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# Evaluating the Effectiveness of the Air Force's Open Topic SBIR and STTR Process to Engage Small Business to Work on Defense

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# Evaluating the Effectiveness of the Air Force's Open Topic SBIR and STTR Process to Engage Small Business to Work on Defense

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# BACKGROUND

## Research Question

Has the Air Force's (AF) use of the "Open Topic" solicitation in the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs increased engagement with non-traditional defense contractors, and is it effective in getting companies on contract that would not otherwise have been likely to contract with the Air Force?

## Innovative Development and Faster Acquisition is Vital to National Security

Issues with the Department of Defense's (DoD) acquisition processes have been identified, highlighted, and targeted for reform for decades, with a renewed push within the last 10 years. There is a long history of reform efforts between Congress and the DoD; one of the most significant historical changes came with the enactment of the Goldwater-Nichols Act of 1986, which mandated more coordination between the services to reduce redundant efforts and more oversight above the service level at the Office of the Secretary of Defense (OSD) level. (McInnis, 2016) Much of this was driven by the more predictable requirements of the Cold War era, but those long and predictable development cycles are not likely to serve national interests well today due to rapidly emerging capabilities all over the world, especially in China.

The DoD, at least at the leadership level, has recognized that faster technological development and innovation are key to United States' (U.S.'s) national security. Both from independent analysis and its own studies, the DoD has recognized that it has bureaucratic structures that inhibit innovation and foster a long, less than responsive capability development cycle (Steinbock, 2014; Kozloski, 2012). Other nations, most notably China, are modernizing some capabilities faster than the U.S. China has even surpassed the U.S. in some areas, including shipbuilding and integrated air defense systems (Office of the Secretary of Defense, 2020).

Improving the U.S.'s ability to continue and accelerate technological innovation is critical to military capability development and maintaining capability advantage.

In 2015, Senator John McCain, then-Chairman of the Senate Armed Services Committee, pushed an acquisition reform proposal as part of the 2016 National Defense Authorization Act (NDAA) stating, "In short, our broken defense acquisition system is a clear and present danger to the national security of the United States" (Erwin, 2015). The defense acquisition bureaucracy has gotten so large that it employs over 200,000 federal workers, with an estimated 180,000 pages of governing regulation. (Chandler, 2017). This level of bureaucratic burden has prompted some insiders to call for drastic changes, or even starting from scratch. Retired Marine Major General Arnold Punaro, former Staff Director of the Senate Armed Services Committee and member of the Pentagon's Defense Business Board, stated, "If it was me, I'd take 'em all (regulations) and put a match to it" (Freedberg, 2012). No agency or department has burned all their governing regulations, but Senator McCain's acquisition reform was included in the 2016 NDAA; as a result, more capability development and acquisition power was pushed back down to the military services. (Clark, 2015).

**Defense is Dominated by Large Defense Contractors**

The DoD's and the AF's capability development, acquisition, and lifecycle sustainment processes are heavily dependent on a small number of large defense contractors. This is in part because there has been significant consolidation in the defense industry in the past 40 years. From 1980 to 2001, more than 70 aerospace and defense companies were consolidated into Lockheed Martin; Boeing; Raytheon; Northrop Grumman; and General Dynamics (Commission on the Future of the United States Aerospace Industry, 2002, pp. 7-4). In federal Fiscal Year (FY) 2020, those same top five defense contractors were awarded $156.4 billion, or roughly

35%, of all DoD contracts (Levinson, 2021). That same budget year, the federal government set a record for U.S. small business contracts, but the $145.7 billion awarded that went to small business was over $10 billion less than awarded to those top five defense contractors. Those small business contracts were awarded across all agencies of the federal government. (U.S. Small Business Administration, 2021). Simply put, five companies earned more from just the DoD than all of U.S. small business earned from the entire federal government.

This domination of the heavily consolidated, top defense contractors has negative effects on innovation and new capability development for the DoD, because over time these companies have become relatively rigid and less likely to be innovative. They are more likely to invest their own research and development funds in safer bets that offer incremental innovation rather than higher risk, more disruptive innovation (Tucker, 2020). A Government Accountability Office (GAO) report found that, despite getting billions of dollars reimbursed by the DoD for independent research and development (R&D), only 38% of contractor independent R&D projects completed in 2018 aligned with the DoD's modernization priorities (GAO, 2020). By a number of measures, prime defense contractors appear to be less innovative when compared to the broader economy. This includes fewer patents *per capita* when compared to smaller companies, and this is not due to a lack of resources, "This falling relative innovation trend in defense has occurred despite a substantial increase in prime contractors' profits and assets" (Howell et al, 2021, p. 11).

These large government contractors are adept at navigating the defense bureaucracy and, over the long term, tend to keep contracts with program offices. Program offices are set up to manage long-term weapon system procurement and life cycles in a predictable manner, significant policy constraints and statutory oversight and tend to prioritize stable program

management over innovation. This culture, and the relationship between large contractors and program offices, tends to recapitalize iterations of older capabilities rather than finding innovative, disruptive, or transformative capabilities. Ultimately, the DoD's traditional contracting methods are outdated, based on Cold War era assumptions, and have the unintended effect of stifling innovation (Wharton & Nurkin, 2021;Erwin, 2010). As one R&D consultant put it, "As business objectives have supplanted technical visions across the defense contracting community, technical leadership has taken a back seat to business management" (Mastin, 2020). In effect, prime defense contractors have become very good at winning large and long-term defense contracts, but measurably worse at technical innovation to meet the DoD's modernization needs.

**Small Business is Underrepresented in the Defense Industrial Base**

Small businesses are a vital part of the overall U.S. economy and a significant driver of innovation, but are not as integrated into the defense industrial base (DIB) as they are in the broader economy. For context, in order to be classified as a small business by the federal government for contacting purposes, a business must be a for-profit business; independently owned and operated; not nationally dominant in its field; physically located in the U.S or its territories; and meet size and revenue limits. Business size is typically limited to 500 employees, but the revenue limits depend on the industry (U.S. Small Business Administration, 2021). Small businesses generate roughly 44% of U.S. economic activity (U.S Small Business Administration, Office of Advocacy, 2019). *Per capita*, they generate more patents than large businesses and, on average, small business patents have a greater impact and higher levels of originality (Breitzman & Hicks, 2008).

Despite being a source of innovation and comprising a substantial portion of the

economy, many small businesses do not pursue federal government contracts. Survey research in a report, by the Boston Consulting Group, outlined a number of barriers to working with the government, including long sales cycles; rigid and complex engagement processes; negative experiences; unclear points of contact; and an "overly prescriptive" acquisition model (Orazem, Mallory, Schlueter, & Werfel, 2017). The time-consuming and bureaucratic nature of federal government contracting can make it difficult for smaller companies to compete. As a result, innovative companies with the potential to contribute to the DIB simply do not engage the federal government for contracts

**The DoD and Military Services Push for Change**

Emphasis on and efforts to speed up innovation and acquisition in defense-oriented technology development have not come solely from Congress. The DoD has prioritized innovation and fielding technology faster with action at the OSD level. Secretary Ash Carter made a public push for faster innovation and stronger defense ties to the commercial technology sector in 2016. (Cronk, 2016); Mehta, 2016) As one of three main lines-of-effort in the 2018 National Defense Strategy, then-Secretary of Defense James M. Mattis acknowledged the problem with the current capability and development processes. In this line of effort, titled "Reform the Department for Greater Performance and Affordability," he stated his assessment: "The current bureaucratic approach, centered on exacting thoroughness and minimizing risk above all else, is proving to be increasingly unresponsive." (p. 10) As part of the overall "Reform the Department" line-of-effort he outlined several supporting efforts including directing that the Department "*deliver performance at the speed of relevance*…prioritize speed of delivery, continuous adaptation, and frequent modular upgrades" (p. 10). He further instructed the Department to

> Harness and protect the National Security Innovation Base. The Department's technological advantage depends on a healthy and secure national security innovation base that includes both traditional and non-traditional defense partners…We will continue to streamline processes so that new entrants and small-scale vendors can provide cutting-edge technologies (p. 11).

For context, the term "National Security Innovation Base" (NSIB) was used in the 2017 National Security Strategy (NSS) and is defined there as "the American network of knowledge, capabilities, and people—including academia, National Laboratories, and the private sector—that turns ideas into innovations, transforms discoveries into successful commercial products and companies, and protects and enhances the American way of life" (Trump, 2017, p. 21). The NSIB concept is closely related to and overlaps with the concept of the DIB (Peters, 2021). The DIB is defined as "the Department of Defense, government, and private sector worldwide industrial complex with capabilities to perform research and development and design, produce, and maintain military weapon systems, subsystems, components, or parts to meet military requirements" (Department of Defense, 2021, p. 59). An in-depth discussion about the breadth and depth of the NSIB and DIB is outside the scope of this research; nonetheless, it is important to understand that, in order for the DoD to have access to the newest and most innovative emerging technologies, the companies that produce those technologies must willingly participate in the DIB. Most importantly, those innovative companies, especially small businesses and start-ups, must be willing and able to work and contract directly with the military for the DoD and the services to acquire and employ the most cutting-edge technologies.

As part of the innovation push that Secretary Carter led, the DoD established the Defense Innovation Unit experimental (DIUx) at Moffett Field in Mountain View, California, in order to

be able to coordinate directly with companies located nearby in Silicon Valley (Pellerin, 2015). In 2015, the organization was renamed Defense Innovation Unit (DIU), but its purpose has remained the same: to connect the DoD with companies that may not have otherwise worked with the military. The intent is to produce, field, and scale technologies and capabilities "at commercial speeds" that have both defense and commercial applications (Defense Innovation Unit, 2020).

The DoD's services and commands have also started their own innovation organizations, such as SOFWERX and AFWERX. SOFWERX was founded in 2015 and operates on behalf of the US Special Operations Command (USSOCOM) (SOFWERX, 2020). Founded in 2017, AFWERX is part of the U.S. Air Force Research Lab (AFRL) (Air Force Public Affairs, 2017). Defense innovation organizations have continued to proliferate, and most work to bring together military stakeholders, including field units, acquisition specialists, research institutions, program offices, and even individual soldiers and airmen, all to engage with companies to innovate outside of the more traditionally structured development and acquisition process.

This effort to get more companies, especially cutting edge and innovative companies from the U. S. commercial sector, to work on defense capabilities can be compared to China's Military Civil Fusion (MCF) strategy. According to the U.S. Department of State:

> MCF, is an aggressive, national strategy…Its goal is to enable the People's Republic of China (PRC) to develop the most technologically advanced military in the world. As the name suggests, a key part of MCF is the elimination of barriers between China's civilian research and commercial sectors, and its military and defense industrial sectors (U.S Department of State, 2020, p. 1).

In both the US and China, the strategy is to incorporate new technology into defense capability by integrating relevant commercial markets directly into military capability development. In China, however, this can be directed by the central government by almost any means, "including through theft" of foreign intellectual property (U.S Department of State, 2020, p. 1). In the U.S., the federal government has limited power to compel private industry to engage the DIB. The federal government can invoke the Defense Production Act, but it is not designed for innovation. The DoD program is designed primarily to make certain that there are enough specifically identified resources prioritized and available by "ensuring the timely availability of essential domestic industrial resources to support national defense" (Department of Defense, 2022, par. 1). Therefore, in order for the DoD and the AF to capitalize on domestic innovation, they must break down barriers that discourage doing business with the government and incentivize industry to engage with the military.

**The SBIR and STTR Programs**

Congress established the SBIR program with the Small Business Innovation Development Act of 1982 and the STTR with the Small Business Technology Transfer Act of 1992. Both the SBIR and STTR programs have been reauthorized by Congress several times since. The original 1982 Act, Public Law 97-219, had four distinct purposes:

> (1) to stimulate technological innovation; (2) to use small business to meet federal research and development needs; (3) to foster and encourage participation by minority and disadvantaged persons in technological innovation; and (4) to increase private sector commercialization innovations derived from federal research and development. (p.1)

The SBIR and STTR programs are designed to allow the government to provide "seed money" to small businesses in order to commercialize technology. In the SBIR program,

companies contract directly with the government; in the STTR program, companies partner with qualified nonprofit research institutions to transition technologies into commercial products. In order to participate in either program, small businesses must be organized for profit, more than 50% owned and controlled by U.S. citizens or permanent resident aliens, and have 500 or fewer employees. Nonprofit research institutions must be located in the US and meet one of the following definitions: nonprofit college or university, domestic nonprofit research organization, or a federally funded R & D center (FFRDC) (U.S. Small Business Administration, 2022).

The SBIR and STTR programs are coordinated and overseen by the Small Business Administration (SBA), but individual federal agencies themselves provide the funding and contract directly with companies through SBIR and STTR awards. Federal agencies with extramural R&D budgets over $100 million are required to spend a percentage through the SBIR program, and federal agencies with extramural budgets over $1 billion are required to also participate in the STTR program. Currently 11 agencies participate in the SBIR, and five participate in the STTR program. (U.S. Small Business Administration, n.d.). The DoD spends the most of any agency on the SBIR and STTR programs, with $1.8 billion budgeted in FY19 (U.S. Small Business Administration, 2020, p. 9), and the AF typically spends the most of any military service, with roughly $795 million spent in FY19 (U.S. Air Force, 2020, p. 8).

