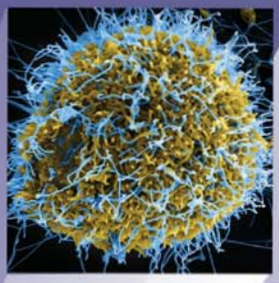
THE AIR FORCE IMPACT

to the ECONOMY *via* SBIR/STTR

U.S. AIR FORCE

Air Force SBIR/STTR




SMALL BUSINESS

2014 ECONOMIC IMPACT STUDY

SMALL BUSINESS INNOVATION RESEARCH | SMALL BUSINESS TECHNOLOGY TRANSFER

the PURPOSE *of the* STUDY

This study was undertaken to quantify the Air Force SBIR/STTR Program's overall contribution to the national economy and nation's defense mission.[1] The study examined the economic outcomes and impacts from all Air Force SBIR/STTR Phase II awards completed during the 2000-2013 period. It was intended to answer the following basic question: What resulted from the Air Force's SBIR/STTR research and development (R&D) investment of nearly $4 billion,[2] provided to 1,750 companies in 4,524 separate SBIR/STTR contracts?

The study's three primary objectives were:

1 To determine the extent to which the Air Force SBIR/STTR Program has contributed to new economic activity and job creation in the United States.

2 To assess its effectiveness in generating new technology for U.S. military use.

3 To identify and highlight notable success stories resulting from this program.

The Air Force SBIR/STTR Program commissioned the study.

2014 ECONOMIC IMPACT STUDY

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U.S. AIR FORCE

[1] *SBIR and STTR are acronyms respectively for Small Business Innovation Research and Small Business Technology Transfer. The two programs are similar; however, the much smaller STTR programs require small businesses to formally collaborate with not-for-profit research institutions, such as universities. See www.sbir.gov.*

[2] *The actual amount was $3,990,545,480.*

NATIONAL ECONOMIC IMPACTS

from the
Air Force SBIR/STTR Program
2000-2013

This study quantifies the Air Force SBIR/STTR Program's overall contribution to the nation's economy and defense mission.

It examines the economic outcomes and impacts from all Air Force Phase II awards completed during the 2000-2013 period, providing definitive answers to the question: What resulted from the Air Force's SBIR/STTR investment of nearly $4 billion, awarded to small U.S. companies in 4,524 contracts?

The research team contacted all 1,750 companies with Air Force SBIR/STTR Phase II contracts completed during the FY 2000-2013 period. Companies were asked to divulge the total sales of new products and services directly related to their Air Force SBIR/STTR Phase II contracts. They were also asked about their related sales to the U.S. military, follow-on R&D contracts, licensing revenue, and sales by licensees and spin-out companies. The response rate was over 96 percent. The research team was able to obtain conclusive information on the outcomes of 4,346 contracts out of a total of 4,524 total.

Well over half of the Air Force Phase II contracts— 58 percent—resulted in sales of new products and services based on the innovations developed with these contracts. Companies reported the following direct commercialization-related outcomes from their Phase II contracts:

HUGE R.O.I.

58%

Of Phase II contracts resulted in sales of new products and services based on the innovations developed with these contracts.

$14.7B

In total sales of new products and services, including **$4.4 billion** in military product sales.

$1.9B

In outside investment from venture capital,angel, & other private-sector funding sources

225

COMPANIES

Acquired by larger corporations

180

TECHNOLOGIES

Licensed to other companies for commercialization

125

NEW SPIN-OUT COMPANIES

To commercialize Air Force-funded innovations

The research team used IMPLAN economic-impact assessment software to estimate the total economic impacts related to both the $4 billion in Air Force SBIR/STTR Phase II contracts and subsequent $14.7 billion in sales of new technologies. **Results included:**

$47.9B **Total economic output nationwide**

$24.7B In value added, representing new wealth creation in the economy

$15.5B In labor income

16,751 Average new full-time jobs per year, with an average wage of **$65,968**

The study was commissioned by the Air Force SBIR/STTR Program. It is the first-ever comprehensive study of the economic impacts of an entire federal SBIR/STTR program. The study was conducted by TechLink, a federally funded technology transfer center at Montana State University-Bozeman, in collaboration with the Business Research Division (BRD) of the Leeds School of Business at the University of Colorado Boulder.

THE AIR FORCE SBIR/STTR PROGRAM IN CONTEXT

Federal SBIR programs date back to 1982 and were created to harness the innovativeness of U.S. small business—both to help meet the high-priority technology needs of the federal government and to benefit the national economy. Establishment of these programs was part of a larger effort in the United States during the early 1980s to make strategic government R&D investments to counter the loss of national economic competitiveness and related budget deficits.

In the enabling legislation, the Small Business Innovation Development Act of 1982,[3] Congress affirmed that technological innovation creates jobs and increases productivity, competitiveness, and economic growth. It also recognized that small businesses are the principal source of innovation in the United States and are generally more cost-effective in conducting R&D than major corporations, universities, and government laboratories. Finally, Congress asserted that, compared to these other entities, small businesses are more capable of converting R&D results into new products. However, it recognized that small businesses face greater difficulty securing funding for R&D and commercialization. Based on these findings, the Act was intended to (1) spur technological innovation in the United States; (2) help meet federal R&D needs; and (3) increase private sector commercialization of innovations resulting from federally funded investments.[4]

All federal agencies with extramural R&D budgets that exceed $100 million, currently eleven agencies, are required to allocate a small portion of their R&D budgets— 2.9 percent in FY 2015—to SBIR. In addition, the five federal agencies with extramural R&D budgets exceeding $1 billion (the Department of Defense, Department of Energy, Department of Health and Human Services, NASA, and National Science Foundation) are required to expend 0.4 percent (FYs 2014 and 2015) of their extramural R&D budgets for STTR.

Each agency determines its own R&D topics, issues solicitations, accepts proposals from small businesses (defined as for-profit entities with not more than 500 employees), establishes evaluation processes for these proposals, and makes awards on a competitive basis. The Small Business Administration (SBA) functions as the overall coordinating agency for both SBIR and STTR.

[3] *Text available at the following URL: http://history.nih.gov/research/downloads/PL97-219.pdf.*

[4] *A fourth objective, "to foster and encourage participation by minority and disadvantaged persons in technological innovation," was added as the bill was being finalized.*

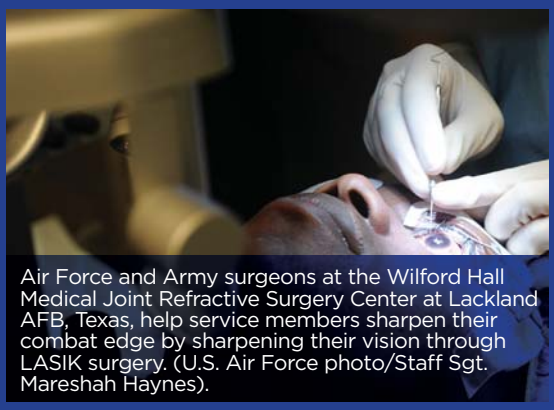
[5] *In FY 2012, the Air Force SBIR/STTR Program had a $345 million budget, versus $119 million for the National Cancer Institute.*

There are three phases to SBIR/STTR programs. Phase I funds short-term (typically six-month) feasibility studies of proposed innovations. These awards normally do not exceed $150,000. Assuming that a company establishes the scientific and technical merit as well as the commercial potential of its proposed innovation, it can compete for follow-on Phase II funding. Phase II funds the further development, testing and/or evaluation, such as by creation of a prototype, of the proposed innovation. Phase II awards normally do not exceed $1,000,000 and are typically for a two-year R&D effort. During Phase III, companies pursue commercialization, which can include transitioning to government acquisition programs, of technologies successfully developed during the previous two phases. No additional SBIR/STTR funding is available for this phase, but some federal agencies provide supplemental, non-SBIR/STTR funding for further development of promising innovations to meet critical U.S. government technology needs.

Approximately $2.3 billion is awarded annually through the federal SBIR/STTR programs. The Department of Defense (DoD) is the largest participant, with approximately $1.2 billion in SBIR/STTR contracts annually. Within DoD, the Air Force has the largest individual program. Its SBIR/STTR Program accounts for approximately 32 percent of the DoD total and 15 percent of the entire federal SBIR budget. Only the National Institutes of Health (NIH) has a larger combined SBIR program than the Air Force. However, the Air Force program is well over twice the size of the largest NIH component, the National Cancer Institute.[5]

SEEDING SUCCESS

Improved Eye Surgery



Air Force and Army surgeons at the Wilford Hall Medical Joint Refractive Surgery Center at Lackland AFB, Texas, help service members sharpen their combat edge by sharpening their vision through LASIK surgery. (U.S. Air Force photo/Staff Sgt. Mareshah Haynes).

LASIK, or laser-assisted in situ keratomileusis, is by far the most popular method of corrective eye surgery for conditions such as farsightedness, nearsightedness, and astigmatism. The procedure traditionally has used a microkeratome surgical blade to cut a flap in the outer layer of the eye, which is then folded back to expose the underlying cornea. However, blades have been associated with LASIK complications such as uneven edges and incomplete flaps.

With Air Force SBIR/STTR Program funding, Irvine, California-based IntraLase developed a bladeless system that replaces the surgical blade with a remote-controlled, high-precision, femtosecond (FS) laser to cut corneal flaps. Originally intended for use on Air Force pilots, this innovation has improved the quality and safety of eye surgeries worldwide. The IntraLase FS Laser System creates accurate and consistent flaps with fewer complications and is regarded as the safest, most advanced method of cutting corneal flaps today.

Over 5 million surgeries have been performed using the IntraLase system, and this system is now employed in half of all LASIK procedures in the U.S., including all LASIK eye surgeries performed by the U.S. military. In 2007, IntraLase was acquired by Advanced Medical Optics, a company owned by Abbott Medical Optics.

