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**Increasing U.S. Competitiveness by Investing in Underrepresented, Entrepreneurial-Minded Postdocs in High-Tech Startups**

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# Abstract

Studies have shown that in the United States, women, African American, and Hispanic American entrepreneurs secure a disproportionately tiny fraction of venture capital funding, especially when compared to their representation in the population. This investment discrepancy is not only socially unjust, but it also deprives the U.S. of the advantages in discovery and global competitiveness that could stem from these groups’ increased participation in innovative sectors. This is particularly true within transdisciplinary startups, like smart energy or nanomedical technologies, all of which increasingly require cross-disciplinary experts. Every new entrepreneur in these fields experiences challenges in finding adequate support. These challenges exist at a time in the 21st century when U.S. innovation is facing unprecedented pressures in competition for primacy. In 1960, the U.S. research and development (R&D) expenditure for defense and private industries was approximately 69 percent of global spending on R&D. By 2016, however, the U.S. share of global R&D expenditure had decreased to just 28% percent due to China’s technological advances. If this trend continues, China’s R&D expenditure measured by gross domestic product (GDP) will outperform that of the U.S. by 2030.

To ensure that the U.S. remains a world leader in R&D, the National Science Foundation (NSF) launched the Small Business Postdoctoral Research Diversity Fellowship (SBPRDF) followed by the Innovative Postdoctoral Entrepreneurial Research Fellowship (IPERF). Both facilitate the professional development of underrepresented postdoctoral research fellows by offering them invaluable experience within research and technology companies. This paper provides a pathway for enhancing diversity in the startup and entrepreneurial landscapes, improving opportunities for researchers from underserved groups, and increasing the number of highly competent entrepreneurs within the U.S. STEM community. The startup companies involved in the fellowship program, which are also supported by NSF, comprise a variety of new, multidisciplinary, and rapidly evolving STEM fields that were unknown just a few decades ago.

# Introduction

In 1960, the U.S. research and development (R&D) expenditure for private and defense industries comprised 69 percent of worldwide spending on R&D (CRS, 2018). By 2016, however, the U.S. share of global R&D expenditure decreased to only 28 percent (CRS, 2018) mostly due to China’s substantial growth and advances. Should this trend continue, China’s R&D expenditure measured by gross domestic product (GDP) will eclipse that of the U.S. by 2030 (CRS, 2018). In order to remain competitive and uphold its leadership in innovation, the U.S. needs to use all the country’s available talent. In the past, only privileged entrepreneurs were able to participate in high-tech startups. As a result, the National Science Foundation (NSF) started programs with the aim of engaging underrepresented groups in a variety of entrepreneurial startups.

In FY 2013, the last year data was available, the Small Business Administration (SBA) awarded 5,159 Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Phase I and Phase II grants totaling more than $2.5 billion, as per the SBA Annual Report (2013). On average, the SBA awards more than 5,000 grants to entrepreneurs every year, totaling $3.5 billion (SBA, 2020). The same 2013 SBA Annual Report disclosed that only about 15 percent of this funding was awarded to women and underserved minority groups, even though those groups represent approximately 50 percent of the U.S. population. For comparison, this is a significantly lower percent than science and engineering (S&E) doctorates awarded to women and underrepresented groups in 2013 (NCSES/NSF, 2020). Such funding at a level of 15 percent does not reflect the capacity or talent of those more than 90,000 underrepresented scholars who earned S&E doctoral degrees between 2005 and 2015 in the U.S. (SED/NSF, 2016). This underfunding trend led Congress to allow eligible agencies to use 3 percent of their small business grant budget, set aside for administrative purposes, to support underserved groups under the SBIR/STTR Reauthorization Act of 2011. As a result, many agencies use this funding for outreach to underserved groups.

The private sector tells a similar story. Diversity VC, a nonprofit partnership promoting diversity in venture capital, reported in 2019 that, according to a comprehensive survey by Azevodo (2019) of around 10,000 business founders receiving venture capital backing, only 9 percent were women and a mere 1 percent were Black. According to former SBA Administrator Maria Contreras-Sweet, “Only 1 percent of VC capital flows to Hispanic or Black entrepreneurs. Does anyone honestly believe these communities are the source of just 1 percent of our best business ideas?” Researchers who study this issue assert that women and minorities are not receiving investments because these underrepresented groups are not connected to venture capital networks, and do not know where to look for new opportunities.

