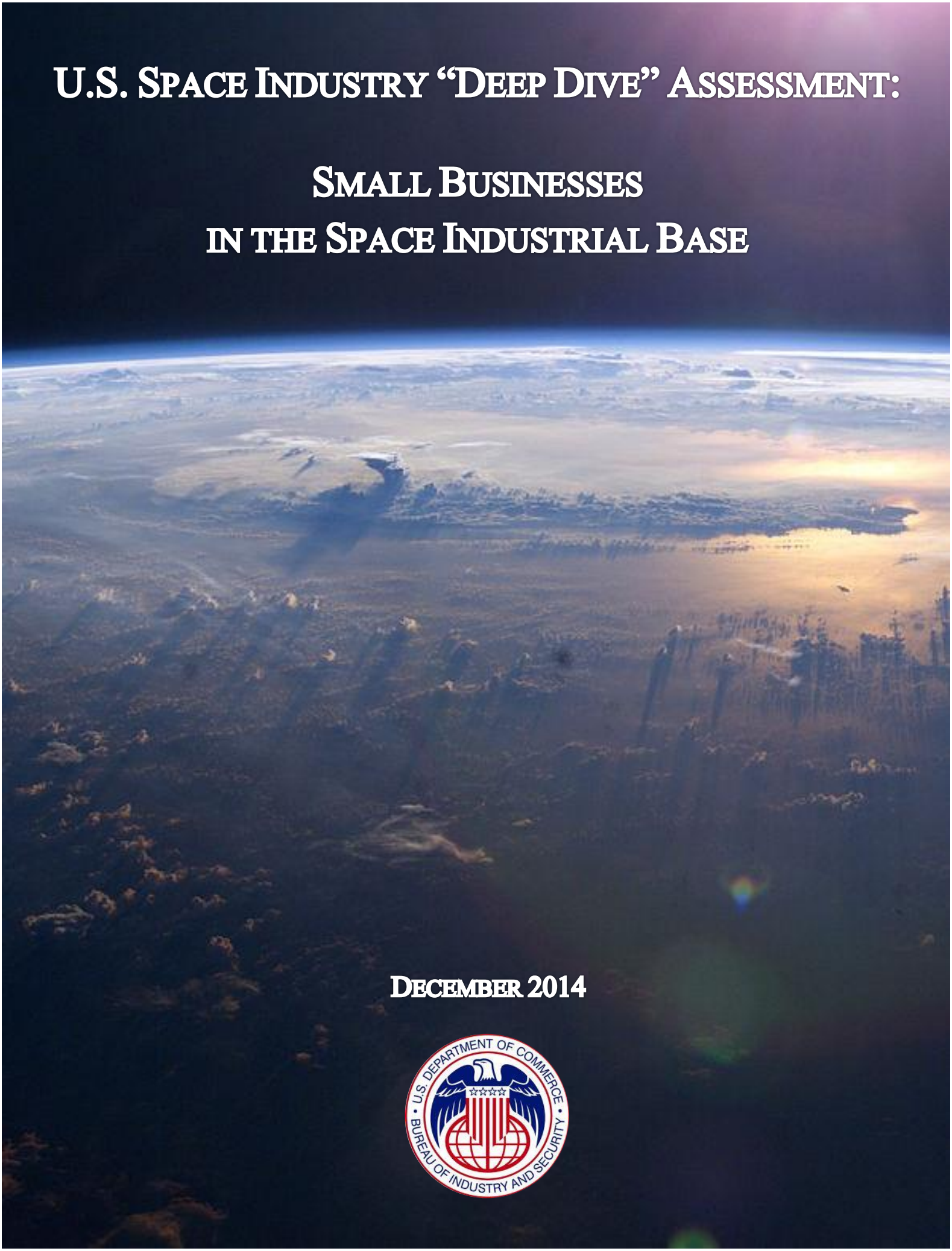
U.S. Space Industry "Deep Dive" Assessment:

Small Businesses in the Space Industrial Base



December 2014

U.S. SPACE INDUSTRY 'DEEP DIVE' ASSESSMENT: SMALL BUSINESSES IN THE SPACE INDUSTRIAL BASE

December 2014

PREPARED BY
U.S. DEPARTMENT OF COMMERCE
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EXECUTIVE SUMMARY

The United States Air Force, National Aeronautics and Space Administration (NASA), and the National Reconnaissance Office (NRO) requested that the U.S. Department of Commerce, Bureau of Industry and Security (BIS) lead a collaborative effort to study the U.S. space industrial base. The effort, called the U.S. Space Industry "Deep Dive" Assessment, sought to map the space industrial base supply chain in unprecedented detail. The project would provide all stakeholders with a single, consistent source of information, highlight interdependencies between agencies and programs, and reduce the survey reporting burden on industry.

BIS utilized its authority delegated under the Defense Production Act of 1950, as amended (50 U.S.C. app. Sec. 2155) to design, distribute, and collect surveys of commercial companies, universities, non-profit organizations, and U.S. Government agencies with equities in the space industrial base. In all, 3,780 organizations provided a completed survey response, which detailed the products and services they provided, their critical suppliers, their financial health and investment expenditures, and many other topics.

BIS developed the following reports based on survey responses, independent research, and field interviews:

- Employment in the U.S. Space Industrial Base
- Impact of U.S. Export Controls on the Space Industrial Base

This report seeks to assess the health and competitiveness of small businesses in the U.S. space industrial base. Small businesses play a critical role in the U.S. economy as they comprise nearly 99.7 percent of U.S. firms and provide 49.2 percent of private-sector employment, according to the U.S. Small Business Administration (SBA). While prime contractors and other large organizations are most visible in the space industry, small businesses provide critical products and services required for the industry to succeed. BIS developed this report to better understand the contributions of small businesses and the challenges facing these organizations.

This report provides a profile of small businesses, including products and services provided, geographic distribution, financial health, and comparisons of overall health and competiveness to larger organizations. In addition, trends in employment, sales, and USG involvement are discussed. Also included is a review of Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) contract awards as well as an overview of the specific challenges facing small businesses.

Key Report Findings:

- 2,325 of the 3,585 commercial respondents (65 percent) self-identified as small businesses, and 422 of those small business respondents (18 percent) indicated they were dependent on USG space programs for their continued viability.

- Ten percent of small business respondents were determined to be at High/Severe financial risk. Fifteen percent of small business respondents dependent on USG space programs were also determined to be at High/Severe financial risk.

- Small businesses reported total sales averaging $62 billion annually from 2009 to 2012, and space-related sales averaging $9.4 billion annually. Their commercial space sales grew from $527 million in 2009 to $1.2 billion in 2012, while their USG non-defense space-related sales grew from $1.9 billion to $2.9 billion.

- Small business respondents employed an average 156,308 staff from 2009 to 2012, or approximately nine percent of total commercial employment. Small businesses' total reported employment grew by 18 percent over the four year period.

- Small business respondents reported 2,508 vacancies for skilled positions, or 13 percent of the total commercial vacancies identified.

- Small business respondents reported an average six percent of all commercial respondent R&D expenditures from 2009 to 2012, or an average $2.1 billion annually. Space-related R&D expenditures grew from $227 million in 2009 to $571 million in 2012.

- Small business respondents reported receiving 50 percent of their R&D funds from the federal government, significantly more than the 17 percent for all other commercial respondents.

- When asked about the impact on R&D activities of future reductions in U.S. Government space-related spending, 36 percent of the 1,087 small businesses completing the question

anticipated moderate to significant impacts, compared to 18 percent of the remaining 629 non-small business commercial respondents.

- SBIR and STTR awards were reported by 223 small businesses with nearly 2,000 awards over four years. Forty-three small businesses reported receiving more than 10 awards from 2009 to 2012; these organizations accounted for nearly two-thirds of the total.

- The top five issues impacting the long term organization viability of small businesses were domestic competition, labor costs, proposed cuts to USG space programs, healthcare, and taxes.

For more detail on the key findings of this report, refer to the Report Findings chapter.

I. BACKGROUND ON THE U.S. SPACE INDUSTRY "DEEP DIVE" ASSESSMENT

The United States has continually recognized that "a resilient, flexible, and healthy space industrial base must underpin all of our space activities."[1] In recent years, the U.S. has grown increasingly reliant upon space-based technologies for its economic and national security. From communications to environmental monitoring, space-related technologies are vital to our everyday lives. As this reliance has grown, so has the interdependency between the civil, commercial, and national security space sectors. Programmatic decisions made by the National Aeronautics and Space Administration (NASA), for example, can have a significant impact on the U.S. Department of Defense's space interests, and vice versa.

In 2011, the U.S. Department of Commerce, Bureau of Industry and Security (BIS) completed an assessment of the U.S. space industry based on a review of 27 existing space-related studies covering the period 2006 to 2010.[2] Through this effort, BIS found that there have been many studies of different facets of the space industrial base in recent years, some very narrow in scope and others relying on anecdotal data. Individual government agencies, industry groups, and research organizations have all attempted to isolate key issues affecting the health and competitiveness of the space industrial base. In many cases, these efforts have been conducted independently, without collaboration or coordination between stakeholders. The end result has

[1] *National Security Space Strategy (Unclassified Summary)*, January 2011, p. 4, http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf.

[2] Presidential Policy Directive/PPD-4, National Space Policy.

often been duplication of effort and an increased reporting burden on industry, while providing minimal benefit to U.S. Government (USG) strategic planners.

These studies did, however, depict the many challenges that face the U.S. space industry. Some studies focused on the uncertain budgetary environment and the potential for adverse industrial base impacts resulting from modifications (or cancellations) to space programs. Other studies highlighted increasing international competition that has eroded the U.S. competitive advantage in the space sector. Several studies also mentioned the difficulties facing lower tier suppliers as they attempt to navigate a procurement environment with long lead times and inconsistent production rates. Finally, these studies touched on common issues, such as finding skilled workers, dealing with complex export control regulations, handling government purchasing requirements, and many other challenges.

Based on previous studies of the space industrial base and experience with other sectors, BIS proposed that there be a collaborative effort to study the U.S. space industrial base. Such a study would provide all stakeholders with a single, consistent source of information, highlight interdependencies between agencies and programs, and reduce the survey reporting burden on industry.

In 2011, the U.S. Air Force (USAF), NASA, and the National Reconnaissance Office (NRO), partnered with BIS to initiate the U.S. Space Industry "Deep Dive" assessment. The principle

goal of the assessment was to gain an understanding of the intricate supply chain network supporting the development, production, and sustainment of products and services across the defense, intelligence, civil, and commercial space sectors.

BIS and partner agencies set the following objectives for the assessment:

a) Map the space industrial base supply chain in unprecedented detail;
b) Identify interdependencies between respondents, suppliers, customers, and USG agencies;
c) Benchmark trends in business practices, competitiveness issues, financial health, and other areas, across many tiers of the industrial base; and
d) Share data with USG stakeholders to better inform strategic planning, targeted outreach, and collaborative problem solving.

The assessment was also designed to be repeatable. BIS will be able to expand this approach to other sectors of the U.S. defense industrial base by incorporating lessons learned from this study.

This report focuses on small businesses in the U.S. space industrial base. In fall of 2014, information regarding other aspects of this "Deep Dive" assessment was made available. These areas included:

- Impact of U.S. Export Controls on the Space Industrial Base
- Employment and the U.S. Space Industrial Base

II. METHODOLOGY

BIS performed this data collection and assessment under authority delegated to the U.S. Department of Commerce under Section 705 of the Defense Production Act of 1950, as amended (50 U.S.C. App. Sec. 2155), and Executive Order 13603. These authorities enable BIS to conduct mandatory surveys, study defense-related industries and technologies, and monitor economic and trade issues affecting the U.S. industrial base. For example, BIS recently completed the following assessments: NASA's Human Space Flight Industrial Base in the Post-Space Shuttle/Constellation Environment, National Security Assessment of the Cartridge and Propellant Actuated Device (CAD/PAD) Industry, and Consumers of Electro-Optical Satellite Imagery.[3]

Upon initiation of the assessment, BIS took a number of steps over several months to better understand the U.S. space industrial base. With the assistance of our USG agency partners, BIS collected information on relevant space programs and their known suppliers. BIS also held discussions with other government agencies with an interest in space, including the U.S. Army, U.S. Navy, U.S. Air Force's Space and Missile Systems Center, National Oceanic and Atmospheric Administration (NOAA), and others. BIS conducted outreach with space-related industry associations, such as the Aerospace Industries Association, Satellite Industry Association, and the American Institute of Aeronautics and Astronautics.

[3] For these and other reports, see www.bis.doc.gov/DIB

In addition, BIS conducted site visits with companies and universities across the country involved in different aspects of the space industrial base, from consortia of small machine shops, such as the Southern California Manufacturing Group, to dedicated space-related companies. These discussions highlighted many of the diverse challenges in maintaining a healthy and competitive space industrial base.

With cooperation and feedback from our partner agencies, BIS developed a survey template that covered respondents' current space-related business operations. The core of the survey is a customized Product and Service List, which served to connect various sections of the survey together in a uniform manner. Based on experience, BIS noted that many respondents were unable to identify specific USG programs they participate in, particularly at the lower tiers of the supply chain. However, all organizations do have an understanding of what products and services they provide. The Product and Service List was created to focus on what respondents were most accustomed to; what they buy and sell in the marketplace.