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Importance Of Study

As a result of the Air Force SBIR/STTR Program's commanding size and funding of innovations in virtually all technology fields (including advanced materials, communications, electronics, energy and power, medical technologies, and software), this program offers a good case study of the economic outcomes and impacts of the entire federal SBIR/STTR enterprise. It is important to understand these economic outcomes and impacts. They are essential for determining how well the nation's major investments in SBIR and STTR are meeting their intended goals: spurring technological innovation, helping meet federal R&D needs, and increasing private-sector commercialization of innovations.

Surprisingly few studies have examined the economic outcomes and impacts of the federal SBIR/STTR programs. Most SBIR-related research has focused on issues such as the effectiveness of government programs in spurring innovation. In 2014, NASA published a report on the economic impact of its SBIR program in fiscal year 2012.[6] However, this report only examined the economic impacts of the actual SBIR funds provided to small businesses, and did not include the impacts resulting from the innovations generated through this program.

The closest antecedents to the present study are a series of reports by the National Research Council (NRC) that were issued beginning in 2007. When Congress reauthorized SBIR in 2000, it asked the NRC to assess the effectiveness of this nearly twenty-year-old federal initiative. In response, the NRC examined the SBIR programs of the five major funding agencies: DoD, NIH, NASA, the Department of Energy, and the National Science Foundation.[7] Together, these agencies account for approximately 96 percent of all SBIR/STTR funding. The NRC studies were intended to assess whether these agency programs were meeting their Congressional objectives by evaluating their outcomes, including the degree to which the SBIR/STTR research resulted in commercialization, this research's value to the agency's mission, and its overall economic and other benefits. The first round of NRC studies, which appeared in the latter-2000s, is now being followed by a second round resulting from Congress's reauthorization of SBIR in 2011.[8]

[6] *National Aeronautical and Space Administration, 2014, SBIR/STTR Economic Impact Report, FY 2012, Washington, DC: NASA.*

[7] *National Research Council, 2008, An Assessment of the SBIR Program at the National Science Foundation, Charles W. Wessner, ed. Washington, DC: The National Academies Press; National Research Council, 2008, An Assessment of the SBIR Program at the Department of Energy, Charles W. Wessner, ed. Washington, DC: The National Academies Press; National Research Council, 2009, An Assessment of the SBIR Program at the National Institutes of Health, Charles W. Wessner, ed. Washington, DC: The National Academies Press; National Research Council, 2009, An Assessment of the SBIR Program at the Department of Defense, Charles W. Wessner, ed. Washington, DC: The National Academies Press; National Research Council, 2009, An Assessment of the SBIR Program at the National Aeronautics and Space Administration, Charles W. Wessner, ed. Washington, DC: The National Academies Press*

[8] *The first in this new round focuses on DoD: National Research Council, 2014, SBIR at the Department of Defense, Washington, DC: The National Academies Press.*

[9] *National Research Council, 2014, SBIR at the Department of Defense, Washington, DC: The National Academies Press, p. 256.*

The current study differs from the NRC's SBIR studies in the following key ways:

1 The NRC studies sampled the commercialization results of companies in each agency SBIR program in order to infer the program's overall level of commercialization success. By contrast, the current study examines the cumulative commercialization success of the entire Air Force SBIR/STTR program during the selected time period—the total sales of all new products and services and other major economic impacts directly related to the innovations that this program has generated.

2 The NRC studies used a multi-faceted approach to assess commercialization results, including surveys of Phase II recipients that employed a two-tier sampling methodology: random samples encompassing 20 percent of the companies with three or more SBIR awards (70 percent of the total awards) and 100 percent of the companies with 1 to 2 awards (30 percent of the total). By contrast, the current study surveyed 100 percent of all Phase II recipients that completed Air Force SBIR/STTR Phase II contracts during the chosen time period.

3 The NRC surveys of commercialization success had a much lower response rate than the present study. For example, the effective response rate of the DoD Phase II recipients in the 2014 NRC study was 28.5 percent.[9] By contrast, the present study had a response rate of over 96 percent. The much lower response rate of the NRC study introduces multiple sources of potential bias that are largely avoided by the high response rate of the current study.

4 The NRC studies did not attempt to assess the overall impacts on the national economy of the agency SBIR programs that they studied. The current study does. By employing the national IMPLAN model, a well-established economic-impact assessment tool, it estimates the economic impacts directly related to both the Air Force SBIR/STTR Phase II contracts themselves and also to the subsequent commercialization of the innovations developed with this funding. These impacts include total economic output, employment, labor income, and value added.

In Conclusion

This study is a first-ever comprehensive study of the economic impacts of an entire federal SBIR/STTR program. It examines the economic impacts resulting not only from the infusion of Air Force SBIR/STTR funding throughout the United States for R&D on topics of interest to the Air Force, but also the national economic impacts from the sales of new products and services derived from the innovations that resulted from this R&D. It provides a comprehensive answer to the guiding question:

What economic impacts resulted from the Air Force's investment of $4 billion in R&D projects by 1,750 small businesses during the FY 2000-2013 period?

Research Team

This economic-impact study was conducted by TechLink, a federally funded technology transfer center at Montana State University-Bozeman, in collaboration with the Bureau Research Division (BRD) of the Leeds School of Business at the University of Colorado Boulder. Since 1999, TechLink has served as DoD's primary national "partnership intermediary," helping to develop technology transfer partnerships between DoD laboratories and U.S. industry nationwide. TechLink's primary focus is helping DoD labs to transfer their inventions to U.S. companies through license agreements. TechLink currently brokers or facilitates approximately 60 percent of all DoD license agreements with industry. These license agreements enable companies to develop, manufacture, and sell new or improved products and services using DoD inventions. (For more information, see www.techlinkcenter.org.) TechLink previously has conducted three national studies of the economic impacts resulting from DoD technology transfer.[10]

The Business Research Division (BRD) at the University of Colorado's Leeds School of Business has been analyzing local, state, and national economies for more than 95 years. The BRD specializes in economic-impact studies and conducting customized research projects that help companies, associations, nonprofits, and government agencies make informed business and policy decisions. It produces the annual Colorado Business Economic Outlook, which provides a forecast of the state's economy by sector, the quarterly Leeds Business Confidence Index, and the quarterly Colorado Business Review. (For more information, see www.colorado.edu/leeds/centers/business-research-division.)

The principal authors of this study were Dr. Will Swearingen and Ray Friesenhahn of TechLink and Brian Lewandowski and Dr. Richard Wobbekind of the BRD. Chris Huvaere, Chandra Morris, Phillip Luebke, Andrew Schoneberg, Christie Bell, and John Verostek were other key members of the TechLink team.

[10] *The most recent of these studies was in 2012: National Economic Impacts from DoD License Agreements with U.S, Industry, 2000-2011, available online at http://techlinkcenter.org/articles/2013-report-economic-impact-dod-invention-licensing.*

(Photo: U.S. Air Force photo/Airman 1st Class Chris Drzazgowski)

Methodology

This study was undertaken in three major phases. First, during the Data Gathering phase, the research team contacted all companies that completed Air Force SBIR/STTR Phase II contracts during the FY 2000-2013 time frame. Companies were asked to divulge the total sales of new products and services and other economic results directly related to these SBIR/STTR contracts. This phase lasted for eight months and ran from April through November 2014. Second, during the Data Analysis phase, the research team analyzed the information gathered and used IMPLAN economic-impact assessment software to estimate the total economic impacts resulting from (1) the initial Phase II funding for R&D, and (2) subsequent sales of new products and services derived from the innovations generated by the R&D. This second phase took five months and extended from October 2014 through February 2015. Finally, the Final Report Generation phase extended over the first quarter of 2015. A timeline of the study is depicted below in Table 1. Specific activities undertaken during the first two phases are subsequently described.

Table 1: Timeline of the Air Force SBIR/STTR Program's Economic-Impact Study

PHASES	APR 2014	MAY 2014	JUN 2014	JUL 2014	AUG 2014	SEP 2014	OCT 2014	NOV 2014	DEC 2014	JAN 2015	FEB 2015	MAR 2015
DATA GATHERING	■	■	■	■	■	■	■	■				
DATA ANALYSIS							■	■	■	■	■	
FINAL REPORT										■	■	■

(Photo: U.S. Air Force photo/Senior Airman Donald Acton)

Data Gathering

To undertake this study, TechLink first assembled essential information on all Air Force SBIR/STTR Phase II contracts that were completed during the FY 2000-2013 period. The study focused exclusively on Phase II contracts because Phase I contracts by themselves rarely lead directly to innovations that can be commercialized; instead, they investigate the feasibility of new technology concepts that can subsequently be developed during Phase II. Information on the Phase II contracts came from the Air Force SBIR/STTR awards database.[11] A total of 4,524 Phase II contracts were included in the study.

The essential information gathered for each Phase II contract was entered into a custom database that was developed for this study, to facilitate data gathering and analysis. Essential Phase II contract information included the company name and location, the contract number and award amount, the start and completion dates of the award, names and contact information for the principal investigator and company executive at the time of the award, and award titles and abstracts, which provided background information on the technology being developed.

In addition, a secondary database was created listing all SBIR and STTR awards, from any agency, that had been given to the Air Force Phase II recipients included in this study. This was to allow the research team and company representatives being interviewed to better distinguish results from the specific Air Force contract under review from the companies' other SBIR/STTR awards. It also permitted later secondary analysis of company commercialization performance compared to their overall success in winning SBIR/STTR awards. This database included 62,828 SBIR/STTR awards out of the SBA's total listing of over 146,000 awards. A total of 131 companies in this study had received 100 or more total SBIR/STTR awards (Phase I and Phase II, any agency), with one company having secured over 1,500 total SBIR/STTR awards.

A team of four TechLink economic research specialists used the Phase II information and databases to contact each of the companies involved. They attempted to contact by email and telephone all 1,750 Phase II recipients about the outcomes of their 4,524 Air Force Phase II contracts. The number of contracts exceeds the number of companies because a sizeable subset of companies included in the study (830, or 47 percent) had two or more Air Force SBIR/STTR Phase II contracts. Of this group, 504 companies (29 percent) had three or more Air Force Phase II contracts, 340 (19 percent) had four or more contracts, and one company had 54 total Air Force Phase II contracts. This data-gathering phase lasted from April through November 2014.

