Testimony of Dr. Pramod Khargonekar
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National Science Foundation
Before the
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Subcommittee on Research and Technology
United States House of Representatives
SBIR/STTR Reauthorization: A Review of Technology Transfer

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Chairwoman Comstock and Ranking Member Lipinski, thank you for this opportunity to testify regarding the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs at the National Science Foundation (NSF). My name is Pramod Khargonekar, and I am the Assistant Director (AD) for Engineering at NSF.

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. NSF is the funding source for approximately 24 percent of all federally supported basic research conducted by America's colleges and universities. In many fields such as mathematics and computer science, NSF is the major source of federal support. Many NSF-funded discoveries and technological advances have been truly revolutionary including 217 of our researchers who have received Nobel Prizes over the past few decades. Our grantees are the winners in this process, so too are the taxpayers who have invested in this research through the NSF.

The Engineering directorate provides about 40 percent of the federal funding for fundamental research in engineering at academic institutions in the United States. Research funded by the NSF's Directorate for Engineering has enabled major advances in manufacturing, electronics, communications, and chemical processes.[1] It has created new knowledge that has helped to fortify the nation's infrastructure. It has invested in programs to educate the next generation of engineers. Engineering is also home to many of NSF's activities that foster innovation and technology transfer and commercialization. The SBIR program at NSF is managed within the Division of Industrial Innovation and Partnerships in the Directorate for Engineering

While NSF's primary mission is to advance the frontiers of science and engineering through basic research, the SBIR program is an integral part of the NSF strategy to stimulate innovation and address societal needs through the commercialization of the results of fundamental research. We fund small businesses at very early stages, when the technology risk is high and before the

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[1] http://www.nsf.gov/dir/index.jsp?org=ENG

private sector is normally willing to invest. Since NSF is not the ultimate customer of the innovation stimulated by the SBIR program, the NSF SBIR research topics are oriented to the needs of the marketplace and the nation as a whole.For example, NSF SBIR research brought about Symantec, which is now a global leader in cybersecurity. It was founded in 1982 by Gary Hendrix who was funded by an NSF SBIR grant. Qualcomm, a world leader in wireless communications and computing technologies, also received NSF SBIR funding during the 1980's in its early years as a small business.

In 1998, NSF SBIR introduced a new supplemental program called Phase IIB as a platform to stimulate NSF-funded active Phase II grantees to attract private sector funding for further technology commercialization. The Phase IIB proposal is submitted while the company is conducting the Phase II research. With Phase II research underway, the small business is better positioned to attract investors because most of the early stage technology risk has already been addressed with NSF funding.

In addition to providing funding in varying stages, we also assist our awardees by providing them with experiential entrepreneurial education based in part on the NSF Innovation Corps (I-Corps) program that helps entrepreneurs and their small businesses understand market needs and customers, thus increasing their chances of successfully commercializing new technologies. I-Corps was designed to foster entrepreneurship that will lead to the commercialization of basic research. I-Corps uses customer discovery and business model development to validate commercialization opportunities, and successful I-Corps projects will be prepared for business formation.

Another program, closely related to I-Corps, is the Partnerships For Innovation (PFI): Accelerating Innovation Research (AIR) program. 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. It also fosters connections between existing NSF innovation research alliances.

In addition to the SBIR program, the Engineering division manages several university-industry partnership programs: Small Business Technology Transfer (STTR), Industry/University Cooperative Research Centers (I/UCRC), and Partnerships for Innovation (PFI) and Grant Opportunities for Academic Liaison with Industry (GOALI). NSF's SBIR and STTR programs enable companies to undertake research and development with high technical risk and high potential commercial reward. In fiscal year (FY) 2015, SBIR awards were made to small technology-based firms across 39 states, including 27 awards made in the Experimental Program to Stimulate Competitive Research (EPSCoR) states and territories. Existing NSF innovation research alliances such as Engineering Research Centers (ERC), I/UCRC, PFI, Science and Technology Centers (STC), Nanoscale Science and Engineering Centers (NSEC) and Materials Research Science and Engineering Centers (MRSEC), complement our other significant investments in fundamental scientific and engineering research. They do so by offering multiple pathways for moving from discovery to innovation to technology.