The Product and Service List consists of 16 general segments comprised of 360 individual products and services. The list was used to identify and categorize relevant respondents; organizations that did not provide a product or service on the list were exempted from the survey requirement. The 16 Product and Service List segments are:

A. Spacecraft & Launch Vehicles
B. Propulsion Systems & Fuels
C. Navigation & Control

D. Communications Systems

E. Space Survivability, Environmental Control/Monitoring, and Life Support

F. Payload Instruments & Measurement Tools

G. Ground Systems

H. Non-Earth Based Surface Systems

I. Power Sources & Energy Storage

J. Electronic Equipment

K. Computer Hardware & Robotics

L. Software

M. Materials, Structures, and Mechanical Systems

N. Manufacturing Tools & Specialty Equipment

O. Services

P. Research & Development

Respondents identified whether they manufactured, distributed, or provided any of the products and services on the list. They then identified their critical suppliers and customers for the selected products and services.

Additionally, if known, respondents identified their participation in any of over 205 USG space-related programs from 2009 to 2012. This program list, assembled with the assistance of our partner agencies, included programs from the U.S. Air Force, U.S. Army, U.S. Navy, Missile Defense Agency, NASA, and NOAA. Respondents were provided fields to identify any

additional programs they participated in that were not on the list.[4] Respondents identified the level of participation in each program (prime contractor, sub-contractor, or other type of support) and selected the specific products and services provided based on the Product and Service List.

The use of a uniform Product and Service List and network analysis software allowed BIS and partner agencies to link together respondents' products and services, critical suppliers, customers, and USG space programs in order to map the space industrial base. Without such a list, it would be exceedingly difficult to meet the objectives of this assessment and the individual needs of members of the USG space community.

The survey also included a series of questions on how frequently respondents used the U.S. export control system for space-related products and services. In addition, respondents reported the lost sales opportunities resulting from space-related export controls and the adverse impacts of space-related export controls on their organizations' competitiveness.

BIS distributed the survey in June 2012 to respondents identified by our partner agencies, previous BIS survey efforts, and independent research. The data collection period was divided into three, three-month long waypoints. At the end of each waypoint, the data was collected, compiled, and analyzed for preliminary results. The data was also disseminated to our partner

[4] Information on classified activities and programs was not collected for this assessment.

agencies in order to facilitate their analysis and strategic planning. Aggregated results were made publically available and presented to the space industry.

In April 2013, the data collection period ended. In total, BIS received 3,780 completed survey responses from commercial companies, universities, non-profit organizations, and U.S. Government agencies (see Figure II-1).

Figure II-1: Respondents by Type of Organization	
Commercial Companies	3,585
Universities	125
Non-Profit Organizations	49
U.S. Government Agencies	21
Total	**3,780**

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

To facilitate analysis, BIS devised respondent size groupings based on their average annual net sales from 2009-2012 (see Figure II-2).

Figure II-2: Respondents by Average Annual Net Sales (2009-2012)	
Very Small (Less than $10M)	1,648
Small ($10 – 50M)	929
Medium ($50 – 250M)	498
Large ($250M – 1B)	234
Very Large (Greater than $1B)	165
No Sales	306

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Small Businesses

Small businesses play a critical role in the U.S. economy as they comprise nearly 99.7 percent of U.S. firms and provide 49.2 percent of private-sector employment, according to the U.S. Small Business Administration (SBA). The SBA is the U.S. Government (USG) agency created to "aid, counsel, assist and protect the interests of small business concerns, to preserve free competitive enterprise and to maintain and strengthen the overall economy of our nation."[5] For an organization to be considered a small business by the SBA, it must:

- Be below a maximum size (either defined by average number of employees over the past year or average annual receipts over the past three years) as determined per North American Industry Classification System (NAICS) codes
- Be for-profit
- Have a place of business in the U.S.
- Operate primarily within the U.S. or make a significant contribution to the U.S. economy
- Be independently owned and operated
- Not dominate its field of business on a national basis.

To assess the space industry, BIS surveyed over 3,500 companies that are part of the space supply chain. With 2,325 small businesses comprising nearly 65 percent of total commercial respondents, it is evident that small businesses provide many critical products and services. Due

[5] http://www.sba.gov/content/mission-statement-0

to their large involvement, it is important to understand the role small businesses play in this sector as well as the unique issues and challenges they face.

Respondents to BIS's Space "Deep Dive" Assessment were asked whether they were small businesses as defined by the SBA, and whether they were one of six special classifications of small business. In general, the SBA classifies an independent business with fewer than 500 employees as a small business. For the purposes of government contracting and procurement, additional classifications of small business (with additional criterion) have been developed by the SBA.

These additional classifications include: 8(a) Firm, Historically Underutilized Business Zone (HUBZone), minority-owned business, woman-owned business, veteran-owned or service-disabled veteran owned business, or other type of small or disadvantaged business. The 8(a) program is a business development program for small disadvantaged businesses. The program offers a wide array of assistance to firms owned and controlled at least 51 percent by socially and economically disadvantaged individuals.[6] HUBZone is a business development program that promotes economic growth and development in distressed geographic areas by providing federal contract opportunities.[7]

This report will provide an overview of small businesses supporting the U.S. space industrial base, primarily comparing their activities and operations to those of all other commercial organizations responding to the survey. The report will examine small businesses' financial

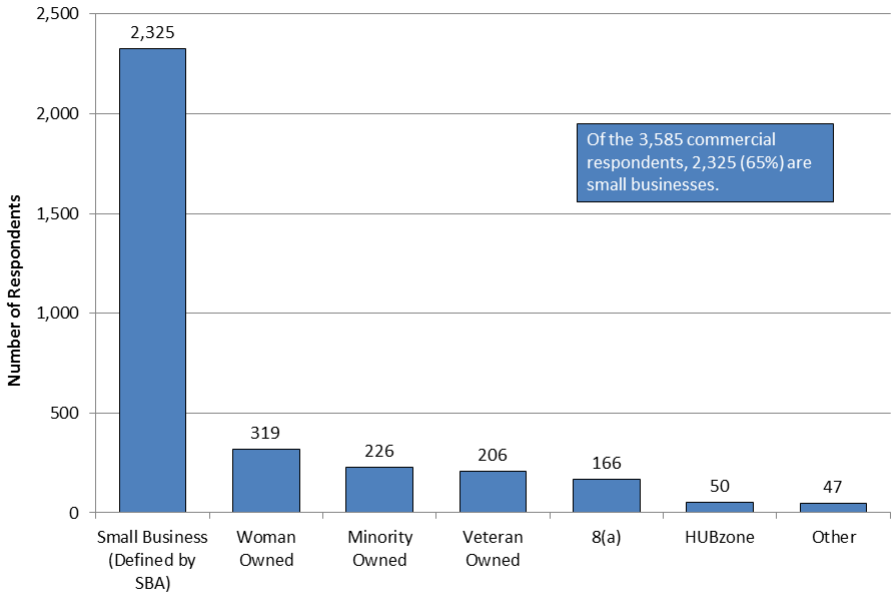
[6] http://www.sba.gov/content/8a-business-development-0
[7] http://www.sba.gov/content/understanding-hubzone-program

health, workforce, Research and Development (R&D) activities, product and service capabilities, sales, and support of USG agencies and space programs.

III. RESPONDENT OVERVIEW

Of the 3,585 commercial respondents that completed the assessment, 2,325 (65 percent) were small businesses. In further detail, women-owned small businesses accounted for 9 percent of commercial respondents, while minority-owned and veteran-owned small businesses accounted for 6 percent of commercial respondents. See Figure III-1 for additional breakouts.

Figure III-1: Self-Identified Small Businesses by Type



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

GEOGRAPHIC DISTRIBUTION

BIS also asked respondents to provide the city and state of their operations, allowing them to be categorized by location. See Figure III-2. California was reported as the location of the greatest number of small business respondents, while New York, Colorado, Pennsylvania, Florida, and Massachusetts each had over 100 small business respondents.

Figure III-2: Small Business Respondents by State					
State	# of Respondents	State	# of Respondents	State	# of Respondents
California	612	Alabama	40	Rhode Island	7
New York	128	New Hampshire	36	Delaware	6
Colorado	125	Utah	34	Montana	6
Pennsylvania	113	North Carolina	33	Maine	5
Florida	107	Nevada	24	West Virginia	5
Massachusetts	105	Oregon	23	Kentucky	5
Texas	99	Wisconsin	23	Iowa	5
Virginia	96	Georgia	21	Mississippi	5
Ohio	89	Indiana	19	Arkansas	4
New Jersey	80	Missouri	18	Hawaii	3
Illinois	66	New Mexico	16	Wyoming	3
Maryland	55	Tennessee	14	Vermont	2
Connecticut	54	Louisiana	12	District of Columbia	2
Arizona	49	Kansas	11	North Dakota	2
Washington	48	Idaho	11	Nebraska	2
Michigan	45	South Carolina	9	South Dakota	1
Minnesota	43	Oklahoma	8	Alaska	1

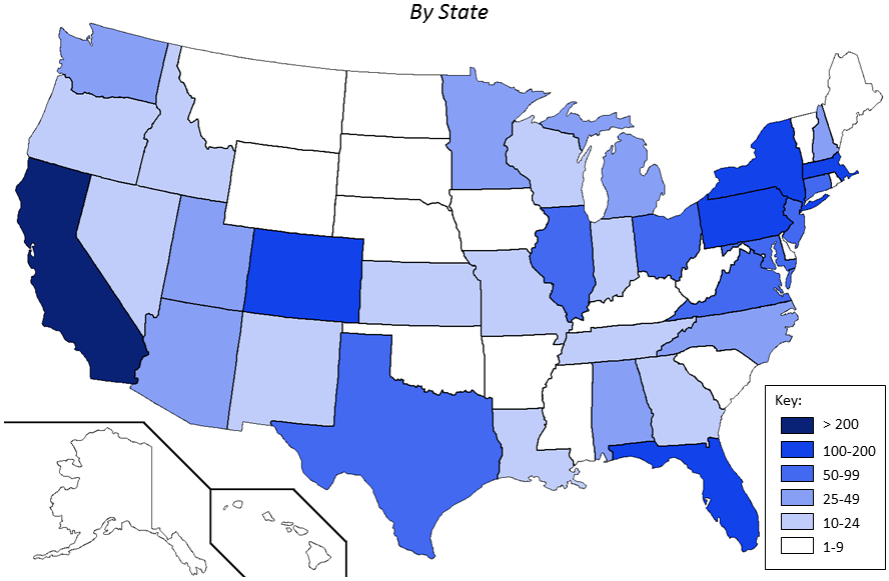
Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Overall, small business respondents tend to be clustered in the West and Northeastern parts of the U.S., similar to the overall pool of commercial respondents. In 10 states, between 26 and 50 percent of commercial respondents were small businesses. Small businesses comprised between 51 and 75 percent of commercial respondents in 31 states, and over 75 percent of respondents in 10 states.[8] All commercial respondents in four states considered themselves to be small businesses. See Figure III-3.

[8] Includes the District of Columbia.

Figure III-3: Small Business Respondents

By State



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

DEPENDENCY ON U.S. GOVERNMENT SPACE PROGRAMS

To better classify organizations, BIS asked respondents if they consider themselves to be dependent on U.S. Government (USG) space programs.[9] Overall, 16 percent of the 3,585 commercial respondents and 18 percent of the 2,325 small business respondents indicated they were dependent on USG space programs.

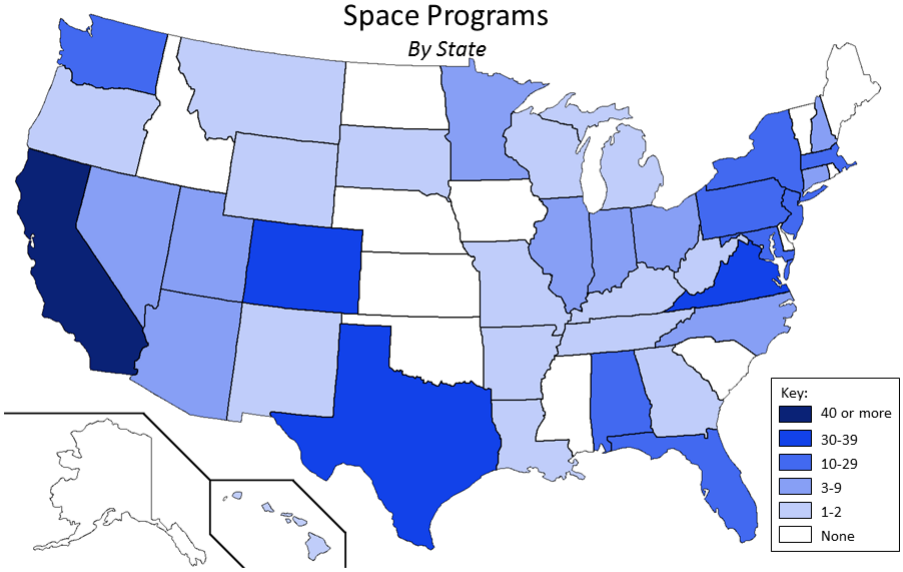
The small businesses dependent on USG space programs were scattered throughout the U.S. As a subcategory of small business respondents, the largest number of businesses dependent on USG space programs were located in California (122 respondents). See Figure III-4. They however, account for only 20 percent of California's total small business respondents. Conversely, Texas, Virginia, and Colorado had the highest percentages of small businesses

[9] Note: Both the small business designation and the dependency on U.S. Government space programs designation utilized in this report were self-reported by each respondent.

dependent on USG space programs. In Virginia, 32 percent of small business respondents (31 of 96) indicated a dependency on USG space programs, 25 percent of small business respondents in Colorado (31 of 125), and 23 percent of small business respondents (38 of 99) in Texas indicated a similar dependency.

Figure III-4: Small Business Respondents Dependent on USG Space Programs

By State



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

FINANCIAL RISK ASSESSMENT

To better determine the financial health and overall viability of the respondents, BIS introduced a scorecard methodology based on annual financial statement line items and other data. This weighted model emphasized standardized analytical measures of profitability, solvency, leverage, and innovation. Based on the results, organizations were divided into three categories: high/severe risk, moderate/elevated risk, and low/neutral risk.