[11] *Available online at http://www.afsbirsttr.com/TechSearch/Default.aspx.*

Survey Questions

Companies were asked a series of questions that focused on the economic outcomes and impacts related to their Air Force SBIR/STTR Phase II contracts. They were assured that their responses would be treated as confidential information and that, in order to conceal their identity, their responses would be aggregated with the responses of other companies and submitted to the Air Force without any company names.

Basic questions included the following:

1 Did your company develop any new products or services based on your Air Force SBIR/STTR Phase II contract(s)? If so, what were the total cumulative sales of these new products or services for each contract?[12]

2 Of the total sales for each Air Force Phase II contract, what was the dollar value of sales to the U.S. military, either directly or through a prime contractor?

3 Did the Phase II contract(s) lead to any follow-on R&D contracts for further development of the technology or technologies resulting from Phase II? If so, what was the total dollar value of these contracts?

4 Did you license any of the technologies developed with Air Force Phase II funding to another company? If so, what were the total royalties received from each licensee? What is the name of the licensee, so we can follow up to ask it about its sales?

5 Did you create a spin-out company to commercialize any of the technologies developed with Air Force SBIR/STTR Phase II funding? If so, what is the name of the company, so we can ask it about its sales?

6 Did you receive any significant subsequent investment funding, such as venture capital or angel funding, directly related to the technology developed or commercialized? If so, what was the total amount of these investments?

7 Was your company acquired as a direct result of the technology or technologies developed with Air Force SBIR/STTR Phase II funding? If so, what was the acquisition amount?

[12] *Companies were not asked to report their sales by year because this would have greatly increased the burden of responding to the survey and, consequently, lowered the response rate.*

Response Rate OVER 96%

The response rate was over 96 percent. The research team was able to obtain definitive information on the outcomes of 4,346 contracts out of the 4,524 total. This equals an effective response rate of slightly over 96 percent with regard to the contracts. Only 64 of the Phase II recipient companies, with a combined total of 120 contracts, openly refused to participate or were non-responsive, despite multiple efforts to secure the necessary information. They represent only 3 percent of the 1,750 companies in the study, yielding an effective company response rate of 97 percent.

An additional 32 companies, with a combined total of 58 contracts, could not be contacted because they had ceased to operate as corporate entities. These companies had gone out of business, changed their names, or been acquired by other companies and had left no trails that could be followed. Rigorous attempts were made to track down individuals who might know about the outcomes of their Phase II contracts. In a few cases, these efforts were successful. However, 32 companies had left no traces.

The primary reasons for the study's high response rate are believed to be the following:

Clear communication about the purpose and legitimacy of the study.

Companies were informed that the study's purpose was to quantify the extent to which the Air Force SBIR/STTR Program was having a positive impact on the national economy and U.S. defense mission, and that the results would be communicated to Air Force policymakers, other government agencies, Congress, and the U.S. public. Companies that questioned the legitimacy of the study were sent a letter from the Air Force SBIR/STTR program manager that explained the purpose, confidential nature, and importance of the study as well as TechLink's role in undertaking it.

Strong assurance that company-specific information would be kept confidential.

Companies were assured that the Air Force was only interested in the overall economic impacts from its SBIR/STTR Program—not in company-specific results. Most companies consider their sales figures to be confidential, proprietary, or business-sensitive. Without the assurance that all responses would be treated as confidential information, few companies would have been willing to divulge their sales information.

Extensive research to find current contact information.

Because of the long time span covered by the study and the impermanent nature of many small R&D companies, the contact information for principal investigators and company executives in the Air Force SBIR/STTR awards database was no longer valid in many cases. Among other things, telephone area codes had changed; companies had gone out of business, moved, or merged with other firms; and the key people had changed positions, moved to other companies, retired, or even died. The research team expended extensive time and effort to find people knowledgeable about the outcomes of the Air Force SBIR/STTR Phase II contracts.

Persistence by the TechLink economic research specialists.

Some companies were contacted more than a dozen times by email or telephone in the attempt to get through to the right person and obtain the necessary information. Several different approaches were tried to secure compliance from recalcitrant companies, including having other team members contact the company, approaching different company personnel, and sending a request by registered mail.

Conciseness of the survey.

The survey questions were few in number and relatively easy to answer. In many cases, the research team was able to secure the necessary information over the telephone on the first contact. More commonly, extensive follow-up by phone and email was required, often involving several different company personnel. However, the conciseness of the survey encouraged participation.

SEEDING SUCCESS

Secure Fingerprint Biometric

An Air Force Security Forces airman conducts a random biometrics systems check as part of the Air Force base's antiterrorism measures. The check matches identification-card holders with their fingerprints. (U.S. Air Force photo/Senior Airman Andria J. Allmond).

Fingerprints have been used to identify people since the early 1900s and are still a leading biometric today. Apple Computer's iPhone 5s, for example, has a Touch ID sensor that can be used to limit access to the device. However, fingerprint verification is plagued with the problem of "spoofing." Prints can be easily lifted for criminal purposes with gelatin or a latex mold, and digits of deceased individuals can also be effectively used.

An Albuquerque, New Mexico-based biometrics identification firm, Lumidigm, addressed the problem by developing a fingerprint authentication system with Air Force SBIR funding. This technique uses multispectral imaging to capture an individual's unique fingerprint image, including characteristics under the skin, to determine if the tissue fingerprinted is live.

Today, Lumidigm fingerprint sensors are used globally for authentication in the banking, healthcare, government, transportation, and retail sectors. The company's annual growth rates have been above 30 percent for the past decade. Lumidigm is now owned by HID Global headquartered in Austin, Texas.

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NAICS Code Assignments

TechLink next assigned each Phase II recipient company to the appropriate 6-digit North American Industry Classification System (NAICS) code or codes specific to that company or commercial outcome. This was an essential step for analysis of the overall economic impacts. NAICS codes are one of the most important inputs to the economic-impact model, IMPLAN (described below), because they are used to accurately determine the economic multipliers specific to the particular industrial activity. NAICS is the U.S. federal government's standard industry classification system. It is a comprehensive production-oriented system that groups companies and divisions of companies into industries based on the activities in which they are primarily engaged. NAICS recognizes 1,065 different industries in the United States and assigns a unique code to each industry.

For analysis of the economic impacts resulting from the Air Force SBIR/STTR Phase II R&D activity itself, all companies in this study were assigned to NAICS code 541712, titled "Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)."[13] In addition, companies that had commercialized the results of this R&D were assigned a second NAICS code for analysis of sales of the specific product or service. Companies with multiple Air Force SBIR/STTR contracts generating sales were frequently assigned to more than one NAICS code. For example, if a company developed an innovative laser with Air Force SBIR/STTR Phase II funding, then manufactured and sold this laser and, in addition, received a follow-on R&D contract to further develop the laser for a specific aerospace application, it would be assigned two different NAICS codes, one specific to the manufacturing and another for the R&D activity.

To identify the appropriate NAICS codes, multiple sources were referenced, including Hoover's (www.hoovers.com), the LexisNexis Academic web site (www.lexisnexis.com), a commercial NAICS-related website (www.naics.com) that provides a convenient system for looking up NAICS codes by industry sectors and subsectors, and the federal System for Award Management (www.sam.gov), which contains NAICS codes self-identified by the companies. For businesses not listed on these sites, the classification tree at the official U.S. government's NAICS code website (http://www.census.gov/eos/www/naics/) was compared to activity reported by the companies in their interviews with the TechLink team to arrive at the appropriate NAICS codes. (See Appendix 1 for a list of all NAICS codes assigned to companies in this study.)

The TechLink research team entered company sales and other economic data and NAICS code information into the custom database developed for this study. The database greatly facilitated data entry from the multiple economic research specialists gathering company information. Once the data were aggregated and carefully validated by the team, the database provided mechanisms for quickly querying and analyzing the data as well as generating a final dataset for economic-impact modeling.

TechLink subsequently submitted the final dataset to the Business Research Division (BRD) at the Leeds School of Business, University of Colorado Boulder. The dataset included—for each Air Force SBIR/STTR contract that had achieved sales (including royalties from licensing)—a code number to identify the agreement and conceal the company's name, the 6-digit NAICS code for the corresponding product or service, and the total sales figures.

The "sales" category included all sales of new products and services directly related to the technologies developed with the Air Force SBIR/STTR funding, including military sales; follow-on R&D contracts to further develop these technologies for specific applications (defined as sales of R&D services); royalties from licensees of the technologies developed with the Air Force SBIR/STTR funding; licensee sales of the licensed Air Force SBIR/STTR-developed technologies, when this information could be obtained; and sales by spin-out companies of the Air Force SBIR/STTR-developed technologies, when this information was available.

[13] *This was the approach used in the 2014 NASA study: National Aeronautical and Space Administration, 2014, SBIR/STTR Economic Impact Report, FY 2012, Washington, DC: NASA.*

(Photo: U.S. Air Force photo/Airman 1st Class Chris Drzazgowski)

Data Analysis

The BRD employed a widely used economic-impact analysis software program, IMPLAN, to estimate the economic contribution effects of the total sales resulting from the Air Force SBIR/STTR Phase II contracts. More than 1,500 entities in academia, the private sector, and government use IMPLAN to model economic impacts. It is employed to determine economic impacts on regions ranging in size from zip code area to county, state, and national levels (www.implan.com).

IMPLAN draws on a mathematical input-output framework originally developed by Wassily Leontief, the 1973 Nobel laureate in economics, to study the flow of money through a regional economy. IMPLAN assumes fixed relationships between producers and their suppliers, based on demand, and that inter-industry relationships within a given region's economy largely determine how that economy responds to change. Increases in demand for a certain product or service causes a multiplier effect—a cascade of ripples through the economy. This increased demand affects the producer of the product, the producer's employees, the producer's suppliers, the supplier's employees, and others, ultimately generating a total impact on the economy that significantly exceeds the initial change in demand.