The SBIRs and STTR programs are structured into three "phases." The Phase I objective is to "establish the technical merit, feasibility, and commercial potential of the proposed R/R&D efforts and to determine the quality of performance of the small business awardee organization prior to providing further Federal support in Phase II." Phase I awards are generally $50,000 to $250,000, and can be up to six months for the SBIR or one year for the STTR. The Phase II objective is "to continue the R/R&D efforts initiated in Phase I. Funding is based on the results

achieved in Phase I and the scientific and technical merit and commercial potential of the project proposed in Phase II." Phase II awards are generally around $750,000 and up to two years (U.S. Small Business Administration, 2022, par. 9-10); however, each Phase II award could go up to $1.73 million as of November 2020 (McCanney, 2020). Phase III is less well defined and is not funded by the SBIR/STTR programs. The Phase III objective "where appropriate, is for the small business to pursue commercialization objectives resulting from the Phase I/II R/R&D activities" (U.S. Small Business Administration, 2022, par. 11). A "successful" Phase III may be a separate contract with the government to continue R&D for that technology. It may be a one-time government purchase of a product that results from a Phase I or II contract, or it may be a successful commercial product that the government does or does not purchase

Most companies' ultimate goal is to transition a product into being a program of record (POR) within the DoD. Though there is not a single, clean DoD definition for a POR, it is typically an acquisition program that is specifically directed and funded to fill an approved defense need, and is recorded in the current Future Year's Defense Program. Once funded and recorded, the program becomes a "line-item record" in the defense budget (Yarmie, 2017; Defense Aquisition University, 2022). A POR is in essence a program that is planned, budgeted, purchased, and likely maintained over the medium to long-term. For a company, a POR often means sustained income beyond just the initial purchase of a product. It can also mean continuing contracts for requirements such as training, technical support, and maintenance over the lifecycle of the product.

The reality is that, just as most start-ups fail (Patel, 2015), most SBIR and STTR contracts do not transition to Phase III, getting caught in the so-called "valley of death." The "valley of death" is a term used to describe the gap between making a workable prototype of a

product and getting that product fielded or transitioned to long term POR (Dillard & Stark, 2021).

The DoD and the AF have been heavy users of the SBIR and STTR programs since their inception, but they have primarily used the process with a fairly conventional contracting approach to engage small businesses. This would typically involve posting solicitations for very specific, typically smaller scale technical problems. Oftentimes these postings are targeted to a small set of narrowly-focused small businesses that already deal with the government. The AF has recently restructured the way it awards SBIR funding. It has made changes with the intent to engage companies that may not have otherwise contracted with the Air Force, and to make the contract award process faster and more responsive to both government and industry stakeholders (AFWERX, 2020b).

**The Air Force Leverages SBIR and STTR Programs to Engage Small Business**

In an attempt to incentivize more small businesses to engage directly with them, the AF significantly changed how it solicited and awarded contracts through the SBIR and STTR programs. One of the potentially most impactful changes came when the AF, through the newly formed AFWERX, began posting an "Open Topic" in their SBIR and STTR solicitations in 2017. Federal agencies typically post very specific needs that they want small businesses to fill. The AF still does this, but since 2018 they have opened their programs to "Open Topic" solicitations. This allows a small business, in essence, to "pitch" what they can provide directly to the AF. It effectively adds a "What can you solve for the AF?" question to all of the "The AF needs X, Y, and Z" statements. This changes the dynamic of the normal requirements process from an AF "pull" only process to a "push" or "pitch" option for small business.

This significant change allows the AF to act more like a venture capitalist, and also gives the AF a tool to attract startups and more small businesses that may not have considered working with the government before. Dr. Will Roper, who oversaw all AF acquisitions as the Assistant Secretary of the Air Force for Acquisition from February 2018 to January 2021, led the AF to use the SBIR and STTR programs as a tool in a larger effort to increase interaction between the AF and the commercial sector. However, in an important distinction, Dr. Roper made clear that these efforts were made not to just increase the number and type of companies that are part of the DIB, but also to shift and change the concept of the DIB. Dr. Roper said he wants to "grow a new kind of defense industrial base for the next century that does not create primes" (Lofgren, 2020, p. 20:50). With the DIB being dominated by large prime contractors and being comprised mostly of companies primarily focused on defense, the DoD misses out on huge swaths of the market, especially leading-edge commercial technologies. In discussing the conceptual shift, Dr. Roper acknowledged that the DoD would continue to be heavily involved with large prime vendors, but the model of the past century will not be enough for the U.S. to compete in this century. "Our defense primes are going to continue to be heavy movers and shakers for us." (Lee, 2020, par. 4) He further expanded:

> We're not going to win against China long term if they've got a nationalized industrial base. They have access to that entire talent pool; they've got access to every company within their borders. And we are only working with a small subset…So we have to have a new model that encourages companies to come in and work with [the] military but not necessarily put them on a path to become a defense prime (Williams, 2020, par. 2-3).

This strategy to engage and incentivize innovative businesses to work with the government on defense problems is not just a military or defense-centric strategy, it is also part

of a commercial and economic security strategy. Dr. Roper and the people running AFWERX understand that national security is much bigger than just military and defense capabilities. As AF Major Jason Rathjae Ph.D., the AFVentures Director, put it in paraphrasing Dr. Roper's guidance, "We are not interested in growing the Defense Industrial Base; we are interested in growing the industrial base that is interested in defense" (Lofgren, 2020, 24:02). AFVentures' goal is not just to increase the AF's military capability, it is to rapidly integrate innovative technology into the AF, and at the same time to foster and expand the U.S. profile overall as the global leader in innovative technologies, both in defense and in the commercial sector. A nation must have a strong commercial sector and a robust economy in order to maintain its broad national security interests. This requires remaining a technologically innovative leader in all areas, especially the commercial sector. To summarize with a quote from Major Chris Benson, paraphrasing Dr. Roper, "If we have all of the greatest fighter jets and tanks and satellites and aircraft carriers of anybody in the entire world, and that all of the leading technology companies are Chinese, we still lose" (Lofgren, 2020, 23:25).

To encourage companies to work with the AF, Dr. Roper directed a number of rapid and iterative changes to complement the Open Topic to increase the AF's engagement through the SBIR and STTR programs. These initiatives included "pitch days" and "contracting sprints" where companies could come and directly pitch their technologies to the AF and even be put on contract the same day. Other innovations included "Spark Colliders," and "Spark Cells," where companies can meet with airmen and other potential end users of the technologies they are pitching. AFWERX also opened three physical offices in commercial districts rather than on AF Bases, to be more accessible to the public.

For the Open Topic Phase II postings, AFWERX made another noteworthy change: they required companies to get letters of interest signed by end users and "customers" in the AF. As part of their proposal submission, companies were required to get signatures from the "warfighter" that was the person intended to use the widget and the person who would buy the widget, if the Phase II was to successfully transition to a Phase III. This is in strong contrast to a conventional posting, which required a proposal to meet the specific technical requirements of the posting. In effect, this required the Open Topic respondents to find someone in the AF who wanted to use their widget, as well as someone who might actually purchase it in the future. As part of the signed letter of interest, the customers and end users had to agree to the milestones and deliverables of the contract and to serve subsequently as a technical point of contact to help confirm that the deliverables were met during contract execution. This meant that not only were companies having to deal with a contracting office, but they were also working to define their scope of work directly with their customers, including airmen in the field. It also meant that there was more outreach, communication, collaboration, and coordination required to have a successful proposal, and that contractor-customer coordination had to continue throughout contract execution.

In March of 2020 Dr. Roper announced the formation of "AFVentures," a new directorate within AFWERX charged with leading the AF's efforts to work with small businesses (AFWERX Public Affairs, 2020). As of this writing, AFVentures continues to run the Open Topic format for its SBIR and STTR programs and to iterate and refine its engagement approach to small business and industry in general. They have also put a focus on facilitating larger funding amounts to small business; they allow Program Office or other acquisition funding to be rolled into the contracts, and even allow private Venture Capital (VC) to be viewed

as “matching funds” to the SBIR/STTR funds. They call these larger contract and matching fund initiatives the Tactical Funding Increase and Strategic Funding Increase or “TACFI and STRATFI” programs. The TACFI and STRATFI programs can bring the total funding for a Phase II contract up to $1.8 million and $15 million respectively. (AFVentures, 2021a) This is intended to increase not just the R&D funds, but also to increase the likelihood of a successful transition to “Phase III” by including the intended defense and commercial stakeholders directly and early in the process. This is a deliberate attempt to build bridges toward a real “Phase III” to cross the “valley of death.” The intent is not just to develop new defense companies, but to create an “innovation ecosystem” (Arora, et al., 2020) in which the same innovative American companies can contribute to both the defense and commercial sectors, thereby strengthening our military and economic security simultaneously.

## LITERATURE REVIEW

The SBIR and STTR programs have been subject to scholarly critique for decades, both as broader programs and the DoD's specific use of the programs. Significant evidence exists that they are a very important source for R&D for small business, and have the intended outcomes both for the businesses and for the public. In one of the most cited works on the SBIR program, Lerner (1996) reported that firms with a successful SBIR award grew faster than similar firms that did not secure a SBIR contract; however, this outcome was primarily limited to geographic areas with significant commercial venture capital activity. Audretsch, Link, & Scott (2002) examined the DoD's SBIR program and concluded that there is "ample evidence" that the DoD program is a net positive in terms of innovation, private sector commercialization, and overall economic and social benefits from public R&D funding.

The National Academies, with Wessner (2009) serving as the editor, performed a comprehensive look at the DoD SBIR program. They found that the DoD's program was "contributing directly to enhanced capabilities for the DoD" and that it "provides substantial benefits for small business" and "supports a diverse array of small businesses contributing to the vitality of the defense industrial base…generating significant intellectual capital" (p. 22). They also concluded that significant work can be done to improve the process, particularly to increase Phase III transition rates. Their recommendations largely focused on making the program more small business friendly by reducing the bureaucratic process required and speeding up the contracting cycle.

After the AF implemented Open Topic postings in 2018, primary scholarship relevant to the changes is found in DoD affiliated graduate programs and academic or industry studies performed by acquisition professionals. The papers have different scopes and focuses, but they

all highlight changes to DoD innovation and engagement with small business, including changes in the SBIR and STTR programs.

Bresler (2018a, 2018b) focused on the engagement of small business through the recently formed DoD innovation organizations, such as AFWERX and DIU. She analyzed data from 1.29 million defense contract awards over seven years and found that half of innovation program participants achieved "no meaningful growth in direct defense business," and that those that did win follow-on contracts generally did not cross service lines for their awards. (Bresler, 2018a, p. 110). Bresler (2018b) did a deeper analysis of 13,449 contracts awarded to 1,140 companies through the SBIR, STTR, or Rapid Innovation Fund (RIF) programs. She found that 40 companies, or just 3.5%, accounted for 80% of the contracts. Unsurprisingly, the RIF contracts, which are not limited to companies defined as "small business," but touted as a "vehicle for small business," included large defense contractors like Raytheon, 3M, and BAE. (Bresler, 2018b, p. 394). Bresler's 2018 papers concluded that the innovation programs were neither engaging companies outside of the current DIB effectively, nor broadly transitioning technologies.

Bresler and Bresler (2020) focused on the size of the DIB, and trends in the DoD's engagement with industry. They first highlighted that, at least in terms of number of "unique DoD vendors" (p. 2) or separate companies that regularly do business with DoD, the size of the DIB shrank from nearly 80,000 vendors in 2010 to just over 51,000 in 2019. They cite a number of reasons for this change, including corporate consolidation and the amount of time and effort it takes companies to deal with government bureaucracy. Bresler and Bresler (2020) further noted that, since AFWERX made changes to their SBIR and STTR processes, there was a "significant increase in the number of gateway (companies doing business with the DoD for the first time)

SBIR/STTR vendors" (p. 10). While their data was not conclusive about cause, at least 25% of the gateway companies' contracts appeared to be connected with the "Open Topic" or pitch day changes at AFWERX, and inferred that the new initiatives at AFWERX had some effect (Bresler & Bresler, 2020).

Chimento (2020) examined the breadth of innovation changes made by the AF over the past several years, including strategic planning changes; cultural changes; the Squadron Innovation Fund; the creation of AFWERX; and the changes in the AF SBIR processes. Chimento dedicated a lot of his analysis to awards made before and after the changes made to the SBIR processes, and the types of companies that won the contracts. He concluded that the changes have attracted more innovative companies. His primary metrics supporting that conclusion are that the companies were smaller and were more likely to be backed by significant private venture capital.

Gist (2020) analyzed just the AFWERX changes to the SBIR process. He compared data for the last year of the "legacy" or conventional AF SBIR process with the most recent year of AF SBIR awards. He did not examine company size or type; rather, he studied the effects of physical engagement spaces or "front doors" on SBIR participation, and focused on commercialization rates as a metric of success. His core finding was that the changes did have a significant effect on commercialization, with 37% of companies making a commercial transition, compared to 8.8% for the legacy process (Gist, 2020).

