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# Unlocking Innovation: Empowering Underrepresented Entrepreneurs in Interdisciplinar Engineering Technology

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Dr. Teddy Ivanitzki is part of Fellowships and Research Opportunities (FRO) by ASEE. FRO is managing a large fellowship/ research and scholarship grants, contracts, and cooperative agreements under STEM umbrella with total of $15M/year.

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**Abstract:**
In the realm of unaddressed ethnic disparities in the United States, the issue of venture capital funding is often overlooked. Despite their significant presence in the population, Hispanic and Black entrepreneurs receive only a fraction of venture capital investment, which is a stark contrast to their demographic representation. A staggering 77% of venture capital recipients are White, 9% women, and nearly 2% Latino, leaving just a minuscule 1% for African American entrepreneurs (remaining were Asians and Middle Easterners), regardless of their gender or educational qualifications [1]. Multiple sources claim an even higher population than 80% of White and approx. 1% Black [9, 10, 11, 12, 13]. This discrepancy is particularly evident in STEM and the burgeoning field of transdisciplinary startups like biotechnology, where interdisciplinary knowledge is increasingly crucial. Consequently, emerging entrepreneurs in these sectors frequently face obstacles in accessing adequate support, a challenge that persists into the 21st century amid fierce global competition for innovation leadership.

Recognizing this trend, Congress authorized eligible agencies under the SBIR/STTR Reauthorization Act of 2011 to allocate 3% of their small business grant budget to support underserved groups [2]. Consequently, several other agencies began utilizing this fund to reach out to those communities.

To maintain its position as a global leader in Research and Development (R&D), alongside the SBA the National Science Foundation (NSF) initiated the Innovative Postdoctoral Entrepreneurial Research Fellowship (IPERF) program. Designed to address the underrepresented researchers in STEM fields, IPERF offers these fellows invaluable experience within technology startups to bolster their professional development and give them valuable tools in the entrepreneurship area, as well as for the authors to create new knowledge about postdoctoral STEM entrepreneurship which might be reused at university levels in the future. The program aims to enrich diversity within the STEM high-tech startups and entrepreneurial spheres, thereby enhancing opportunities for marginalized groups. As interdisciplinary high-tech startups (nearly 70% of them) experience exponential growth, biotechnology companies within IPERF constitute nearly 40% of its participant companies. This paper presents part of the results, focusing on fellows post-IPERF time, i.e., longevity findings, and rapidly growing interdisciplinarity of the high-tech startups. A longitudinal study involving 60 fellows who completed the program over one to four years ago revealed that while the host companies hired 35% at the beginning, 25% still remained at various startup businesses after three years, and the majority (50%) transitioned into roles within industry labs. Through IPERF, highly educated yet primarily theoretical fellows gain hands-on experience in the intricacies of entrepreneurship, with the option to either continue with the current company or embark on their entrepreneurial ventures following the high-tech internship. This practical education not only benefits the fellows themselves but also contributes to the broader objective of diversifying startup leadership in the United States.

## Introduction

The United States accounted for 69% of global Research and Development (R&D) expenditure in private and defense industries in 1960 [3]. By 2016, this share had dropped to just 28% [4], largely due to significant growth and advances in China. If this trend continues, China's R&D expenditure as a percentage of GDP will surpass that of the U.S. by 2030 [5]. To maintain its competitive edge and leadership in innovation, the U.S. must leverage the talents of all its citizens. Historically, only privileged individuals have been able to participate in high-tech startups. Especially as overwhelming disparities are evident in the private sector, as noted already by Diversity VC, a nonprofit focused on enhancing diversity in Venture Capital, their 2019 survey of around 10,000 venture capital-backed founders found that only 9% were women and just 1% were Black [1]. “While many VCs have publicly declared they are working on diversity initiatives, that dialog is just lip service”, stated Anthony Zhang, RateMyInvestor’s chief growth officer [1]. In its article from 2019 analyzing 200 venture capital-backed startups, Harvard Business Review stated “Our findings show that the boards of elite private firms are incredibly homogenous. Women held just over 7% of board seats in our study. But most strikingly, roughly 60% of the businesses in our sample did not have a single female board member” [10]. A similar 2019 study revealed that women represented only 7% of the board seats in venture capital-backed companies [11]. The HuffPost in 2017 stated that “Just 6% of partners at venture capital firms are women, down from 10 percent in 1999” [12]. Lastly, Axios (2019) described that only 10% of decision-makers at U.S. venture capital firms were women, which represented a 9% growth from the previous year [13].