For example, Company X develops a laser-based eye surgery device with its Air Force SBIR/STTR Phase II contract, which it then manufactures and sells nationwide. This requires it to hire factory workers, who spend their payroll checks on groceries and other goods. In addition, Company X has to purchase components and raw materials from other companies, which also employ workers who purchase groceries and other goods, and so on.

In this example, direct effects are the sales of the eye surgery device developed with Air Force funding. Indirect effects are the inter-industry purchases of components and raw materials needed to manufacture this device. Induced effects are the household expenditures as workers spend their payroll checks on goods and services across a wide spectrum of the economy. Economic impacts are the sum of direct effects, indirect effects, and induced effects. Multipliers are the ratio of the overall economic impact to the initial change and are typically derived from the following equation: (direct effect + indirect effect + induced effect) / direct effect. Multipliers are very specific to industry sectors and regions. IMPLAN uses NAICS codes to distinguish between 536 industry sectors recognized by the U.S. Department of Commerce. Each sector has a unique output multiplier because it has a different pattern of purchases from firms inside and outside of the regional economy. Each year, IMPLAN is updated using data collected by various federal government agencies.

In this study, the BRD converted the NAICS codes provided by TechLink to the 536-sector IMPLAN input-output model, then applied this model to (1) the Air Force SBIR/STTR Phase II R&D activity, and (2) the total sales figures directly attributable to the sales of the innovations resulting from this activity. As previously indicated, these sales figures included all sales of products and services related to the Air Force SBIR/STTR Phase II contracts completed during the FY 2000-2013 period. Using IMPLAN, BRD was able to estimate the sum of the direct, indirect, and induced effects of these sales. The overall purpose of this modeling exercise was to estimate the total economic contribution of these sales to the nation's economy, including total economic output, value added, employment, and labor income.

Data presented are for the year 2013 accounting period and are expressed in 2013 dollars. The large majority of the company sales occurred prior to 2013 and some date back to the early 2000s. However, many of these sales are ongoing and there was a need to standardize the year. Use of 2013 as the reference year represents a conservative approach because it does not consider the relatively higher value of the earlier sales figures due to inflation: a dollar in 2013 was worth 35.3 percent less than a dollar in 2000.[14]

[14] *Per the U.S. Bureau of Labor Statistics Consumer Price Index (CPI) Inflation Calculator, available online at http://www.bls.gov/data/inflation_calculator.htm.*

(U.S. Air Force photo/Senior Airman David Owsianka)

Survey Results

Sales from Air Force SBIR/STTR Phase II contracts

Well over half of the Air Force SBIR/STTR Phase II contracts resulted in commercialization (see Table 2). Of the 4,524 Phase II contracts, 2,631 resulted in sales—a total of 58 percent.[15] Of the rest, 1,715 (38 percent) did not result in sales and 178 (4 percent) consisted of contracts awarded to companies that were unwilling to provide information or were no longer contactable because they had ceased to exist as corporate entities. Ultimately, the commercialization level achieved by these Air Force SBIR/STTR Phase II contracts may be significantly higher—it usually takes 2 to 8 years to convert a new technology into a product.

Total cumulative sales from the Air Force SBIR/STTR Phase II contracts were nearly $14.7 billion ($14,691,776,039). This equates to average sales of approximately $5.6 million for each of the 2,631 contracts that achieved commercialization. This sales figure is over 6 times the average contract amount of $882,084. The average sales per contract, when considering all of the Air Force Phase II awards, including those without commercialization success, was slightly over $3.2 million. This is 3.6 times the size of the average contract amount, demonstrating that the Air Force SBIR/STTR Program achieved substantial commercialization success from its funding of small R&D companies nationwide.

Table 2: Sales resulting from Air Force SBIR/STTR Phase II contracts, 2000-2013

AIR FORCE SBIR/STTR PHASE II CONTRACTS	Total Number Of Contracts	Percent of Total	Total Sales *$ Billions*
TOTAL CONTACTS	4,524	100	$14.692
Contacts With Sales	2,631	58	$14.692
Contacts Without Sales	1,715	38	———
Companies Not Responding	178	4	———

As previously noted, the "sales" category included all of the following sources of revenue from commercialization of the technologies developed with Air Force SBIR/STTR Phase II funding:

- Sales of new products and services, including both commercial (civilian) sales and sales to the U.S. military
- Follow-on R&D contracts to further develop these Air Force SBIR/STTR-developed technologies for specific applications (these were treated as sales of R&D services)
- Royalties accruing to the Air Force SBIR/STTR Phase II contract recipients from sales by licensees of the technologies developed with the Air Force funding
- Sales by licensees of the Air Force SBIR/STTR-developed technologies—when this information could be obtained
- Sales by spin-out companies that were commercializing the Air Force SBIR/STTR-developed technologies—when this information was available

Product and service sales. Table 3 shows the total sales from the Air Force SBIR/STTR Phase II contracts, broken down by sales category. As this table shows, commercial (civilian) product and service sales totaled slightly over $6.3 billion and accounted for 43 percent of the total sales. Military product and service sales were nearly $4.4 billion and constituted 30 percent of the total. However, they accounted for approximately 41 percent of the total product sales. This high level of sales indicates that the Air Force SBIR/STTR Program is achieving its objective of developing new technology to support the U.S. defense mission.

Table 3. Sales from Air Force SBIR/STTR Phase II contracts, by sales category

SALES CATEGORY	Total Sales *$ Millions*	Percent of Total
Commercial Product/Service Sales	$6,329	43
Military Product/Service Sales	$4,386	30
Follow-on R&D Contracts	$3,545	24
Royalties From Licensees	$60	0.5
Sales By Licensees	$268	2
Sales By Spin-Out Companies	$104	0.5
TOTAL	**$14,692**	**100**

[15] *This commercialization level is higher than the 48 percent reported for DoD SBIR/STTR Phase II projects as a whole in the NRC study, National Research Council, 2014, SBIR at the Department of Defense, Washington, DC: The National Academies Press.*

Follow-on R&D contracts, to further develop the technologies generated with Air Force SBIR/STTR funding, totaled around $3.5 billion and accounted for 24 percent of the total. This R&D funding came from the government and private sectors and included Phase III contracts as well as additional, directly related SBIR/STTR contracts from other federal government agencies.

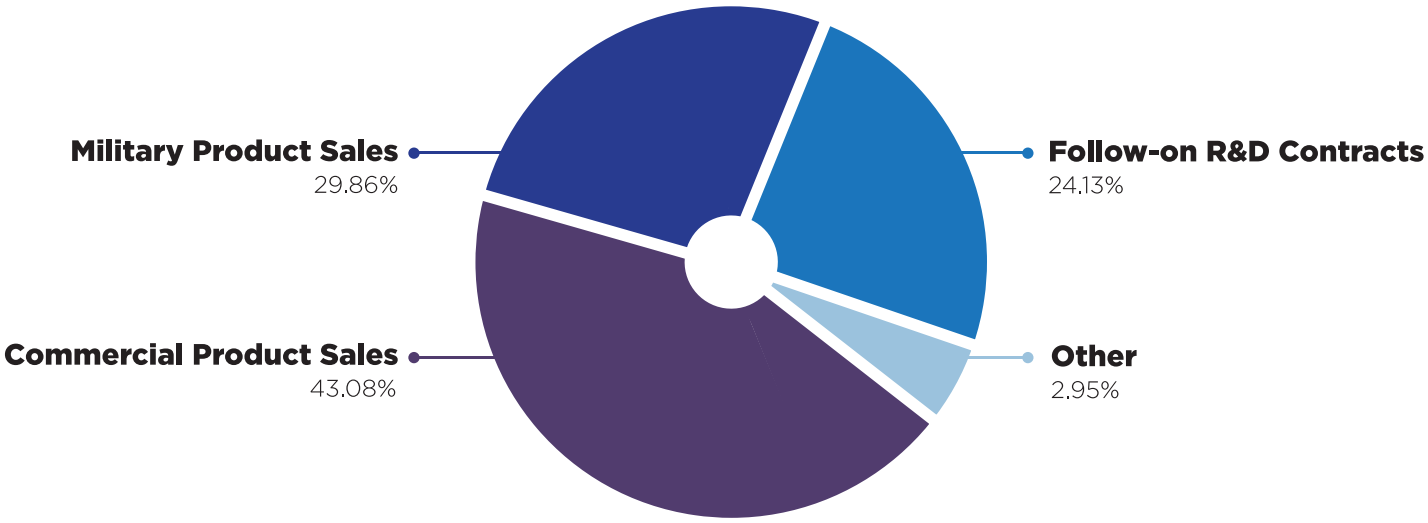
Other sales. Royalties resulting from licensee sales of the technologies developed with Air Force Phase II funding were around $60 million. Sales by licensees were reported to be $268 million. Sales by spin-out companies, of which there were 125, totaled $104 million. Together, the last three categories accounted for only 3 percent of the total sales.

The most productive SBIR/STTR Phase II contract generated nearly $1.5 billion in commercial product sales. This amount was nearly 3 times larger than sales from the second most successful Phase II contract, which generated approximately $560 million in commercial product sales. A total of 23 Phase II contracts had sales exceeding $100 million; 220 had sales exceeding $10 million; 1,151 had sales of more than $1 million; and 1,192 had sales larger than $882,084, which was the average size of the Air Force SBIR/STTR Phase II contract.

Virtually all of the $14.7 billion in sales was clustered in just three industry sectors. "Manufacturing" accounted for around $9.4 billion of the sales, or 64 percent. "Professional, Scientific, and Technical Services" accounted for some $4.2 billion, representing 29 percent of the total. "Information" accounted for slightly less than $1 billion, or nearly 7 percent. Together, these three sectors accounted for 99.6 percent of all sales.

Figure 1 below presents a more readily understandable summary of the total sales from all Air Force SBIR/STTR Phase II contracts that were completed during the FY 2000-2013 period, broken down by sales category.

Figure 1. Sales Results by Sales Category



Sales Figures Understate the Reality.