BIS assigned a financial risk categorization to 3,567 commercial respondents, 2,309 of which were small businesses (a small segment of survey respondents did not provide financial data).

Of those small businesses, 420 self-identified as being dependent on USG space programs.[10] Overall, the distribution of respondents across the three financial risk rankings were relatively comparable between small business and non-small business commercial respondents, with approximately 60 percent of both groups categorized as low/neutral risk, 30 percent categorized as moderate/elevated risk and 10 percent categorized as high/severe risk. See Figure III-5.

Figure III-5: Financial Risk Score – Small Businesses

Risk Rating	Commercial Respondent Type	
	Small Business	Small Businesses Dependent on USG Space Programs
Low/Neutral	1,385	221
Moderate/Elevated	691	134
High/Severe	233	65
Total	**2,309**	**420**

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

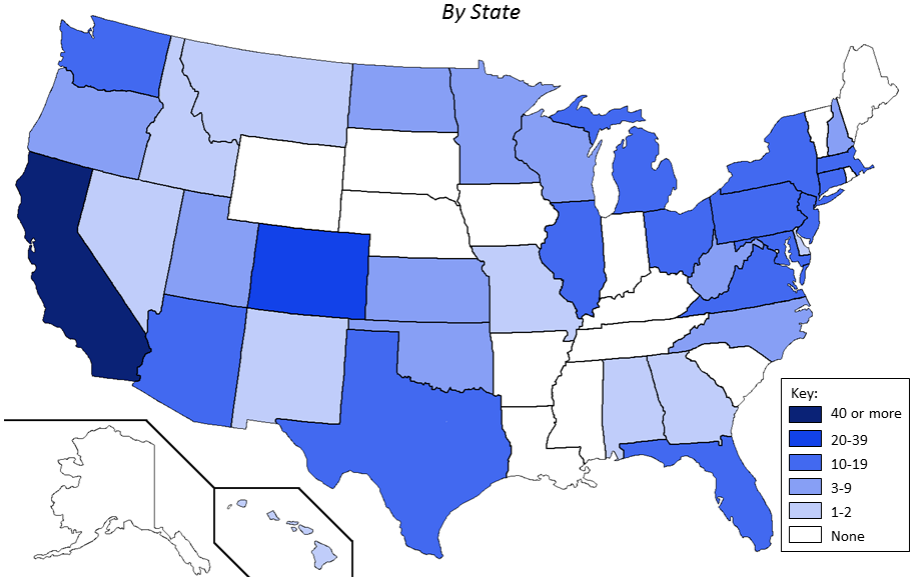
The subcategory of small business respondents dependent on USG space programs exhibited a greater degree of financial risk than the overall small business respondent group. Of those, 15 percent were categorized as high/severe risk, 32 percent were categorized as moderate/elevated risk and 53 percent were categorized as low/neutral risk.

Sixteen states had five or more small business respondents considered to be at high/severe risk. California had the highest number of small business respondents (49) in the high/severe risk category, followed by Colorado (20) and Texas (19). See Figure III-6.

[10] The financial risk analysis includes a subset of commercial respondents that provided the necessary data to calculate and categorize their overall financial risk.

Figure III-6: High/Severe Financial Risk Small Businesses

By State



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

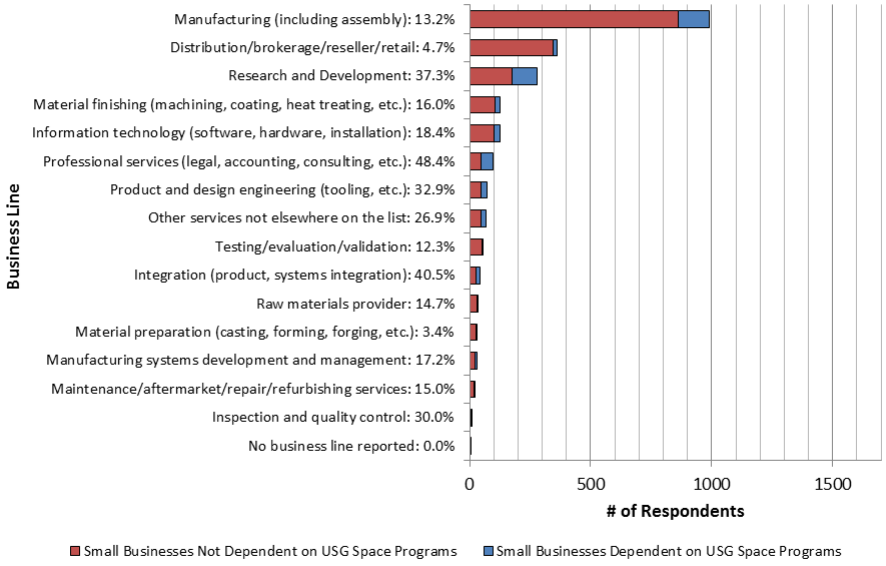
In states with more than ten small business respondents, the percentage of those respondents classified as high/severe financial risk was highest in Kansas, at 36 percent (4 of 11 respondents) followed by:

- Texas, at 20 percent (19 of 97 respondents)
- Washington, at 17 percent (8 of 48 respondents)
- Colorado, at 16 percent (20 of 124 respondents)

IV. PRIMARY OPERATIONS

Respondents were asked to identify their primary business lines and the specific product/service areas they provided. More specifically, they were asked to select one primary business line and any secondary business line(s) from 15 options. Nearly 45 percent of small business respondents (991) indicated Manufacturing as their primary business line, 15 percent (362) selected Distribution and 12 percent (279) chose Research and Development. Manufacturing, Research and Development, and Professional Services were the primary business lines selected by the most small business respondents dependent on USG space programs. However, as a percent of respondents by business lines Professional Services, Integration, and Research and Development were the biggest. See Figure IV-1.

Figure IV-1: Primary Business Line of Small Business Respondents
(percent dependent on USG space programs)



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

While small businesses represented a significant portion of the overall respondent group, they indicated primary business lines of Research and Development, Inspection and Quality Control, and Material Finishing much more frequently. Over 91 percent of the commercial respondents

whose primary business line was Research and Development were small businesses. That same figure for Inspection and Quality Control was 83 percent, and for Material Finishing was 82 percent. In addition, over 70 percent of commercial respondents indicating their primary business line as Product Design and Engineering, Testing/Evaluation/Validation, and Professional Services were also small businesses.

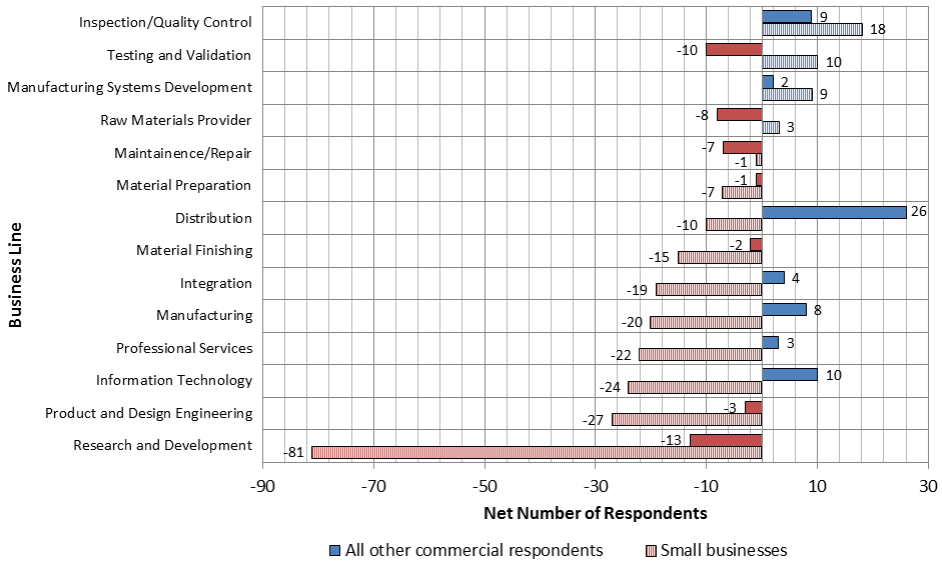
Pairing respondents' primary business line and BIS-determined financial risk categorization is a helpful way of assessing the health of specific portions of the U.S. space industrial base. While over 91 percent of respondents with Research and Development as their primary business line were small businesses, 18 percent (49 of 276) of those were classified as high/severe risk, nearly double the percentage of high/severe risk respondents in the overall small business group. Small business respondents whose primary business line was Information Technology also reported a higher degree of financial risk, 17 percent (7 of 42) were classified as high/severe risk.

Change in Customer Demand for Business Lines

After identifying the primary and additional business lines where their organizations participate, respondents were asked if they experienced an increase, a decrease, or no change in space-related customer demand from 2009 to 2012. By summing the total number of respondents that experienced an increase and those that experienced a decrease, the net impact on respondents to this assessment is illustrated. See Figure IV-2.

Figure IV-2: Change in Customer Demand by Business Line

Commercial respondents, 2009-2012



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

As small businesses comprised 91 percent of the commercial respondents indicating Research and Development as their primary business line, the net change in small businesses' space-related demand is particularly important. Of the 393 small businesses indicating they experienced a change in demand for their Research and Development business lines from 2009 to 2012, 156 experienced an increase and 237 experienced a decrease, for a net decrease of 81. This was the largest reported net decrease for small businesses across all business lines.

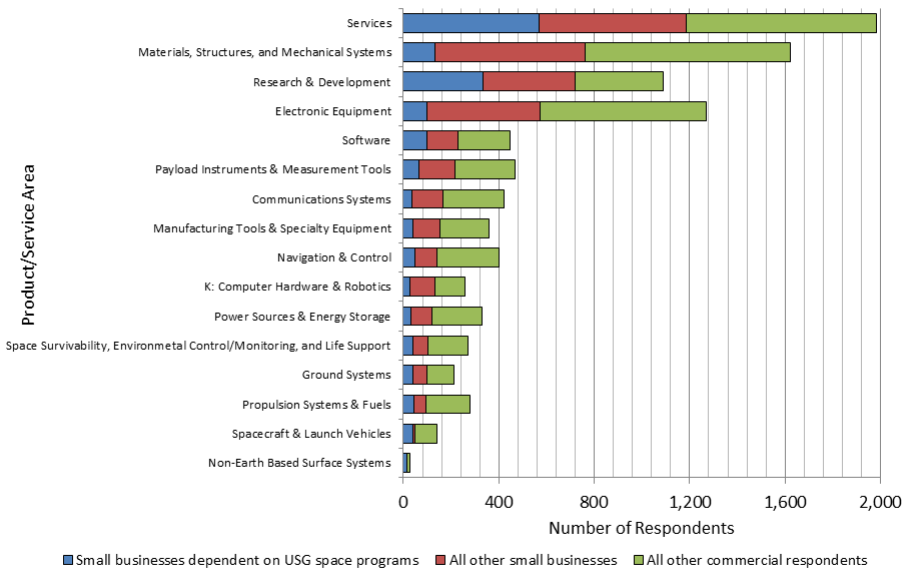
Of those respondents who indicated that Inspection and Quality Control and Material Finishing was their primary business line, over 80 percent were small businesses. Inspection and Quality Control was the business line with the most positive net change in space-related customer demand, with 90 small businesses indicating increase and 72 indicating decrease, for a net increase of 18. The Material Finishing business line reported weaker performance with a net decrease in demand for 15 respondents.

Products/Services

Respondents were also given a listing of 360 specific product/service areas and asked to indicate if they provided any of the listed items. Overall, small business respondents reported providing 57 percent of the product/service areas identified by commercial respondents. Similar to the concentration by primary business line, 71 percent of the Research and Development product/service area identifications were by small businesses. In addition, 64 percent of the Service, 60 percent of the Ground Systems, and 60 percent of the Non-Earth-Based Surface Systems product/service areas were provided by small businesses. See Figure IV-3. As a subset of that group, small businesses dependent on USG space programs reported providing 17 percent of all product/service areas reported by commercial respondents. Of particular note, they reported providing 33 percent of the Non-Earth Based Surface Systems product area, the highest of all product/service areas, followed by Spacecraft and Launch Vehicles (30 percent), R&D (29 percent), and Services (26 percent).

Figure IV-3: Product and Service Areas Provided

by Respondent Type



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Small businesses comprised over 80 percent of the respondents providing 21 specific product/service areas. See Figure IV-4. They were the only respondents providing ten of the product/service areas, ranging from forging and foundry machinery to lunar wireless networking. Of the ten areas supported only by small business respondents, five indicated their firms to be the single or sole source of the specific product.

