible and have none of them really move forward. This is not to say that the federal government should bear the cost of these types of programs alone. It is possible to leverage the federal investment with private funding and in fact, the federal investment can be viewed as a de-risking strategy that attracts private funding that would not otherwise be available. This is the strategy of the CAI program described above, which requires a commitment of non-federal dollars to leverage the federal investment. Another example of matching

public to private funds is the CIPRIT program in Texas, which will match on a 2 for 1 basis, funds obtained from private investors for start-up companies. The I-Corp program is already doing something like this by requiring identification of potential customers for each technology funded and I believe that if I-Corps funding is increased, this approach can be expanded to seek out actual commitments of funds that can match or exceed the government investment. This drastically lowers the barriers for entry into commercialization and in my opinion, spurs entrepreneurship and economic growth.

Mr. Chairman, thank you for providing me an opportunity to provide testimony at this field hearing on the Innovation Corps. This concludes my remarks. I would be happy to answer any questions that you may have at this time.

Chairman BROOKS. Thank you, Dr. Mazar.

Just that everyone will understand, we have your submitted testimonies; they're much more extensive than, of course, what you were able to deliver in a five-minute span, so we appreciate you abiding by our time limitation, but know that the full remarks will be a part of the hearing record.

At this point, we go into the questioning segment by Members of the Committee. Normally, we have a five-minute limitation, too. But under the circumstances, the time that's been allotted for the hearing, I'm going to be somewhat liberal in the amount of time that's allowed for myself and Mr. Lipinski. And, again, since this is Mr. Lipinski's home court, I recognize Mr. Lipinski first.

Mr. LIPINSKI. Thank you, Mr. Chairman. And I'll try to keep it close to five minutes, then you can go, we can have a—each have second round, maybe the best way to go through this. Probably the first thing I need to do is hold up my I–Corps cup, that maybe the camera is not on me, promoting I–Corps and now that the camera is coming around.

But not paid for with taxpayer dollars, I was assured.

I just want to say, I was at the—this morning I spoke to a—the local chamber of commerce. West Suburban Chamber of Commerce. And they had one question. And I think most American's question right now, even if they're not directed at anything, is, What's the future of our country? Where are the jobs going to come from? We're in this—we're in a deep hole that we're slowly getting out of, but too slowly getting. What's the future of employment going to be? And I think the future is largely going to come from American innovation. And that's why I think programs such as I–Corps are critically important. We have here in the Chicago area great research universities, we have National Labs. They're doing great work. And we need to do a better job of taking that research, those discoveries—and not everything can be turned into a product, I'm not claiming that, but those that can, getting that into the market and providing jobs here in America. So, that's—I think that's the number one thing, the number-one question that really is on everyone's mind. We've heard—we're hearing—I wish we were hearing more about innovation and the role innovation plays in that—and needs to play for our country.

I want to—first I have a question that I think Dr. Peterson and Mr. Blank would be best to address but some of the other witnesses may want to jump in. Some of the witnesses offered thoughts on how the program can continue to be improved and/or expanded in their testimony. Mr. Kane suggested an additional educational module on what the startup process looks like.

Dr. Popescu suggested some one-on-one time with teams and instructors to address challenges unique to each team. Mr. Blank recommended trying I–Corps training—tying I–Corps training SBIR grants. Dr. Mazar talked about the need of a larger grants to support proof of concept activities. So, Dr. Peterson, Mr. Blank I'd like to get your thoughts on some of these suggestions. I'll start with Dr. Peterson.

Dr. PETERSON. Thank you, Congressman Lipinski. Let me first of all begin by reminding everyone that the I–Corps is just barely one year old. I think, as with any program, it's very important to care-

fully analyze how the program is going, not make drastic changes in a short period of time.

Very carefully we learn the lessons that we can on the investments that we're making. I think one of the key lessons that we have learned, as has been pointed out, both from your comments and the comments from others around this table, that the key element of the Innovation Corps program is education. It is the entrepreneurial education, innovation education, that is to be provided to students and the faculty to help them in this process and innovation. And what we found, really, is that in this first year the education component has in effect become the great learning step. We have outstanding ideas that are available from NSF grantees, both current and former. Providing the education components, components that Steve Blank has talked about, has been the great learning step.

So, the first thing that we are going to focus on is expanding our ability to provide those education components in other geographical locations. NSF just recently made awards to both the University of Michigan and Georgia Tech to do so. In this next year we will try to expand to other universities. So, I would say, if there are other changes that may take place within the I–Corps next year, the primary focus at this point, is to expand the education component.

Chairman BROOKS. I'm going to interject just for a moment. I've been requested to ask everyone, including the Members, to make sure that their microphone is on and that it is close to their mouths, because it is being recorded, and it will assist with that sound recording.

Mr. BLANK. Thank you, Congressman Lipinski. You know, I think that's a great question, what can we do with more, and what we will do more with less. I think that's the role of government in the coming years in this budget. And I think, again, if you think about where the I–Corps sits, it's basic research, research that's looking to be commercialized. And on the other side, SBIR, SDAT, our funds and private capital.

And what the I–Corps is for me, is we now know something we didn't know ten years ago, didn't even know five years ago. And what we now know, and combined and embedded in this program, is how to make these startups sufficient. That is, how do we not give them tens, or hundreds of millions of dollars before they even know what is it they're doing. And that's the core of the program. I believe that every basic research organization in the United States, not just the NSF; ARPA-E, DOE, NIH, all of them have an I–Corps program, and that would be the best use of taxpayer money, instead of just writing blank checks. I think having an efficient education program, because, for me, this isn't a funding program, this is an education program that actually helps scientists themselves discover whether this is a viable business. So, instead of coming to Congress or private capital with their hand out, they're now coming with customers. And that's the first time we actually know how to do this.