Howell, Rathje, Van Reenen, & Wong (2021) studied the specific implementation of the AF SBIR Open Topic, and directly compared it to conventional awards. They found that the "Open program attracted high-tech startups to the defense market" (p. 37), and that winning an Open Topic award had positive correlations to private venture capital investment, patents, and

winning other DoD contracts. Conversely, winning a conventional topic increased the chances of a subsequent SBIR award, but was not strongly associated with outside funding, patents, or commercial transition. This correlation between a conventional award and subsequent SBIR awards, often without commercialization, was characterized as a "lock-in" effect. With the "lock-in" effect, small businesses tend to rely primarily on conventional SBIR contracts as a primary revenue stream, sometimes without any other government contracts or commercial business.

Taken together, recent work has shown that the changes to the AF SBIR program have affected the numbers and types of different vendors winning AF contracts through the SBIR and STTR programs. The data also suggest that the newer processes have had a positive effect on the level of innovation in the SBIR and STTR programs, as well as on transition and commercialization rates, which is all in line with the Congress' original intent.

# METHODOLOGY

The original research for this paper was an electronic survey sent directly to companies that secured an AF SBIR or STTR contract from FY 2017 through FY 2021. The survey was designed to gauge the impact of the Open Topic from the small business's point of view. In addition to the survey, some of the basic contract data was drawn from publicly available SBIR data, and compared with the AFWERX and AFVentures programs' self-reported data taken from their impact reports and yearly reviews. This research and survey responses in particular, augment the more empirically driven statistical work of Bresler (2018a, 2020b), Bresler & Bresler (2020), Chimento (2020), Gist (2020), and Howell, Rathje, Van Reenen, & Wong (2021).

The Process Evaluation framework detailed in Sylvia & Sylvia was used to shape the research. The process evaluation framework includes:

1) Problem Identification

2) Solution Development

3) Implementation

4) Feedback Evaluation. (2012, p. 94)

Table 1 summarizes the Process Evaluation as presented in this paper.

| Table 1: Process Evaluation Summary | | |
|---|---|---|
| **Phase** | **Location** | **Summary** |
| 1. Problem Identification | BACKGROUND | It was not worth the time and effort for many small innovative businesses to engage with the AF to develop or sell defense applicable products for the AF. |
| 2. Solution Development | BACKGROUND | The AF leveraged the existing SBIR and STTR processes in order to get wider engagement with small business on defense issues. |
| 3. Implementation | BACKGROUND & FINDINGS | The AF created the "Open Topic" solicitation which allows small businesses to "pitch" their ideas to the AF for R&D contracts, rather than only respond to specific "conventional" contract solicitations. The Open Topic was initiated in conjunction with streamlined contract awards, "pitch days," and other engagement initiatives to make working with the AF easier and more beneficial for small business. |
| 4. Feedback Evaluation | FINDINGS & ANALYSIS | The direct feedback from SBIR and STTR companies was generally favorable to the Open Topic. The Open Topic solicitation was successful in attracting a significant number of companies that would have otherwise been unlikely to participate in the SBIR/STTR process. But after their SBIR experience, a significant majority of all respondents replied that they were likely or very likely to pursue future SBIR contracts. More importantly, the vast majority of respondents, 89%, said that they are likely or very likely to seek future government and defense related contracts outside the SBIR program. This strongly suggests that the Open Topic has been successful in both engaging small businesses that otherwise would not have considered defense contracts, and further, getting those businesses interested in contracting directly with the government for defense needs. |

**Data Collection**

Basic SBIR and STTR contract award data, company information, and points-of-contact (POC) e-mail addresses were collected from the publicly accessible SBIR and STTR database: https://www.sbir.gov/sbirsearch/award/. The database is regularly updated and contract information was downloaded in November 2021 for all AF SBIR and STTR Phase II awards that

were awarded from FY 2017 to FY 2021. At the time of download, over 1,600 contract awards were identified but, as some companies had multiple Phase II awards, there were only 1,118 unique POC e-mails. The survey was sent via a commercial web-based survey company to POC e-mail addresses and was open for just over three weeks. One hundred forty-seven survey responses were collected, which equates to about a 13% participation rate from total e-mail invitations.

The survey focused on the following factors: how important the SBIR/STTR contract is to each company's innovation efforts; its overall experiences working through the process; its assessment of the Open Topic; the likelihood that it would participate in the SBIR/STTR process again in the future; and the likelihood it will pursue other business with the government. The survey questions and response summaries are located in Appendix A. In addition to the survey and contract data downloaded from the SBA SBIR and STTR database, the findings include some self-reported data from AFWERX and AFVentures, as detailed in their publicly published reports and reviews.

**IRB Exclusion**

This study qualified for an exclusion from IRB review, since the subjects of this analysis are companies working with federal agencies, and the content included in the questionnaire was solicited for professional data and company positions, not personal opinions or experiences. The survey data presented was also generalized and anonymized, with no company or personal contact information presented in this paper or the appendices.

# FINDINGS

## Overall AF SBIR and STTR Trends

Through AFWERX and AFVentures, the AF made enough iterative changes to the way it conducts the SBIR and STTR programs that it is difficult to draw a quantifiable conclusion clearly and causally about the impact of a single change. As mentioned in the background section, AFWERX not only allowed companies to pitch solutions through the Open Topic, they also greatly increased outreach to industry and AF stakeholders and made significant effort to reduce the amount of time to secure an AF SBIR or STTR contract. Before trying to single out the impact of the Open Topic, it is appropriate just to look at the overall trends in the AF SBIR and STTR program.

The most basic metric to evaluate, to determine the level of interest and engagement from small business, is the total number of proposals submitted to the AF SBIR and STTR programs. In FY17, the last full year before the Open Topic changes began, 2,678 proposals were submitted. In FY19, the first full year after the Open Topic process started, there were 6,445 proposals submitted (US Air Force, 2020), a 241% increase.

The next metric is the number of SBIR and STTR contracts awarded before and after the Open Topic and related changes. The data show a significant increase in numbers of awards after AFWERX and AFVentures made changes to their processes. Comparing FY17, the last year before the Open Topic and related changes, and FY21, the last full year of available data, the differences are clear. According to the sbir.gov award database, there were 384 Phase I and 246 Phase II SBIR and STTR contracts awarded in FY17. In FY21, there were 1,136 Phase I and 588 Phase II contracts awarded. Those numbers represent a 296% increase in Phase I, a 239% increase in Phase II, and a 273% increase in overall SBIR and STTR contracts.

The data indicate that changes made by including the Open Topic in the AF SBIR and STTR processes have had a clear impact, both in interest and in a higher number of contracts awarded. Beyond that, their success or failure and overall impact is more difficult to quantify. This is in part because of the broad definition of a successful Phase III. Transitioning a SBIR directly forward into a POR is the traditional goal in the DoD, but a commercial product, or even a conventional R&D contract directly related to the SBIR effort, can be considered a successful Phase III. As such, it is difficult to objectively track even the number of successful Phase IIIs, let alone the total impact, including on the private sector. AFVentures does specifically track the follow-on government contracts to its Open Topic contracts, and attempts to follow the private funding directly associated with its SBIR contracts. In order to quantify the impact of the Open Topic, they calculate a ratio to show the return on investment (ROI), which is "defined as sum of post-award private investment, post-award government contracts, and public and private matched funding (AFVentures, 2021b, p. 5). According to their self-reported data from 2018 to 2020, the ROI for Open Topic SBIRs was 5.8 to 1.

## Survey Findings

The following section outlines the relevant findings from the survey of 147 respondents.

### *Open versus Conventional Company Profiles*

Of the responding POCs, 53% reported their companies winning Open Topics, 32% reported their companies winning conventional SBIRs contracts, and 15% responded as winning both. Sorting the data for type of contracts and comparing responses reveals some general differences between the companies that tend to win Open vs conventional SBIRs and STTRs. For clarity and brevity, a company that reported being awarded only Open Topic contracts is referred to an "open awardee." A company reporting being awarded conventional contracts only

is identified as a "conventional awardee." Finally, a company reporting both Open Topic and conventional awards is referred to as a "combined awardee."

### *Age of Company*

Conventional awardees tended to be older, with 78% being more than 10 years old, and 0% being less than four years old. By contrast, open awardees were much newer, with 25% being less than four years old, 49% being four to 10 years old, and only 25% more than 10 years old. Combined awardees had ages more closely aligned with the conventional companies, with 73% being in existence for more than 10 years but, unlike the conventional-only awardees, the combined awardees had 9% of responses from a company less than four years old.

### *Types of Company*

When respondents were asked to characterize the kind of company they were, competencies across the range of engineering, aerospace, defense focus, information technology (IT), software, hardware, and systems integration, and "other," but some differences emerged. Companies that considered themselves "defense focused" were more prevalent if the company had been awarded any conventional SBIR or STTR, with 50% of conventional awardees and 64% of combined awardees considering themselves as defense focused. Only 30% of open awardees considered their companies to be defense focused. Engineering was also more prevalent in the conventional awardees, with 63% of conventional awardees and 82% of combined awardees responding as an engineering company, with 35% of open awardees reporting as an engineering company. The software and IT category was another differentiator, with conventional awardees only reporting 20% as software and 2% as IT companies. By contrast, open awardees reported 55% for software and 29% as IT companies. The combined

category more closely aligned with open awardees, with combined awardees reporting 41% as software and 23% as IT companies.

### *Previous Government Contract Experience*

Majorities, 89% of conventional awardees and 77% of combined awardees, reported federal government contracts that predated the 2017-2021 SBIR/STTR postings. By contrast, only 29% of open awardees reported a previous federal contract. For the companies that reported previous contracts, previous SBIR/STTR contracts were well represented across the awardees; however, “open compete” or standard type federal contracts were reported by only 32% of open awardees that had a previous government contract. This is significantly less than the 49% of conventional awardees and 89% of combined awardees that listed “open compete” awards as a previous type of government contract.

The numbers of previous SBIR/STTR contracts were also starkly different between open awardees and conventional/combined awardees. The vast majority, 69%, of open awardees listed two or fewer SBIR/STTR awards, while a majority of conventional and combined awardees, 54%, in both categories, reported more than 10 SBIR/STTR contracts.

### *Association with Large Defense Contractors*

Only 9% of combined awardees, 4% of open awardees, and only 2% of conventional awardees reported an association with a large defense contractor.

### *Company Founding Intent*

Conventional awardee companies and open awardee companies reported that 30% and 29%, respectively, of the companies were created with the intent to transition a specific technology to the government. Forty-five percent of respondent combined award companies replied that they were formed to transition a technology to the government.

### *Private Venture Capital*

VC investment in conventional and combined awardees was relatively low, with both reporting 9% of companies having private VC investment, while open awardees reported 41% of companies having VC funds. Of all companies that reported VC investment, open awardees reported higher VC rates, with only a single conventional awardee reporting VC investment of more than $5 million. Conversely, 10 open awardee companies reported VC investment of more than $5 million, with six of those reporting an investment of more than $10 million. A majority, 59%, of open awardees that reported VC also reported that their VC investment funds were aligned with their SBIR/STTR contract. Only two of seven combined or conventional awardees reported that their VC investment was aligned with their SBIR/STTR contract.

### *Process Difficulty*

Across all awardee categories, 41-49% of respondents found that the process was neither easy nor difficult and "manageable/neutral." Among open awardees, 30% reported it was easy or very easy, and 21% found it difficult or extremely difficult. That trend was different from companies that had conventional or combined awards, with more finding the Open Topic process difficult than easy. For combined awardees, 23% found it easy or very easy and 36% found it difficult or extremely difficult. For conventional awardees, 21% found it easy or very easy, and 35% found it difficult or extremely difficult. It was notable that 19% of conventional awardees found the Open Topic process extremely difficult, as compared to only 4% of open awardees, who found the process extremely difficult.

### *Transition Rates*

For respondents, transition rates to Phase III were reported at 26% for open awardees, 33% for conventional awardees, and 47% for combined awardees.

### *Likelihood of Participation without the Open Topic Process*

A clear majority, 84% of conventional awardees, said that they would have been likely or very likely to participate outside of the Open Topic process; only 5% said they would have been unlikely and none said that they would have been not at all likely. This compares to 77% of combined awardees answering likely or very likely, and 14% who said they would have been unlikely or not at all likely. This contrasts with open awardee companies, of which only 41% responded that they would have been likely or very likely to participate; 25% stating unsure/neutral; and 34% saying that they would have been unlikely or not likely at all to participate outside of the Open Topic process.