## Addressing the Impending Issue

To address the disparities, the National Science Foundation (NSF) has launched programs to involve underrepresented citizens in various entrepreneurial startups based on the SBIR/STTR Reauthorization Act of 2011 to allocate 3% of the budget to small businesses [2]. One of the NSF's first tasks was introducing the Small Business Postdoctoral Research Diversity Fellowship (SBPRDF) program [6] which took six years starting in 2012. The American Society for Engineering Education (ASEE) was appointed to manage it. The SBPRDF aimed to significantly boost the participation of underrepresented minorities in small business research and high-tech entrepreneurship, thereby accelerating U.S. innovation. Throughout the grant cycle, program administrators and ASEE conducted surveys to assess the program's effectiveness. The feedback helped refine the next iteration, NSF's Innovative Postdoctoral Entrepreneurial Research Fellowship (IPERF) program, which started at the end of 2018 to enhance successful aspects and address shortcomings.

The independent evaluator of SBPRDF recommended more inclusive training, such as adding more diverse experienced trainers, VCs, and even more personal advisory in future IPERF programs. As a result, the team and NSF defined the following strategic goals in IPERF:

- Facilitating placement of postdoctoral STEM fellows through the IPERF, which places recent Ph.D. degree recipients into active Phase II SBIR/STTR companies, as identified and updated every quarter by the NSF.
- To attract and fund mainly postdoctoral candidates from underserved groups defined herein as women, people with disabilities, African Americans, Hispanics, American Indians, Alaska Natives and Pacific Islanders, first-generation college students, and veterans to

participate in research and entrepreneurial activities at NSF SBIR/STTR Phase II companies.
- To select and support entrepreneurially minded, early career STEM doctorates, across the range of NSF-defined disciplines, with additional, educational & research opportunities outside of the traditional academic setting, to further their careers, enhance diversity in SMB, and accelerate the U.S. national economy.
- To catalyze the collaboration between early career, STEM doctoral degree holders from underserved backgrounds, and in high-tech, small business enterprises, through training and mentoring of the fellows.
- To expose NSF-selected and supported SBIR/STTR Phase II companies and our nation's entrepreneurship ecosystem to the untapped pool of high-level talent from underrepresented and historically underserved groups.
- To provide SBIR/STTR Phase II companies with talented STEM doctoral-level engineers who ~~can~~ bring the most current technological skills and training from the academic sector to apply within their companies.
- Increase the visibility of the IPERF program among U.S. small business stakeholders in the public and private sectors.

Based on the COVID-19 pandemic experience, especially in remote/online participation, the IPERF team effectively implemented innovative communication methods to engage with applicants and scholars despite the remote setting. This included hosting monthly webinars as a cost-efficient way to connect with a diverse audience. Webinars served as the primary platform for conducting professional development activities sponsored by IPERF for fellows. Leveraging our networks, ASEE utilized a variety of Subject Matter Experts (SMEs), entrepreneurs, consultants, and NSF program officers to deliver insightful presentations on entrepreneurship and grant funding initiatives, which have proved highly beneficial to the fellows. Based on multiple post-webinar surveys conducted to evaluate the impact of each topic and presenter, these webinars sparked increased interest among fellows and applicants in exploring entrepreneurship opportunities more deeply. The participants also proposed a diverse array of training topics. These encompassed instructions on navigating STEM grant and contract applications, identifying pertinent websites, launching a business, grasping startup essentials, influencing others with innovative ideas, introducing concepts of intellectual property, and effectively collaborating within varied high-tech environments which were all fulfilled by the IPERF team.

