

## Expand Underrepresented Participation in High-Tech Startups with Entrepreneurial-Minded Postdocs

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### Abstract

In the United States, women, African American, and Hispanic American entrepreneurs receive a significantly smaller share of venture capital funding, especially compared to their proportional representation in the population. This funding disparity also raises social equity concerns and hampers the nation's ability to harness the benefits of increased participation by these groups in cutting-edge industries. This is particularly notable in transdisciplinary startups such as smart energy and nanomedical technologies, where cross-disciplinary expertise is increasingly vital. As a result, emerging entrepreneurs in these sectors often encounter challenges in accessing adequate support. These challenges persist in the 21st century, when U.S. innovation faces unprecedented competition for leadership. In 1960, U.S. research and development (R&D) spending for defense and private industries constituted approximately 69% of the global total (CRS, 2018). However, by 2016, the U.S. share of global R&D spending had dwindled to just 28%, largely due to China's remarkable technological advancements. If this trajectory continues, China's R&D spending as a percentage of gross domestic product (GDP) is poised to surpass that of the U.S. by 2030 (CRS, 2018). To secure the United States' position as a global leader in research and development, the National Science Foundation (NSF) initiated the Small Business Postdoctoral Research Diversity Fellowship (SBPRDF) program. Subsequently, it introduced the Innovative Postdoctoral Entrepreneurial Research Fellowship (IPERF) program.

With the establishment of the IPERF program in 2018, the American Society for Engineering Education (ASEE) was able to attract 90 high-quality postdocs into the IPERF program during the 2019-2023 program years. Of these 90 postdocs, over 70% were from groups historically underrepresented in STEM. The ASEE's IPERF project has so far resulted in increasing the participation of women/underrepresented groups in high-tech entrepreneurship as one of the first of many successful and supportive activities in the U.S. No other or similar programs/grants in STEM represent such high participation of underrepresented groups among their cohorts.

Interdisciplinary expertise was one of the significant factors in finding appropriate candidates for high-tech startup companies. An extensive amount of time was spent finding candidates with appropriate credentials who could advance the program's goal of increasing the participation of underserved populations. Some of the startups could not find a suitable candidate and were lowering their expectations in lieu of the required expertise. Biotechnology companies make up nearly 40% of the IPERF companies. These startups are also interested in employing postdocs and other individuals at the post-graduate level.

The IPERF program continues to contribute to the increase of postdoctoral and post-graduate entrepreneurs and graduate Fellows. The program is positioning and inspiring diverse Fellows to start their own firms or join the modern industry, create jobs, win innovative research grants, and attract investment during their careers.

### **Introduction and First Results**

The IPERF program recruits, trains, places, mentors, and funds early-career STEM doctoral degree recipients to participate in innovative research and hands-on entrepreneurship training at some of the nation's most promising early-stage companies. These companies, identified by the NSF, are active NSF Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) Phase II grantees. IPERF program continues to build upon the success of its predecessor program, the ASEE/NSF Small Business Postdoctoral Research Diversity Fellowship (SBPRDF) program, with new policies and objectives. The central aim of the IPERF program is to accelerate small business innovation by increasing the number of Science & Engineering (S&E) doctorates from underserved groups and opening the doors for creating new start-ups by participating Fellows.

Since 2019, ASEE has attracted 90 high-quality postdocs into the IPERF program. Of these 90 postdocs, over 70% were from groups historically underrepresented in STEM (Table 1 below). The SBIR/STTR program companies received help from these highly talented postdoctoral research Fellows to accelerate their business enterprise; at the same time, historically underrepresented groups such as women, African Americans, Hispanic Americans, Native Americans, and Hawaiian/Pacific Islanders received valuable experience in small business innovative research.

ASEE has experienced tremendous success in broadening its reach to attract candidates from underserved communities. Since the SBPRDF program's inception, ASEE's involvement has significantly strengthened the program. However, ASEE realized that opportunities exist for the program to serve its Fellows better and address minority-owned firms' lack of participation in research supporting high-tech entrepreneurship and the federal government's needs. Historically, there has been an underrepresentation of entrepreneurial startups owned by minorities due to a lack of access to higher education, minimal financial support from risk-averse venture capital firms, and limited support from previous governmental agencies or programs.