# Solving the Problem on the Horizon

In order to accelerate innovation, increase participation of underrepresented minorities in new startups, and ensure U.S. competitiveness in the global economy, NSF introduced the Small Business Postdoctoral Research Diversity Fellowship (SBPRDF) program in 2011 (Tull, 2018). NSF selected the American Society for Engineering Education (ASEE) to manage the fellowship. The SBPRDF provided an opportunity to measurably increase the participation of underrepresented minorities in small business research and high-tech entrepreneurship, thereby accelerating U.S. innovation. Throughout the grant cycle for the SBPRDF, the program administrators and ASEE conducted surveys regarding program effectiveness so that the next iteration, NSF's Innovative Postdoctoral Entrepreneurial Research Fellowship (IPERF) program, could expand what worked and correct what didn't.

In the first iteration of the program, the SBPRDF invested in a total of 79 S&E Ph.D. recipients, placing them in research positions at eligible NSF Phase II SBIR companies. ASEE facilitated these placements. These individuals acquired real-life entrepreneurial research experience, bringing the latest innovative theories and techniques from the academic community to the country’s entrepreneurial technology sector. By working with cutting-edge startup companies, where research and development are accomplished within a framework of expected business outcomes and constraints, research fellows learned to work in multidisciplinary teams and apply their academic expertise to realize products in a globally competitive environment. The program aimed to establish mutually beneficial relationships between the companies and the fellows.

The Phase II SBIR program companies received help from these highly talented postdoctoral research fellows to accelerate their business enterprise; at the same time, underrepresented groups such as women, African Americans, Hispanic Americans, American Indians, and Hawaiian/Pacific Islanders received valuable experience in small business innovative research. Since the SBPRDF program’s inception in 2011, ASEE’s involvement has brought much success. However, ASEE realizes that opportunities exist for the program not only to better serve its fellows’ professional development, but also to address minority-owned firms’ lack of participation in research supporting high-tech entrepreneurship and the federal government’s needs. Historically, there have been almost no high-tech entrepreneurial startups owned by underrepresented minorities due to lack of minority access to higher education, nonexistent financial support by conservative venture capital firms, and basically no additional support by previous governmental agencies or programs.

The SBPRDF program placed 79 fellows in 77 different Phase II Active SBIR companies from 2011 to 2018. Program participant surveys conducted in 2014 and 2019 (Tull, 2019) found many positive outcomes. One of these was that the proportion of underrepresented groups in the fellowship applicant pool and the proportion of those selected exceeded those among newly graduated engineering doctoral students.

Based on the final SBPRDF report (Tull, 2019), among 79 fellows, women and underrepresented minorities represented more than 40 percent of program participants. Additionally, 40 percent of the SBIR host companies ultimately hired their fellows as full-time employees for performance testing and prototype commercialization. Seventy-two percent of the postdocs noted that the SBPRDF fellowship gave them a competitive edge in the job market, with some further reporting that they gained valuable grant writing and business experience. Of all the fellows in the SBPRDF program, 43 percent of the participants were offered employment by their host companies, and 84 percent believed that the fellowship experience enhanced their professional qualifications.

A longitudinal survey conducted in December 2021 (Figure 1), of 50 SBPRDF fellows who left the program more than three years prior, showed that even though 40 percent were hired by the host companies, only a tiny fraction of 5 percent were still working at those startups. Many others found jobs either within the larger industry (30 percent) or other startup companies (30 percent). The remaining fellows went into various governmental labs or administration positions.

There were three primary reasons cited by the fellows for not being offered employment by their host companies:

1. The company did not have enough funding resources to extend an offer of permanent employment to the fellow. Interviews with departing fellows described a correlation between the size of the company and funding available to the fellow. In small businesses that employed less than five persons, the funding was relatively short, especially for employees commanding salaries in excess of $80,000 per year; however, in enterprises with more than 10 employees, funding was more readily available.
2. The fellow was not interested in pursuing a career with the host company.
3. It was too early for either the fellow or the host company to make an employment decision.