We frequently find that NSF-funded researchers will pursue and receive grants from many of these eight programs in parallel, in sequence, or on a combined path. For example, PFI-AIR

grants first before pursuing I-Corps training. We are seeing strong interactions between these programs as well as with our SBIR/STTR program where researchers start with NSF-funded fundamental research, advance to PFI: AIR, then go through I-Corps and then pursue SBIR and STTR funding.

SBIR and STTR are vital components of NSF's agenda to enable commercialization of technologies stemming from basic research. We strongly support a permanent reauthorization of this program. NSF also strongly recommends that the yearly set-aside percentages for SBIR/STTR be maintained at FY17 levels.

Since FY11, the SBIR program has expanded by 5 percent a year, or almost 30 percent overall. This is almost three times as much as the rest of the agency during the same time period. The House proposal, H.R. 4783, would continue a similar path, increasing program funding by 40 percent over 6 years for SBIR and 33 percent over 6 years for STTR. The proposed increases would come at the expense of reducing funding in existing highly meritorious fundamental research programs at NSF as well as other non-SBIR/STTR innovation programs I have highlighted today. We believe any future growth in NSF SBIR and STTR programs should be realized through overall extramural R&D budget increases for NSF. In the current budget environment, increases in these programs mean real cuts to the remainder of the extramural budget. We do not see annual increases in the set-asides for these programs as justified, especially at the cost of others, when the overall budget of the agency is flat.

We appreciate the flexibilities provided by the current program which allow NSF to support activities to strengthen the nation's innovation ecosystem. Specifically, agency flexibility on award size and sequencing, consistent with the diverse needs of small businesses in different industries and technology arenas, is critical. The NSF SBIR program funds grants in diverse technology topic areas including: Smart Health (SH) and Biomedical (BM) Technologies; Biological Technologies (BT); Chemical and Environmental Technologies (CT); Educational Technologies and Applications (EA); Electronic Hardware, Robotics and Wireless Technologies (EW); the Internet of Things (I); Information Technologies (IT); Semiconductors (S) and Photonic (PH) Devices and Materials; Advanced Materials and Instrumentation (MI); and Advanced Manufacturing and Nanotechnology (MN).

Lastly, I should note that NSF participated in an interagency process to detail principles all the SBIR/STTR agencies can support for reauthorization, which include permanent reauthorization, growth in the program through overall extramural research growth, and maintaining flexibility.

Madame Chairwoman, this concludes my testimony. On behalf of the National Science Foundation, the SBIR program and our awardees, I want to thank you for this opportunity to highlight a program that provides small businesses with the means to keep America on the forefront of innovation. I would be pleased to provide any additional information that would be useful to you.

Pramod P. Khargonekar
Biographical Sketch

Dr. Pramod P. Khargonekar was appointed by the National Science Foundation (NSF) to serve as Assistant Director for the Directorate of Engineering (ENG) in March 2013. In this position, Khargonekar leads the ENG Directorate with an annual budget of more than $900 million. He is also a member of the NSF senior leadership team that sets policies and priorities for the Foundation. The ENG Directorate invests in frontier engineering research and education, cultivates an innovation ecosystem, and develops the next-generation of engineers.

Khargonekar was Chairman of the Department of Electrical Engineering and Computer Science from 1997 to 2001 and also held the position of Claude E. Shannon Professor of Engineering Science at The University of Michigan. From 2001 to 2009, he was Dean of the College of Engineering and is currently Eckis Professor of Electrical and Computer Engineering there. He also served briefly as Deputy Director of Technology at ARPA-E, U. S. Department of Energy in 2012-13.

Khargonekar's current interests include systems and control theory, machine learning, and applications to smart electric grid and neural engineering. He has authored more than 300 journal and conference publications. He is a recipient of the NSF Presidential Young Investigator Award, the American Automatic Control Council's Donald Eckman Award, the Japan Society for Promotion of Science fellowships, the IEEE W. R. G. Baker Prize Award, the IEEE George Axelby Award, the American Automatic Control Council's Hugo Schuck Award, and the Distinguished Alumnus and Distinguished Service Awards from the Indian Institute of Technology, Bombay. He is a Fellow of IEEE and IFAC. At the University of Michigan, he received the Arthur F. Thurnau Professorship. He has been recognized as a Web of Science *Highly Cited Researcher*.