Figure IV-4: Products and Services Provided Primarily by Small Businesses

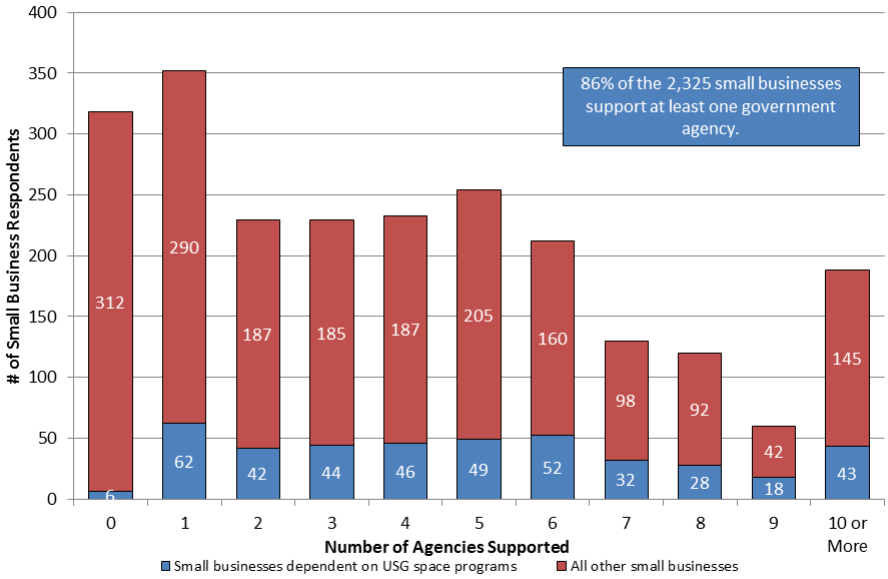
Product/Service Area	Percent of Respondents that are Small Businesses	Number or Small Business Single/Sole Source Providers
High dexterity manipulation systems	100%	2
Mineral mapping systems	100%	1
Volatile (H, C, N, He) extraction from regolith	100%	0
Lunar excavation	100%	0
Regolith excavation and handling	100%	1
Lunar wireless network	100%	1
Nuclear fission power systems	100%	0
Heavy atom detectors	100%	1
Foundry machinery	100%	0
Forging machinery	100%	0
Theoretical and scientific R&D	88%	0
Plating services	86%	5
Magnetic field sensors and magnetometers	86%	5
Oxygen and water extraction from regolith	86%	2
Biomedical research	84%	0
Atmospheric probes	83%	2
Damage protection systems	83%	3
Chemical production machinery	83%	1
Semi-finished machined parts	83%	2
Atmospheric/suborbital research	82%	0
Precision machined parts	81%	2

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

V. GOVERNMENT INVOLVEMENT

Respondents were asked a series of questions regarding their involvement with and support of USG agencies and space programs. Of the 2,325 small business respondents, 2,007 indicated supporting at least one USG agency, while 188 supported at least 10 agencies. Of the small businesses dependent on USG space programs, 43 supported at least 10 agencies. See Figure V-1.

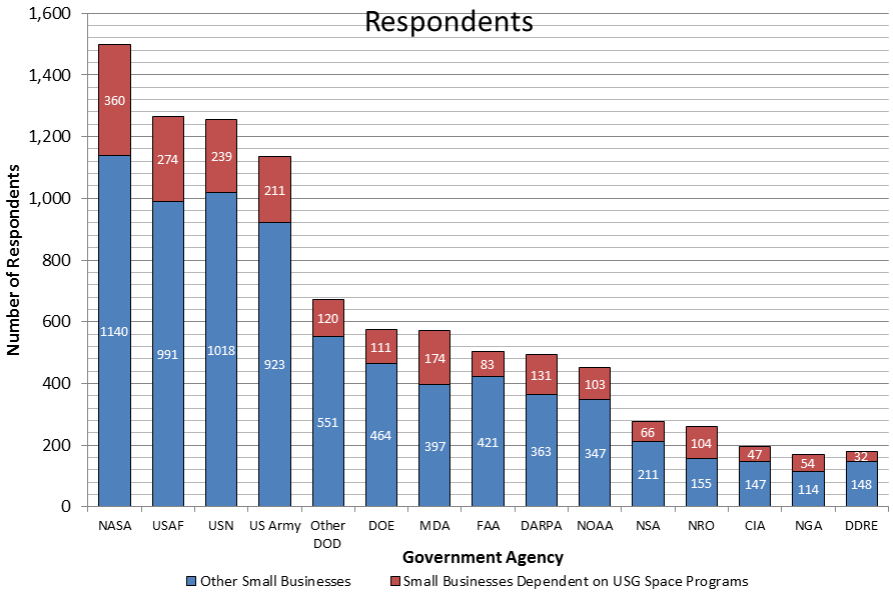
Figure V-1: Number of Government Agencies Supported



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Of the government agencies, the largest number of small businesses reported supporting NASA (1,500), the U.S. Air Force (USAF) (1,265), the U.S. Navy (USN) (1,257), and the U.S. Army (1,134). In addition, over 500 small businesses supported the Department of Energy (DOE), Missile Defense Agency (MDA), and Federal Aviation Administration (FAA). See Figure V-2.

Figure V-2: Agencies Supported: Small Business Respondents



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

The agencies supported by the largest percentage of small business respondents (as a percentage of commercial respondents) were NASA (69 percent), the MDA (64 percent), the USN (64 percent), the USAF (64 percent), and the U.S. Army (62 percent). The USAF, USN, and U.S. Army also had the largest number of small businesses dependent on USG space programs supporting them, as each had over 200. See Figure V-3.

Figure V-3: USG Agencies Supported by Small Businesses

	Commercial Respondents				
USG Agency	All	Small Businesses	% Small Businesses	Small Businesses Dependent on USG Space Programs	% Small Businesses Dependent on USG Space Programs
DDRE	312	180	58%	32	18%
NGA	322	168	52%	54	32%
CIA	364	194	53%	47	24%
NRO	480	259	54%	104	40%
NSA	520	277	53%	66	24%
NOAA	753	450	60%	103	23%
DARPA	816	494	61%	131	27%
FAA	867	504	58%	83	16%
MDA	888	571	64%	174	30%
DOE	948	575	61%	111	19%
Other DOD	1096	671	61%	120	18%
US Army	1821	1134	62%	211	19%
USN	1975	1257	64%	239	19%
USAF	1984	1265	64%	274	22%
NASA	2180	1500	69%	360	24%

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

VI. WORKFORCE

Respondents were asked to provide information regarding their employment levels from 2009 to 2012, including total employment by professional occupation, space-related and STEM- (Science, Technology, Engineering and Mathematics) related employment, and the number of unfilled vacancies for skilled positions. This section will provide a brief overview of those topics for small businesses.

OVERVIEW

Small business respondents represented nine percent of total commercial respondent employment from 2009 to 2012, equating to roughly 160,000 of the 1,670,000 employees reported. Employment reported by small business respondents grew at a higher rate over the period (18 percent) than employment reported by all commercial respondents (10 percent). From 2009 to 2012, small businesses added 25,280, while all commercial respondents added 163,030 staff.

PROFESSIONAL OCCUPATIONS

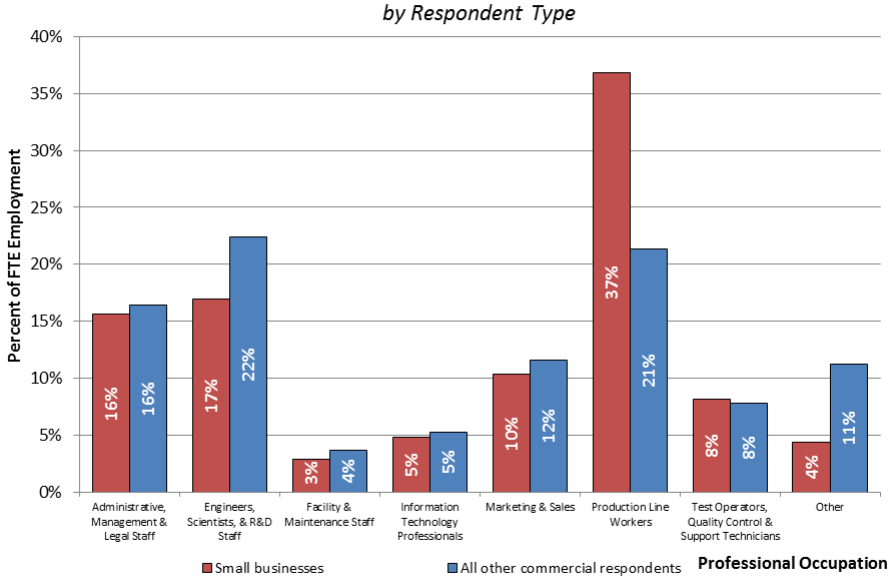
Respondents were asked to classify employees by seven basic professional occupations (in addition to an "Other" category). These occupations included:

- Administrative, Management and Legal
- Engineers, Scientists, and R&D
- Facility and Maintenance
- Information Technology

- Marketing and Sales
- Production Line
- Test Operators, Quality Control, and Support

As a percentage of total full time equivalent (FTE) employment from 2009 to 2012, small businesses reported the largest portion as Production Line Workers (37 percent). This portion of total FTE employment was significantly above that reported by all other commercial respondents (21 percent). See Figure VI-1. Small businesses reported a smaller portion of FTE employees as Engineers, Scientists, and R&D Staff than the remaining commercial respondents (17 percent and 22 percent, respectively).

Figure VI-1: Employment – Professional Occupations
by Respondent Type



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) WORKFORCE

Respondents were asked to report the percentage of FTE employees that perform STEM-related functions. Employment in these areas is of particular importance as they tend to drive technological development and innovation.

Overall, 70 percent of small business respondents (1,625), 82 percent of small business respondents dependent on USG space programs (347), and 73 percent of non-small business commercial respondents (947) reported at least some staff performing STEM-related functions. In addition, over 90 percent of the commercial respondents with Research and Development as their primary business line were small businesses, further highlighting their importance in driving innovation and technological advancement.

On average, small business respondents with STEM-related staff reported that 46 percent of their workforce performed STEM-related functions, while that same figure for small business respondents dependent on USG space programs was 63 percent. Commercial respondents not considered small businesses reported 32 percent of their workforce performing those functions. According to the U.S. Census Bureau, there were 7.2 million STEM workers between the ages of 25 and 64 working in the U.S. in 2011 comprising approximately six percent of the workforce.[11] See Figure VI-2.

[11] Census Bureau, U.S. Department of Commerce: http://www.census.gov/prod/2013pubs/acs-24.pdf, p.4.

Figure VI-2: Employment – STEM-Related 2012			
Respondent Type	Respondents with STEM-Related Employees		Average Percent of FTE's in STEM-Related Positions*
	Number	Percentage of Category Total	
Small Businesses	1,625	70 %	46 %
Small Businesses Dependent on USG Space Programs	347	82 %	63 %
All other commercial respondents	926	73 %	32 %
*Average percent reported by respondents with STEM-related employees			

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

SPACE-RELATED WORKFORCE

Similarly, respondents were asked to report the percentage of their FTE workforce engaged with space-related products and/or services. Overall, 48 percent of small business respondents (1,131) and 88 percent of small business respondents dependent on USG space programs (373) reported at least some staff working on space-related products and/or services. On average, these companies had 37 percent of their staff working on space-related products and/or services while small businesses dependent on USG space programs had 63 percent of their staff performing similar functions. See Figure VI-3.

Figure VI-3: Employment – Space-Related
2012

Respondent Type	Respondents with Space-Related Employees		Average Percent of FTE's in Space-Related Positions*
	Number	Percentage of Category Total	
Small Businesses	1,131	48 %	37 %
Small Businesses Dependent on USG Space Programs	424	88 %	63 %
All other commercial respondents	1,272	42 %	27 %
*Average percent reported by respondents with space-related employees			

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

UNFILLED VACANCIES FOR SKILLED WORKERS

Respondents were asked to report the number of unfilled vacancies they currently have in the following types of positions:

- Engineers, Scientists and R&D Staff
- Production Line Workers
- Testing Operators, Quality Control and Support Technicians

Small business respondents reported 2,511 of the 19,127 indicated commercial vacancies, or 13 percent of the total. The share of unfilled vacancies reported by small businesses was greater than their share of total commercial FTE employment (nine percent).

Respondents were also given the opportunity to comment on their unfilled vacancies. Several common themes emerged. Many respondents were particularly concerned about the lack of skilled machinists and production line workers. As one small business reported, "It is extremely difficult to find production workers with proper training or education in technical skills/trades."

Another small manufacturer stated, "It is hard to find workers with CNC machine shop experience. We usually have to train machinists ourselves."

Small businesses also commented on the lack of skilled engineers and scientists with U.S. citizenship. One small business respondent with approximately 30 FTE employees reported a "lack of specialized U.S. citizen PhD-level applications." Adding further perspective, a second small manufacturer with 30 FTE employees reported "some of the government-funded contracts require U.S. citizenship for employees; however, over 50 percent of the qualified applicants are non-U.S. citizens." Similarly, another small business respondent stated, "Qualified engineers have been difficult to find. Many applicants are foreign nationals and since we have both space and defense contracts, we require personnel who can obtain U.S. Security clearance and foreign nationals do not qualify for that."

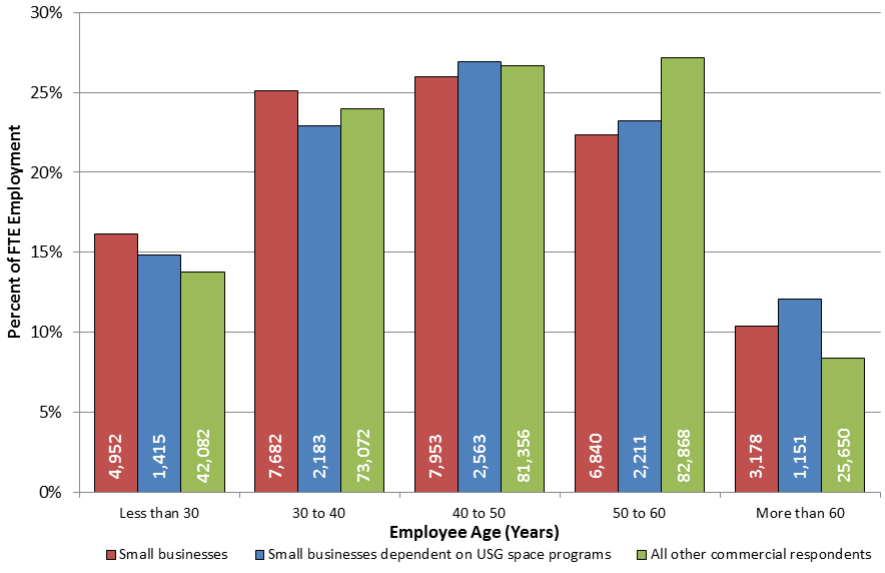
A number of respondents also highlighted the staffing challenges associated with being a small business, particularly related to offering competitive compensation packages for highly skilled workers. These workers are often attracted to larger firms that have more resources to offer these critical employees. A small manufacturer with approximately 60 FTE staff stated, "We have difficulty finding engineering staff at wages commensurate with what a small company can afford." Another small manufacturer with approximately 20 FTE employees voiced similar concerns, "It is hard to find qualified and experienced employees that meet our small-business salary requirements, and training is very costly and time-consuming."