And so, my first request to Congress, if I had a wish list, would be, we've got to think about expanding this past NSF, in front of every resource or organization that's running SBIR and STTR programs. We'd make them incredibly efficient for just a ridiculously

small amount of money, because it's an education program, not a funding program.

Mr. LIPINSKI. Anything else anyone wants to add on that? Okay. I think I'll—with that, I'll yield back, and I—we'll come back with more questions. Thank you.

Chairman BROOKS. Thank you, Mr. Lipinski. I want to cover some of the background that Congress is dealing with right now, financial climate of the United States of America. You all probably have a feel for this, but I'm going to give you some specifics. We're looking at a 1.4-trillion-dollar deficit, followed by a 1.3-trillion-dollar deficit, followed by a 1.3-trillion-dollar deficit. This fiscal year we blew through the one trillion dollar mark in the last week or so, and we still have two and a half months to go. Last November we blew through the 15-trillion-dollar debt mark; sometime this year we're going to blow through the 16-trillion-dollar debt mark. The cost to service America's debt from FY 2010, to FY 2011, went up 25 billion dollars a year. From 196 billion to 221 billion. Now, what's 25 billion dollars?

That is more than the entire NASA budget. Okay? So, that amount of money is in perpetuity now is being spent on servicing our creditors, instead of giving some kind of return for taxpayers who are losing that money to the federal government, in hopes of getting some kind of service back in return.

You've seen what's happened in Spain, Italy and Greece, where their interest rates are significantly higher. They're on a downward spiral, trying desperately to avoid an insolvency and bankruptcy of their nations. But for the bailouts by other nations in the European community, they would have gone into insolvency and bankruptcy. What does that mean? Well, their unemployment rates generally are in the neighborhood of 20 percent, those three nations on average. Two of them are higher, one of them is lower.

Now, think about that, the impact on the Unites States of America, if we follow that same path. So, Congress is working hard to try to determine ways to avoid a federal government insolvency and bankruptcy. For emphasis, if we have a federal government insolvency and bankruptcy, you might see zero money for National Defense; you might see zero money for the NSF; you might see zero money for Social Security; you might see zero money for Medicaid and Medicare. Think of the federal government program, there might be zero for it.

Right now, thirty-six cents on every dollar that the federal government spends is borrowed. No business, as I'm sure Mr. Kane. Since he's in that field, knows, no business can last very long when their operational cost, 36 cents on the dollar is borrowed. Okay? And while I wish I could say that things are getting better, they're not. The hole just keeps getting deeper and deeper as evidenced by our, again, having another trillion-dollar deficit for this fiscal year.

And, surprisingly, in the atmosphere in Washington, about how, you know, there are cuts, I'm sure you've seen about it in the media, in the context of those cuts, yes, there have been some cuts to some programs. But in the fiscal year that ended September 30th of last year, actual federal government spending went up well over 100 billion dollars. So, when Washington talks about cuts, it's not like we understand the words, net; Washington is talking about

picking a little cut there, picking a little cut there, but nonetheless, the overall spending is still ballooning.

So, what we have to do, what I desire from you all as much as possible, is information that will help me determine why spending has to be cut in order to save our federal government from an insolvency and bankruptcy. Now, I have a background in economics, and, to me, the insolvency and bankruptcy, if we continue on the path that we're on, is inevitable. It is an absolute certainty. The only question is when. Now, if we get off that path and we get off quick enough, then maybe we can save our country from insolvency and bankruptcy.

And to kind of put it into perspective, and I know when I talk these big numbers sometimes people kind of get their eyes glazed over, but think the Great Depression. Think 15 and 20 percent unemployment. Then think about having a federal government that is not solvent and can't pay any bills. In the Great Depression we had a government that was solvent. Albeit it was difficult times, they at least could pay their bills. And when World War II broke out, the federal government was in a position to help defend our country, not on one front, but two fronts.

So, that having been said, I'm going to start asking some questions about the I–Corps program. For those of you who are not aware, each team picked to participate in the I–Corps program gets $50,000. In 2011 there were 46 teams, only 2.3 million dollars out of all the trillions of dollars being spent by the federal government. In 2012, the year we're now in, a hundred teams will be picked, at a cost of five million. The projection for 2013, according to some of the testimony I received, is 250. So, over a two-year period, you're talking about, roughly, a five-fold increase in spending, and the number of teams that will be selected to participate in the I–Corps program.

Very basic question. Where does the $50,000 go? Anyone who wants to answer feel free.

And just as an aside, these mikes seem to be the opposite of those mikes. Those mikes you push down, and it's on. This one, if you push down, you've turned it off. Okay. So, when the button is up, that's when it's on. So, who would like to make a stab now on the fifty thousands.

Dr. PETERSON. Chairman Brooks. Let me begin—is this——

Chairman BROOKS. You just turned your mic off. There you go, now it's on.

Dr. PETERSON. All right.

Chairman BROOKS. There you go, now you can answer.

Dr. PETERSON. I will just give a very simple answer and let my colleagues elaborate, perhaps with very specific examples. The $50,000 is to provide the additional support for the already funded NSF researchers, or previously funded NSF researchers, to either develop a proof of concept or a prototype for their particular idea. It's not meant to replace venture capital or anything like that, but to provide a modest amount of support where they can develop their proof of concept or prototype.