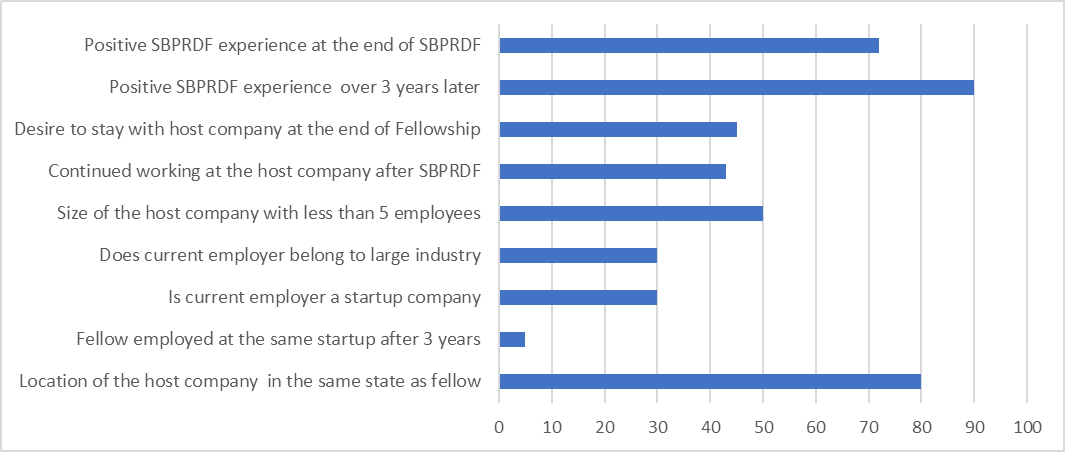


Fig. 1: SBPRDF survey immediately after the fellowship and three years later

An especially notable survey finding was the increase among participants who reported, three years after the program ended, that their participation in the program was a positive experience. While most of the fellows—72 percent—reported a positive experience immediately following the program, even more came to see the value in it as time went on. Three years later, 90 percent of the participants described their experience as either “extremely valuable” or “valuable.”

In 2019, the program hired an independent evaluator to conduct a survey to understand the financial impacts of fellowships on the participants. About half of the fellowship host-company mentors reported that they offered stock options to their fellows. More than 70 percent of those mentors who did not give fellows stock options reported being willing to do so in the future in hopes of attracting a postdoctoral fellow to their company. One third of the fellows said they accepted stock options and/or other deferred compensation when hired by their company. Fifty percent of the fellows who received stock options reported that they were able to exercise their options and participate in a liquidity event.

The evaluator also noted that, while the SBPRDF program has been quite successful, there was still room for improvement. The evaluator recommended that the SBPRDF be more engaged with the fellows both during and after the fellowship. The program should also facilitate the formation of a community engaging current fellows and program alumni. Additionally, fellows reported that expectations for the fellowship could and should be better laid out, and that fellows wanted opportunities to meet and learn from the experiences of other fellows. Those issues were explicitly addressed in the recently awarded grant proposal entitled “NSF Innovative Postdoctoral Entrepreneurial Research Fellowship (IPERF), NSF #1853888” in 2019. Based on additional programs developed specifically for IPERF, the ASEE team was able to improve both the program quality and fellows’ satisfaction levels. Details will be published at the end of IPERF in 2023.

The project team focused on developing intensive, low-cost online communications rather than person-to-person engagement. The team and the fellows also discussed and agreed on the most important training topics to be offered to fellows. These topics included: i) how to start a business, startup prerequisites, and how to influence others with their own ideas; ii) the ABC’s of seeking SBIR/STTR research funding and how to find the most important funding websites; iii) an Introduction to Intellectual Property (IP) for High-Tech Entrepreneurially Minded Postdocs; iv) management, mentors, and money: decoding the chasm between invention/research and product commercialization; and v) managing the pressure and stress of a startup environment during a pandemic.

ASEE did offer one-on-one, face-to-face consultations via computer to fellows looking for guidance on their next career steps, especially pertaining to entrepreneurship; approximately 15 hours of counseling were delivered. The consultants came from the venture capital field, and a large portion were from underrepresented groups. Topics of these consultations included: mentoring and commercialization aspects, transitioning from academia to startup, time management/prioritization, and how to manage work-life balance, especially during a pandemic.