Based on the final SBPRDF report (Tull, 2019), among 79 Fellows, women and underrepresented minorities represented nearly 56% of program participants. Additionally, nearly 40% of the SBIR host companies ultimately hired their Fellows full-time 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 Fellows surveyed, 84% believed the fellowship experience enhanced their professional qualifications. While the longitudinal survey of the SBPRDF program participants taken in 2020/2021 (Ivanitzki, 2022) by the IPERF team reported many positive outcomes attributable

to the program, the program showed limited success in participation from underrepresented groups stated above.

While the SBPRDF program had been quite successful, the project team recognized that there was still room for improvement. The project evaluators recommended that the future Fellows be more engaged in their professional development during the fellowship. The program should also facilitate forming a community to engage the current Fellows and program alumni. Additionally, Fellows desired more opportunities to meet and learn from the experiences of other Fellows. Those issues were explicitly addressed in the 2018 grant award “NSF Innovative Postdoctoral Entrepreneurial Research Fellowship (IPERF),” NSF #1853888. Based on additional programs explicitly developed for the IPERF project, the ASEE project team improved the program quality and the Fellows’ satisfaction levels.

### **IPERF Program Achievements and Challenges**

In addition to the project’s success in increasing the participation of underrepresented minorities and improvements in the website, the project team tracked the professional life of the IPERF postdocs during and after the completion of the fellowship (Ivanitzki, 2023). Experiences gained during the Ppostdoc assignment significantly influenced a Postdoc’s decision to either seek an industry/entrepreneurship path or return to the academic environment. Rather than seek a job or other academic-oriented fellowship, entrepreneurial interest (50%) and research topics (30%) were two major factors driving the postdocs’ decision to join the IPERF program. Financial conditions (9%) and curiosity (5%) were of minor interest. Eighty-five percent of Fellows reported having received enough training by the host company to perform their jobs, and 94% reported that the webinars and professional training delivered by ASEE were of value to them. Eighty-eight percent stated that their work environment was adequate to complete their research or developmental work.

The post-fellowship life of the Fellows is of great interest to the IPERF project team. Fifty-five percent of the Fellows responded that the primary reason to leave the program was “other”; the project team intends to dig deeper into understanding this. As to the future of the Fellows, 41% stated that they intend to stay at the company, which is like the former SBPRDF grant, 37% will stay within the same industry, and 5% will go back to university or create their own startup. Also, 77% stated that they would return to the host company in the future if positions or funding were available. Ninety-one percent stated that the opportunity to receive great experience is a prerequisite to joining a startup business, and 9% disagreed with that statement; the IPERF program provides a 72% more expansive opportunity for industry experience than the previous SBPRDF program. The surveys obtained from the startup companies confirm the tendency of answers from their Fellows; however, they differ in the adaptation to their startup culture and environment; nearly 30% of startups claimed the slow adaptation process of their Fellows vs. only a few percent of Fellows confirmed such a situation. The project team believes that intense webinars with various experts contributed to such success, as many Fellows stated that the personal development training was advantageous for them.

The project team focused on developing intensive, low-cost online communications rather than costly in-person engagement. The project team and the Fellows mutually 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 ABCs of seeking SBIR/STTR research funding and how to find the most critical funding websites; iii) 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 offered online one-on-one, face-to-face consultations to Fellows looking for guidance on their next career steps, especially about entrepreneurship. Approximately 15 hours of career counseling was delivered. The consultants came from the venture capital field; many 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.

In addition, IPERF host companies have signed up and committed to offering a mentor from each of their companies to collaborate closely with their Fellow during the Fellow's postdoctoral appointment as a condition of participating in this program. Additionally, each mentor company delivered a report summarizing the Fellow's progress every six months. The progress report included 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 Fellows. ASEE has been evaluating these reports and giving informal feedback to the Fellows for improvement, especially if Fellows were seeking possible employment after the fellowship.

### **Program Success Testimonials**

Dr. Brian Bender is CSO of Intake Health, ([www.intake.health](http://www.intake.health)) a company that is developing machine learning techniques for passive, remote monitoring of elderly heart failure patients from home. Bender confirms that Fellow Dr. Kelvin Frazier has been a unique asset to the company. "We are obliged to IPERF that we found such a unique match.... His skills are unparalleled for our company," he adds.

Immersed Games is harnessing the engaging power of video games to create a next generation STEM learning platform. It's a video game for middle school students to learn science content and skills. The student experience includes activities like building ecosystems to learn ecology or breeding dragons to learn heredity.