The following detailed activities were implemented in IPERF:
**Quarterly eCoffee Sessions**: These are informal, Zoom-based discussions led by the IPERF team as moderators. The sessions provide a platform for postdocs to discuss current trends, opportunities, and challenges in an informal setting.
**Webinars:** The program organizes interactive webinars focusing on entrepreneurship-related topics, including IPERF and the fellowship application process. These webinars occur every 6-8 weeks and aim to deliver valuable information and insights to prospective candidates.
**One-on-One Consultations**: Fellows can access personalized consultations lasting approximately eight hours during their assignment to discuss their career paths, with a particular emphasis on entrepreneurship and their future after IPERF. These consultations are led by experienced professionals from the venture capital sector and former fellowship recipients, often

from underrepresented backgrounds. Topics covered during these sessions include mentoring, commercialization, transitioning into startups, time management, and achieving work-life balance.

**Professional Development**: Participants are encouraged to dedicate up to 20% of their time to personal professional development, supported by a budget of up to $3,000 each. The specific topics for these activities are collaboratively chosen between the host company, fellow, and the ASEE team.

**Host Company Mentorship**: Each IPERF host company pledges to assign a mentor to every accepted fellow. These mentors work closely with the fellows throughout their postdoctoral tenure. Every six months, mentors submit progress reports evaluating the fellow's research project, documenting joint publications, and proposing potential areas for future collaboration.

**Program Evaluation & Feedback**: The ASEE team evaluates all the progress reports submitted by mentors/fellows and provides informal Zoom feedback to the Fellows based on those assessments.

In sum, the IPERF program offers a thorough and systematic method to prepare postdoctoral scholars for careers in entrepreneurship and high-tech sectors. The program's blend of training, mentorship, personalized consultations, and professional development opportunities is meticulously crafted to equip participants with the essential skills and knowledge needed for success in these industries.

**Summary of First Results**

**Fellow Acceptance Rates:** The IPERF team delivered nearly 100 Fellowship awards for four years, with 17 remaining fellows in the last phase-out stage until May 2025. All awards were counted as a one-year assignment plus a few cases of extension, based on financial savings. Out of 126 applications received during FY2024, the ASEE team pre-approved 27 fellows for hiring by the startup companies, i.e., the fellows passed all the required prerequisites successfully, such as citizenship, a PhD in STEM completed within 7 years, a PhD recognized in the U.S., three or more supporting references, a high GPA, an acceptable research statement and outstanding publications, etc. Out of those 27 pre-approved fellows, 10 fellows were awarded during the FY24 based on final selection and approval by the host company with ASEE support. The final awards are mainly determined by startup companies, which focus on the expertise-deepness of the candidates, who frequently fail to fulfill such required unique expertise by those startups. The interdisciplinarity requirement exacerbates the situation.

Status of IPERF Awards as of April 2024:

- 2020 440 Applications -> 90 Approved Matches -> 23 Awards.
- 2021 330 Applications -> 61 Approved Matches -> 25 Awards.
- 2022 210 Applications -> 37 Approved Matches -> 21 Awards.
- 2023 184 Applications -> 38 Approved Matches -> 17 Awards.
- 2024 126 Applications -> 27 Approved Matches -> 10 Awards.

**Longitudinal Results:** To better understand the experiences and asses the post-fellowship entrepreneurial journey of both fellows and host companies, ASEE has initiated a series of short and long-term surveys. These surveys were distributed to postdoctoral participants from the previous SBPRDF program and departed IPERF Fellows. Concurrently, the IPERF team is evaluating the survey responses to identify potential immediate enhancements to the program.