For several reasons, total sales figures obtained by this survey are probably significantly smaller than the actual total sales resulting from Air Force SBIR/STTR Phase II contracts completed during the 2000-2013 period. Reasons include the following:

Non-responding companies

Sales information was not available from a significant number of companies. As previously noted, 96 companies with a total of 178 Air Force SBIR/STTR Phase II contracts did not participate in the study—64 because they declined to participate and another 32 that were uncontactable because they had ceased to operate as corporate entities. Many of the non-compliant companies are believed to have substantial sales. For example, a sizeable number were large corporations that had acquired Phase II recipient companies because of the commercial strength of the technologies developed with Air Force SBIR/STTR funding.

Licensee underreporting of sales and underpayment of royalties

Another reason why the total reported sales, as well as the royalties from such sales, are believed to be substantially larger than this survey discovered is that underreporting is common in the licensing world. Historic royalty audit data from the Invotex Group, a well-established accounting and intellectual property management company, reveals that over 80 percent of licensees underreport and underpay royalties to their licensors.[16] There are various reasons why royalties are underreported. However, the Invotex Group found that at least half of the licenses it audited had underreported sales.

Licensee sales information generally unavailable

The total sales figures also underreport the reality because they do not include most of the licensee sales. Companies reported that they had licensed a total of 180 technologies. However, the TechLink team was able to obtain sales information for only 48 (27 percent) of these licensed technologies. Many companies declined to identify their licensees or to divulge what they knew of licensee sales. In cases where the licensees were identified and contact information was provided, the licensees proved to be resistant. For the most part, licensees did not feel obligated to participate in this study and were not responsive to requests for information on their sales.

Sales information for spin-out companies generally unavailable

The total sales figures do not include most of the sales by companies spun out of the Phase II recipient companies to commercialize the technologies developed with Air Force SBIR/STTR funding. A total of 125 companies reported that they had created spin-out companies. However, the TechLink team was able to obtain sales information for only 27 of these companies (22 percent). As in the case of licensees, most of the spin-out companies did not feel obligated to participate in this study and were not responsive to requests for information on their sales.

Inflation

Finally, inflation contributes, in effect, to an under-valuation of sales. All sales data are expressed in 2013 dollars as previously discussed. However, some of the company sales date back to the early 2000s and most occurred prior to 2013. Use of 2013 as the reference year does not consider the higher value of the earlier sales figures. For example, a dollar in 2013 was worth 35.3 percent less than a dollar in 2000, and 15.6 percent less than a dollar in 2005.[17]

For all of the above reasons, the total sales figures reported in this survey are conservative and substantially understate the actual total sales resulting from Air Force SBIR/STTR Phase II contracts completed during the FY 2000-2013 period.

[16] *D.R. Stewart and J.A. Byrd, "The Significance of Underreported Royalties-2007 Update: The Magnitude and Meaning of Royalty Misreporting," Invotex Group, Baltimore, MD, February 2007, online at: www.lawseminars.com/materials/07LICIL/licil%20m%20stewart2.pdf; D.R. Stewart and J.A. Byrd, "89% of Royalty Revenue is Underreported! Top Five Questions You Should Ask Your Licensee to Avoid Becoming a Statistic," Invotex Group, Baltimore, MD, April 2012, online at: www.invotex.com/assets/2012_Royalty_Audit_Article.pdf.*

[17] *U.S. Bureau of Labor Statistics Consumer Price Index (CPI) Inflation Calculator, available online at http://www.bls.gov/data/inflation_calculator.htm*

Commercialization Success was Inversely Related to the Number of Awards

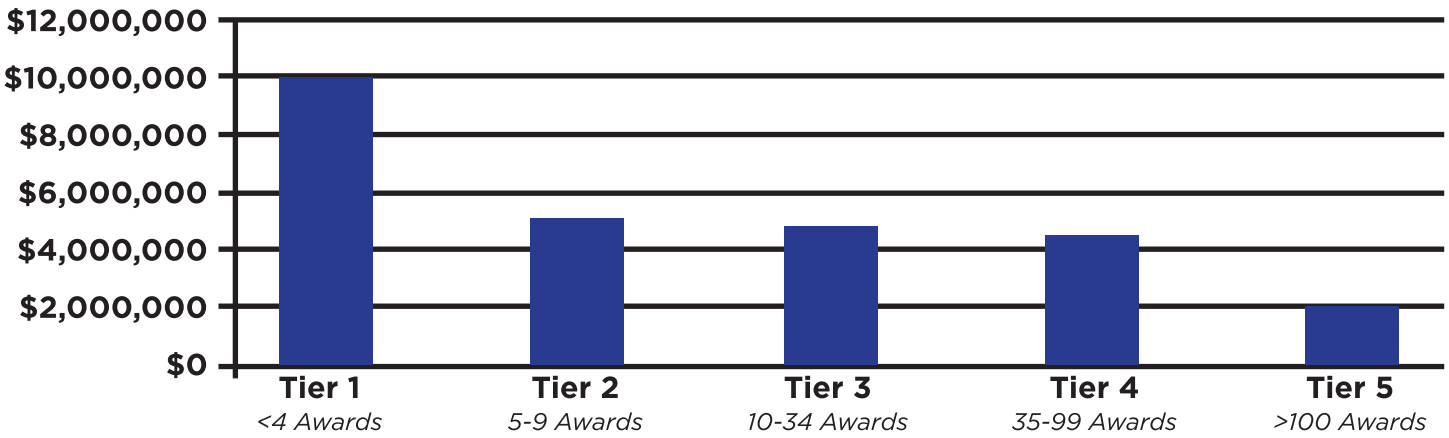
One of the study's surprising discoveries is that the commercialization success of the companies receiving Air Force SBIR/STTR Phase II contracts is on average inversely related to the total number of SBIR/STTR awards (Phase I and II) received by those companies from any federal agency. That is, the more SBIR funding they received, the less successful they were at converting that funding into new products and services that achieved commercial sales and/or supported the U.S. defense mission. This finding runs counter to the common wisdom in many SBIR circles, which is that the "most successful" companies are those that secure the most SBIR awards.

For purposes of analysis, the companies in the study were divided into tiers, based on the total number of Phase I and Phase II SBIR/STTR awards that they had received from the U.S. government, regardless of the federal agency:

- **Tier 1 companies:** 4 or fewer total awards
- **Tier 2 companies:** 5 to 9 awards
- **Tier 3 companies:** 10 to 34 awards
- **Tier 4 companies:** 35 to 99 awards
- **Tier 5 companies:** 100 or more total SBIR/STTR awards.

Tier 1 companies were generally the most successful at commercializing technologies developed with Air Force SBIR/STTR Phase II funding, and Tier 5 companies were, on the whole, the least successful. Table 4 shows the strong inverse relationship between the number of awards and commercialization success.

Table 4. Sales from Air Force SBIR/STTR Phase II Contracts Related to Number of Awards



This table shows that Tier 1 companies, with 4 or fewer total SBIR/STTR awards, achieved sales averaging nearly $10 million ($9,941,387) from each Air Force SBIR/STTR contract that achieved sales. This was five times the average of slightly less than $2 million ($1,978,740) in sales achieved by Tier 5 companies, which had each received 100 or more awards. It was also twice the average achieved by Tier 2 companies ($5,021,508). Average sales for Tier 3 companies were $4,517,090, followed by $4,516,062 for Tier 4 companies. As earlier noted, the average for all companies with sales was $5.6 million. This means that the Tier 1 companies were so successful, they raised the average of all contracts in the survey above that achieved in any of the other tiers.

Tier 1 companies accounted for four out of five of the most successful Air Force SBIR/STTR Phase II contracts (the other was a Tier 4 contract). Of the 23 contracts that achieved sales of $100 million or more, Tier 1 accounted for ten contracts, Tier 2 for four, Tier 3 for six, Tier 4 for two, and Tier 5 for one.

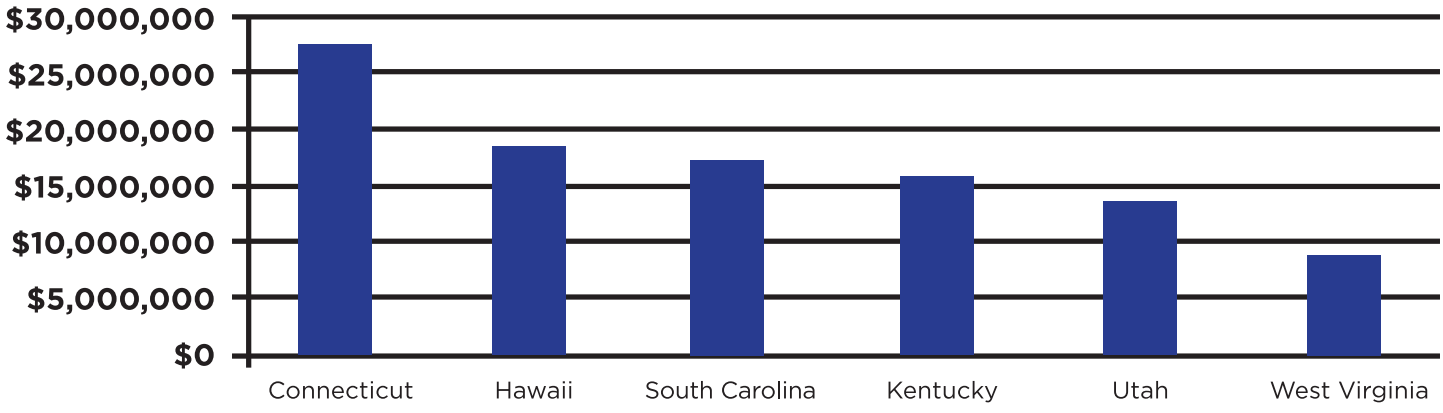
Underserved States Were More Successful at Commercialization, but Received Substantially Fewer Awards

Another surprising discovery is that, on average, the companies that were most successful at commercializing technologies developed with Air Force SBIR/STTR Phase II funding were located in states classified by the SBA as "underserved," as measured by the number of total SBIR/STTR awards received. The SBA considers 27 states and territories (subsequently referred to as "states") to be underserved: Alaska, Arkansas, District of Columbia, Delaware, Hawaii, Iowa, Idaho, Kansas, Kentucky, Louisiana, Maine, Missouri, Mississippi, Montana, North Dakota, Nebraska, Nevada, Oklahoma, Puerto Rico, Rhode Island, South Carolina, South Dakota, Tennessee, Utah, Vermont, West Virginia, and Wyoming.[18]

The present study found that, on average, companies in the SBA underserved states significantly outperformed companies in the other states in commercialization success. Their average sales amount per contract (among contracts generating sales) was $6.6 million, compared to $5.5 million for companies in other states. For all contracts, the sales per contract in SBA underserved states averaged $4.1 million, versus $3.2 million for the other states. Moreover, companies in underserved states achieved sales with 63 percent of their Air Force Phase II contracts, compared to 55 percent for companies in the other states.