Chairman BROOKS. Well, more specifically, as I understand, 6,000 goes to education; right?

Dr. PETERSON. There is a component that's associated with the indirects from the university and the components associated with providing the educational part of the I–Corps, yes. So, it does provide support for those teams who are participating in the educational component.

Chairman BROOKS. And is it roughly $6,000?

Dr. PETERSON. I believe that's correct, yes.

Chairman BROOKS. Who gets that money; the universities or somebody else, the 6,000.

Dr. PETERSON. That money is used to pay for the educational component, the curriculum that's provided for the I–Corps program. There is an intense one-week course, in addition to the long-term course, that's associated with I–Corps and it's meant to provide the support for that.

Chairman BROOKS. Specifically, who gets the money? Do you pay the instructors for teaching the I–Corps course, or are you talking about the $6,000 is being used to print the document, or whatever constitute the curriculum, where does the 6,000 actually go.

Dr. PETERSON. It's to provide the support for the instructors, yes, sir.

Chairman BROOKS. Well, when you say, "support for the instructors", what do you mean.

Dr. PETERSON. Well, Congressman, could I provide specific details for you, for the record? I don't have the exact numbers for exactly how every dollar in that educational investment goes, so I'd be happy to provide that for you.

Chairman BROOKS. Okay. Can anyone help illuminate on where the 6,000—who actually receives the six grand.

Mr. BLANK. So, Congressman, I absolutely could tell you it's not me. The good news is for the first two cohorts, every one of the instructors volunteer for their time. And I mean every one of them. Not only me. We're talking about venture capitalists who have full-time jobs, who I convinced to teach in this program by themselves. And in addition, at least, if I understood correctly, National Science Foundation raised over a million dollars in private capital, not from the Kaplan Foundation——

Chairman BROOKS. Okay. I appreciate you going off on the private capital part, Mr. Blank. But right now I'm just trying to figure out where the $50,000 goes, that the federal government provides.

Mr. BLANK. Right. I think we——

Chairman BROOKS. I mean, it's a basic question.

Mr. BLANK. Since I'm not part of the NSF, I think we should have some of the staffers here, who could probably answer that one.

Chairman BROOKS. Well, we've got 44,000 that roughly goes to things that are not educational. From what I understand, travel expense would be one; is that correct.

Dr. POPESCU. Yes.

Chairman BROOKS. Building and prototype would be another.

Dr. POPESCU. Yes. For probably us, as a PI——

Chairman BROOKS. You got the money.

Dr. POPESCU. Yes.

Chairman BROOKS. What did you do with that.

Dr. POPESCU. So, we have to—the three members of our team have to pay the tuition educational component, and then we have to pay for the entrepreneurial's efforts, and for the business mentor's consulting efforts. And in terms of, as it was mentioned, we wanted to design the first viable product that would come out of the lab.

Chairman BROOKS. So, Mr. Blank perhaps you could help. Well, if any of you all could help. It sounds like the 50,000 goes to things that would normally be, if you're starting a business, the startup cost of that business, and the people who are owning that business would be the ones that would front that money; is that a fair statement? With the exception of the 6,000 for education.

Dr. POPESCU. Let me offer this. I don't think that's accurate, we haven't started receiving the private funds yet, but—so, in addition to the condition that they're—the cost of the trips, everything is about, to us, it is about $8,000 per person for the trips and in our capacity.

And the rest is just, as I mentioned, the effort of my team. And, you know, I don't think this qualifies as a good placement for it.

Chairman BROOKS. Well, I'll take Dr. Peterson up on the offer, and Mr. Blank up on the offer, the offer to submit to me an itemization of how the money normally is spent, who actually receives it, that would be beneficial. At this time, I'm going to send the microphone back to Mr. Lipinski for additional Q and A.

Mr. LIPINSKI. Thank you, Chairman Brooks. And I agree, certainly, with all the issues with the federal budget deficit and our debt. I recently attended a meeting with a bipartisan group of members of the Committee for Responsible Federal Budget, and the CEO of Honeywell talked about we have somewhere between six and three years—no one knows exactly how long— before we do something serious to show that we're serious about reducing the deficit. So, I am very hopeful. And I think it is an important question, about where exactly the money goes to for I–Corps. But I also think we have to look at the rewards we get for this, we have to go through everything in the federal budget and figure out, what do we get for the money that we're spending here.

I want to talk a little bit; hear from the witnesses more about the entrepreneurial education and the leveraging of this from I–Corps. But just in general, especially Mr. Mazar. What can be done in terms of teaching those who are in the lab? I mean, I was a political science professor, assistant professor, but I also have a background in engineering. And I'd be one of the first people to say that this is not something, entrepreneurship turning research into a product, is something with some of the hard sciences that engineers—not something that they necessarily have an idea of how to do. Also, I know social science also has some recipients of I–Corps funding—they also had some very good idea.

But, how have you seen—anyone on the panel— the kind of the leveraging of the information coming from the I–Corps program, how have you seen that have an impact, especially Dr. Popescu, but anyone else, how is it that that helped sort of to bring a new sort of information and entrepreneurial spirit and knowledge to beyond what you have learned with I–Corps.