AGE OF ENGINEERS, SCIENTISTS AND RESEARCH & DEVELOPMENT STAFF

Respondents were also asked to report the age of Engineers, Scientists, and Research and Development (R&D) staff. Of those staff reported by small business respondents, 41 percent were under the age of 40, as compared to 38 percent for all other commercial respondents. Small business respondents also reported the highest percentage of those staff under the age of 30 (16 percent). In addition, small businesses had the highest percentage of staff over age 60 (11 percent), with small businesses dependent on USG space programs having 13 percent. All other commercial respondents reported eight percent. See Figure VI-4.

Figure VI-4: Age of Engineers, Scientists and R&D Staff

by Respondent Type, Number of Employees



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

EMPLOYMENT OF SMALL BUSINESSES SUPPORTING USG AGENCIES

In addition to overall employment levels, BIS was able to calculate the employment of respondents supporting government agencies and programs. NASA and the Air Force (USAF) were the two agencies supported by the largest number of respondents.

Employment reported by all commercial respondents indicating their support of NASA declined 13 percent from 1.36 million in 2009 to 1.19 million in 2012; however, small businesses supporting NASA reported employment growth of 19 percent from 100,900 in 2009 to 119,900 in 2012. Employment growth of small businesses indicating their support of the USAF also performed stronger than that of all commercial respondents supporting the USAF. Those small businesses' employment grew 20 percent from 95,800 in 2009 to 114,500 in 2012, while employment reported by all commercial respondents supporting the USAF grew nine percent from 1.25 million in 2009 to 1.37 million in 2012.

VII. SALES

Respondents were asked to detail their U.S. and non-U.S. sales from 2009 to 2012 in a number of subcategories including:

- Total Sales
    - Government
    - Non-Government
- Space-Related Sales
    - Commercial Space
    - USG, Non-Defense Space[12]
    - USG, Defense Space

This section will discuss the total sales, space-related sales, and U.S/non-U.S. sales of small businesses.

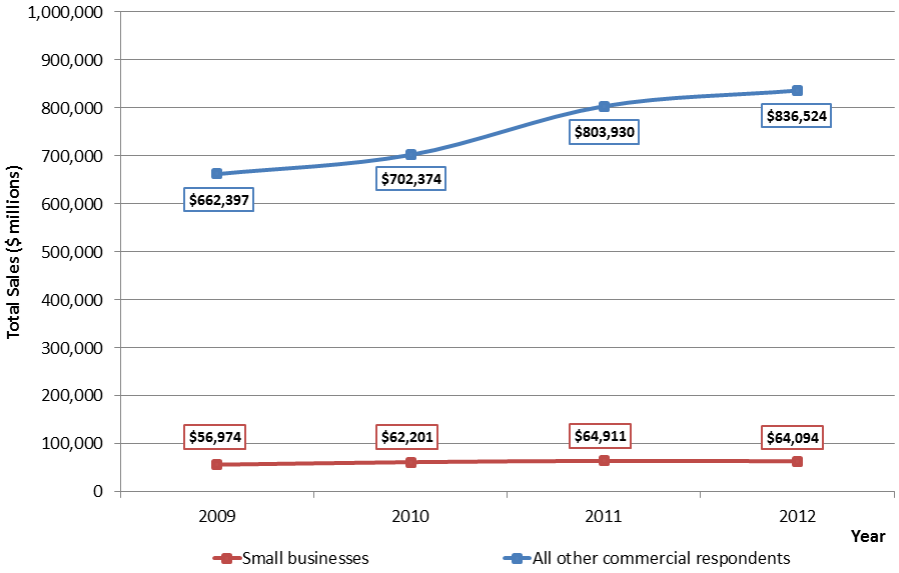
TOTAL SALES

Small business respondents' total sales averaged $62 billion annually from 2009 to 2012 (eight percent of total sales reported by all commercial respondents). They also reported non-government sales averaging $36 billion annually (six percent of commercial respondents' non-government sales) and government sales averaging $26 billion annually (16 percent of commercial respondents' government sales). See Figure VII-1.

[12] USG non-defense space sales includes sales to agencies such as NASA and the National Oceanic and Atmospheric Administration (NOAA).

Figure VII-1: Total Sales

Commercial Respondents 2009-2012



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

While small business respondents outperformed their non-small business commercial respondent counterparts in a number of measures, their overall four-year sales growth was approximately half that of the remaining commercial respondents (13 percent and 26 percent, respectively). In particular, small business respondents reported non-government sales growth of 19 percent from 2009 to 2012, while that same percentage for all remaining commercial respondents was 32 percent. Reported growth of government sales over the four-year period was also stronger for all other commercial respondents (six percent) than for small business respondents (five percent).

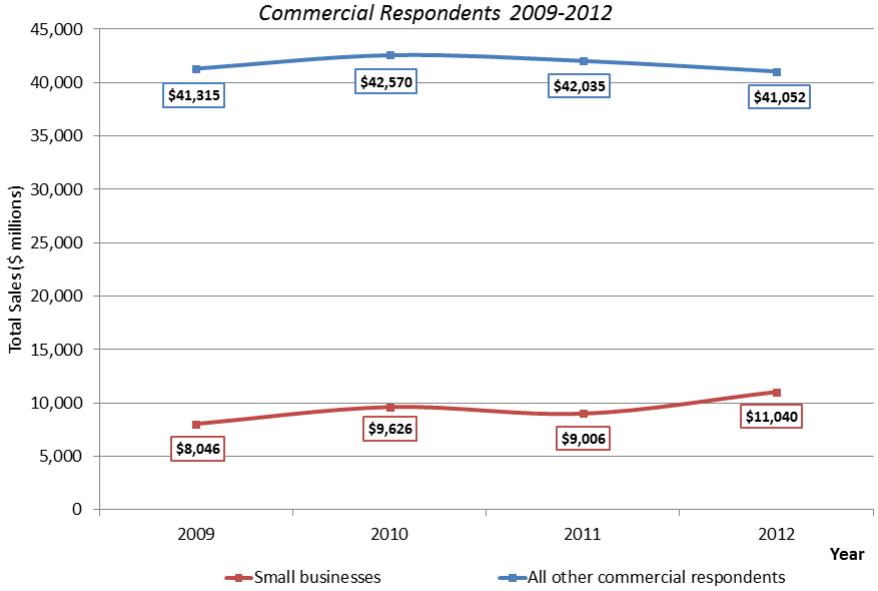
SPACE-RELATED SALES

Small businesses reported an average $9.4 billion in space-related sales annually (18 percent of the space-related sales reported by all commercial respondents). Those sales grew 37 percent from $8 billion in 2009 to $11 billion in 2012. See Figure VII-2. As the space-related sales of

all other commercial respondents remained flat over the four years, the space-related sales growth of small businesses significantly outperformed that of all other commercial respondents.

Figure VII-2: Space-Related Sales

Commercial Respondents 2009-2012

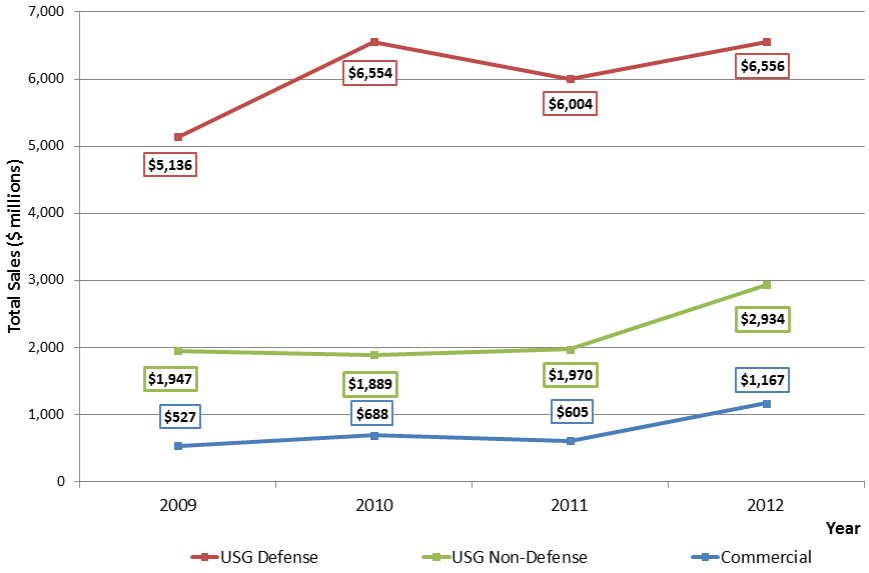


Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Small business respondents' commercial sector space sales growth also outpaced that of all other commercial respondents (four-year growth of 121 percent and 7 percent, respectively). As a result, small business respondents' share of commercial space sales grew from four percent in 2009 to eight percent in 2012 or from $527 million to $1.2 billion. See Figure VII-3.

Figure VII-3: Space-Related Sales by Customer Type

Small Business Respondents 2009-2012

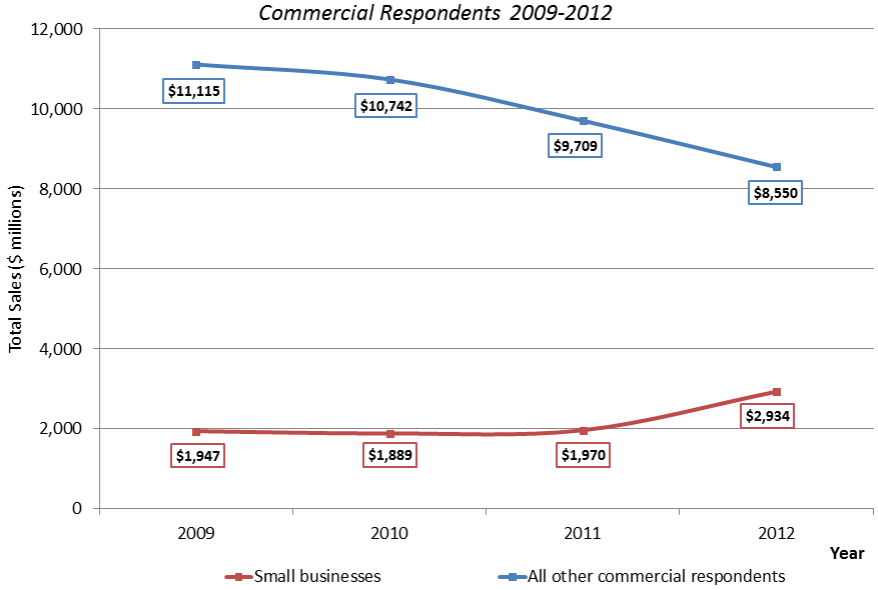


Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Similarly, small business respondents' USG space-related sales growth outpaced that of all other commercial respondents (four year growth of 34 percent and 9 percent, respectively). Small business respondents' share of sales to the USG space sector grew from 21 percent in 2009 to 28 percent in 2012, or from $7 billion to $9.5 billion. In particular, small business space-related sales to USG, non-defense customers grew by over 50 percent from $1.9 billion in 2009 to $2.9 billion in 2012, while sales by all remaining commercial respondents to USG, non-defense customers declined 23 percent from $11.1 billion to $8.6 billion. As a result, the share of commercial respondent sales to the USG non-defense space sector reported by small business respondents grew from 15 percent in 2009 to 26 percent in 2012. See Figure VII-4.

Figure VII-4: USG Non-Defense Sales

Commercial Respondents 2009-2012



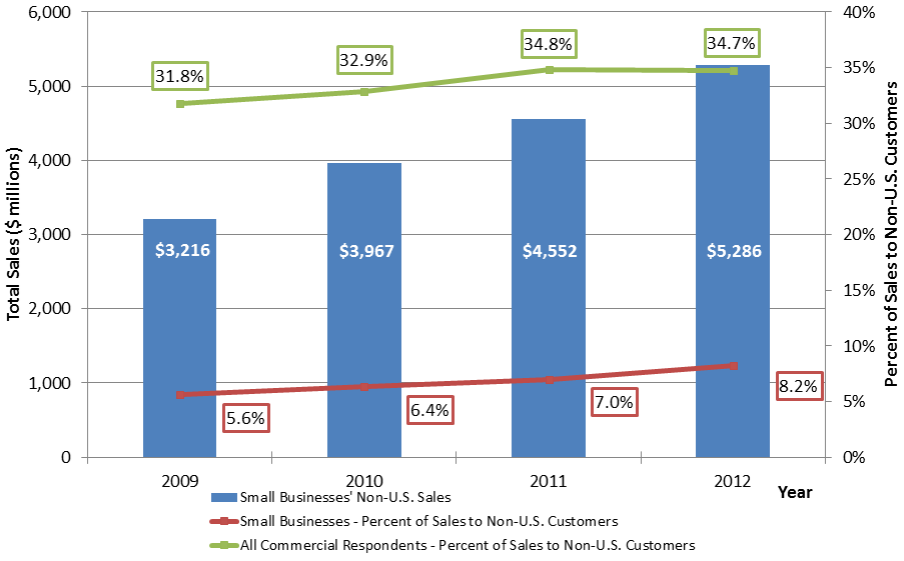
Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

NON-U.S. SALES

Respondents were also asked to break out their U.S. and non-U.S. sales, allowing for further analysis of overall government, non-government and commercial space exports. Small businesses' non-U.S. sales grew from $3.2 billion in 2009 to $5.3 billion in 2012, a 64 percent increase. Non-U.S. sales reported by small business respondents over the four years accounted for seven percent of their total sales, on average. This was much lower than the overall commercial respondent average of 34 percent to non-U.S. customers. See Figure VII-5.