### *Likelihood of Future Participation*

Respondents were asked when taking into consideration their Open Topic solicitation experience, whether they would be likely to participate in future SBIR/STTR solicitations, and whether they would seek other government contracts outside of the SBIR/STTR programs. A solid majority of all awardee groups responded that they would be likely or very likely to participate in both future SBIR/STTR solicitations and seek out other government contract opportunities. For conventional awardees 70% said they were likely or very likely to seek more SBIR/STTR awards and 84% were likely or very likely to seek other government awards. For combined awardees, it was 86% likely/very likely for future SBIR/STTR awards and 100% likely/very likely for other government contracts. For open awardees, it was 83% likely/very likely for future SBIR/STTR awards and 88% likely/very likely for other government contracts.

### *Open Response Questions*

The last two questions of the survey, questions 21 and question 22, allowed the respondents to type a text response of any content and length. The two open questions were:

21. Do you have any suggestions that could improve the SBIR/STTR process to allow small business to better innovate for the warfighter?

22. Please provide any other information you think may be relevant or important to this research.

Some respondents skipped the questions, but there were 108 answers to question 21, and 67 answers to question 22. Answers varied from "No" to a 400-plus word, multi-point paragraph giving in-depth perspective and critiques of the Open Topic process and AFWERX.

All responses were manually reviewed and "tagged" to categories to represent each response's content. Categories were created to include the relevant content from all answers; for this reason, some categories have only one response. Some responses were tagged to multiple categories if an answer addressed multiple issues. Of all the 175 open-text responses, 25 were determined to be not applicable; some variant of "no;" were irrelevant; or unclear. Those 25 answers were not included in the final percentage determination. Table 2 lists the top 10 categories along with the number and percentage of responses tagged to each category. A summary table, Table 3, contains all categories and responses and is located in Appendix A. Table 3 includes quotations that were most representative of that category of responses.

| Table 2: Top 10 Open Response Categories | | | |
|---|---|---|---|
| # | Response Category | Number of Responses Tagged to Category | Percent* of Responses Tagged to Category |
| 1 | Provide better feedback to the small business and increase transparency in the entire process | 34 | 22.7% |
| 2 | Foster a better link and more interaction between the small businesses and AF stakeholders and end users | 33 | 22.0% |
| 3 | Offer more access to program offices and other acquisition specialists that make POR purchasing decisions | 30 | 20.0% |
| 4 | Response was specifically positive to Open Topic format | 22 | 14.7% |
| 4 | Provide a clearer process to transition to Phase III (build a bridge across the "valley of death") | 22 | 14.7% |
| 6 | Process was confusing or overly complicated | 15 | 10.0% |
| 6 | Reduce the time for review and award process | 15 | 10.0% |
| 8 | Educate the larger AF, especially end users and program offices, on the intent and accessibility of the SBIR/STTR program | 14 | 9.3% |
| 8 | The process is too bureaucratic or cumbersome | 14 | 9.3% |
| 10 | Response was specifically negative to the recent changes by AFWERX, including the Open Topic format | 11 | 7.3% |

The most consistent themes and core issues identified in the top three categories were better communication and access throughout the process. As can be read in Table 2 and Table 3, some form of process challenge or critique was the most common theme in the top 10 categories. Remarkably, the response category that tied for fourth most popular was one that was specifically positive to the Open Topic format. The tenth most common response category was a comment specifically negative to the Open Topic format.

When compared directly, companies that made specifically positive and negative comments about the Open Topic format, identifiably stark differences appear. All companies that made clearly negative comments about the Open Topic format had won some sort of conventional SBIR/STTR. Ten of 11 negative comments came from companies more than 10 years old, all 11 had government contracts prior to 2017, and none of them had any VC

investment. Of the companies that made specific positive statements about the Open Topic format, 21 of 22 had won some type of Open Topic award. They were also younger, with only 4 of 22 being more than 10 years old, and 32% had VC investment.

Outside of the comments about process and positive or negative comments about the Open Topic format, a number of other responses were worth noting, including some technical issues related generally to government contracting. Several of these responses commented about how certain mandates such as information protection (e.g., National Institute of Standards and Technology - NIST compliance) were overly burdensome for small business.

Other comments questioned whether a dual use (commercial and military) emphasis was appropriate. One reason cited was that a lot of military technology is assigned an International Traffic in Arms Regulation (ITAR) restriction, which limits to whom awardee companies can sell, thereby limiting their access to commercial markets. A related counter point was that, if companies are encouraged to make their innovations available commercially, it may give U.S. adversaries more access to that innovative technology.

# ANALYSIS

## Limitations

The Open Topic data from AFWERX was self-reported and was not independently verified for this research. The survey permitted only voluntary electronic survey participation by company POCs; therefore, sample size was limited, the POCs self-selected to respond, and their responses could not be feasibly checked for accuracy. There was no way to fact check the responses within the scope of this research. Companies asked to respond to the survey included only small businesses that were successful in getting a Phase II contract, so the survey did not include any companies that had submitted proposals but had not secured a contract.

## Overall Effects of AFWERX and AFVentures's SBIR and STTR Program Changes

The data are clear that the AF has greatly increased both the number of proposals and the number of contracts since AFWERX started making iterative changes to the SBIR and STTR programs in 2018. Given that there were so many changes to the process in a short period, it is difficult, if not impossible, to determine how many were a direct result of the Open Topic format or were due to efforts to increase engagement and decrease process and contracting burden. Though the survey produced only 147 respondents, it did reveal some very clear trends, both from the data trends and from the content of the open responses.

Overall, the data suggest that the changes to the AF SBIR and STTR processes have had the types of effects that Dr. Roper intended in making the changes, and that the trends are in line with not only the DoD's push for innovation, but also with the original legislative intent for both programs. The evidence further suggests that not only were companies attracted to doing business with the government that likely would not have otherwise, but also that the types of companies attracted were more likely to be innovative companies with business interests outside

the government. After their Open Topic experience, the vast majority stated that they were very likely not only to participate in future SBIR or STTR solicitations, but also likely to pursue other government contracting opportunities.

Survey results suggest that companies that succeeded in the Open Topic process tended to be younger and much more likely to have VC investment. Howell et al. described a "lock-in" effect with the conventional SBIR and STTR programs, where over-time companies tended to become serial SBIR/STR contract awardees that seemed to draw their income from repeated SBIR/STTR contracts, and not necessarily from selling things to the government and on the open market. From survey respondents, 54%, of conventional awardees reported more than 10 total SBIR or STTR contracts, but for open awardees the vast majority, 69%, had only one or two SBIR/STTR contracts. These results support earlier findings that a conventional approach is more strongly correlated with a lock-in effect; since the Open Topic process is relatively new, however, there may not have been enough time for the lock-in effect to develop for open awardees. In other words, there simply may not have been enough Open Topic cycles for newer open awardee companies to win enough contracts to show a lock-in effect.

The significant presence of VC in the open awardee category suggests that these companies are beholden to other stakeholders outside the AF, and have both the intention and the funding to commercialize a product, meaning that the SBIR contract and working with the government is only part of their overall strategy. This is consistent with Dr. Roper's intent to build an industrial base of companies interested in working with the military rather than building companies to be the next defense-only prime contractors.

There were no direct measures of "innovation" in this survey, but if previous research linking small business age and VC investment (Lerner, 1996; Howell, et al., 2021) holds true, the AF appears to be engaging with more innovative companies with the Open Topic process.

In the survey, conventional awardees reported at a higher level that the Open Topic process was extremely difficult, and open awardees reported it being easy at a much higher rate. This may have been partly from frustration in encountering any change in the process from what the conventional awardees were used to, but it might also give some insight into the approach and culture of each type of company. The conventional awardees were typically responding to a specific technical question in a fairly rigid contracting framework, with limited interaction outside of answering the solicitation with a technical proposal. Because the Open Topic process requires companies to pitch their solutions, find and coordinate with AF end users, and deal with iterative changes from AFWERX/AFVentures, it is a more dynamic and less prescriptively defined process. It can be reasoned that more innovative and entrepreneurial companies that are willing to seek out opportunity would be more comfortable and thrive better within the Open Topic process.

The open responses in the survey focused a lot on giving more feedback; further reducing contracting timelines; facilitating connection with end users and program offices; and generally reducing bureaucratic time and churn. None of this is surprising; it reinforces the National Academy of Science's findings and recommendations to improve the SBIR process (Wessner, 2009). There will likely always be significant bureaucratic overhead to maintain a government process, and some opaqueness to that process, when looked at from the outside. Results suggest that there is a need for documented process and accountability in government spending, which will always involve some bureaucracy, because any time an organization gets past a certain size,

it can be harder to understand and engage. AFVentures may have been partly a victim of their own success. The Open Topic and related changes resulted in a surge of interest, greatly increasing the volume of submissions, which the program was not initially staffed up to handle. This likely increased solicitation processing time and reduced responsiveness to individual company inquiries. It will be an ongoing process for AFVentures to strike a balance between moving fast to facilitate innovation while maintaining a repeatable and accountable process.

Issus with transition to Phase III were also mentioned a number of times in the responses, and solutions should remain a goal for AFVentures, to focus on continuing to improve Phase III rates. The broad definition of a Phase III project makes it nearly impossible for the SBA or AFWERX to track accurately. Of interest in the survey is that open awardees reported the lowest rate of transition to Phase III at 26%, with 33% of conventional awardees, and 48% of combined awardees reporting a successful Phase III transition. This may be influenced to some degree by how relatively new the Open Topic process is, as it takes time to transition to another government contract--especially a POR--and the purely open awardees may still be working through that. As the rate of combined awardees is so much higher than the other groups, however, those companies may possess some of the innovative qualities of the open awardees and may possess some of the established government contracting savvy and experience of the conventional awardees. Having a mixed skillset may lead to better long-term success.

**Specific Open Topic Impact**

Perhaps the most striking data points were the responses to how likely companies would have been to participate outside of the Open Topic process, and how likely they will be to continue to pursue government contracts in the future. A full third of the open awardees responded that they would have been unlikely or not likely at all to participate in the AF SBIR or

STTR process without the Open Topic. This in a strong indication that the Open Topic has been a catalyst to bring companies, that otherwise would not have dealt with the military, to contract with the AF. Further, across all awardee categories, the vast majority, 89%, responded that given their SBIR and STTR experience, they would be likely or very likely to seek out other contracts and business opportunities with the government.

**Broader Impact**

The results of the survey indicate that, through the Open Topic, not only is the AF attracting non-traditional defense contractors, but they are increasing the pool of companies willing to work with the government in the future, while they pursue business in commercial markets. When compared to conventional awardees, the profiles of the open awardee companies are newer, more tech-focused companies, with outside investment for commercialization of their technology; for these companies, defense contracting is only part of their strategy. They are likely not planning to be "locked-in" serial SBIR and STTR focused companies. The indication that open awardees are working to have mixed commercial and defense strategies suggest that the AFWERX initiatives are contributing to, not just to growing and strengthening, the DIB, but also the broader NSIB.

**Potential for Future Research**

Perhaps the most helpful focus for future SBIR and STTR Open Topic research would be Phase III transitions. Focus should not just be on the rates of a successful transition, or the overall dollar figures of the Phase III, but the speed and quantitative and qualitative impact of the transition. One potential focus could be on Open Topic contracts that make the transition to a traditional POR, and then comparing those Open Topic PORs to similar PORs that went through

the traditional capability development and acquisition processes. Development time, development cost, and end user satisfaction could be potential focus areas.

## CONCLUSION

The changes the AF has made through AFWERX and AFVentures to the SBIR and STTR processes, including the Open Topic, have objectively and quantifiably increased interest and participation in the program. The data gathered for this paper also strongly indicates that the Open Topic has not just increased engagement and overall participation, but has increased participation by non-traditional defense contractors. Further, it has been successful at getting new companies on contract that would have not otherwise been likely to contract with the AF. This research also indicated that these recently attracted companies are more likely to have strategies to create dual-use technologies, with both commercial and defense applications, leveraging both public and private investment. All of this is not just in line with the original congressional intent, but also supports the current NSS and NDS to bolster the overall innovation in the commercial and defense sector by growing the NSIB.

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## APPENDIX A: Open Response Summary Table

This appendix has a table to summarize the open-ended responses allowed in questions 21 and 22:

21. Do you have any suggestions that could improve the SBIR/STTR process to allow small business to better innovate for the warfighter?