Dr. POPESCU. Okay. Thank you very much for the question. For me, the main benefit for—I would say the first benefit was to kind of clarify the message of our technology. If you remember, still remember our first presentation of the I–Corps was kind of, we were explaining our technology in terms of what it could do, very technical terms. It could do 3D imaging and nanoscale resolutions and all that. And then we were told that, "Hold on, the customers, they want to hear the value proposition." So, the first benefit was that now in our business proposal we have this very clearly stated. And we started to have—we have recently given the local investors, where this message was very sharp and very well received. And we're very confident that we will raise our $400,000 in a couple of months. We're very confident about that. So, I would say that's one thing, but we learned, basically, a whole lot from the startup program.

Mr. LIPINSKI. Mr. Kane?

Mr. KANE. Thank you. Let me state for the record that at the time the decision was made to apply for I–Corps, it was a university project and there was no presumption or commitment to start a new company. So, all of the efforts that you would typically expect one to make, in the investment of time and resources that people would make into getting a startup off the ground, really wasn't a consideration at the time that we decided to apply for I–Corps. It was only after going through I–Corps that we got the confirmation to suggest that we should start a company.

But, Congressman Lipinski, to address your question specifically about the leverage, I'll talk briefly about my own personal experience. As you know, I do a lot of advisory work, consulting, and even though I'm the CEO of GlucoSentient, I also am involved in several other startups.

And since the time that I went through I–Corps and first got exposed to Steve's curriculum in the lectures at Stanford last October, since then I have spoken at the University of Illinois, at Northwestern, at Notre Dame. We had a group of MBA students from Kellogg who were assigned, as a semester-long project, to assist the Northwestern startup that I'm working on, to do some market development and characterization of the opportunity. And I actually encouraged them and brought the business model generation techniques that I learned in Steve's class at Stanford to this project at Kellogg. They went out and bought the textbook and read it, and now some of that methodology is being infused there.

So, over time, I mean, I'm just the data point of one, but now that I've been exposed to the curriculum, and then you multiply my efforts by the dozens and soon hundreds of other mentors who have gone through the program, we're out in the community, at the business schools, at the engineering schools, helping to diffuse that knowledge. And I think over time you're going to see an exponential gain as that starts to accure.

Mr. BLANK. And if I can, Congressman Lipinski, since I designed the course to do this on purpose, let me assure you and Chairman Brooks that the goal was shock and awe for the students who went through it. And I think they could all tell you that they were certainly changed from the first day of that class. And given their experience and their stature, I don't think anybody spoke to them

like that in the last 20 years. And they certainly learned about what was important in the shortest period of time. And more importantly, for the country, I think we changed them forever. I think we made them incredibly efficient.

Now, I think Chairman Brooks' issue about the $50,000, while, relevant, this is not funding for the startup. I think, as Mr. Kane said, they don't come in thinking they're going to build a company, they come in thinking, How can I commercialize this? And all of a sudden when they leave, they now understand what it takes to build a company, with no doubt. I think this was the—probably the shortest period of emersion we could get a team with the biggest bang for the buck. And I think we did a pretty good job of it, and I'm pretty proud that we're going to continue to do this.

The other comment I should make for the Committee, is you should understand that this process is being adopted in Silicon Valley, literally, by qualifier. And the thing that concerns me, it's not just Silicon Valley, this process has been being conducted for a while. You know, commercialization and research is going to go ahead, whether we decide to join it or not. It's one of those great adventures of our time. And I just kind of believe that this country wants to be the leader of other nations. We can't be left behind here. Because I hope the fruits of all these investments, and all this research that this Committee has been helping fund for these decades, I hope we see those products printed in English and not in Chinese. Because this technology and this course, this educational process, can be adopted elsewhere. It's the one thing we know how to do in the United States, which is fail fast, and fail quickly, and test our hypothesis, that make this unique here. We fail to capitalize on that, how we literally will be seeing these products not made in Shanghai and Beijing. And that just bothers me as an American.

Mr. LIPINSKI. Before I let Dr. Mazar address this, I want to say, having spent some time in the ivory towers, at the universities, I know in my own, in just looking at my experiences in political science, I saw some great research being done. And my question always was, "So what?" I come from a very practical midwestern background, and that was always my question, "So what?" I want to know what the application is here?

And I think this has relevance in that there's a lot of great work that's being done and getting—Dr. Popescu said, "What's the value proposition?" I think if you spend your time doing a lot of research, you can come up with all kinds of great discoveries, great findings. But, you cannot—it might be, at some point, applicable to starting, to creating a new product. Starting a new company.

But you're not challenged as a researcher to think about that, really, in the normal process of what goes on at universities. And trying to get tenure, working on research, and publishing, and I think that is something that we need to do more of here in this country.

And I want to ask Dr. Mazar how Northwestern is doing that, and how you may see others doing that. We have a lot of—now it seems like it has become very popular in the last decade or two, to have some kind of center or institute, some kind of program at universities to focus on technology transfer. And I think this is

something very new and something that's really critically important for, as I said, innovation and jobs in this country. So, how do you see that? How do you see the whole mindset is changing?

I'll tell you, I sat in on a class that Mr. Blank had for graduate students. Not the I–Corps class, but teaching Lean LaunchPad to graduate students. I was a Stanford graduate student 20 years ago. I didn't know graduate students who were thinking like this. There is a whole different mindset there, at least at Stanford, hopefully at other schools, of entrepreneurship and coming up with these ideas. It was almost shocking to me, in a very good way, that I saw these graduate students—like my colleagues, I was not thinking like that when I was at Stanford 20 something years ago. I didn't know anyone who was thinking like that. So, it's a whole different change of mindset among people who are doing research.

So, with that, Dr. Mazar, what are you doing at Northwestern, and how do you see the—sort of the mindset changing of people who are doing the research, in terms of the possibilities when they do have something that could possibly become an innovation?