Impressively, the SBA underserved states accounted for 5 of the "Top 6" states for average commercialization success (see Table 5). These underserved states were Hawaii, South Carolina, Kentucky, Utah, and West Virginia. Connecticut was the only non-underserved state in this top-performing group. Phase II contract recipients in Hawaii achieved average sales of $19.1 million from their Air Force SBIR/STTR innovations—well over three times the national average for contracts with sales and six times the average for all contracts. Companies in the other SBA underserved states in this top group had sales that were roughly 3 to 5 times the average for all contracts.

Table 5. The "Top 6" States for Average Sales Resulting from Air Force SBIR/STTR Phase II Contracts



[18] *SBIR/STTR Outreach, The Small Business Innovation Research (SBIR) & Small Business Technology Transfer (STTR) Program Interagency Policy Committee Report to Congress, Office of Science and Technology, Small Business Administration, September 15, 2014*

Despite the greater commercialization success of companies in the underserved states, the 27 SBA underserved states received only 6 percent of the Air Force SBIR/STTR Phase II awards in this study.[19] The remainder of the awards went to the other states. In fact, slightly over half (50.1 percent) of all Air Force Phase II awards in the study were concentrated in just four states: California, Massachusetts, Ohio, and Colorado. (See Appendix 2 for a breakout of the Air Force SBIR/STTR Phase II awards by state.)

The small 6-percent number of awards to SBA underserved states, found in this study, is similar to the percentage of awards to SBA underserved states from all federal SBIR/STTR programs: 8.2 percent of all awards (Phases I and II) during the period from 1983 to 2014.[20] Because the SBA underserved states have a much smaller population, this lower award level might initially seem appropriate. However, the underserved states do constitute a fifth of the total U.S. population (21 percent per 2010 census figures), a significantly higher percentage than the SBIR/STTR award levels. When normalized for population, companies in the underserved states received only 24 percent of the total Air Force SBIR/STTR Phase II awards.[21]

This is the first study able to quantify the commercialization success of companies in SBA underserved states versus companies in the rest of the United States. The disconnect between the significantly greater commercialization success of companies in the SBA underserved states and the substantially lower number of Phase II awards warrants further investigation and indicates an area for possible targeted intervention.

Other Economic Outcomes and Impacts

In addition to sales, the companies in the study reported other significant economic outcomes and impacts. The total outside investment funding (including venture capital and angel funding) directly related to the innovations developed with Air Force SBIR/STTR Phase II contracts was reported to be approximately $1.9 billion. The number of companies that were acquired primarily because of the technology developed with Air Force SBIR/STTR funding was **225**, with a total acquisition value reported to be around $6.8 billion. However, this figure certainly understates the actual value. A large majority of acquired companies stated that the terms of acquisition prevented them from disclosing the acquisition amount. Finally, companies in the study reported that they had licensed 180 technologies to other companies, and that they had created a total of 125 spin-out companies specifically to commercialize 147 of the technologies developed with Air Force SBIR/STTR Phase II funding. These other economic outcomes and impacts are summarized below:

- **Total outside investment funding:**
  $1,872,054,662
- **Number of companies that were acquired:**
  225
- **Total acquisition value of companies acquired:**
  $6,768,331,783
- **Number of technologies licensed to other companies:**
  180
- **Number of spin-out companies created:**
  125
- **Number of technologies being commercialized by spin-outs**
  147

[19] *Per the Air Force SBIR/STTR awards database, the SBA underserved states received 267 Phase II contracts out of a total of 4,524 contracts included in the study period.*
[20] *Per the Small Business Administration SBIR/STTR Awards database at the time of this analysis, underserved states received a total of 11,970 SBIR/STTR awards, out of a total of 146,434 awards nationally. See www.sbir.gov/past-awards.*
[21] *Companies in SBA underserved states completed 4.1 Air Force SBIR/STTR Phase II contracts per one million residents during the FY 2000-2013 study period, versus 17.2 contracts per one million residents for the other U.S. states.*

Economic Impact Analysis

Upon receiving the company sales and six-digit NAICS code data from TechLink, the Business Research Division (BRD) at the Leeds School of Business, University of Colorado Boulder, used the national IMPLAN input-output model to determine the economic impacts of the Air Force SBIR/STTR Phase II contracts completed during the study period, FY 2000-2013. This was undertaken in two stages: (1) IMPLAN analysis of the economic impacts resulting from the nearly $4 billion in Phase II R&D activity; and (2) IMPLAN analysis of the sales of the innovations resulting from this R&D. Results below are presented for output, employment, labor income, and value added. As previously noted, all dollar figures are reported in 2013 dollars.

Output

Output is the total value of all goods or services (including intermediate goods and services) produced during a given time period, whether used for further production or consumed. The concept of national output is an integral part of macroeconomics. Output is closely associated with economic-impact analysis and is one of the values most frequently cited following the completion of economic-impact studies.

Air Force SBIR/STTR Phase II R&D Activity.
According to the national IMPLAN model, the nearly $4 billion (2013 $) in Air Force SBIR/STTR Phase II R&D contracts provided to small businesses throughout the United States generated a total of $10.51 billion in economic output nationwide. Of this amount, around $2.85 billion was generated indirectly as the result of inter-industry purchases (firms purchasing from each other), and $3.67 billion was generated from the induced effect, the result of households spending payroll on goods and services economy-wide (see Table 6).

Dividing the economy-wide output ($10.51 billion) by the direct value of the Air Force SBIR/STTR Phase II contracts ($3.99 billion) yields an output multiplier of 2.64. That is, for every dollar in economic activity directly attributable to the Air Force SBIR/STTR Phase II R&D, an additional $1.64 in economic activity was generated nationwide.

Table 6: Economic Impact of Air Force SBIR/STTR Phase II R&D Activity, FY 2000-2013

IMPACT TYPE	Employment *Job Years*	Employment *Av. per year*	Labor Income *In Billions*	Labor Income *Per Job*	Value Added *In Billions*	Output *In Billions*
Direct Effect	17,978	1,284	$1.64	$91,045	$2.07	$3.99
Indirect Effect	17,806	1,272	$1.06	$59,609	$1.78	$2.85
Induced Effect	23,931	1,709	$1.15	$48,163	$2.03	$3.67
Total Effect	**59,715**	**4,265**	**$3.85**	**$64,486**	**$5.88**	**$10.51**

Sales of Air Force SBIR/STTR Phase II innovations

In addition to the economic output from Phase II R&D, this study examined the output from the subsequent sales of the innovations resulting from this R&D. According to the national IMPLAN model, the $14.7 billion (2013 $) in direct sales of new products and services reported by companies generated an additional $22.7 billion in sales economy-wide. Of this amount, around $11.6 billion was generated indirectly as the result of inter-industry purchases, and $11.1 billion was generated from households spending payroll on goods and services (the induced effect). The total economy-wide output from sales of the Air Force SBIR/STTR Phase II-developed technology was $37.4 billion (see Table 7).

Dividing total economy-wide output ($37.4 billion) by the direct output of companies selling products and services related to their Air Force SBIR/STTR Phase II contracts yields an output multiplier of 2.55. For every dollar in sales directly attributable to the Air Force SBIR/STTR Phase II contracts, an additional $1.55 in sales was generated economy-wide.

Table 7: Economic Impact of Subsequent Company Sales, FY 2000-2013

IMPACT TYPE	Employment *Job Years*	Employment *Av. per year*	Labor Income *In Billions*	Labor Income *Per Job*	Value Added *In Billions*	Output *In Billions*
Direct Effect	47,359	3,383	$4.55	$96,152	$6.79	$14.69
Indirect Effect	55,312	3,951	$3.59	$64,933	$5.95	$11.60
Induced Effect	72,124	5,152	$3.47	$48,169	$6.11	$11.07
Total Effect	**174,795**	**12,485**	**$11.62**	**$66,474**	**$18.85**	**$37.36**

Value Added

Value added is the difference between an industry's or company's output and the cost of intermediate inputs. Expressed differently, it is the difference between a product's sale price and its production cost. This measure recognizes that companies buy goods and services from other companies in order to create products of greater value than the sum of the goods and services used to make these products. This increase in value resulting from the production process is the "value added." As estimated by IMPLAN, value added is equal to the total sales (plus or minus inventory adjustments) minus the cost of the goods and services purchased to produce the products sold.

The main difference between output and value added is that output includes the value of intermediate goods and services, while value added does not. Many economists prefer value added as an economic measure because, at the macroeconomic scale, output multiple-counts the value of inputs. For example, in the previously cited case of Company X, which sells an eye surgery laser device developed with its Air Force SBIR/STTR Phase II contract: Company X purchases laser rods, electronic components, optical components, and various raw materials to make the device. The value of Company X's sales incorporates the value of these laser rods and other inputs. Further, each of the companies from which Company X purchases its inputs incorporates the value of their respective inputs from other companies. By combining and aggregating the values of intermediate and final products, output overstates the size of the US economy by a factor of roughly 2. For this reason, Gross Domestic Product (GDP), a measure of value added, is used to track the size of the U.S. economy because it is a non-duplicative aggregation of production across all industries in the United States. In the current study, value added measures the real contribution that the Air Force SBIR/STTR Phase II contract recipients made to the national economy as a result of receiving that funding.