22. Please provide any other information you think may be relevant or important to this research.

To create Table 3, all responses were manually reviewed and "tagged" to categories to represent the response content. Categories were created to include the relevant content from all answers; thus, some categories only have one response. In all, there were 27 categories created to classify all types of responses, including a category for answers that were "No" or otherwise not applicable the survey's data collection. Responses from this last category were not included in percentage calculations. Some responses were tagged with multiple categories, so there are more tags than total responses. Representative quotes were included for each category.

| Table 3: Summary of Open Response Questions | | | | |
|---|---|---|---|---|
| # | Response Category | Number of Responses Tagged to Category | Percent of Responses Tagged to Category | Representative Quotes |
| 1 | Provide better feedback to the small business and increase transparency in the entire process | 34 | 22.7% | “Proposal evaluation process need to be improved and should be more transparent.”<br><br>"Make selection process more visible and less dependent upon good old boy networks"<br><br>"More open access to feedback, decision-makers, etc. (beyond user or customer sponsors, i.e., AFWERX in addition to PEO or other acquisitions staff, etc.)"<br><br>“Prefer to have constructive critical comments if the proposal does not get selected so that small businesses can learn and provide better solutions."<br><br>"AFWERX is a nightmare! Lost a proposal that cost us almost a year. Never returns phone calls."<br><br>"More 1 on 1 conversation with AF"<br><br>"More transparency in the selection process and timeframes involved would be much appreciated." |
| 2 | Foster a better link and more interaction between the small businesses and AF stakeholders and end users | 33 | 22.0% | "Develop some form of ombudsman to guide small business through the process of connecting with USAF end users and customers (PEOs)."<br><br>"Air Force should give technical points of contact and assist with overall MOU process to progress to phase 2"<br><br>"Needs to be a better matching system between these good ideas and the people in the air force that care." |

| | | | | |
|---|---|---|---|---|
| 3 | Offer more access to program offices and other acquisition specialists that make POR purchasing decisions | 30 | 20.0% | “Please integrate procurement and innovation. We've had an infinite set of meetings with people who have no ability to help with transition. It's honestly a waste of everyone's time and also had us doing time-intensive demos that ultimately weren't useful to anyone."<br><br>"Connect to potential program of record POC's who would be interested in the tech." |
| 4 | Response was specifically positive to Open Topic format | 22 | 14.7% | “Keep the open topic! Keep the fast awards and the traditional bureaucracy of government out of it. There is so much innovation happening in the startups, and we've personally helped 10 other companies find the AFWERX program and utilize it. Truly a game changer for small biz and for our country!"<br><br>"More open topics and fewer program office-specific topics"<br><br>"AFWERX and the Open Topics were a breath of fresh air compared to pre-existing SBIR programs"<br><br>“The open topic format has given us the opportunity to present new and innovative solutions that are 'outside the box' to deliver value and capability to the American Warfighter. We believe they have enormous value to the Air Force."<br><br>"It has been said before but bears repeating without this kind of Open Topic support there are promising technologies that would never leave the academic environment"<br><br>"Open topics are important (what AF calls Blue Sky) as you don't know what's out there that could potentially become a game-changer." |

| | | | | |
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| 5 | Provide a clearer process to transition to Phase III (build a bridge across the “valley of death”) | 22 | 14.7% | "Better paths forward to Phase 3 out of open topics"<br><br>"Invest in SBIR/STTR technologies to help them transition through the valley of death!"<br><br>"Provide better post Phase 2 transition help."<br><br>"SBIR/STTR projects need a gov't/agency "champion" to push them to Phase III insertion/commercialization. The "open topic" concept has to be strongly linked to an individual who adopts the topic and will see it through a 2–4-year development process. Otherwise, the innovation will be left on the shelf." |
| 6 | Process was confusing or overly complicated | 15 | 10.0% | "The process is onerous and very black box and it's difficult because there isn't one place to get all the information from. Submit at this site. Results come from another site you've never heard about. Use a completely different site for information about the program. "<br><br>"The Air Force / DOD should hire a UX design firm to go through the SBIR application process from end-to-end and propose low-hanging fruit improvements to the design of forms and information."<br><br>"Clearer instructions for submission" |
| 7 | Reduce the time for review and award process | 15 | 10.0% | “Speed up time to award, small biz needs cash flow to stay afloat. The bureaucracy of the contracting/funding process deters smalls from being all in."<br><br>"But post Phase II, companies have to lay off staff and scale down because govt. money and contracting is so slow even if you were to get a Phase III (we haven't gotten a Phase III yet). All SBIR/STTR companies are doomed to be small this way." |

| | | | | |
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| | | | | "The only way the government can be as effective as VC is to figure out a way to deploy capital fast. There may be product/market fit and a customer that wants to buy but the deployment of capital can take 6-8 months. I've brought this up with govt. folks and they shrug and say that's just the way it is. The SBIR program helps source the new ideas but to actually bring it to fruition, the govt. has to fix their speed of deploying capital asap. A lot of technology will be lost as a result."<br><br>"With the current 3-to-4-month delays, this impacts the personnel needed to perform the technical work. The purchasing/award process should be more streamlined as the SBIR program continues forward."<br><br>"As was said by a keynote speaker at a recent defense conference 'the only people/entities that celebrate our pace of innovation are our competitors and our adversaries.'" |
| 8 | Educate the larger AF, especially end users and program offices, on the intent and accessibility of the SBIR/STTR program | 14 | 9.3% | "Help with messaging to better inform DOD of the purpose and intent of SBIR/STTR for better reception/understanding of the program."<br><br>"Create an Air Force Instruction- way too many Airmen and legal teams consider participating in SBIRs as career suicide."<br><br>"Educate the force on SBIR"<br><br>"Enabling further education around the program to other potential USAF stakeholders" |

| | | | | |
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| 9 | The process is too bureaucratic or cumbersome | 14 | 9.3% | "Reduce paperwork requirements, make proposal process more streamlined."<br><br>"It was fairly difficult to navigate all of the requirements for a first-time recipient. I'm not sure we would participate again given that we don't have dedicated staff to manage the paperwork end of the grant fulfillment process." |
| 10 | Response was specifically negative to the recent changes by AFWERX, including the Open Topic format | 11 | 7.3% | Get rid of the "open topic" format"<br><br>"Go back to previous process. Support companies that do R&D for the government."<br><br>"Un-executable ideas in attractive proposals win. Executable/realistic technology doesn't win in SBIRs. This is bad for the taxpayer and the warfighter."<br><br>"The move by the Air Force to stop funding key R&D topic areas highlighted by AFRL and other key technical people, to more a small company 'marketing' approach, has turned us off the AF SBIR/STTR program. They have moved funding from Innovative Research to supporting program offices and primes."<br><br>"My experience with "Open Topics" is very disappointing and I can't wait for the Air Force to have need-based topics with specificity." |
| 11 | Go back to the Conventional SBIR system | 10 | 6.7% | "An innovator often does not know, and cannot know, what specific problems the government needs solved. With the new open topic process, it becomes "solution looking for a problem"."<br><br>"Go back to the traditional SBIR system"<br><br>"Older SBIR system was much better; we were successful with that (Phase 2s and Phase 3s), maybe with more focus on getting program buy-in." |

| | | | | |
|---|---|---|---|---|
| | | | | "My experience with "Open Topics" is very disappointing and I can't wait for the Air Force to have need-based topics with specificity." |
| 12 | Increase funding to the program | 8 | 5.3% | “Ensure funding for topics. One Phase I had two submissions selected for award, but not funded."<br><br>"The concept of select and not funded is a detriment to the process."<br><br>"Fund the selected not funded" |
| 13 | Some government acquisition requirement is overly burdensome to small business (such as NIST compliance or ITAR complications) | 6 | 4.0% | "Recognize the futility of imposing NIST 800-171 on very small companies"<br><br>"Change ITAR so once there is significant commercial investment it goes way. ITAR restrictions kill DoD's use of commercial technology." |
| 14 | Put more emphasis on innovation for defense focused solutions, not commercialization | 6 | 4.0% | “Recognize the value of SBs that have been founded specifically to address challenging Defense mission gaps vs. favoring companies that were founded with a focus on commercial and improve the use of Rapid Innovation Fund and other approaches so that government agencies that participate in SBIR/STTR have establish POR approaches for transitioning good products"<br><br>"The AFWERX pivot to already-commercial technology is adaptation, not innovation and research" |
| 15 | Offer more flexibility in what counts as matching funds | 6 | 4.0% | “Need to allow convertible notes (debt) raises instead of just venture capital (priced rounds)"<br><br>"When implementing matching funds for a contract - these should take into account funds previously raised." |

| | | | | |
|---|---|---|---|---|
| 16 | Submission processing and technical issues | 5 | 3.3% | "There were significant technical issues with the submission process that if addressed would improve the process"<br><br>"I'm not crazy about the Union communication method." |
| 17 | Newer processes have largely removed technical subject matter experts (SME) from the review process | 4 | 2.7% | "I was told to brief my topic regarding missile defense to an open community with no subject matter experts,"<br><br>"Involve the labs more in the review process. There seems to be little rhyme or reason for why some of our proposals have been chosen while others have not."<br><br>"The open topic process...makes it worse since it removes the SBIR selection process from the SMEs within the Air Force that have a deep understanding of what is needed."<br><br>"Put technical personnel back in the loop. I don't need a 'Sherpa'. I need people who know what I am talking about in a technical solution to be involved in the evaluation." |
| 18 | The SBIR and STTR Programs are important | 4 | 2.7% | "The SBIR program is very important to a small business that has technology that can be used for the warfighter. Without this funding, it would be near impossible for a small business to compete against the much larger Prime government subcontractors." |
| 19 | Time invested is not worth the funding level | 3 | 2.0% | "The ratio of effort-to-funds is too high for SBIR/STTR. For a company that has the potential to get venture funding, pursuing venture funding is a better use of precious time." |
| 20 | Poor oversight / inappropriate use | 2 | 1.3% | "Many SBIRs are being used fraudulently to sole source work to small business by AF individuals and then establish Phase IIIs for rapid innovation. SBIR execution is poorly monitored by the SBIR program office. SBA policy makes this AF offense reportable to Congress." |

| | | | | |
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| 21 | Allow for contract payment flexibility | 1 | 0.7% | “Shift dollar value of progress payments forward in the contract period to help small businesses with working capital constraints.” |
| 22 | Encourage prime contractors to contract with successful SBIR companies | 1 | 0.7% | “Encourage Primes to implement SBIR technologies into their deliverables by encouraging and incentivizing them to subcontract to SBIR firms, perhaps to include added value in procurement decisions or perhaps through setting percentage targets under major awards. Writing a guideline to Primes on rights and obligations relating to SBIR Phase III subcontracts would clear the way for many more Prime Phase III awards. The law allows incentives for primes.” |
| 23 | Integrate testing and evaluation into Phase II | 1 | 0.7% | "When building milestones, suggest a mandatory T&E phase that would enable the end user/customer make a determination to continue to a Phase III." |
| 24 | Assistance in getting an Authority to Operate (ATO) | 1 | 0.7% | "Getting ATO for prototype/R&D work is pretty impossible." |
| 25 | Commercialization makes technology available to adversaries | 1 | 0.7% | "VC funding is more likely to produce commercial products that would provide technology to our adversaries." |
| 26 | Balance older process with new process | 1 | 0.7% | “Strike a balance between the old way SBIR/STTR was executed and what has been happening today; the old way required highly technical detailed and lengthy proposals while the new way simplifies this process. The old way resulted in offices/teams that annually provide topics and support selection of new awards and tended to favor small groups of prior performance. That is fine but a higher level of consideration of 'new' offerers track record for transitioning technology should be emphasized during selection process" |
| 27 | N/A, No, unclear or irrelevant answer | 25 | | "No" |

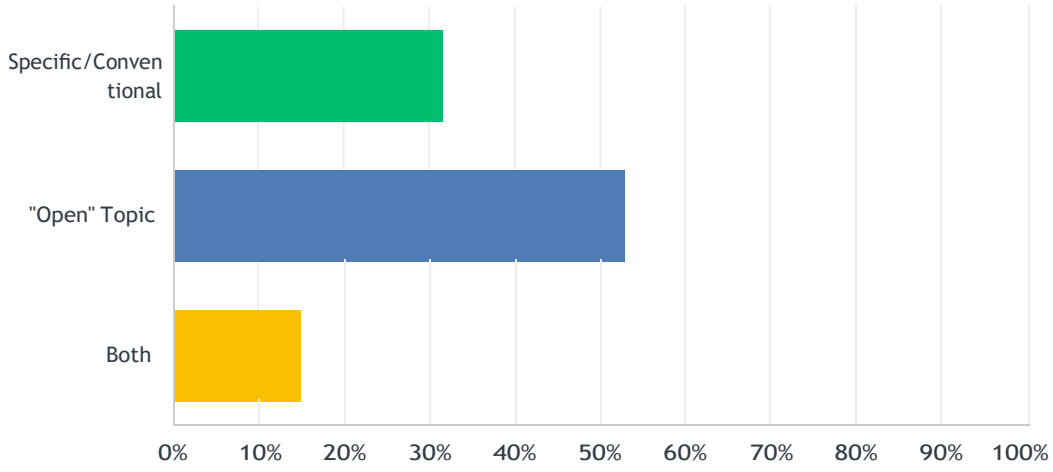
| | | | | |
|---|---|---|---|---|
| | | | | "In general, central planning is bad. AFWERX seems to prevent local control & decision making."<br><br>"None, asking the right questions!" |

## APPENDIX B: Summary Data for Survey Questions

This appendix contains a summary graph and table for each of the first 20 survey questions that were either multiple choice or allowed the user to check multiple answers.