Dr. MAZAR. So, thank you, Congressman. I'll try and keep my comments brief since that's blinking a lot right now. Seems to be angrier everysecond for some reason.

Mr. LIPINSKI. Don't worry.

Dr. MAZAR. So, Northwestern, I think, in observing over the past several years just the culturalship, the way everybody started, the students all way through faculty, through administration and senior leadership, is viewing entrepreneurship as well in the university. And I think Northwestern has been forward-looking in that way, by allowing to have it organic. There's a lot of programs for students and faculty that are adaptive programs. There's, for example, the Fawn Center For Entrepreneurship, where, in this case, actually bred into the neotype of the students, graduate students and even undergraduates, very early on in their approach to pursue their ideas and think about how to commercialize and go out in the competition, write business plans. There's lot of support for that. And a lot of that is coming from, I'd say, two big sources; one being the Innovation New Venture Office, which is sort of the next generation tech transfer, but much, much more at Northwestern.

The transfer function is just one little part of that. But they are the ones that are really pushing a lot of these adaptive programs, but also pushing hands-on training side by side with mentors and entrepreneurs. And so, that's sort of how I came to be here, is because I could sit down with faculty, and we'll just talk about theory, or you should do this, you should do that. But I actually rolled up my sleeves and I rode with them side by side and take their therapeutic ideas, and moved them forward toward the clinical, towards commercialization. And I think that most faculty have worked in sort of medically-related research.

If you talk to most people, they say, "Man, I'd really like to translate my idea into a drug, but I don't know how to do it." So, as soon as you sit down with them and show them how to do it, that process just begins to flow and occur naturally. And so, consequently, a lot of these projects now, that sort of used to stop at what I call the power one stage. So, once you write your papers, what do you do next? Well, in most universities here of late, you

send that to a transfer office. Here we're now trying to take those projects and advance them further, so we can get them out the door, out into pharmaceutical companies or partnership, or startups or spin-offs, so we're immediately commercializing, generating revenues to the University.

And so, I think, to me, that cultural shift, and also just having people within the University who have been there, done that, who have that expertise, that will work side by side with faculty, has been sort of the biggest change that I've seen that's helped a lot of these things move forward.

Mr. LIPINSKI. Thank you. And I have to thank the Chairman very much for all the extra time. When I was at Stanford, I was in the Engineering Economics Systems Program there, which is now Management of Science of Engineering, to see students who are in that same program coming to that class, and have these ideas. It's great to see that and I think we need to have more of that across this country for the future of our country. Thank you.

Chairman BROOKS. I'm going to try to reduce this to a general sense again. We basically have three kinds of expenditures in Washington D.C., one is interest on the debt. We have no choice but to pay it. If we don't pay it, our creditors charge us a lot more, or they can cut us off. If they cut us off, all of a sudden you have to have a 36-cent-on-the-dollar reduction federal spending across the board. But that's one place. The second place is the entitlement programs. That's where the big boom is, over a hundred-billion-dollar increase in spending for Social Security, Medicaid, Medicare, wealth transfer programs, a variety of different stewards. And then we've got the third pot of money, which is where NSF comes from, which is where National Defense comes from, and that's discretionary spending. That is the one area of the federal government where spending has actually been cut. And so, what I'm looking for is information that would help me protect this program as opposed to others that are being cut. I use National Defense as an example. With sequestration, if it comes to fruition, and it's scheduled to for January 1st of 2013, you're looking at 700,000 layoffs. Seven hundred thousand layoffs. And the DOD said that it was court workers, uniform defense personnel, or private sector support contractors. A reduction in our National Defense capabilities of approximately 25 percent, according to Committee estimates. House Armed Services Committee estimates. So, you're seeing great competition for the dollars that we have. And even with that competition, we're not reducing spending enough to adequately reduce the risk of insolvency and bankruptcy.

I note, and I really appreciate Mr. Lipinski reducing it to fewer words than I could have. He said, "So what?" And that's really the gist of it. For us to be successful in defending this type of program, we have to be able to show results.

And I'm going to just read a few of the comments of some of the witnesses from our witness statements. Dr. Peterson said, "Initial anecdotal indicators suggest that 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."

Now, we have another comment by—this one's Mr. Blank. The I–Corps program, quote, "will pay us back with jobs and a competitive edge on a global scale," end quote.

Then we have another quote by Mr. Kane, which is closer to the "So what" comment, but it's pretty much where I am. Quote, "As an entrepreneur I see things through a different lens. In my world view, technologies have limited value unless they are applied. And for jobs to be created and the tax base to go up, somebody eventually needs to make a profit," end quote.

I'm looking at the teams, our efforts that we've engaged in so far, were 46 in 2011, 100 in 2012, and 250 projected for 2013. I know we can't do anything about 2013, because that's projection. Probably can't do anything about 2012, because that's also just in an embryonic stage. But with respect to the 46 I–Corps teams that were set up to market products to start up a business, how many of those 46 are today profitable and self-sufficient, i.e., they're receiving no federal government or other taxpayer funds.