Lindsey Tropf, CEO of Immersed Games, was mentoring Fellow Dr. Holly Pope and explains that while at Immersed Games, Dr. Pope acquired skills useful in developing her own start-up company as well as learning about possible funding resources available to women and other underrepresented groups.

Jeff Kirschner, CEO of Litterati is mentoring Fellow Dr. Natalie Hallinger and explains that she “started making connections to better align the community's passion with the company's purpose and ultimately help Litterati market our products to a wider audience.” While at Litterati, Dr. Hallinger acquired skills useful in developing her own start-up company as well as learning about possible funding resources available to women and other underrepresented groups.

### Program Challenges

The main challenge facing the IPERF program was and continues to be the lack of sufficient financial support to the Fellows, especially in high-cost of living regions. In these regions,, the startups were forced to add significant additional benefits to attract the Fellows to the company. In the low-cost regions the level of financial support was never an issue, however, not many startups are available in those areas. With COVID disappearing from the horizon, the competition between industry and such programs like IPERF is intensifying, resulting in some early departures of the Fellows. Approximately 6% of the Fellows have left for competitors or large industries before reaching their one year of service.

### Supporting Underserved Communities

In Table 1, “URM(M+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 2023. The above definitions follow the National Center for Science and Engineering Statistics (NCSES/NSF, 2019) report as an indicator for underserved populations in the U.S.

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

	<b>URM(M+W)</b>	<b>W</b>	<b>URM</b>	<b>URM/W</b>	<b>URM/M</b>
US population average	67.4%	51.5%	32.9%	17.0%	15.9%
SBPRDF	55.8%	37.2%	26.6%	4.7%	20.9%
<b>IPERF</b>	<b>70%</b>	<b>55 %</b>	<b>31%</b>	<b>12%</b>	<b>17%</b>

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 many successful and supportive activities in the U.S. No other or similar programs/grants in STEM represent such high participation of underrepresented groups among their cohorts. Dedicated advertisements in various publications and engagement of Fellows during their fellowship contributed significantly to the increased success of engaging URM(M+W) groups in the IPERF program. The program publicized widely the results in scientific and general journals to promote the visibility of many success stories. These included HBCU-Matters Magazine, A House of Representatives poster

sessions, numerous ASEE conferences, Scientia International, and Technology International Magazine.

The sections below describe several support programs the ASEE project team offers to the Fellows. These support programs are helping achieve the desired results.

### **Regular Training Topics**

A variety of training topics were available to Fellows. These include guidance on successfully applying for STEM grants and contracts, seeking relevant websites, starting a business, understanding startup prerequisites, influencing others with their ideas, introducing intellectual property concepts, multidisciplinary research, communication, and how to collaborate in diverse high-tech environments effectively.

The following topics were added to the training:

- Where and how to successfully apply for STEM grants and contracts, and how to seek and identify important websites.
- How to Start a Business; Start-up Prerequisites & How to Influence Others.
- Intellectual Property (I.P.) and Introduction for High-Tech Entrepreneurially Minded Postdocs
- How to Research and Collaborate in diverse high-tech environments, plus networking tips.
- Successful prerequisites for cross-disciplinary entrepreneurship, how to thrive in the first years.
- Entrepreneurship vs. University life, similarities and differences, and
- Venture Capital (VC) vs. local Angel funds in a high-tech environment and access to it.

### **Outreach Webinars**

The program hosted engagement webinars on topics related to entrepreneurship. These webinars are conducted every 6-8 weeks and aim to provide information and insights to potential candidates.

### **Quarterly eCoffee Sessions**

ASEE has found that informal, periodic “e-Coffee” sessions with IPERF scholars were helpful in gauging the postdoc’s experience with their host company from a first-person perspective. Postdoctoral scholars have also utilized these sessions to share ideas relating to their individual experiences at their respective host companies and support their peers undergoing a similar experience. These digital sessions are not recorded for confidentiality purposes so that the IPERF team can have unrestricted conversations and provide the best advice on how to assist with resolving any issues experienced by a Fellow. Fellows were encouraged to be open and honest during these informal digital meetings to provide a support system amongst their peers.

### **One-on-One Consultations**

All Fellows had the unique opportunity to receive a personalized consultation (approximately one hour each) on their next career steps, focusing on entrepreneurship. Consultants are experienced professionals from the venture capital field and former fellowship awardees, typically from underrepresented groups. The topics covered in these consultations included Fellows mentoring in case of slow assimilation to the new startup, commercialization improvements, transitioning from/to other startups, time management, and work-life balance vs. company culture.