Air Force SBIR/STTR Phase II R&D Activity

According to the national IMPLAN model, the initial nearly $4 billion in R&D contracts (2013 $) generated an additional $5.88 billion in value added impact economy-wide. Of this total, $2.07 billion was generated directly, $1.78 billion was generated indirectly, and $2.03 billion was generated from the induced effect (see Table 6).

Sales of Air Force SBIR/STTR Phase II innovations

Subsequent IMPLAN analysis showed that the $14.7 billion (2013 $) in sales reported by companies generated $18.85 billion in value added impact economy-wide: $6.8 billion generated directly, $5.9 billion indirectly, and $6.1 billion from the induced effect (see Table 7).

Employment

Employment in this analysis refers to the number of jobs created or sustained by an economic activity. It is a measure of the number of workers (either full-time or full-time equivalent, if part-time) expressed in "job years" (one full-time position for a year).

Air Force SBIR/STTR Phase II R&D Activity

The national IMPLAN model estimated that 17,978 jobs were directly sustained economy-wide by the nearly $4 billion in Phase II R&D activity. Indirect effects were responsible for an additional 17,806 jobs, and induced effects for 23,931 jobs. The IMPLAN model estimates that, altogether, 59,715 jobs nationwide resulted from the direct, indirect, and induced effects of the Air Force SBIR/STTR Phase II R&D activity (see Table 6).

Sales of Air Force SBIR/STTR Phase II innovations

According to the national IMPLAN model, the $14.7 billion in sales directly sustained an estimated 47,359 jobs economy-wide. Indirect effects were responsible for an additional 55,312 jobs, and induced effects for 72,124 jobs. The IMPLAN model estimates that, altogether, 174,795 jobs nationwide resulted from the direct, indirect, and induced effects of the sales of Air Force SBIR/STTR Phase II innovations (see Table 7).

SEEDING SUCCESS

Lifesaving Emergency Medical Device

An Air Force combat medical technician simulates inserting an intraosseous device in a casualty during a joint tactical exercise designed to provide realistic military training in an urban setting. *(U.S. Air Force photo by Airman 1st Class Jasmonet Jackson)*

In emergency medicine, many patients urgently need intravenous (IV) infusion at the very moment that their veins are inaccessible to traditional IV needles. Severe shock from injury or heart failure causes peripheral veins to collapse.

In 2006, San Antonio-based Vidacare received Air Force SBIR/STTR Program funding, which led to development of the EZ-IO Intraosseous Infusion System used today. EZ-IO provides a rapid, near-foolproof way of getting blood, rehydration fluids, or medicine into a patient's circulation system by injecting these fluids into bone marrow, a process that is nearly painless.

The device, battery-operated and about the size of a glue gun, is lifesaving in cases of cardiac arrest, major trauma, shock, sepsis, and extreme dehydration. EZ-IO has an impressive 97 percent success rate, much higher than achieved with standard IVs.

To date, roughly 3 million EZ-IO units have been purchased in over 50 countries, with many more provided gratis for humanitarian relief efforts, resulting in tens of thousands of lives saved. In the U.S., an EZ-IO kit is carried in 95 percent of all ambulances and about 85 percent of emergency departments. The EZ-IO system is also widely used by the U.S. military. In 2013, Vidacare was acquired by Teleflex, a global provider of medical devices used in critical care and surgery.

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Labor Income

Labor income consists of employee compensation (wage and salary payments, including benefits), paid to workers as well as proprietary income (income received by self-employed individuals).

Air Force SBIR/STTR Phase II R&D Activity

The national IMPLAN model estimated that labor income directly associated with the nearly $4 billion in Phase II R&D activity was $1.64 billion in 2013, or approximately $91,045 per job (see Table 6). This was 83 percent higher than the average annual pay in the U.S. in 2013 of $49,808.[22] The indirect labor income was estimated at $1.06 billion, or approximately $59,609 per job. The induced labor income was estimated to be $1.15 billion, or $48,163 per job. Average wages for the indirect and induced jobs were substantially lower than the average wage for the jobs directly created or retained because many of these jobs were in lower-paid manufacturing and service sectors. Together, the indirect and induced labor income amounted to $2.21 billion. The total economy-wide labor income resulting in 2013 from the Air Force SBIR/STTR Phase II R&D activity was $3.85 billion. The average wage of the approximately 59,715 jobs created or retained as a result of the Air Force SBIR/STTR Phase II activity was $64,486, approximately 29 percent higher than the average U.S. wage of $49,808 in 2013.

Sales of Air Force SBIR/STTR Phase II innovations

According to the national IMPLAN model, the labor income directly associated with the $14.7 billion in sales reported by companies was $4.6 billion in 2013, or approximately $96,152 per job (see Table 7). This was nearly twice the average U.S. wage in 2013. The indirect labor income was estimated at $3.6 billion, or approximately $64,933 per job. The induced labor income was estimated to be $3.5 billion, or $48,169 per job. The total economy-wide labor income resulting in 2013 from sales of the Air Force SBIR/STTR Phase II innovations was $11.6 billion. The average wage of the approximately 174,795 jobs created or retained as a result of the Air Force SBIR/STTR Phase II contracts was $66,474, approximately 33 percent higher than the average U.S. wage of $49,808 in 2013.

[22] *Bureau of Labor Statistics, Quarterly Census of Employment and Wages, www.bls.gov.*

Tax Revenue

Tax revenues were estimated for the nearly $4 billion in Air Force Phase II R&D activity and $14.7 billion in subsequent sales, including their associated economy-wide indirect and induced effects. These tax revenues included social insurance taxes (paid by employers, employees, and the self-employed), personal income taxes, motor vehicle licenses, property taxes, corporate profits taxes and dividends, and indirect business taxes (comprised mainly of excise and property taxes, fees, licenses, and sales taxes). Total taxes collected by federal, state, and local government entities were estimated at $3.9 billion. This included $1.25 billion in tax revenues on direct sales, $1.24 billion on indirect sales, and $1.41 billion on induced sales (see Table 8).

SUMMARY

NEARLY

$48B

In Economic Impact

In summary, this study estimated the economic contribution to the U.S. economy of Air Force SBIR/STTR Phase II contracts completed during the FY 2000-2013 period. Its purpose was to determine the extent to which these contracts both contributed to new economic activity and job creation in the United States, and resulted in the transition of new technology to U.S. military use.

The research team contacted 1,750 companies that completed SBIR/STTR Phase II contracts from the Air Force during the FY 2000-2013 period. A total of 4,524 Phase II contracts were included in the study because some companies had multiple contracts. Companies were asked to divulge the total sales of new products and services directly related to their Air Force SBIR/STTR Phase II contracts. They were also asked about their related sales to the U.S. military (either directly or through a defense contractor) as well as follow-on R&D contracts, licensing revenue, and sales by licensees and spin-out companies.

Companies reported that 58 percent of their Air Force Phase II contracts—2,631 out of 4,524—resulted in sales. Collectively, they reported approximately $14.7 billion in total sales and nearly $4.4 billion in military product sales (in 2013 dollars). Other significant economic outcomes directly related to the innovations developed with Air Force SBIR/STTR Phase II funding included outside investment funding of around $1.9 billion, 225 company acquisitions with a total acquisition value of well over $6.8 billion (the majority of companies were unable to disclose the acquisition terms), 180 technologies licensed to other companies, and a total of 125 new spin-out companies.

IMPLAN economic-impact assessment software was used to estimate the total economic impacts related to both the Air Force SBIR/STTR Phase II R&D activity and subsequent sales of new technologies developed with this R&D. Impacts analyzed included economic output, value added, employment, and labor income. Total economy-wide sales, as measured by output, were estimated at $47.87 billion. Value added was estimated at $24.73 billion, representing new wealth creation in the economy. Labor income in 2013 was estimated at $15.47 billion. Employment impacts included 234,511 total job years, or an average of 16,751 jobs per year, with an average wage of approximately $65,968. Table 8 summarizes the total economic contribution of the Air Force SBIR/STTR Program.

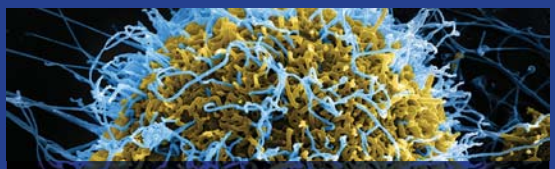
Table 8. Nationwide Economic Impacts from Air Force SBIR/STTR Phase II Contracts, FY 2000-2013

IMPACT TYPE	Employment *Job Years*	Employment *Av. per year*	Labor Income *In Billions*	Labor Income *Per Job*	Value Added *In Billions*	Output *In Billions*
Direct Effect	65,337	4,667	$6.19	$94,747	$8.86	$18.68
Indirect Effect	73,118	5,223	$4.65	$63,636	$7.72	$14.44
Induced Effect	96,056	6,861	$4.63	$48,167	$8.14	$14.74
Total Effect	**234,511**	**16,751**	**$15.47**	**$65,968**	**$24.73**	**$47.87**

Source: Business Research Division, Leeds School of Business, University of Colorado, Boulder; 2013 IMPLAN National Model
Note: Totals may not tally due to rounding

SEEDING SUCCESS

Rapid Disease Detection



Ebola virus particles are shown in blue as the particles bud from an infected cell, shown in yellow. (National Institute of Allergy and Infectious Diseases). *Previously released at directorsblog.nih.gov without a copyright restriction.*

Identifying infectious diseases in the field is difficult. Rarely is a fully stocked testing laboratory nearby. Yet, the timely detection of diseases such as Ebola is essential in order to contain outbreaks and provide much-needed treatment.

Biofire Diagnostics, based in Salt Lake City, Utah, received Air Force SBIR funding in 2002 (under its previous name, Idaho Technology), to develop a major breakthrough in disease diagnostics with its automated FilmArray System — a lab-in-a-box about the size of a toaster. Instead of requiring liquid chemicals, each test packet contains reagents in room-temperature-stable, freeze-dried form. It requires only two minutes of hands-on setup, then automatically provides results in an hour.