Dr. PETERSON. Chairman Brooks, if I could begin first of all, and then I'll ask Steve Blank to comment more specifically. I think it's very important to be realistic about what we can expect in a specific amount of time for this program. Absolutely all the things that we need to develop with new jobs, new companies, all of these we hope and have every expectation that this program will do, and if it doesn't do more things we shouldn't be investing in it. We've never promised that in one year, that all of a sudden there's going to be thousands of new jobs, or every single investment in the I–Corps program turns out to be a successful company. But as has been pointed out, this is a key investment in development of innovation, and I think without that step we can't anticipate the future, future developments,——

Chairman BROOKS. And, Mr. Peterson, if I could interject for a moment. You're answering my next question, I haven't asked it yet, but it was going to be why. My first question is: How many of the 46 are stand-alone, profitable, self-sufficient, without taxpayer subsidy——

Mr. LIPINSKI. Could anyone——

Chairman BROOKS. —or assistance.

Mr. LIPINSKI. Can anyone talk about any progress, anything——

Mr. BLANK. Yeah. So,——

Mr. LIPINSKI. —that looks potentially——

Mr. BLANK. So, let me ask—try to answer Congressman Brooks' direct question by saying, I think it's a divide by zero question. Which I mean is, it implicitly says that the goal was to set up a series of profitable companies, is the outcome of the I–Corps program. Which, that wasn't the program I was teaching.

Chairman BROOKS. That's not, the goal is not to establish——

Mr. BLANK. So,——

Chairman BROOKS. —startup companies, that are successful——

Mr. BLANK. The goal for what I was teaching was to understand whether these entities were capable of being startup companies. And, in fact, the viable answer for $50,000, which is probably the cheapest investment the government will make, is to find out, no, let's not spend or raise millions of dollars, that, gee, there is no market for this. So, number one is, is this a go or no-go decision.

Number two is, are these technically add business viable enough to actually apply for an SBIR Phase I grant. Or, two is, is it possible that these entities could go out and become companies and raise private capital. And the key idea is, Chairman Brooks, I know you're familiar with NASA's technology readiness level, when they take a look at technology and say, "Is it ready?" We've never had a business readiness level anywhere in this country. What this program does is not build companies——

Chairman BROOKS. Mr. Blank, I'm going to have to interject again. Can anyone answer my question as to whether any of the 46 are profitable, stand-alone, don't-need-government assistance? Any of the 46?

Mr. BLANK. I don't know, but I don't think that was the goal.

Chairman BROOKS. Well, that—I'm not asking you what you thought the goal was.

Mr. BLANK. I have no idea.

Chairman BROOKS. I'm asking, again, if anyone can answer the question as to whether any of the 46 of these startups have been successful?

Dr. PETERSON. Okay. I——

Chairman BROOKS. And I'll get to Mr. Peterson, he's answering—asking—he was answering my second question, which I haven't asked yet. But right now the question stands, does anyone know of any of the 46 that are making a profit and are successful in the business environment.

Dr. PETERSON. Chairman Brooks, you understand my reticence just to directly give you a yes-or-no answer, simply because I don't necessarily agree that if they aren't stand-alone companies, that they haven't been successful. My guess is, and we'll look, and again, we'll get exactly these numbers for you, but very few of the investments are now totally self-sufficient, stand-alone, profitable companies. That was not an expectation in one year's investment from the I–Corps program. We will get you that specific information.

Chairman BROOKS. All right. Well, until I get something to the contrary, I'm going to infer from the silence, or the answering different questions, that there are no known profitable businesses so far of the 46.

My second question, which, Mr. Peterson, you were focusing on in advance of having—of me receiving an answer to the first one was, why not? And if I can now summarize, the why not is because it's premature, and also because of Mr. Blank's comment, that it really wasn't the goal of the I–Corps program. And, Mr. Kane, you have something to add.

Mr. KANE. I would just add that the earliest time that anybody could have started a company, if they had gone through the first I–Corps, would have been January of this year. So, the question you're asking is whether any companies that got started from a standing start, in seven months are profitable.

Chairman BROOKS. Well, my third question is going to be: At what point in time should we be in a position where we can properly evaluate the startup numbers? And I'm looking at a quote from Dr. Peterson's written testimony, "Specifically, the Priority Goal states that by September 30th, 2013, 80 percent of teams par-

ticipating in the Innovation Corps program will have tested the commercial viability of their product or service." So, is 2013 when we should, as a Committee, start being in a position where we can sincerely evaluate at least the 46 startups from 2011?

Dr. PETERSON. I think the answer to that is yes. That is exactly what we're stating. Then we will be able to test the viability. That does not say, and I'm going to make it very clear, we are not saying that 80 percent of all of the I–Corps investments will end up being profitable companies. But we will be able answer that question.

Chairman BROOKS. And let me move to another part of Mr. Blank's testimony. And I thought this was an interesting comment interposed, and the rest of his remarks. Quote, It's why Silicon Valley investors fund startups when over 90 percent of startups fail, end quote. Is it your anticipation that with the I–Corps program, that kind of success rate is what we can expect, ten percent success, 90 percent failure.

Mr. BLANK. You know, Chairman Brooks, I think if anybody knew that, we'd be venture capitalists. I think the goal for me in building this course is to change the odds. I think we now know what makes startups fail. I think we now know how to make them fail less. I think we now know how to make them spend a lot less of government and taxpayers' money by finding these things out up front. I would hope that we actually look at the data. And the preliminary data, I think tells us a quite a bit, that we're actually achieving that goal. I think your question about how should we measure this for the next couple of years is exactly what we should be doing. And I think, as I said, the data we see now gives us great comfort that we're actually using taxpayers' money incredibly efficiently. And so, yeah, I think we should see better numbers from that. Because of what we're doing here is an education program, we're teaching them to be parsimonious with their time, their energy, and more importantly, our money.