Figure VII-5: Non-U.S. Sales

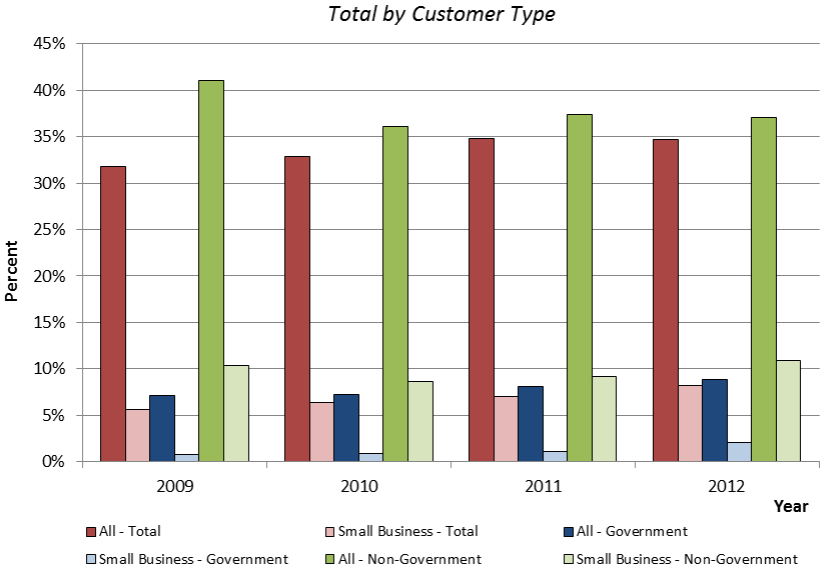
Small Business Respondents 2009-2012



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

From 2009 to 2012 an average of one percent of small businesses' sales to the government sector was to non-U.S. customers (eight percent for all commercial respondents). An average of ten percent of small businesses' sales to the non-government (commercial) sector was to customers outside the U.S. during the same four-year period (38 percent for all commercial respondents). See Figure VII-6.

Figure VII-6: Sales - Percent of Sales to Non-U.S. Customers

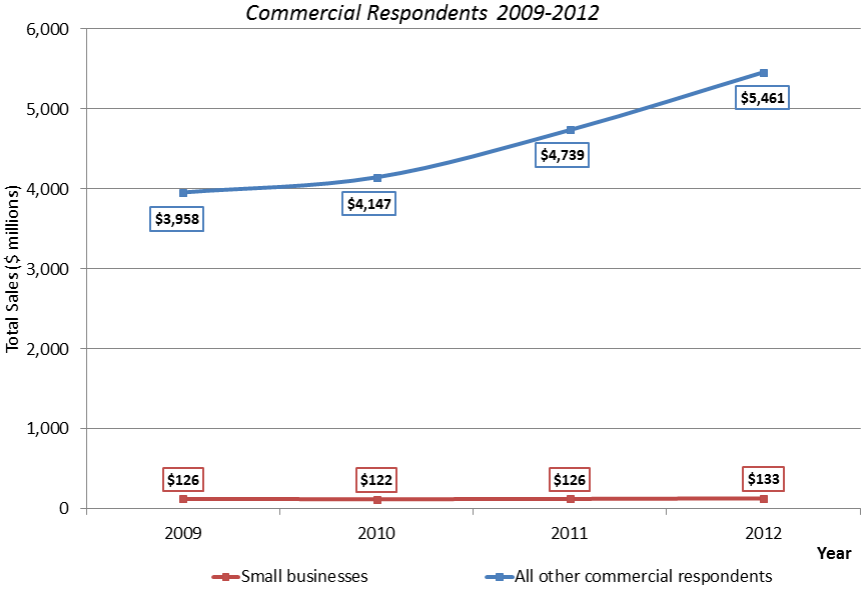


Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Space-related exports accounted for a much lower portion of small businesses' sales than they did for larger businesses. An average of 12 percent of space-related sales reported by non-small business commercial respondents went to non-U.S. customers, compared to two percent of space sales reported by small businesses. From 2009 to 2012 small businesses did not keep pace with their larger counterparts in export sales growth, particularly for non-governmental sales. Non-small business commercial respondents increased these sales by 37 percent, to nearly $5.5 billion in 2012, while small businesses saw their non-U.S. commercial sales increase six percent, to $133 million. See Figure VII-7.

Figure VII-7: Non-U.S. Commercial Space Sales

Commercial Respondents 2009-2012



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

VIII. FINANCIAL PERFORMANCE

Respondents were asked to provide information regarding their overall financial health, including select items from their organizations' income statements and balance sheets. BIS compiled this information in a number of ways to better understand the financial health of the supply chain supporting the U.S. space industry. As previously discussed, BIS assigned a financial risk rating to each respondent based on a series of criterion. Each respondent was assigned a ranking of high/severe, moderate/elevated, or low/neutral. In addition, BIS calculated net profit margins and debt-to-equity ratios from 2009 to 2012 to provide greater insight into respondent financial performance. This section will discuss these measures.

PROFITABILITY: NET PROFIT MARGIN

Net profit margin was utilized to investigate respondent profitability.[13] In total, 3,353 commercial respondents provided the data necessary to perform this calculation. Of those, 2,151 were small businesses and 391 were small business respondents dependent on USG space programs. Overall, the number of small business respondents with a positive net profit margin increased from 1,497 in 2009 to 1,789 in 2012.

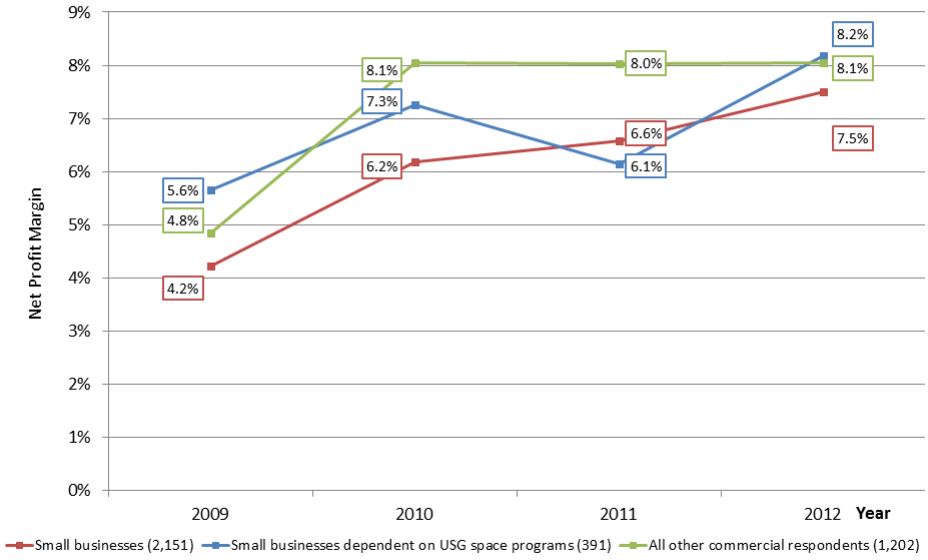
However, mean and median small business respondent net profit margins were below that of all other commercial respondents. When calculated as a mean value, small business net profit margins grew from 4.2 percent in 2009 to 7.5 percent in 2012, while non-small business respondent net profit margins grew from 4.8 percent in 2009 to 8.1 percent in 2012. As a subset

[13] Net profit margin was calculated as net income / net sales.

of small business respondents, those dependent on USG space programs reported average net profit margins slightly above those of all other small business respondents. The average net profit margin of small businesses dependent on USG space programs grew from 5.6 percent to 8.2 percent. See Figure VIII-1.

Figure VIII-1: Net Profit Margin (after tax)

Commercial Respondents (Number of Respondents), Mean



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Median net profit margins of the respondent groups described above were slightly below their mean values over the four years. The small business respondent median value grew from 3.0 percent in 2009 to 5.0 percent in 2012, while that of all other commercial respondents grew from 4.3 percent to 6.7 percent over the same period. Small business respondents dependent on USG space programs' median net profit margin grew from 4.0 percent in 2009 to 5.2 percent in 2012, slightly above that of all other small business respondents.

Finally, in an effort to examine firm-level profitability over the four years, BIS calculated the number of years of negative net profit margins and the number of years of improving net profit

margins reported by respondents from 2009 to 2012. Both measures reported by small business respondents were roughly reflective of that reported by all other commercial respondents.

Approximately 80 percent of small businesses reported negative net profit margins in zero or one year and eight percent reported negative net profit margins in three or four years. At the same time, a smaller portion of small business respondents reported two or three consecutive years of improved net profit margins (26.6 percent and 10.3 percent) as compared to non-small business respondents (29.2 percent and 14.6 percent).

LEVERAGE: DEBT-TO-EQUITY RATIO

Respondents' debt-to-equity ratios were also calculated to determine the portion of equity and debt used to finance assets.[14] Although the preferred (healthy) ratio varies across industries, those between 0.5 and 1.5 are generally considered acceptable, as they suggest a relatively equal mix of debt and equity is being utilized to finance an organization's assets. Overall, 2,945 commercial respondents, 1,915 small business respondents and 330 small business respondents dependent on USG space programs provided data allowing their debt-to-equity ratios to be calculated.

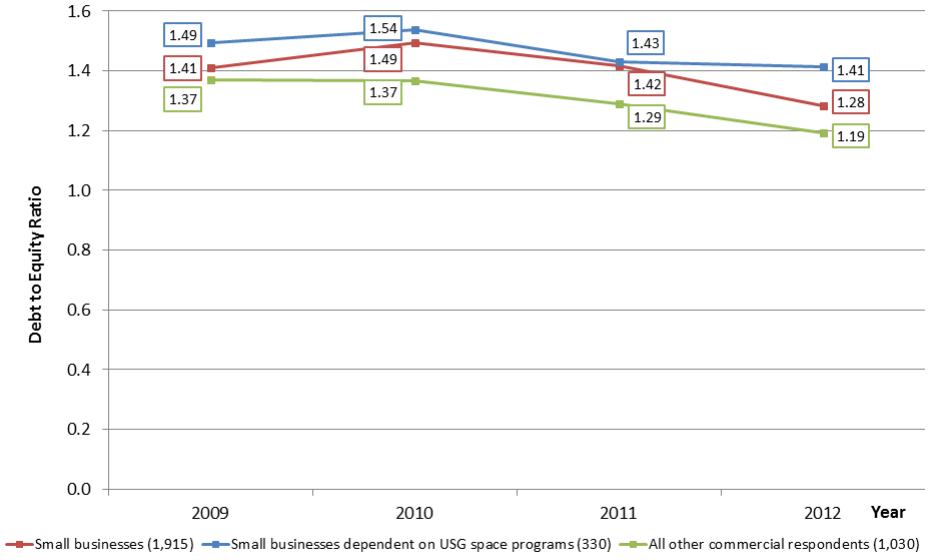
Over the period, small business respondent debt-to-equity ratios were higher than those of all other commercial respondents when calculated as both mean and median values. The small business respondent mean debt-to-equity ratio fell from 1.41 in 2009 to 1.28 in 2012, while the

[14] Debt to equity ratios were calculated as Total Liabilities / Equity

non-small business respondent mean debt-to-equity ratio fell from 1.37 to 1.19. See Figure VIII-2.

Figure VIII-2: Debt-to-Equity Ratio

Commercial Respondents (Number of Respondents), Mean



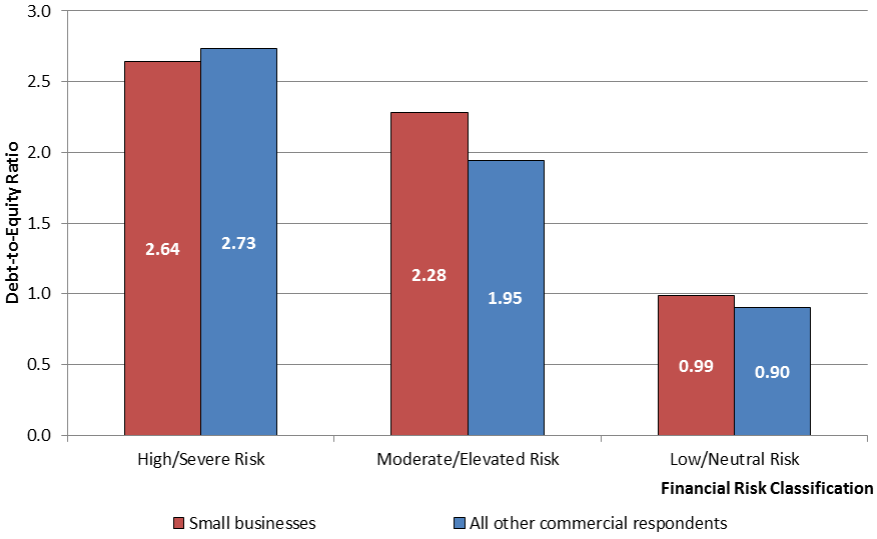
Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Median debt-to-equity ratios of all respondent groups were significantly below their mean values; however they followed a similar trend. The small business respondent median debt-to-equity ratio fell from 0.77 in 2009 to 0.66 in 2012, while the non-small business ratio fell from 0.66 to 0.58.