The first findings from the surveys are also being compared with exit interviews conducted with each Postdoc fellow upon their departure from the program, as well as with the host company exit surveys.
The latest longitudinal survey of 60 IPERF fellows who left the program between one and four years ago revealed that although 35% were hired by their host companies in the first year after IPERF, 25% were still working at various startups three years later. Others found jobs either within the industry or governmental labs (approx. 64%) or back in academia (approx. 11%) three years after their fellowship. A more detailed distribution is provided in Table 1.

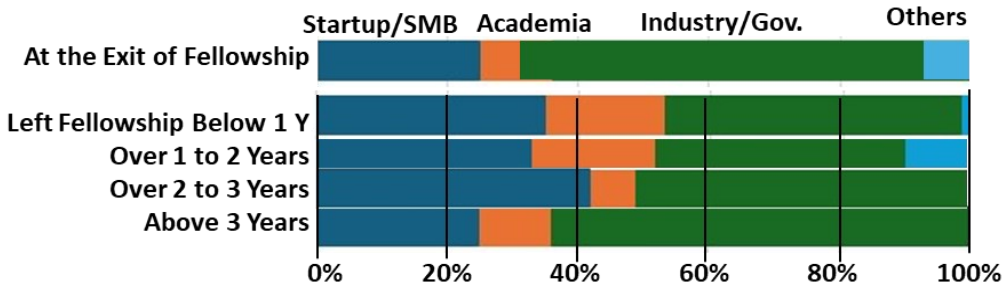


Table 1: IPERF Fellowship distribution in Longevity Survey

The fellows and host companies cited three primary reasons for not securing permanent employment with their host companies:

1. Lack of funding or resources: companies did not have sufficient financial resources to extend permanent job offers. Interviews with departing fellows revealed a correlation between the companies' size and funding available to the fellow — the smaller the startup the fewer employment opportunities. While 74% of startup companies indicated they would consider hiring the fellow if their financial situation allowed, only 10% said they would not. Since most of these startups had fewer than seven employees, financial constraints made employment offers challenging (see Chart 1).
2. Fellows disinterest: 27% of Fellows were not interested in pursuing a career with their host company. However, 48% expressed a desire to remain with their startup, while 19% were indifferent to staying. Six percent did not respond to this question.
3. Timing of employment decision: for some Fellows and host companies, it was too early to make a decision about permanent employment.

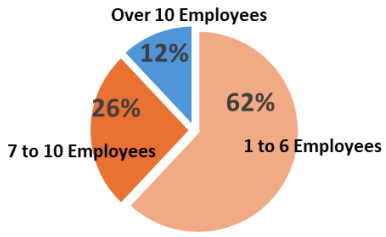


Chart 1: Size of the IPERF Startup Company

Compared to the previous SBPRDF program, where 33% of participants were offered employment by their host companies [8], the current IPERF program shows a slight increase, with 35% of fellows receiving job offers. Interdisciplinary expertise is increasingly recognized as a critical factor in identifying suitable candidates for high-tech startup companies. As a result, some startups struggled to find the right candidates. Considerable time and effort were invested in searching and selecting candidates with exceptional qualifications, aligned with the project's goal of enhancing the participation of underserved populations. The

influence of interdisciplinarity on the program is currently being analyzed by the IPERF team. The fellow survey also confirmed that 68% of their host companies were interdisciplinary. The authors of this publication confirmed the multidisciplinary character of their startups, of which nearly 40% were in the biotechnology sector [7]. Lastly, fellows evaluated their entrepreneurial experiences highly, with 61% rating their experience as extremely valuable, 34% as valuable, and 5% as not very valuable. Nearly 90% of postdocs noted that the fellowship gave them a competitive edge in the job market, with many reporting valuable experience in grant writing and business experience. In contrast, 84% of SBPRDF fellows [8] believed their fellowship experience enhanced their professional qualifications.