### **Professional Development**

Participants could allocate up to 20% of their time towards their professional development. The topics for these activities were agreed upon mutually between the host company and the ASEE team. As part of the program's offerings, mentors with expertise in entrepreneurship were utilized to assist postdocs. To enforce the participation of Fellows, the IPERF team added a clause to the startup agreements requiring a minimum of five hours spent on individual mentoring for every Fellow during the first six months of the fellowship.

### **Mentorship from Host Companies**

The IPERF host companies are committed to providing a mentor for each accepted Fellow. These mentors collaborate closely with the Fellows during their postdoctoral appointments. These included: i) A quarterly reporting schedule to enhance the working relationship between the Postdoc Fellow and their host company to ensure specific goals and plans were met by all parties, ii) All reports included the Fellow's improvements made while working with the host company as well as a detailed description of how the host company was actively working to further the postdoc's professional development within industry.

### **Increasing Participation with Interdisciplinary Expertise**

Interdisciplinary expertise was one of the significant factors in finding appropriate candidates for high-tech startup companies. An extensive amount of time was spent finding appropriate candidates with outstanding credentials to advance the project goal of increasing the participation of underserved populations. Some of the startups could not find a suitable candidate, thus were lowering their expectations in lieu of the required expertise. Table 2 shows the interdisciplinarity level at IPERF startups.

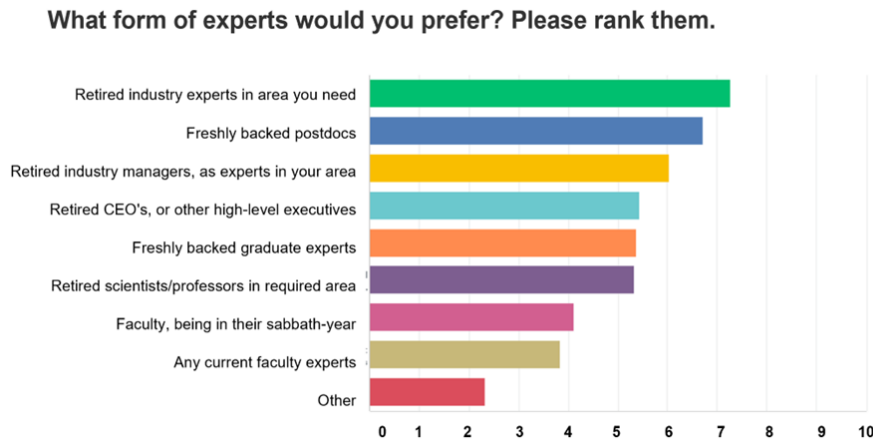
Table 2.: Main research/development discipline of SBIR/STTR startups in IPERF grant (Ivanitzki, Johnson, 2023).

Bioengineering	6%
Biomedical	20%
Biochemical Eng.	7%
Chemical Eng.	10%
Information Sciences	5%
Food Engineering	2%
Energy	12%
Geosciences	1%
Ind. and Systems Eng.	4%
Life Sciences	1%
Materials Sciences and Eng.	2%
Mechatronics	10%
Physics and Astronomy	1%
Psychology	4%
Social Sciences	2%
STEM Education and Learning	11%
Additive Manufacturing	1%
	100%

### Engagement of Biotechnology Companies

Biotechnology companies make up nearly 40% of the IPERF companies. These Biotechnology startups are also interested in employing postdocs and those at the post-graduate level (see Table 3).

Table 3. Surveyed IPERF startups and their ranked need for experts.





## Lessons Learned – Expanding Geographical Representation

While keeping the focus on underrepresented groups and increasing their participation to 70%, the IPERF team is also trying to broaden the geographical representation in the IPERF program. ASEE is making a concerted effort to increase the engagement of companies from the underserved regions, the regions based on the current heat-map of the SBIR/STTR startup distribution (Figure 1 below). Phase II companies should have a visible presence and representation in all regions of the country. The focus of targeted regions is mainly the west and south-west regions of the U.S. Since the number of SBIR/STTR companies located in these underrepresented geographical regions is small, this would seem to be a challenging goal to reach. However, the IPERF team is applying a more personal approach and directly contacting potential companies in these regions.