# Q1: For what type(s) of Air Force SBIR/STTR posting did your small business get a Phase 2 contract(s)?

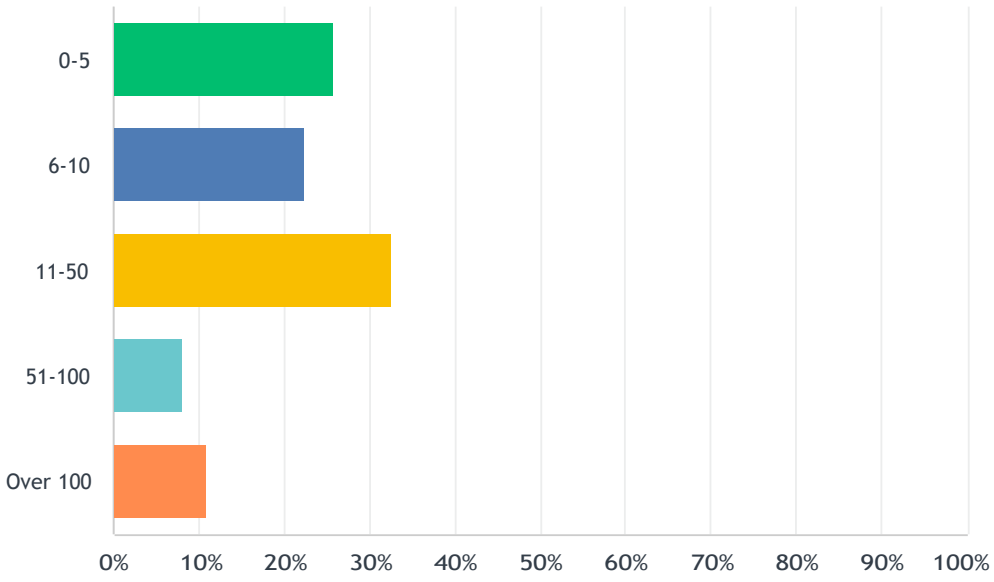
Answered: 145 Skipped: 2




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Specific/Conventional | 31.72% | 46 |
| "Open" Topic | 53.10% | 77 |
| Both | 15.17% | 22 |
| TOTAL | | 145 |

# Q2: How many employees does the small business involved have?

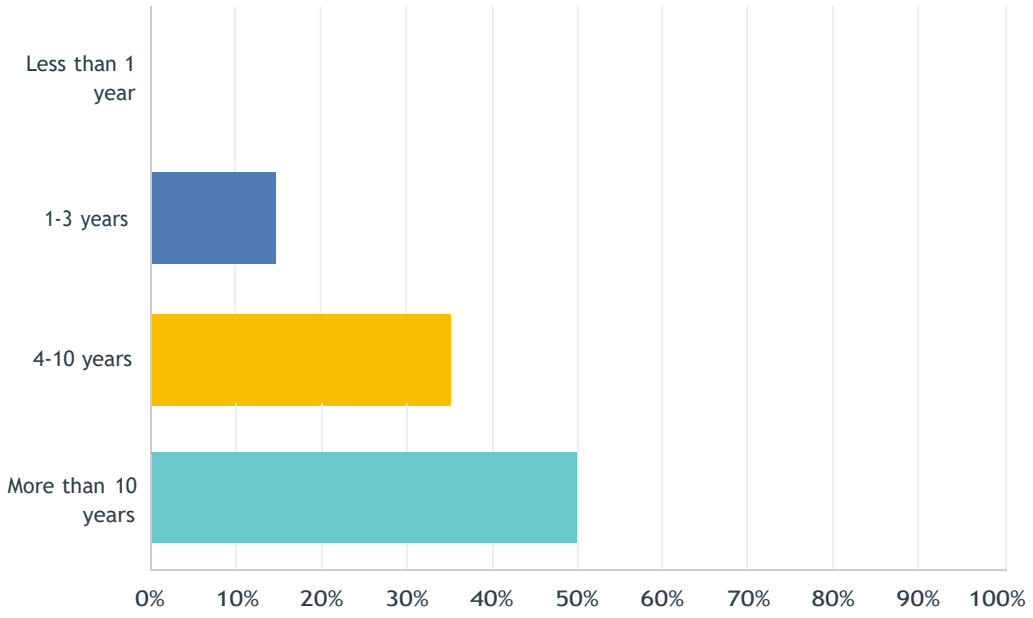
Answered: 147 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| 0-5 | 25.85% | 38 |
| 6-10 | 22.45% | 33 |
| 11-50 | 32.65% | 48 |
| 51-100 | 8.16% | 12 |
| Over 100 | 10.88% | 16 |
| TOTAL | | 147 |

# Q3: How many years has the involved small business been in existence?

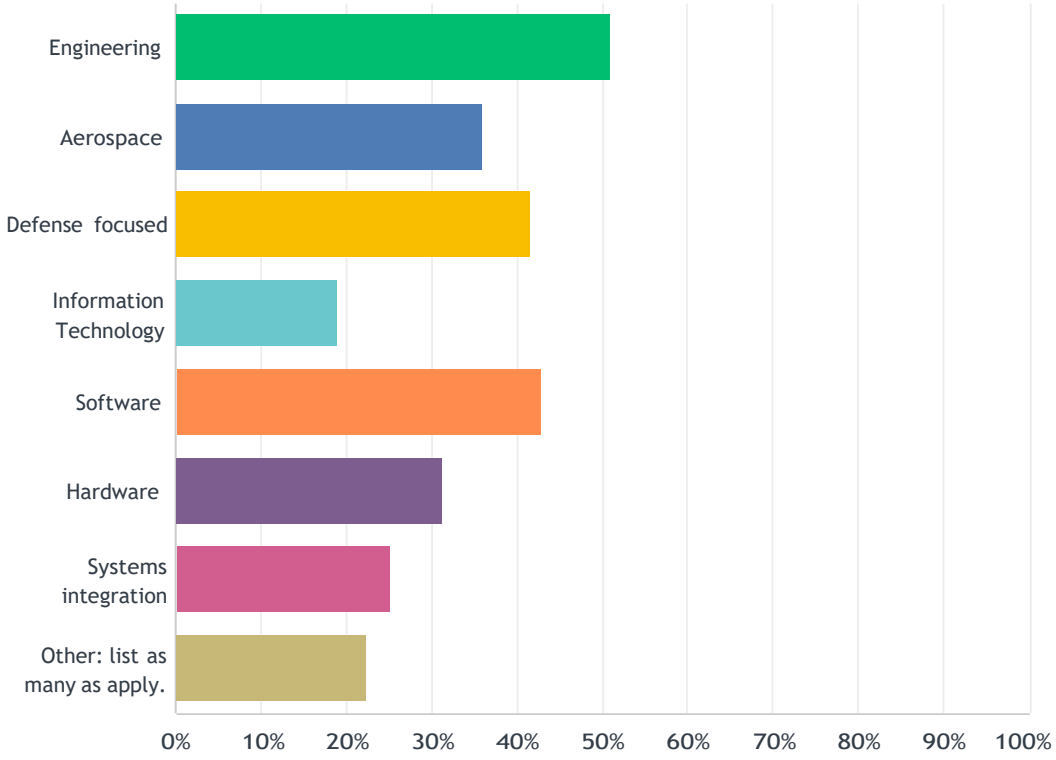
Answered: 147 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Less than 1 year | 0.00% | 0 |
| 1-3 years | 14.97% | 22 |
| 4-10 years | 35.37% | 52 |
| More than 10 years | 49.66% | 73 |
| TOTAL | | 147 |

# Q4: How would you characterize the small business? (check all that apply):

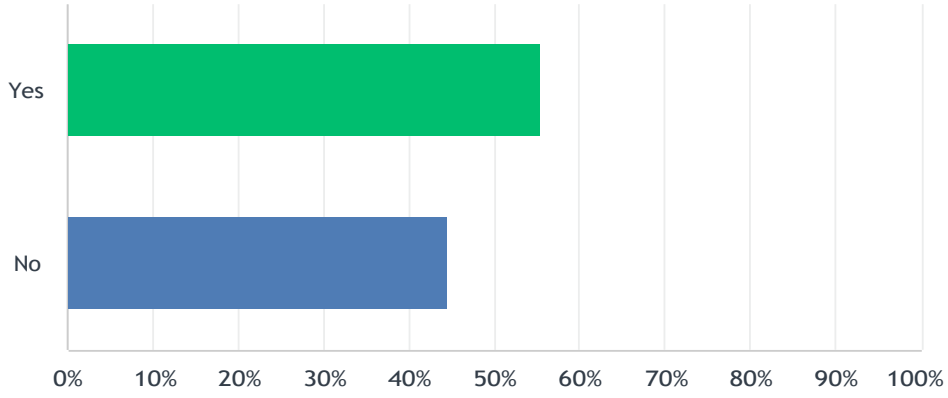
Answered: 147 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Engineering | 51.02% | 75 |
| Aerospace | 36.05% | 53 |
| Defense focused | 41.50% | 61 |
| Information Technology | 19.05% | 28 |
| Software | 42.86% | 63 |
| Hardware | 31.29% | 46 |
| Systems integration | 25.17% | 37 |
| Other: list as many as apply. | 22.45% | 33 |
| Total Respondents: 147 | | |

# Q5: Did the small business have a federal government contract prior to the2017-2021 SBIR(s)?

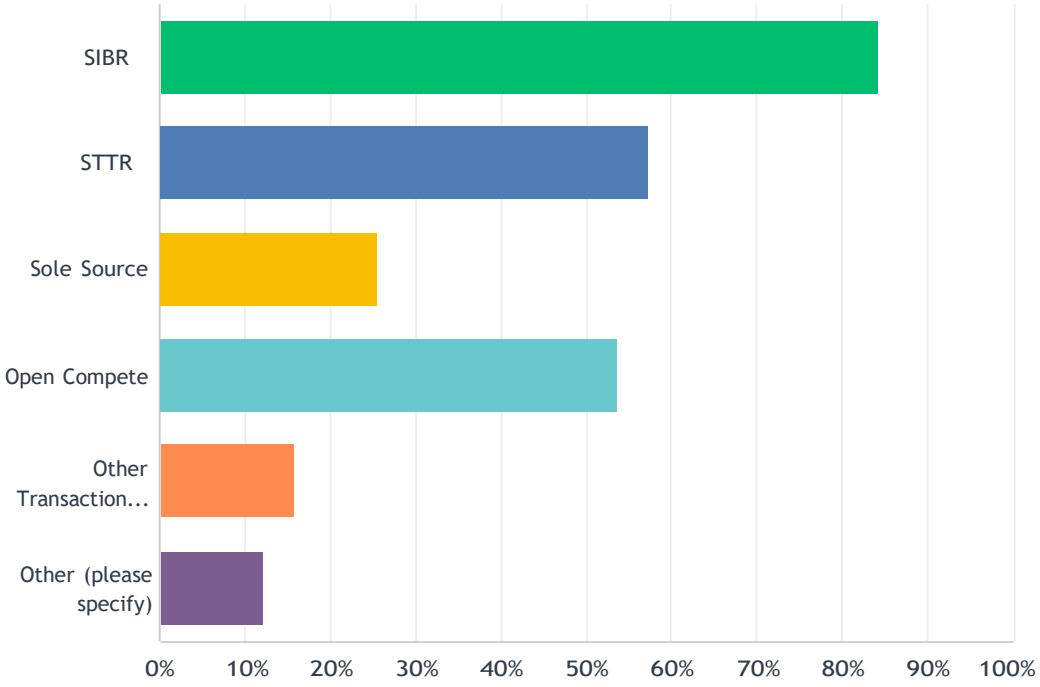
Answered: 146 Skipped: 1




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 55.48% | 81 |
| No | 44.52% | 65 |
| TOTAL | | 146 |

# Q6: What type of federal government contract(s) did the small business have prior to the recent SBIR/STTR? (Check all that apply)

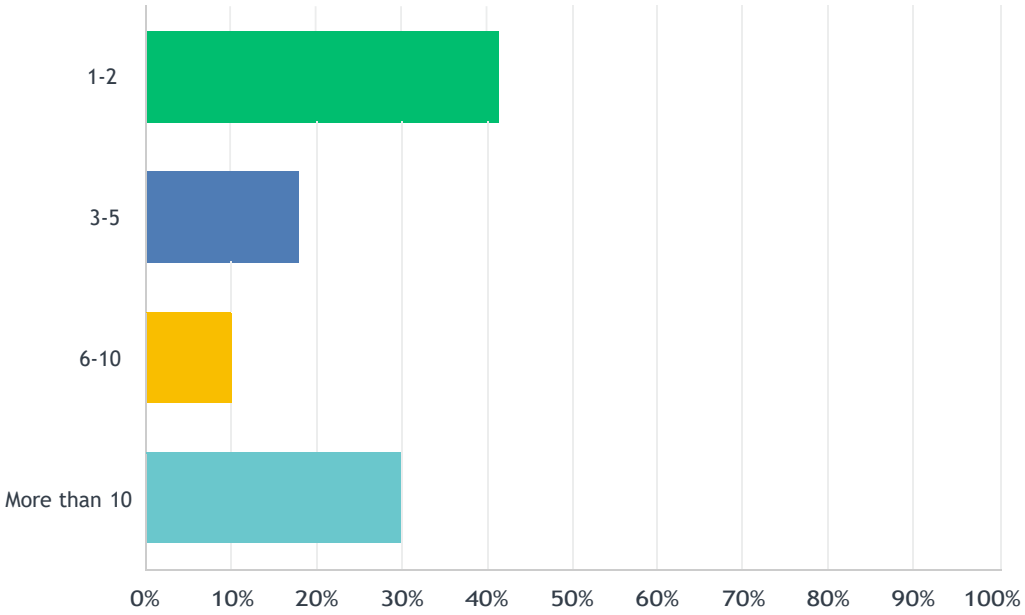
Answered: 82 Skipped: 65




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| SIBR | 84.15% | 69 |
| STTR | 57.32% | 47 |
| Sole Source | 25.61% | 21 |
| Open Compete | 53.66% | 44 |
| Other Transaction Authority | 15.85% | 13 |
| Other (please specify) | 12.20% | 10 |
| Total Respondents: 82 | | |