When examining respondents' debt-to-equity ratios by the financial risk categorizations previously discussed (high/severe, moderate/elevated, low/neutral), small business respondents classified as less at-risk tended to have lower ratios than their high/severe risk counterparts. Small business respondents classified with a low/neutral risk rating reported an average debt-to-equity ratio of 0.99, while the average of those with a high/severe risk rating was 2.64. See Figure VIII-3.

Figure VIII-3: Debt-to-Equity Ratio

by Financial Risk and Respondent Type, Mean



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

IX. RESEARCH AND DEVELOPMENT

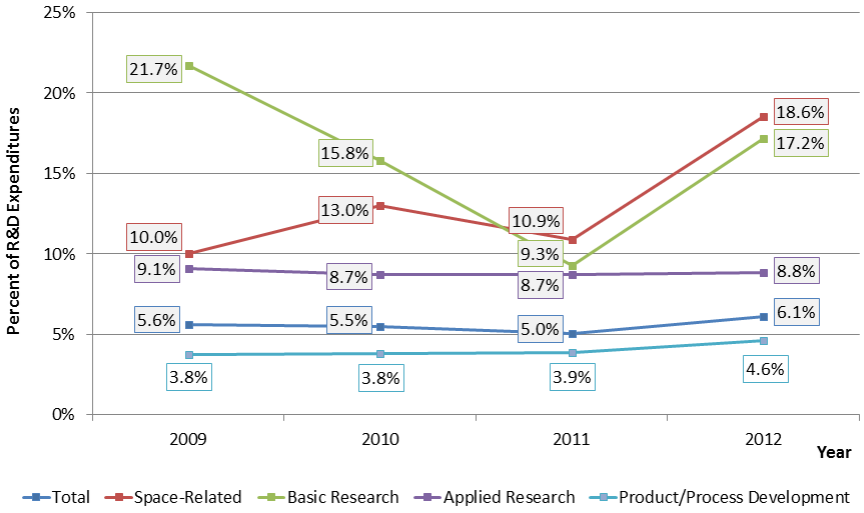
Respondents were asked to report their R&D activities, including expenditures, source of funds, and the impact reductions in USG space-related spending have had and may have on R&D initiatives. Overall, 1,122 small businesses and 249 small businesses dependent on USG space programs reported R&D expenditures from 2009 to 2012.

With regard to space-related R&D, 479 small businesses and 188 small businesses dependent on USG space programs reported space-related R&D expenditures over the four years. In total, 21 percent of small businesses conducted space-related R&D and 44 percent of those dependent on USG space programs were conducting space-related R&D.

R&D EXPENDITURES

Small business respondents accounted for six percent of all commercial respondent R&D expenditures from 2009 to 2012, an average $2.1 billion annually. Those expenditures were divided into three categories: basic, applied, and product/process development. Small business respondents accounted for approximately 16 percent of the basic research, nine percent of the applied research, and four percent of product/process development expenditures reported by commercial respondents. Small businesses were also responsible for 13 percent of all space-related R&D expenditures. See Figure IX-1.

Figure IX-1: R&D - Small Business Share of Commercial Respondent R&D Expenditures



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Space-related R&D expenditures reported by small business respondents grew 106 percent over the four years, from $227 million in 2009 to $571 million in 2012. In contrast, space-related R&D expenditures by all other commercial respondents grew by less than one percent to reach $2.5 billion in 2012. In comparison to all other commercial respondents, small businesses spent significantly more R&D funds on space-related activities (19 percent of their total) than all other commercial respondents (seven percent). Small businesses' R&D efforts were also more concentrated in basic research efforts as over 15 percent of their total R&D expenses went to such work, while only five percent of all other commercial respondents' R&D expenditures supported basic research. See Figure IX-2.

Figure IX-2: R&D Expenditures by Type *Percent of Total Expenditures, 2009-2012 Average*		
Type of Expenditure	**Small businesses**	**All other commercial respondents**
Basic Research	15.4%	4.9%
Applied Research	29.4%	17.9%
Product/Process Development	55.2%	77.2%
Space-Related	18.6%	7.2%

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

R&D FUNDING SOURCES

In describing their R&D activities, respondents were also asked to report the source of their R&D funds by selecting from a number of options, including: internal/self-funded; federal government; state and local government; universities; U.S. industry, venture capital, non-profits, and non-U.S. investors. Small business respondents reported receiving $4.4 billion (50 percent of their R&D funding) from the federal government for R&D activities, and internally funding $3.7 billion (42 percent). In contrast, non-small business commercial respondents received $24.4 billion in R&D funding from the federal government, but this accounted for only 17 percent of their full R&D budgets. See Figure IX-3.

While small businesses are far more reliant on government funding for their R&D activities, the funds they received from the government accounted for a small portion of all government R&D funding. Thirty percent of the $103 million provided by state and local governments to commercial respondents for R&D went to small businesses, as did 15 percent of the $29 billion in federal funding, despite small businesses accounting for 65 percent of all respondents.

Figure IX-3: R&D Funding by Source
Total Funding, 2009-2012, in Millions

Source of Funding	Small Businesses		All Other Commercial Respondents	
	Millions of $	Percent of Total Funding	Millions of $	Percent of Total Funding
Federal Government	$4,359	50.1%	$24,351	17.1%
State and Local Governments	$31	0.4%	$72	0.1%
Internal/Self-Funded/IRAD	$3,678	42.2%	$111,855	78.3%
Universities	$19	0.2%	$417	0.3%
U.S. Industry	$436	5.0%	$2,799	2.0%
Non-U.S. Investors	$87	1.0%	$1,031	0.7%
Other	$97	1.1%	$2,280	1.6%

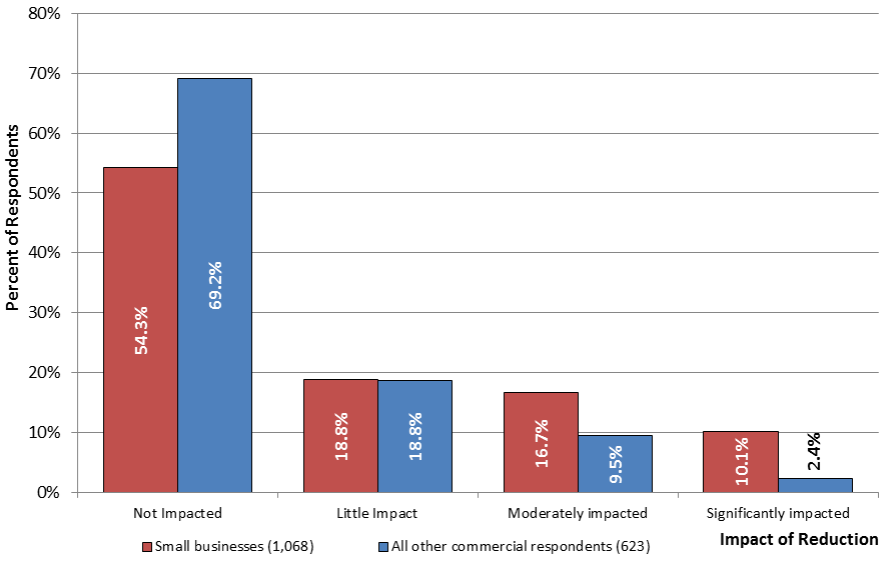
Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

IMPACT OF REDUCTIONS IN U.S. GOVERNMENT SPACE-RELATED SPENDING

Survey respondents were asked about the impact of reductions in USG space-related spending on their R&D activities. Of the 1,068 small business respondents completing the question, 27 percent indicated their R&D activities have been either moderately or significantly impacted. This compares to 12 percent for all other respondents for the same two categories. See Figure IX-5.

Figure IX-5: Reduction in USG Space-Related Spending

Impact on Past/Current R&D Expenditure

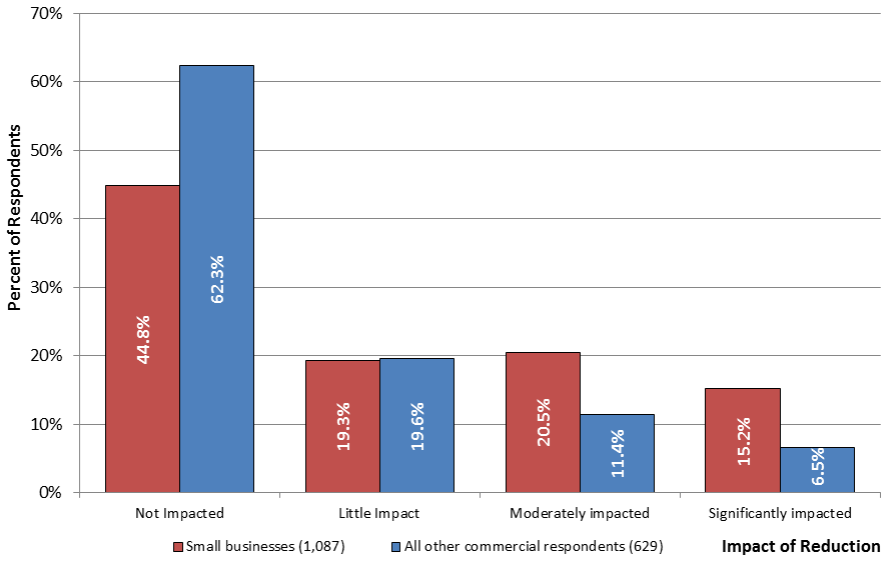


Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

When asked about the impact of those reductions on future R&D activities, respondents were more pessimistic. Of the 1,087 small business respondents providing information, 36 percent anticipate moderate to significant impacts as compared to 18 percent of the remaining 629 non-small business commercial respondents completing the question. See Figure IX-6.

Figure IX-6: Reduction in USG Space-Related Spending

Impact on Future R&D Expenditure



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

Several small businesses commented on the impact these USG spending reductions have had on their R&D initiatives. "We were originally awarded part of a long term R&D program for five years. Unfortunately, it was funded yearly and not funded beyond the first year." A number of small businesses also pointed to the sharper impact of the reductions on small businesses, primarily due to their size. "As a small business, our R&D budget relates closely to our revenue. Without growth in the space industry, our revenue will stall impacting our ability to perform R&D."

Additionally, several companies indicated the reduction has or will impede their ability to further develop emerging, advanced technologies. "Our company specializes in the research and development of advanced technologies. Cutbacks in R&D will almost certainly have a negative impact on our business and our ability to bring those technologies to a final product." Further emphasizing that point, another respondent stated "A reduction in R&D spending for space

related projects reduced the opportunity for leading edge technologies like nano-tech materials to be developed, tested and adopted elsewhere in the economy. Much of today's standard technology was birthed in the early space programs of NASA."

X. SBIR & STTR PROGRAM PARTICIPATION

The federal government, through the Small Business Administration (SBA), provides several programs designed to foster the research and development (R&D) activities of small businesses. Two key programs are the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. Both programs follow a three phase process in providing support to small businesses. Phase I provides a maximum $150,000 in funding over six months allowing the participant to conduct a feasibility study and develop a proof of concept; Phase II provides a maximum $1 million in funding over 12 months for the full research and development effort; and Phase III is the commercialization stage where the awarding agency does not provide any additional funds because the sponsored small business should be able to either finance its own operations or secure outside funding sources.

Through the SBIR program, 11 federal agencies with budgets for external R&D efforts exceeding $100 million allocate 2.5 percent of that total to small businesses. According to the SBA, the SBIR program provided 5,011 awards worth a total of $1.9 billion in 2012. The SBIR program has four primary goals:

1. Stimulate technological innovation.
2. Meet federal research and development needs.
3. Foster and encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons.

4. Increase private sector commercialization of innovations derived from federal research and development funding.[15]

The STTR program, while similar, focuses on promoting public private partnerships between small businesses and non-profit research institutions by requiring collaboration between the two for the initial two phases of the program. Only agencies with external R&D budgets exceeding $1 billion are required to participate in the STTR program, allocating 0.3 percent of those budgets to small businesses. According to the SBA, the STTR program provided 635 awards worth $215 million in 2012.[16] The primary goals of the STTR program are:

1. Stimulate technological innovation.
2. Foster technology transfer through cooperative R&D between small businesses and research institutions.
3. Increase private sector commercialization of innovations derived from federal R&D.[17]

Respondents were asked to report the number of space-related SBIR and STTR contracts they received, by phase, over the 2009-2012 period. Overall, 223 commercial respondents reported 1,874 SBIR awards and 71 commercial respondents reported 204 STTR awards. A small number of companies were responsible for generating a large portion of the awards. Forty-three small businesses received more than 10 awards from 2009 to 2012, accounting for 1,164 awards—nearly two-thirds of the total reported by small businesses.

[15] More information on the SBIR program can be found at: http://www.sbir.gov/about/about-sbir
[16] An SBIR/STTR program database can be found at: http://www.sbir.gov/past-awards?program=STTR&period=4
[17] More information on the STTR program can be found at: http://www.sbir.gov/about/about-sttr

Among the 223 respondents receiving SBIR or STTR contracts, 25 percent of SBIR recipients and eight percent of STTR recipients had Phase III awards. Many more of both types of recipients had Phase II awards between 2009 and 2012 (75 percent of SBIR recipients and 72 percent of STTR recipients). Nearly all respondents with SBIR or STTR awards had a Phase I contract – 96 percent and 89 percent, respectively. See Figure X-1.

Figure X-1: Space-Related SBIR and STTR Awards
2009-2012

Award Type	Phase	Number of Companies	Number of Awards
SBIR	Phase I	213	1102
	Phase II	168	596
	Phase III	56	176
	Total	**223**	**1874**
STTR	Phase I	63	128
	Phase II	51	67
	Phase III	6	9
	Total	**71**	**204**

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

These programs are critical to many small businesses as they enable them to develop new products, services, and technologies. As one respondent suggested, "Many of our current products were developed under the SBIR and similar programs in the 1990's. Under the current SBIR practices, this would not have been possible."