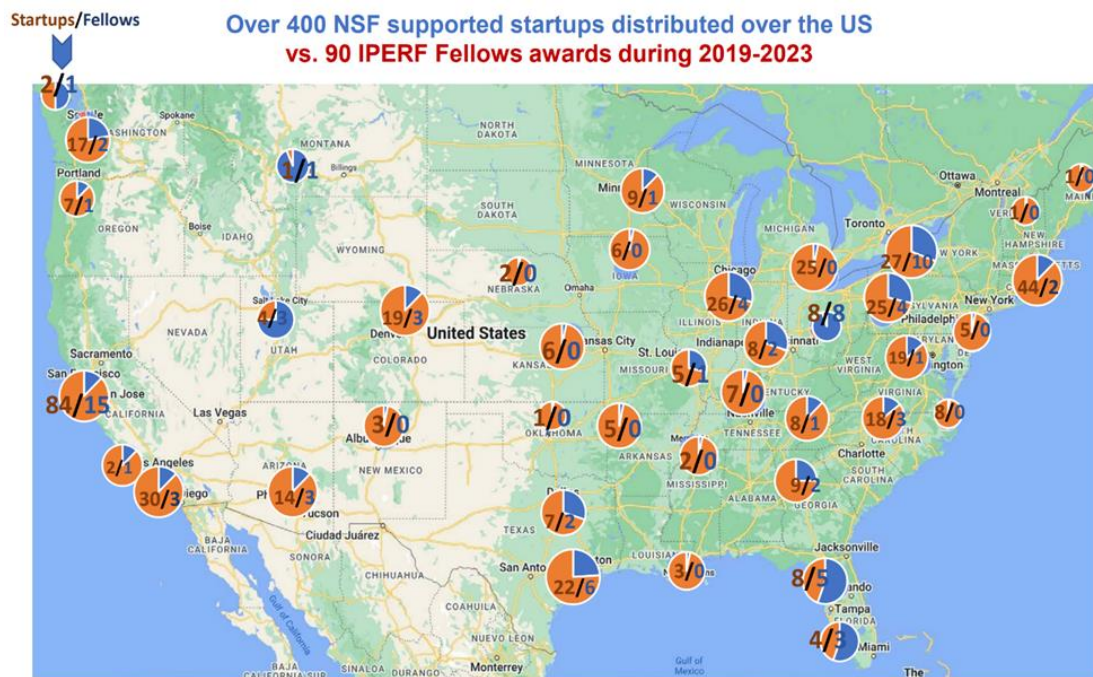


Fig. 1. The distribution of the SBIR/STTR NSF supported startups during nearly the last 5 years vs. placed Fellows in IPERF in the form of the heat-map.

## Conclusions

The broader impact of the IPERF program has been an increase to over 70% in STEM vs. a generic national average of 67% representation from underrepresented groups such as women, African Americans, Hispanic Americans, Native Americans, and Hawaiian/Pacific Islanders and those with disabilities who perform small business research in support of the federal government and participate in technology entrepreneurship in the private sector. Additionally, entrepreneurship in geographically underserved areas of the United States has increased, especially in biotechnology. The IPERF program has also contributed to the increase of postdoctoral entrepreneurs and the increased education level of the Fellows. ASEE believes the

program inspired diverse Fellows to start their own firms or join the modern industry, create jobs, win innovative research grants, and attract investment.

## Acknowledgments

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## Biographies

**TEDDY IVANITZKI** is one of ASEE’s directors within the Fellowships and Research Opportunities Department. He has more than 25 years of experience in managing the commercialization of technologies within IT industries and as the CTO/CEO of multiple high-tech startups in Europe and the United States. Before joining ASEE, Dr. Ivanitzki was managing director of the Ethiopian Institute of Technology in Mekelle, Ethiopia; previously, he served as dean of the College of Engineering and IT at DeVry University in Houston, Texas.

**ASHOK AGRAWAL** recently retired from managing director for professional services and director of external affairs and outreach at the American Society for Engineering Education. At ASEE, Agrawal supervised the NSF-funded Graduate Research Fellowship Program, Small Business Postdoctoral Research Diversity Fellowship, and Innovative Postdoctoral Entrepreneurial Research Fellowship programs. He has served as a program officer at the Division of Undergraduate Education at the National Science Foundation and continues to assist NSF on special projects. Agrawal has also served on the National Academy of Engineering Committee to Advance Engineering Studies at Tribal Colleges, the NAE Committee on Community Colleges Role in Engineering and Education, and the National Research Council Board on Engineering Education. Dr. Agrawal has also served on NSF’s Committee on Equal Opportunities in Science and Engineering.