**Case Studies:** Ross Stein, CEO of Temblor Inc., a startup providing information about seismic risks to building construction companies, spoke highly of his fellow, Jennifer Schmidt:
"She has been proactive in creating an app to track stories related to our earthquake studies and has quickly become a thoughtful and reliable member of the Temblor team," Stein said. "Her research skills are phenomenal. We are very grateful to IPERF for helping us find such a wonderful match." [14]
Lindsey Tropf, CEO of Immersed Games, Inc., a developer of augmented reality video games, mentored fellow Holly Pope: "Holly easily strengthened connections with schools and teachers by interviewing them about potential tools to assist with their teaching plans. While at Immersed, she also acquired skills useful for developing her startup, such as understanding launch requirements and how to apply for next-level funding. She also learned about resources available to women and underrepresented groups." [14]

**Details of Ethnic and Racial Distribution:** According to the National Center for Science and Engineering Statistics (NCSES)/NSF19-304, underrepresentation and overrepresentation of women and racial or ethnic groups vary by field of study and occupation. Women and underrepresented minorities constitute a significant portion of the U.S. population ages 18–64 years. In 2017, women made up 51.5% of the population; Hispanics or Latinos, 14%; African Americans, 12%; Asians, 5%; and other racial and ethnic groups combined, 2%.

IPERF has reached a record high number of Underrepresented Minorities (URM) representation compared to the U.S. average and the STEM field, as well as the former SBPRDF grant. URMs are identified as African Americans, Hispanics, American Indians, Alaska Natives, and Pacific Islanders. As per Table 2 below, the URM/W is the sum of non-URM women and URM men and women in the program. URM+W represents the number of URM women in the program, and URM+M denotes the number of URM males in the program. W represents a total of all female participants in the program as of July 2024.

Table 2 outlines an overall percentage of URM and women participants in the IPERF/SBPRDF programs across all major groups compared to STEM and the U.S. average population. These results are unique, especially as the IPERF market represents only a high-end STEM environment. Approximately 70% of postdoctoral scholars in IPERF come from underserved groups in STEM fields, exceeding national demographic norms across all categories.

A key factor in maintaining high participation of URM groups in IPERF was targeted advertising aimed at attracting highly qualified applicants. All applicants, irrespective of their

background, were required to submit a compelling statement outlining how their participation in the program would benefit underserved communities. This approach ensured equal consideration of credentials and commitment to serving underrepresented groups in STEM. As a result, these applicants were chosen for the fellowship.

| | URM/W | W | URM | URM+W | URM+M |
|---|---|---|---|---|---|
| **US population average** | 67.4% | 51.5% | 32.9% | 17.0% | 15.9% |
| **STEM area** | 59% | 35% | 24% | 3% | 6% |
| **SBPRDF** | 55.8% | 37.2% | 26.6% | 4.7% | 20.9% |
| **IPERF** | **70%** | **52 %** | **27%** | **9%** | **15%** |

Table 2: Demographic comparison of various populations in the U.S.

**Conclusion**

The program has achieved multiple successes:

1. IPERF has significantly increased the participation of women and underrepresented groups in entrepreneurship, exceeding national averages and even STEM field representation. See Table 2.
2. High-tech startups received substantial support in daily research activities without spending significant time on hiring, as the IPERF team served as their Human Resources (HR) department, providing experts tailored to their requirements.
3. Over 35% of IPERF fellows were hired by their startup companies.
4. Approximately 90% of fellows valued their entrepreneurial experience and training, even years after completing the fellowship.
5. Approximately 30% of fellows continued to be involved in small business ventures after the fellowship.
6. Over 90% of fellows reported gaining a competitive edge in the job market, which is especially important to underserved IPERF fellows when searching for new opportunities after the program.

The involvement of fellows in entrepreneurial activities is expected to enhance the economic status of these individuals and their communities, many of which are economically disadvantaged. Through IPERF, these highly educated but theoretically inclined fellows gain practical skills in modern entrepreneurship through on-the-job training. Upon completion of the fellowship, they have the option to join a high-tech startup or launch their own business. The professional development and education they receive are invaluable, fostering both personal growth and helping to bridge the diversity gap in high-tech entrepreneurship and leadership in the United States.

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