# Q7: How many previous SBIR/STTR contracts has the small business had?

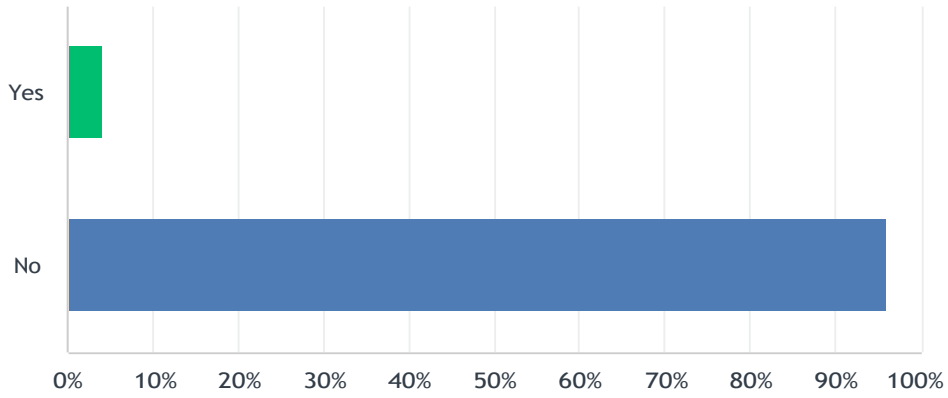
Answered: 144 Skipped: 3




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| 1-2 | 41.67% | 60 |
| 3-5 | 18.06% | 26 |
| 6-10 | 10.42% | 15 |
| More than 10 | 29.86% | 43 |
| TOTAL | | 144 |

# Q8: Is the small business associated with a large defense contractor?

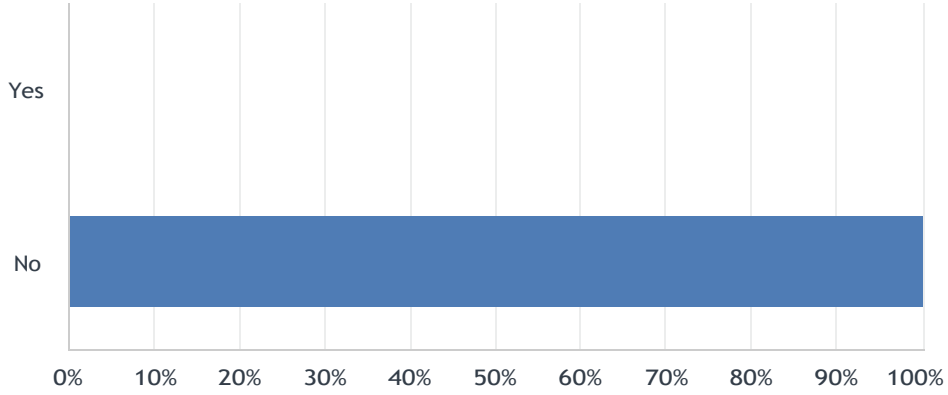
Answered: 147 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 4.08% | 6 |
| No | 95.92% | 141 |
| TOTAL | | 147 |

# Q9: If the small business associated with a large defense contractor, was this company spun-off from that larger company, at least partially, in order to participate in the SBIR/STTR program?

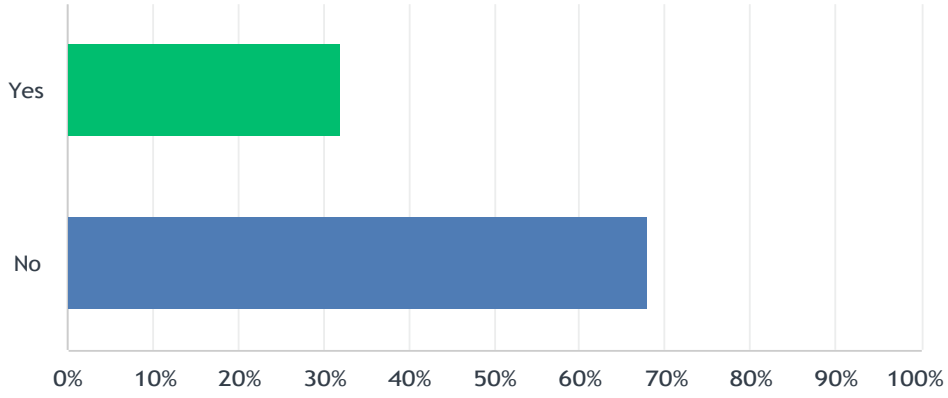
Answered: 9 Skipped: 138




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 0.00% | 0 |
| No | 100.00% | 9 |
| TOTAL | | 9 |

# Q10: Was the small business started with the intent of marketing or transitioning a specific technology to the government?

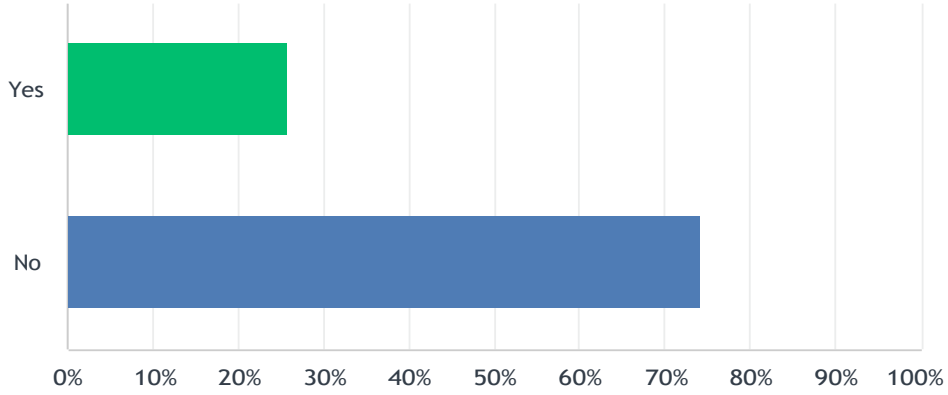
Answered: 147 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 31.97% | 47 |
| No | 68.03% | 100 |
| TOTAL | | 147 |

# Q11: Does the small business have private venture capital investment?

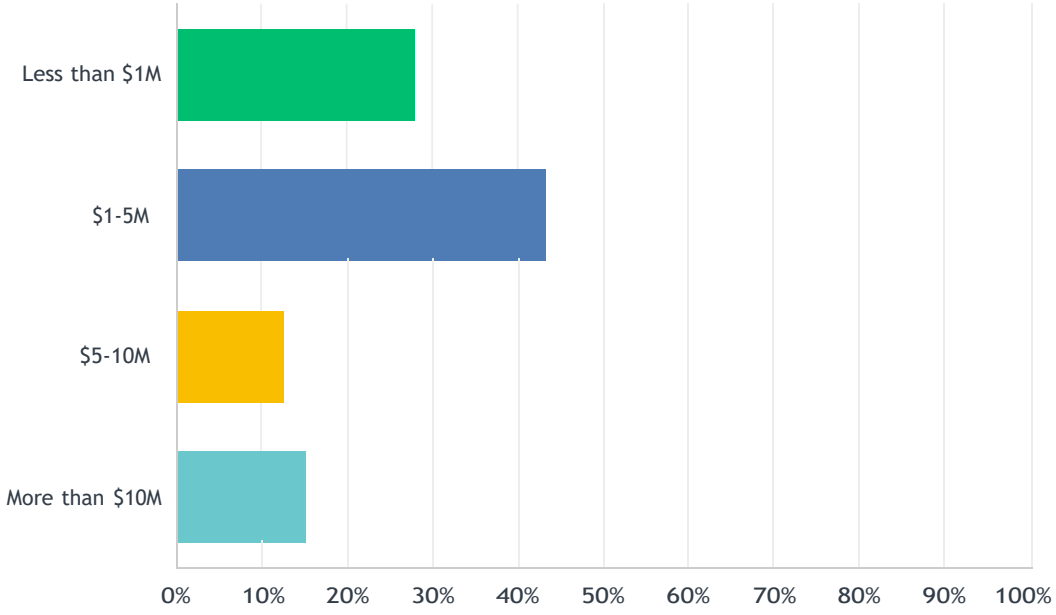
Answered: 144 Skipped: 3




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 25.69% | 37 |
| No | 74.31% | 107 |
| TOTAL | | 144 |

# Q12: How much venture capital is invested in the small business?

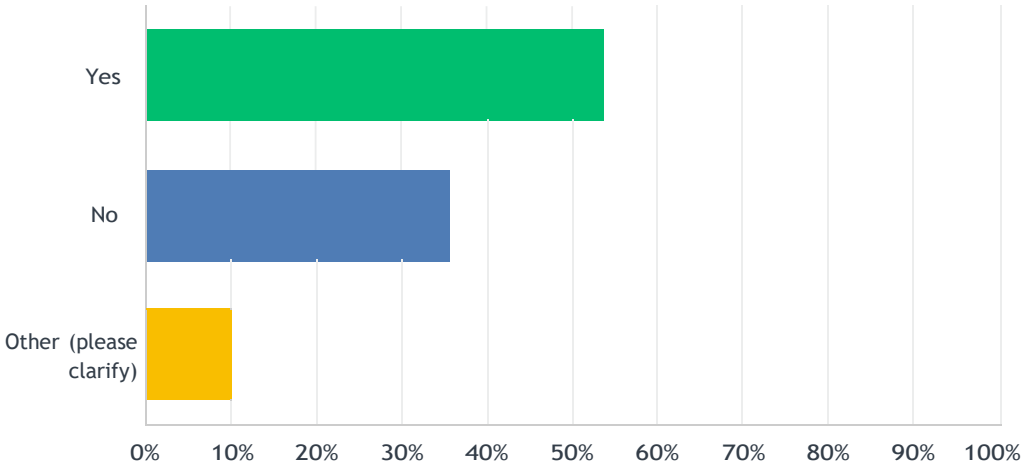
Answered: 39 Skipped: 108




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Less than $1M | 28.21% | 11 |
| $1-5M | 43.59% | 17 |
| $5-10M | 12.82% | 5 |
| More than $10M | 15.38% | 6 |
| TOTAL | | 39 |

# Q13: Is that venture capital investment directly in support of the same effort or technology as the small business's SIBR effort?

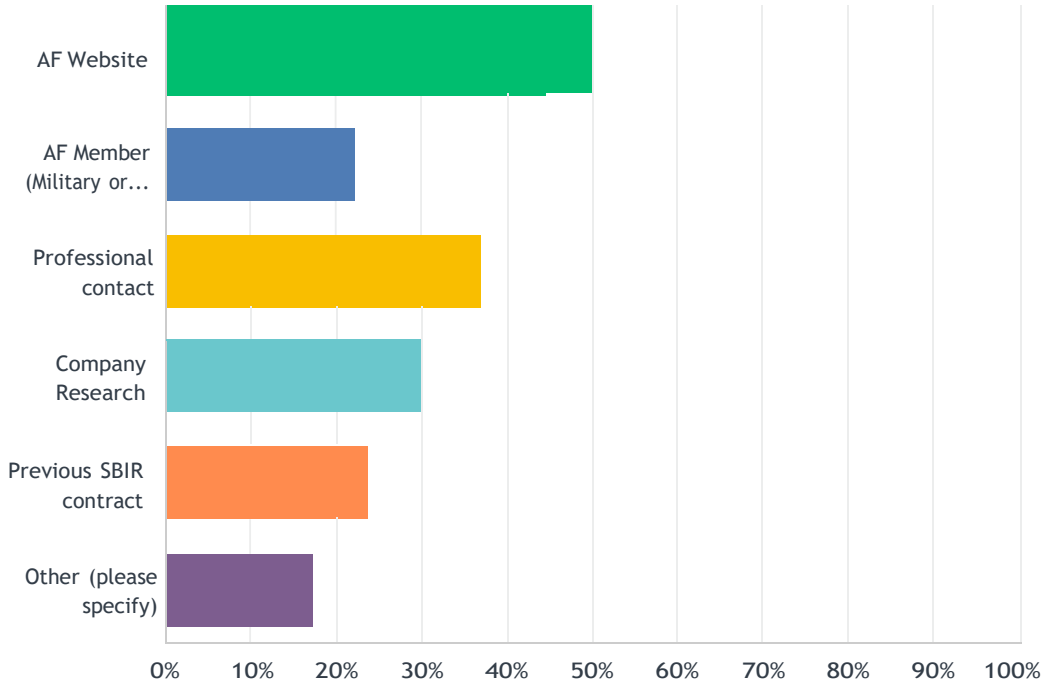
Answered: 39 Skipped: 108




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 53.85% | 21 |
| No | 35.90% | 14 |
| Other (please clarify) | 10.26% | 4 |
| TOTAL | | 39 |