The IPERF host companies have signed up and committed to offering a mentor from each of their companies, to collaborate closely with their accepted fellow during the fellow’s postdoctoral appointment, as a condition of participating in this program. Additionally, every six months, each mentor company delivers a report summarizing the fellow’s progress. The progress report includes assessments of the fellow’s research project, a list of joint publications by the fellow and mentor company researchers, and areas of possible future collaboration with the fellow. ASEE has been evaluating these reports and giving informal feedback to the fellows for improvement, especially if fellows were seeking a second-year award extension.

# Details of Ethnic and Racial Distribution in SBPRDF versus IPERF

Both cohorts surveyed, the SBPRDF vs. IPERF, were composed of underrepresented minority (URM) groups including African Americans, Hispanic Americans, American Indians, Alaska Natives, and Pacific Islanders. In the following Table 1, “URM/W” is the sum of all URM men and women plus non-URM women in the program, and represents the level of underserved populations?. “URM+W” represents the number of URM women in the program, and “URM+M” denotes the number of URM men in the program. Finally, “W” represents the sum of all women in the program as of September 2021. The above definitions are following the National Center for Science and Engineering Statistics (NCSES) report, (NCSES/NSF 2019) as indicator for underserved populations? in the U.S.

ASEE’s overarching goal of increasing the participation of women/underrepresented groups in the IPERF program has so far achieved great success. In two years of outreach activities, 48 fellows joined the IPERF program. More than 70 percent were women or held URM status. The remaining 20 percent were of Middle Eastern or Asian descent (not defined as underrepresented minorities). This is a significant increase over the previous SBPRDF grant project, which was composed of 56 percent URM/W. We attribute our success in IPERF vs. SBPRDF in reaching more diverse candidates to an increase in our advertising in dedicated markets, such as Historically Black Colleges and Universities (HBCUs), the Society for Advancement of Chicanos and Native Americans in Science (SACNAS), and the National Postdoctoral Association (NPA). We also required a diversity statement with the fellowship application, which was meant to illustrate the candidates’ involvement in supporting underrepresented groups. We evaluated each candidate’s application based on their commitment to serving underrepresented populations in STEM. Both factors—dedicated advertisements and diversity statements—contributed significantly to our increased success at engaging URM/W groups in IPERF vs. SBPRDF. The team’s explorative research of multiple STEM fellowships in the U.S. reveals significantly lower URM participation in other programs, with the exception of some medical fields, where only women were adequately represented.

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|  | **URM/W** | **W** | **URM** | **URM+W** | **URM+M** |
| **IPERF FY 2021** | **72%** | **49%** | **32%** | **9%** | **23%** |
| **IPERF FY 2020** | **65%** | **43%** | **39%** | **8%** | **22%** |
| **SBPRDF Final** | **56%** | **37%** | **27%** | **5%** | **21%** |
| **U.S. population average** | **67%** | **52%** | **33%** | **17%** | **16%** |

Table 1: Racial distribution in the grants vs. average population in the U.S. (NCSES/NSF, 2019)

# Conclusion

The IPERF project has so far resulted in increasing the participation of women/underrepresented groups in high-tech entrepreneurship, as one of the first of such successful and supportive activities in the U.S. No other or similar programs/grants in STEM represent a high participation of underrepresented groups among their cohorts. So far only the IPERF program has shown such success, to the authors’ knowledge. Both factors of frequent, dedicated advertisements and diversity statements by applicants contributed significantly to our increased success of engaging URM/W groups in IPERF. The fellows’ engagement in entrepreneurial activities should help increase the socioeconomic status of those individuals, and of groups who are often left on the lower rungs of the economic ladder. Through IPERF, these highly educated, theoretically oriented fellows will learn on-the-job, practical skills of modern entrepreneurship. They will have the choice of either staying and joining the high-tech startup, launching their own business after their fellowship, or even joining any industry labs as experienced entrepreneurs. The professional development and education they receive will be invaluable both to them and to the overall goal of closing the diversity gap in high-tech entrepreneurship and leadership in the United States. Every fellow leaving the program is equipped with needed skills and insights to follow the path of entrepreneurship, contributing to a healthy and diverse balance of successful entrepreneurs in the U.S. The IPERF program initiated by NSF is worthy of duplicating within every governmental agency and of publicizing across the U.S., especially within the venture capital community—which will profit tremendously from the breadth of innovative and highly trained young entrepreneurs, ready to develop and deliver highly competitive and world-changing products to the global economy.

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