Chairman BROOKS. Did anyone else want to add anything to what Mr. Blank has just stated? Otherwise I'll go to my final comment, question, before we go back to Mr. Lipinski, on the chance that he wants to go another round.

Mr. KANE. Chairman, if I could add something, perhaps, on your opening statement, where you said that as a congressman you're trying to figure out how we reduce the budget deficit and where the cuts are going to be made, and as a citizen I have the same concern, although I haven't been elected to solve the problem. But, we understand that debt is a difficult problem. And my suggestion, to be brief, is that entitlements is what you should look at. Because if I look at my own personal household, once I made the decision to become self-employed, I realized that there was certain freedom once I knew that I had an opportunity to sell my services and could be assured of making a living on my own. And I think that the only way to reduce the entitlement's burden over time is to create wealth. And there's no faster or better or more effective way to do that in the United States than through entrepreneurship.

So, my closing statement is just a big flag waving need for the necessity of teaching entrepreneurship. It's not a problem that's going to get solved in a year, probably not even five years. We all know there's no silver bullet. But over time, creating wealth by

training people how to be self-sufficient is the thing, in my humble opinion, that will eventually reduce the entitlement's burden, which is one of the solutions to solving the debt problem.

Chairman BROOKS. Well, Mr. Kane, I don't know whose congressional district you live in, but if you're saying focus only entitlements, the wealth-transfer programs, that we can invest in things that produce jobs, I would encourage you to consider an application for Congress. Because we need people to work on——

Mr. LIPINSKI. If he doesn't live in my district, that's fine.

Chairman BROOKS. Let me move on. My test for the I–Corps program is a different test than I would apply for most National Science Foundation work. When you're doing basic research, you don't know what you're going to come up with, you don't know what the end result is going to be, you're trying to expand the human mind. Okay? And just the expansion of the human mind, in and of itself, may be worth the taxpayer money that's being spent on those research projects.

But when you get to something like I–Corps, as I perceive it, granted this is my first term in office, but I'm more akin to the "so what" comment of Mr. Lipinski. We have to have results if we're going to be able to justify this program long-term. And to me, the results are that we're generating the kind of jobs and wealth that most of you guys have testified to in your written statements as being the end result of the I–Corps program.

And so, I'll be anxiously awaiting 2013 and 2014 voters willing in my district that I return to the United States Congress, and if we have significant improvement in the creation of businesses successfully, and the creation of jobs, then that enables us, or empowers us to be able to explain to our constituents back home that we're being wise stewards of the taxpayers' dollars.

I will say that I'm very much concerned by the analogy, indirectly, not directly, to Silicon Valley, where venture capitalists are looking at a 90-percent failure rate and ten percent success rate. Well, we can expect 10-percent success rate out of them, because that's their decision. Okay? If they want to do ten percent or five percent, or 10 or 30 or 40, it's their money. Can't question it. And if that's what they are comfortable with, that's fine, that's meeting their expectation. But when you're talking about taxpayer's dollars, I'm not sure there are going to be very many Americans around the country that are satisfied with a 90-percent failure rate and a 10-percent success rate.

Now, again, granted, we're early in the program. Too early, quite frankly, to be able to make a thumbs up, thumbs down decision on it. But over the ensuing few years, I hope that you all's involvement in it, you all will do what you all can to try to make sure that we have a good success rate, that in turn will translate into our ability to defend this program as opposed to defending another program that is able to project a better return on taxpayers' dollars.

With that having been said, Mr. Lipinski, if you'd like to make any more remarks, or if you want to follow up with more questions we still have time.

Mr. LIPINSKI. Thank you, Mr. Chairman. I think that we have to consider why venture capitalists are willing to go in and put

their money on the line with only 90 percent failure rate. And that's because what we should be looking at is not success or failure rate, but what do we wind up getting out of this. And I don't think we should be looking at what percentage of these I–Corps grant recipients go on to actually create successful business. It's what's the end result, what is not percentage-wise how many succeed, but what do we get out of this.

And if only one percent, if only one of them succeeds but succeeds in a big way, for example, then it's worthwhile.

And we can't really measure, it's difficult to measure the change, as Dr. Mazar was talking about. Just the change in thinking of the people who participated in this program, even if this idea that they have brought to I–Corps doesn't work, doesn't mean something will not work in the future, or maybe some of their colleagues learned better how to be entrepreneurial. So, it's hard to measure the success.

And I completely agree with you, Chairman Brooks, that we have to be careful about how we're spending money. And I think that we have to be—have to watch and see what does happen with I–Corps and the money that we are—NSF is putting towards I–Corps and it's important to have that oversight, as Congress does, and our Subcommittee is in charge of that oversight of NSF over on the House side.

And I think that it's crucial to do that, that's why we wanted to hold this hearing, and I thank you for doing that. But I think if we are looking at a solution, and we say well we can't have a 90-percent failure rate with the money that goes to I–Corps—that's not really what we should be focusing on.

It looks like Mr. Blank wants to jump in here.

Mr. BLANK. I just want to maybe make a point for Chairman Brooks' comment. Chairman Brooks, you're from Huntsville, is that the district you represent?

Chairman BROOKS. Yes, sir, home of the country's second largest Research Park.

Mr. BLANK. Right. And Saturn Five was developed there, wasn't it, the institute?

Chairman BROOKS. It certainly was.

Mr. BLANK. And I seem to remember in the early days, in 1960s, when I was a young boy, I think that one had a failure rate, those things kept falling out all the time. Not only Saturn Five, but all the rockets.