# Q14: How did your company become aware of the AF SBIR/STTR “Open Topic” process? (Check all that apply)

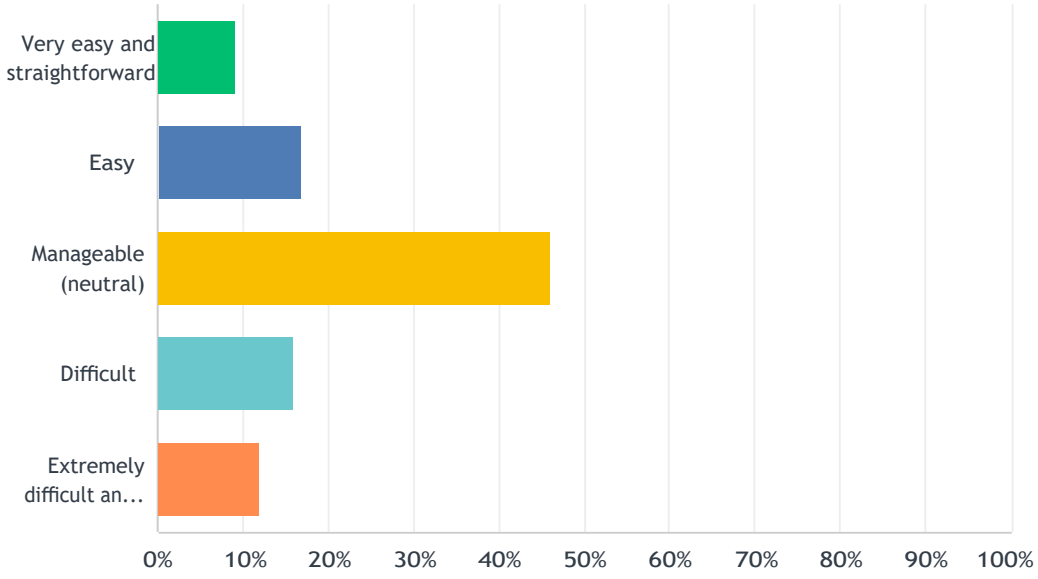
Answered: 143 Skipped: 4




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| AF Website | 44.76% | 64 |
| AF Member (Military or Civilian) | 22.38% | 32 |
| Professional contact | 37.06% | 53 |
| Company Research | 29.37% | 42 |
| Previous SBIR contract | 23.78% | 34 |
| Other (please specify) | 17.48% | 25 |
| Total Respondents: 143 | | |

# Q15: How easy or difficult was it for the small business to work through the AF “Open Topic” process?

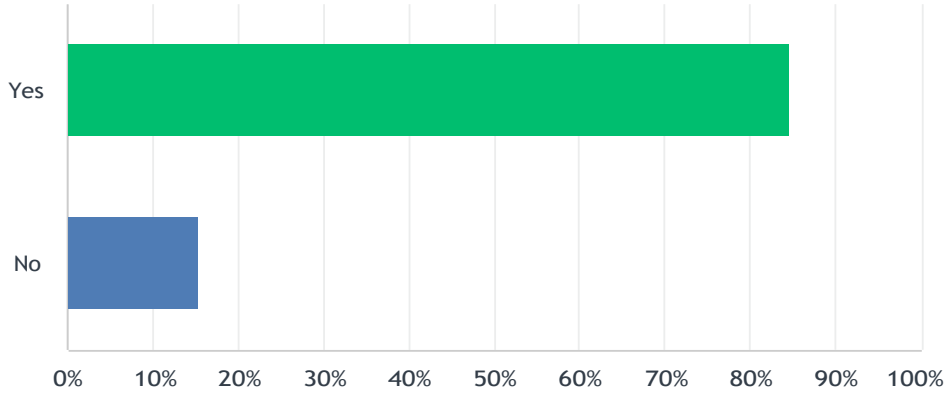
Answered: 143 Skipped: 4




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Very easy and straightforward | 9.09% | 13 |
| Easy | 16.78% | 24 |
| Manageable (neutral) | 46.15% | 66 |
| Difficult | 16.08% | 23 |
| Extremely difficult and confusing | 11.89% | 17 |
| TOTAL | | 143 |

# Q16: Have Phase 2 deliverables been completed by the small business ona SBIR/STTR?

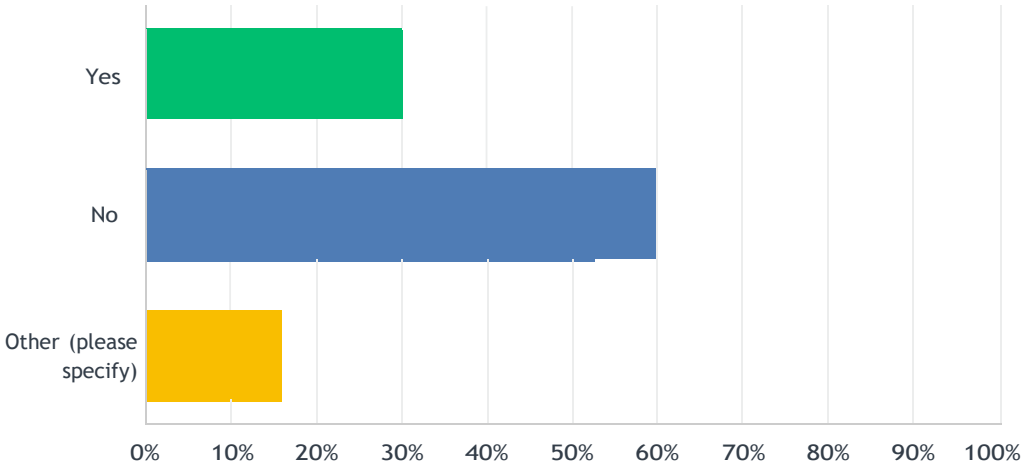
Answered: 143 Skipped: 4




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 84.62% | 121 |
| No | 15.38% | 22 |
| TOTAL | | 143 |

# Q17: Has the small business Phase 2 transitioned to a Phase 3 with a subsequent government purchase or follow on contract?

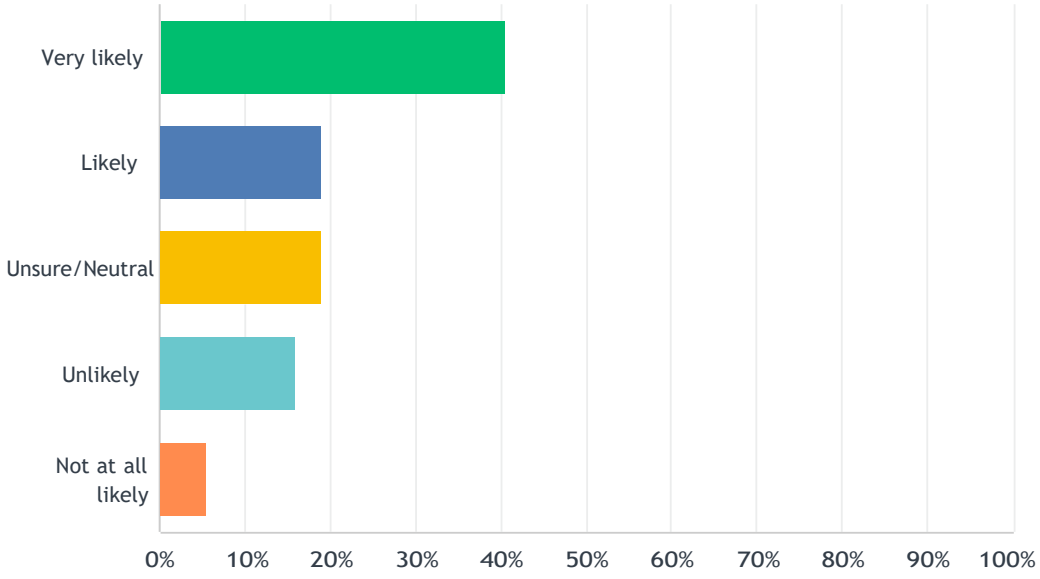
Answered: 142 Skipped: 5




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 30.99% | 44 |
| No | 52.82% | 75 |
| Other (please specify) | 16.20% | 23 |
| TOTAL | | 142 |

# Q18: How likely would your company have been to participate in the AF SBIR/STTR process outside of the “Open Topic” posting?

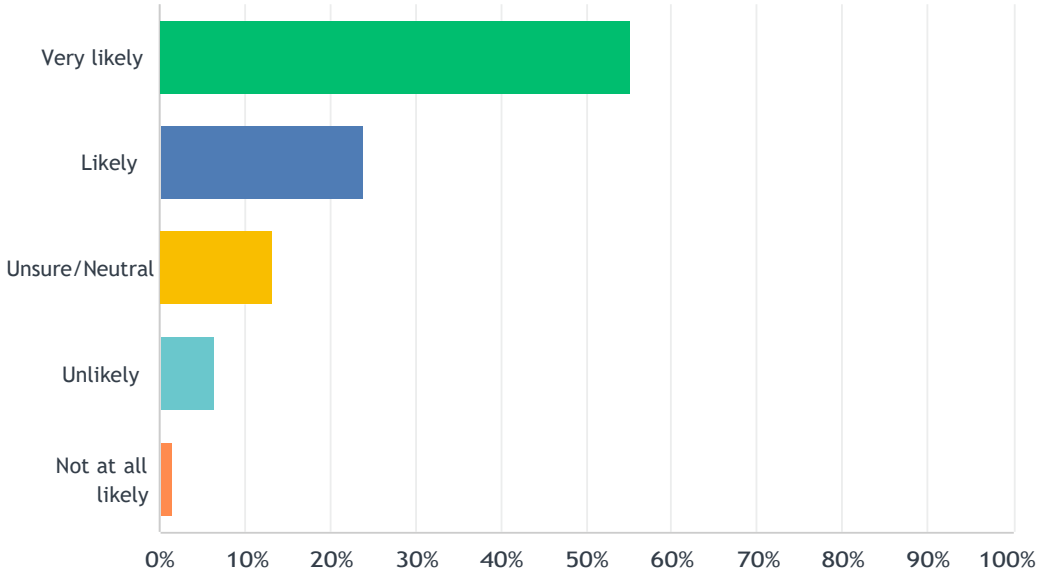
Answered: 143 Skipped: 4




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Very likely | 40.56% | 58 |
| Likely | 18.88% | 27 |
| Unsure/Neutral | 18.88% | 27 |
| Unlikely | 16.08% | 23 |
| Not at all likely | 5.59% | 8 |
| TOTAL | | 143 |

# Q19: Given your company's SBIR/STTR experience, how likely is it that your company will participate in the AF SBIR/STTR process again?

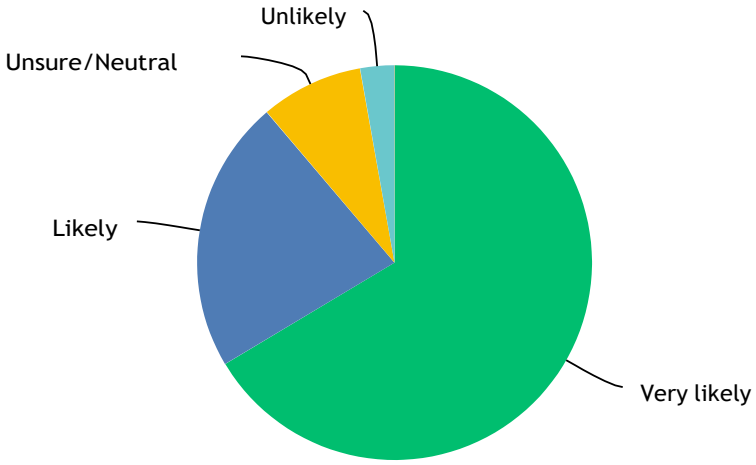
Answered: 143 Skipped: 4




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Very likely | 55.24% | 79 |
| Likely | 23.78% | 34 |
| Unsure/Neutral | 13.29% | 19 |
| Unlikely | 6.29% | 9 |
| Not at all likely | 1.40% | 2 |
| TOTAL | | 143 |

# Q20: Given your company's SBIR/STTR experience, how likely is it that your company will seek out other contracts and business opportunities with the government outside of the SBIR/STTR process?

Answered: 143 Skipped: 4




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Very likely | 66.43% | 95 |
| Likely | 22.38% | 32 |
| Unsure/Neutral | 8.39% | 12 |
| Unlikely | 2.80% | 4 |
| Not at all likely | 0.00% | 0 |
| TOTAL | | 143 |