The FilmArray is the only system that completely integrates all the processes required to analyze a patient sample. It simultaneously identifies multiple disease pathogens, including bacteria, fungi, viruses, and parasites. The FilmArray biothreat panel, for example, identifies anthrax, Ebola, plague, botulism, and thirteen other deadly pathogens. There are separate respiratory, gastrointestinal, and blood culture panels for identifying more common diseases.

The FilmArray was recently deployed by the U.S. military in Africa as an Ebola screening tool, and has now been adopted by the U.S. government and over 300 major hospitals because of its ease of use and rapid results. In January 2014, multinational biotechnology company BioMérieux acquired BioFire, enabling greatly expanded international use of this life-saving technology.

Appendix 1: NAICS Codes Assigned to Companies in the Study

NAICS	DESCRIPTION
321213	Engineered wood member (except truss) manufacturing
322299	Epitaxial Technologies for SiGeSn High Performance Optoelectronic Devices
325130	Synthetic dye and pigment manufacturing
325180	Other basic inorganic chemical manufacturing
325199	All other basic organic chemical manufacturing
325211	Plastic material and resin manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325510	Paint and coating manufacturing
325520	Adhesive manufacturing
325613	Surface active agent manufacturing
325998	All other miscellaneous chemical product and preparation manufacturing
326150	Urethane and other foam product (except polystyrene), manufacturing
326199	All other plastic product manufacturing

NAICS	DESCRIPTION
327999	All other miscellaneous nonmetallic mineral product manufacturing
331313	Alumina refining and primary aluminum production
331513	Steel foundries (except investment)
331524	Aluminum foundries (except die-casting)
331529	Other nonferrous metal foundries (except die-casting)
332216	Saw blade and handtool manufacturing
332313	Plate work manufacturing
332410	Power boiler and heat exchanger manufacturing
332510	Hardware manufacturing
332811	Metal heat treating
332812	Metal coating, engraving (except jewelry and silverware), and allied services to manufacturers
332813	Electroplating, plating, polishing, anodizing, and coloring
332991	Ball and roller bearing manufacturing
332993	Ammunition (except small arms) manufacturing
332999	All other miscellaneous fabricated metal product manufacturing
333242	Semiconductor machinery manufacturing
333249	Other industrial machinery manufacturing
333314	Optical instrument and lens manufacturing
333316	Photographic and photocopying equipment manufacturing
333318	Other commercial and service industry machinery manufacturing
333414	Heating equipment (except warm air furnaces) manufacturing
333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration manufacturing
333514	Special die and tool, die set, jig, and fixture manufacturing
333515	Cutting tool and machine tool accessory manufacturing
333517	Machine tool manufacturing
333612	Speed changer, industrial high-speed drive, and gear manufacturing
334111	Electronic computer manufacturing
334118	Computer terminal and other computer peripheral equipment manufacturing
334210	Telephone apparatus manufacturing
334220	Radio and television broadcasting and wireless communications equipment manufacturing
334290	Other communications equipment manufacturing
334413	Semiconductor and related device manufacturing
334417	Electronic connector manufacturing
334418	Printed circuit assembly (electronic assembly) manufacturing
334419	Other electronic component manufacturing
334510	Electromedical and electrotherapeutic apparatus manufacturing
334511	Search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing
334513	Instruments and related products manufacturing for measuring, displaying, and controlling industrial processes
334515	Instrument manufacturing for measuring and testing electricity and electrical signals
334516	Analytical laboratory instrument manufacturing
334519	Other measuring and controlling device manufacturing
335311	Power, distribution, and specialty transformer manufacturing
335312	Motor and generator manufacturing
335911	Storage battery manufacturing
335912	Primary battery manufacturing
335921	Fiber optic cable manufacturing
335991	Carbon and graphite product manufacturing
335999	All other miscellaneous electrical equipment and component manufacturing

NAICS	DESCRIPTION
336310	Motor vehicle gasoline engine and engine parts manufacturing
336390	Other motor vehicle parts manufacturing
336411	Aircraft manufacturing
336412	Aircraft engine and engine parts manufacturing
336413	Other aircraft parts and auxiliary equipment manufacturing
336414	Guided missile and space vehicle manufacturing
336415	Guided missile and space vehicle propulsion unit and propulsion unit parts manufacturing
336419	Other guided missile and space vehicle parts and auxiliary equipment manufacturing
336992	Military armored vehicle, tank, and tank component manufacturing
339112	Surgical and medical equipment manufacturing
339113	Surgical appliance and supplies manufacturing
339115	Ophthalmic goods manufacturing
339920	Sporting and athletic goods manufacturing
339991	Gasket, packing, and sealing device manufacturing
339999	All other miscellaneous manufacturing
488190	Other support activities for air transportation
511210	Software publishers
518210	Data processing, hosting, and related services
541330	Engineering services
541360	Geophysical surveying and mapping services
541380	Testing laboratories
541420	Industrial design services
541511	Custom computer programming services
541512	Computer systems design services
541690	Other scientific and technical consulting services
541711	Research and development in biotechnology
541712	Research and development in the physical, engineering, and life sciences (except biotechnology)
541720	Research and development in the social sciences and humanities
562910	Remediation services
611420	Computer training
611430	Professional and management development training
611512	Flight training

Appendix 2: Air Force SBIR/STTR Phase II Contracts by State

RANK	STATE	FUNDING ($)	PERCENTAGE	CUMULATIVE %
1	CA	906,570,759	22.7%	22.7%
2	MA	544,719,047	13.6%	36.3%
3	OH	328,784,535	8.2%	44.6%
4	CO	242,960,183	6.1%	50.7%
5	VA	240,551,992	6.0%	56.7%

RANK	STATE	FUNDING ($)	PERCENTAGE	CUMULATIVE %
6	TX	187,709,126	4.7%	61.4%
7	NY	157,582,090	3.9%	65.3%
8	FL	133,396,253	3.3%	68.7%
9	MD	124,115,872	3.1%	71.8%
10	PA	113,214,010	2.8%	74.6%
11	AL	97,161,337	2.4%	77.1%
12	NM	95,310,144	2.4%	79.5%
13	MI	82,991,175	2.1%	81.5%
14	WA	71,908,964	1.8%	83.3%
15	NJ	66,685,817	1.7%	85.0%
16	AZ	64,370,391	1.6%	86.6%
17	NH	57,203,370	1.4%	88.1%
18	IL	54,983,305	1.4%	89.4%
19	CT	45,075,691	1.1%	90.6%
20	UT*	43,226,848	1.1%	91.6%
21	GA	39,036,526	1.0%	92.6%
22	MN	31,751,265	0.8%	93.4%
23	NC	28,924,988	0.7%	94.1%
24	TN	22,756,826	0.6%	94.7%
25	IN	21,807,461	0.5%	95.3%
26	NV*	17,130,673	0.4%	95.7%
27	OK*	16,199,976	0.4%	96.1%
28	WI	15,051,566	0.4%	96.5%
29	MO*	14,575,533	0.4%	96.8%
30	OR	13,588,463	0.3%	97.2%
31	WV*	12,088,678	0.3%	97.5%
32	AR*	10,969,698	0.3%	97.8%
33	VT*	9,974,314	0.2%	98.0%
34	MT*	9,820,486	0.2%	98.2%
35	NE*	8,344,970	0.2%	98.5%
36	DE*	7,383,765	0.2%	98.6%
37	SC*	6,728,803	0.2%	98.8%
38	RI*	5,967,819	0.1%	99.0%
39	ID*	5,674,449	0.1%	99.1%
40	ME*	5,512,081	0.1%	99.2%
41	HI*	4,566,603	0.1%	99.4%
42	WY*	4,481,838	0.1%	99.5%
43	MS*	4,249,615	0.1%	99.6%
44	LA*	3,680,198	0.1%	99.7%
45	DC*	2,788,897	0.1%	99.7%
46	ND*	2,748,268	0.1%	99.8%
47	IA*	2,499,231	0.1%	99.9%
48	KS*	2,221,606	0.1%	99.9%
49	KY*	1,499,975	0.0%	**100.0%**
TOTAL:		**$3,990,545,480**	**100%**	

** Underserved states. Note: AK, PR, and SD are also listed as underserved but received no Air Force Phase II contracts during the study period.*

About SBIR/STTR

The Small Business Innovation Research program was established by Congress in 1982 to fund research and development (R&D) by small businesses of 500 or fewer employees. Eleven federal agencies participate in the program, including the Department of Defense.

The Small Business Technology Transfer program was established in 1992 to fund cooperative R&D projects with small businesses and non-profit U.S. research institutions, such as universities. Five federal agencies participate, including the Department of Defense.

Both programs focus on projects and services with the potential to develop into a product for military or commercial sectors.

BUDGET

SBIR
$284 MIL For Air Force

STTR
$39 MIL For Air Force

The Air Force Is Both An Investor & A Customer

- **Focused on the WARFIGHTER**
- **About 160 topics per year**
- **Company retains data rights for 5 years**
- **Sole sourcing allowed for follow-on awards**
- **25% of awardees are first-time selectees**

SEEDING SUCCESS

Rapid Electric Charging Stations

A fleet of plug-in electric vehicles sits ready to roll at Los Angeles Air Force Base, California. *(U.S. Air Force photo by Technical Sgt. Sarah Corrice)*

Large amounts of fuel are consumed in airports by ground support vehicles. Although many airports have electric vehicles, most require exchanging the battery packs, which takes time and requires a dedicated space.

AeroVironment, a pioneer in electric vehicles based in Monrovia, California, addressed this problem with Air Force SBIR funding by developing the PosiCharge® rapid battery charging system. The system allows multiple battery packs to be charged in a station in as little as ten minutes. Batteries are recharged in-vehicle when operators take breaks and between shifts, allowing vehicle operation 24 hours a day every day.

PosiCharge now powers over 3,500 vehicles in the nation's airports and more than 10,000 vehicles in factories and distribution centers. Seattle-Tacoma International Airport, for example, is installing 576 PosiCharge system ports and plans to convert all its ground support vehicles to electric, saving up to $3 million in energy costs and reducing its carbon footprint by 10,000 metric tons a year.

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(Photo: U.S. Air Force photo/Senior Airman Debbie Lockhart)


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