Chairman BROOKS. You must be older than me, my memory is we had it excellent——

Mr. BLANK. Not at the Center, but I remember the early red stones and the Jupiters, and the first grandparents all kind of blew up in the pan for the country. Understood.

But, the cost of science and experimentation was failure, not—and that's—again, we didn't shoot our scientists when they failed. We don't shoot our entrepreneurs, we embrace the fact, that this is what we do.

And I understand you have to explain that to taxpayers. But, in fact, if we actually look at some of the labs that we fund, we don't have a hundred percent success rate in these experiments. We don't expect that. We understand that's the nature of science. And

I know you understand that. And I want you to know that I understand. My personal goal is to increase this hit rate, but I just want it you to understand that, for me, entrepreneurship, on day one is a faith based. Faith based, call 'em. And very quickly we turn these into facts. And that's what we use this process to do. And hopefully we can increase that rate to where we're all proud of what it is. I just wanted to share those comments.

Chairman BROOKS. Well, thank you for your comments.

And I will make this distinction philosophically. It is one thing to be involved in basic science, which to some degree Saturn Five was with our effort to explore space, as it has been with nanotechnology and all of these other things that the National Science Foundation has been excellent at doing. And we understand that with basic science, there's going to be a significant failure rate. It is another thing, though, for the federal government to go past the basic science and to start getting into the free enterprise system. As you probably are aware, in Washington we had a serious philosophical battle between socialism on the one hand, which gives an economic model that does not work. Korea would be the best example. And free enterprise on the other end. And to what degree does the federal government's involvement help determine which of our entrepreneurs are going to be successful and which are going to fail, and to the extent the federal government is the determiner of who is successful and who fails, then you have politicians that are making those decisions, often for political allies as opposed to what should be a fair and impartial system, which is what you have with free enterprise. And so, I see a difference between basic research and the government, any government's, involvement in free enterprise. Not withstanding that difference, I understand that government has a role in education, and to the extent this is an education program that does produce results, that is something that we certainly need to consider perhaps in a favorable light. But to me, what I want to try to get more than anything else, is an idea of the timetable we should look at before we seriously evaluate this program. Because we have that in 2013, 2014, we should be expecting some results that justify the federal government expenditures of funds. And I think Mr. Lipinski hit the nail on the head when he also talked about, it's not just a success rate. You give us one Microsoft, with the thousands upon thousands of jobs that they create, we can overlook a whole lot of other efforts that were unsuccessful.

And my staff is reminding me that you are on Mr. Lipinski's time. For that, Mr. Lipinski, I hand it back to you. Thank you.

Mr. LIPINSKI. Thank you, Mr. Chairman. And, well, if the voters return both of us to Congress, I look forward to taking a further look at this topic in the next Congress. I think that gets back to, and I think we agree for the most part, on what we're talking about here. We want to be good stewards of the taxpayers' dollars, and know that it's their money that we're talking about here. But I think that this program, we have to be looking at—I think one last thing I want to mention is, is that Mr. Blank continued to talk about SBIR. We spent how much—let me ask Dr. Peterson. How much of NSF money goes to SBIR?

Dr. PETERSON. As you know, Congressman, it's a specific fraction of the research and related expenses. And with NSF, it's about $140 million a year, that is what our SBIR budget is at this time.

Mr. LIPINSKI. And, I think that this is a way of hopefully having better results coming out of SBIR—also across the federal government. Not just at the NSF, we could have this kind of program like I–Corps at other places. It could be a great feeder to SBIR, and then that money, which is more money than what's being spent on I–Corps, that taxpayer money can be better spent and have a better likelihood of having good results, and really having successful companies come out of it.

But, I want to conclude by thanking the witnesses for their testimony. I really think that this this program has great potential, and we need to keep watching what is happening in terms of results. Results are not always easy to see, but the potential for a great payoff, and I appreciate what Chairman Brooks said, if we have one Microsoft-type come out of this, then we can say that it's been a success. Like every other program we need to keep looking at it. And I thank the Chairman for coming out here to Chicago and taking a look at the I–Corps program during this hearing, and where the program is going. But I think we have to keep on focusing on innovation, it is the way that our country is going to succeed. A way American people are going to be successful is through innovation. We already spent a lot amount of money on the research, and I'm very happy to hear Chairman Brooks talk about understanding what we receive out of spending on this basic research. I want to thank our witnesses and thank Chairman Brooks.

Chairman BROOKS. I, too, would like to thank—well, first I'd like to thank the witnesses—oops, I did it, sorry. That's what Dr. Peterson did, pushed it in, turns it off. Now it's off, now it's on.

I want to thank the witnesses for participating in this hearing, particularly Mr. Blank for the extraordinary efforts you made to come here. I look forward to additional interaction with each of you as this program, process, works its way through the system as we continue to battle over funding in Washington. I can assure you of one thing, the intensity of the debate over what's going to get funded and what is not is only going to get worse over the coming years because of the financial limitations of our country. I want to thank Mr. Lipinski for calling this hearing in Chicago, his hometown neighborhood. It also happens to be my wife's neck of the woods, she was born in Evanston, just a little bit to the north of Northwestern. So, she's enjoying herself while I'm in this hearing. The Members of the Subcommittee may have additional questions for any one of you. I would ask you to respond to those in writing. Of course, that includes any questions from the Committee staff. The record will remain open for two weeks for additional comments from Members. And with that, this—the witnesses are excused and this hearing is adjourned.

[Whereupon, at 11:44 a.m. CST, the subcommittee was adjourned.]

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