While these programs are critical, many small business respondents commented on the "valley of death," a term used to describe what happens to products and technologies between Phase II and commercialization (Phase III). Many of the products these small businesses are developing need to be space-qualified which adds an additional layer of complexity onto an already difficult process. According to one respondent experienced in the SBIR/STTR process, "Space-related

projects suffer from the valley of death since Phase II money isn't sufficient to qualify the product for use in space. [Projects] require Phase III investment to do qualification."

While the SBIR and STTR programs aim to help small businesses, their small size results in added obstacles. As one respondent stated, "As a small business we do not have large amounts of internal funding available. The gap between a new technology development, however promising, and a space qualified product usually far outstrips the dollars available in an SBIR or other similar technology development program."

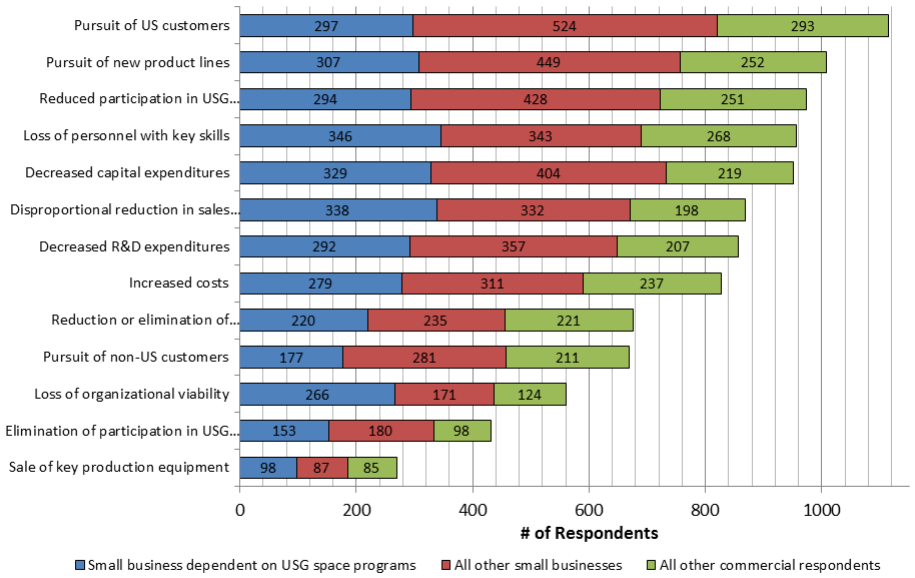
Small businesses also struggle to get private financing for the technologies developed during Phase II, resulting in many products never reaching Phase III. One respondent stated that, "The private capital markets have not yet accepted the commercial space industry as a viable growth market largely due to the perception that space is too expensive and only available to government budgets."

The cost of applying for awards can also deter small businesses as one respondent indicated, "We have [submitted a proposal] for SBIR funding and lost every time. We concluded that the amount of available SBIR funding is not worth the expense of pursing it." In addition, many small businesses are increasingly discouraged by the shrinking quantity of available funds, as one respondent pointed out, "As the overall likelihood of proposal selection goes down we will have to weigh our options of return on investment. It is getting to the point that we will no longer be able to afford proposal writing due to the low percentage of being selected."

XI. CHALLENGES FACING SMALL BUSINESSES

Respondents were asked a series of questions designed to better understand the key issues and challenges facing their organizations. First, they were asked about the potential impact on their organization of a sudden decrease in USG space-related demand. Response options ranged from pursuit of other U.S. and non-U.S. customers to loss of organizational viability. Beyond pursuing new customers and new product lines, which were the most frequently selected options, 733 small businesses stated they would decrease capital expenditures. Moreover, 689 small businesses indicated they would lose personnel with key skills. See Figure XI-1. In addition, 437 small businesses said their organization would lose its viability or solvency if it experienced a sudden decrease in USG space-related demand. Those 437 respondents provide a wide array of products and services and represent nearly 20 percent of the 2,339 small businesses that completed the assessment.

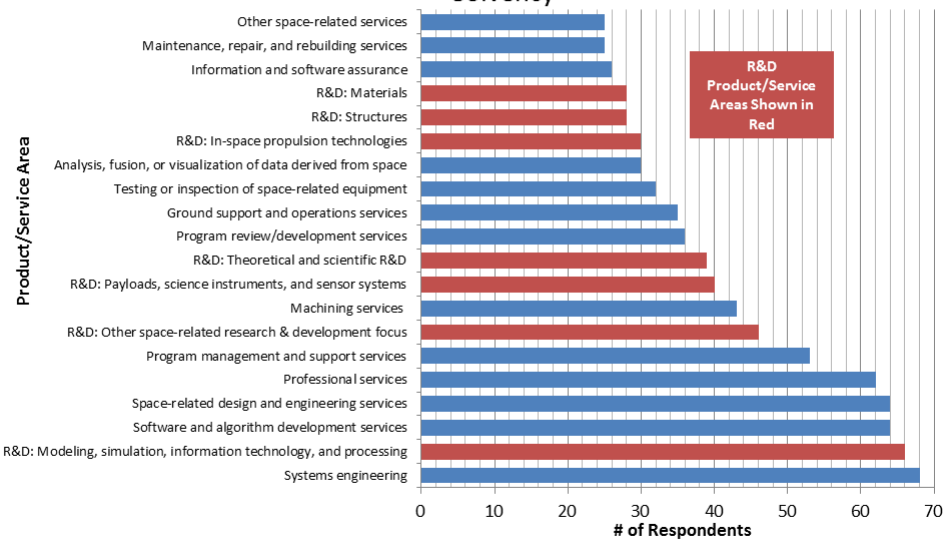
Figure XI-1: Impact of a Reduction in USG Space-Related Spending



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

For example, Systems Engineering was identified by 68 of these 437 small businesses, the largest number of all the product/service areas. In reviewing the top 20 product and service areas provided by these potentially vulnerable respondents, seven were Research and Development categories, including modeling, simulation, information technology, and processing to basic structures and materials. See Figure XI-2.

Figure XI-2: Most Identified Product/Service Areas Provided by Small Business Respondents With a Potential Loss of Viability or Solvency



Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

In comparing comments from two small business respondents, one with strong dependence on space-related demand and the other without, the impact of a reduction in USG space-related demand is not viewed as positive by either party. According to the more dependent respondent, "Depending on the size of the decrease, such a reduction could be devastating to our company to the point of insolvency." The less dependent respondent was still not optimistic about the impact on the organization's operations: "While we do not do much 'space' the trickle down through industry would cause more competition, margin squeeze and reduced volume with commercial customers all resulting in lower profits and or viability".

Thus, a decrease in USG space-related demand can cause direct and indirect impacts on small businesses regardless of their dependency in the sector. As noted in Chapter 4, Figure IV-2, customer demand for R&D has already experienced a major drop over the 2009 to 2012 period. Finally, as reported by one small R&D company, a decrease in demand has especially significant impacts on their R&D, "With cuts made and proposed, small R&D firms do not have lobbying capabilities the large contractors have which makes competing for funds very difficult."

Beyond the potential impact of a reduction in USG space-related demand, respondents were asked to rank the top five issues and challenges affecting their long term viability from a list of 27 options that ranged from increased competition to government policies and regulations. By assigning a weight to each ranking, the relative importance of each issue to respondents can be determined.[18] All commercial respondents had a number of similar issues and challenges; however, there were also several distinctions between the issues facing small business and those facing all other commercial respondents.

The top issue impacting both small businesses' and all other commercial respondents' long term viability was domestic competition, followed by labor costs (ranked second for small businesses and third for all other commercial respondents). Both small businesses and all other commercial respondents also ranked the government acquisition process, regulatory burden, and purchasing volatility to be of medium importance. Finally, there was a general consensus among

[18] Respondents were asked to rank their top five issues with one being the top concern. To calculate the importance, the following weights were given to each ranking: 1 = 5 points; 2 = 4 points; 3 = 3 points; 4 = 2 points; 5 = 1 point. This was then multiplied by the number of respondents selecting a ranking for each issue.

commercial respondents that issues related to supplier proximity and reliability, counterfeits, pension costs, and foreign subsidies were of least concern over the longer term. See Figure XI-3.

Figure XI-3: Top Issues Impacting Long Term Organizational Viability

Issue	Small Businesses' Ranking	All Other Commercial Respondents' Ranking
Domestic competition	1	1
Labor costs	2	3
Proposed cuts to USG space programs	3	5
Healthcare	4	8
Taxes	5	10
Foreign competition	6	2
Variability in demand	7	4
Government acquisition process	8	9
Government regulatory burden	9	11
Skills retention	10	6

Source: U.S. Department of Commerce, Bureau of Industry and Security, *U.S. Space Industry Deep Dive Assessment*, December 2014.

There were, however, several issues and challenges where small business and all other commercial respondents' rankings diverged. While small businesses ranked foreign competition as the 6th most important issue, all remaining commercial respondents ranked it as second. Similarly, small businesses viewed export controls as the 15th most important issue, while all remaining commercial respondents viewed those controls as the 7th most important. These rankings fall in line with the relatively small share of small businesses' sales that was destined for non-U.S. customers in comparison to their larger counterparts.

Small businesses also viewed healthcare and taxes as significantly more important than all other commercial respondents. They ranked healthcare as the fourth most important issue and taxes as the fifth, while all other commercial respondents ranked healthcare as eighth and taxes as tenth.

Last, small businesses ranked barriers to entry as the 13th most important issue, while all other commercial respondents ranked it 19th.

XII. FINDINGS

- **General Findings:**
    - 2,325 of the 3,585 commercial respondents (65 percent) self-identified as small businesses, and 422 of those small business respondents (18 percent) indicated they were dependent on USG space programs for their continued viability.
    - Approximately 45-55 percent of commercial respondents supporting a given government agency were small businesses and approximately 20-30 percent were dependent on USG space programs for their continued viability. Forty-three of the 190 small business respondents supporting at least 10 government agencies were also dependent on USG space programs.
- **Financials and Sales:**
    - Ten percent of small business respondents were determined to be at High/Severe financial risk by BIS. Fifteen percent of small business respondents dependent on USG space programs were also determined to be at High/Severe financial risk by BIS.
    - Small businesses reported total sales averaging $62 billion annually from 2009 to 2012, and space-related sales averaging $9.4 billion annually. Their commercial space sales grew from $527 million in 2009 to $1.2 billion in 2012, while their space-related USG non-defense space sales grew from $1.9 billion to $2.9 billion.
- **Employment**
    - Small business respondents employed an average 156,308 staff from 2009 to 2012, or approximately nine percent of total commercial employment. Small

businesses' total reported employment grew by 18 percent over the four year period.

- Small business respondents reported 2,511 current vacancies for skilled positions, or 13 percent of the total vacancies.

- **R&D**
  - Small business respondents reported an average six percent of all commercial respondent R&D expenditures from 2009 to 2012, or an average $2.1 billion annually. Space-related R&D expenditures grew from $227 million in 2009 to $571 million in 2012.
  - Small business respondents reported receiving 50 percent of their R&D funds from the federal government, significantly more than the 17 percent for all other commercial respondents.
  - When asked about the impact on R&D activities of future reductions in U.S. government space-related spending, 36 percent of the 1,087 small businesses completing the question anticipate moderate to significant impacts as compared to 18 percent of the remaining 629 non-small business commercial respondents.
  - Twenty-five percent of SBIR participants and eight percent of STTR participants reached Phase III, the final phase of the program, while 75 percent of SBIR participants and 72 percent of STTR participants reached Phase II.

- **Challenges**
  - A potential reduction in USG space-related demand will impact small businesses across the board but especially those respondents involved in Systems Engineering and various types of Research and Development.

- The top five long term issues impacting small businesses are: domestic competition, labor costs, proposed cuts to USG space programs, healthcare, and taxes.

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February 5, 2015

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PUBLICATION TITLE	*__Bold__ indicate forthcoming studies
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National Security Assessment of the Cartridge and Propellant Actuated Device Industry: Third Review – August 2006	

Archived Studies	
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National Security Assessment of the Munitions Power Sources Industry – Dec. 2004	Critical Technology Assessment of U.S. Superconductivity - April 1994
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Statistical Handbook of the Ball and Roller Bearing Industry (Update) - June 2001	National Security Assessment of the U.S. Robotics Industry - March 1991
National Security Assessment of the Cartridge and Propellant Actuated Device Industry: Update – Dec.2000	National Security Assessment of the U.S. Gear Industry – Jan. 1991
The Effect on the National Security of Imports of Crude Oil and Refined Petroleum Products – Nov. 1999	The Effect of Imports of Uranium on the National Security – Sept. 1989
U.S. Commercial Technology Transfers to The People's Republic of China – Jan. 1999	The Effect of Imports of Crude Oil and Refined Petroleum on Natl. Security – Jan. 1989
Critical Technology Assessment of Optoelectronics – Oct. 1998	The Effect of Imports of Plastic Injection Molding Machines on Natl. Security – Jan. 1989
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Critical Technology Assessment of the U.S. Semiconductor Materials Industry - April 1997	Investment Castings: A Natl. Security Assessment – Dec. 1987
National Security Assessment of the Cartridge and Propellant Actuated Device Industry – Oct.1995	An Economic Assessment of the U.S. Industrial Fastener Industry – Mar. 1987
International Market for Computer Software with Encryption – NSA -1995	Joint Logistics Commanders/DOC Precision Optics Study - June 1987
The Effect of Imports of Crude Oil and Petroleum Products on the National Security – Dec. 1994	Joint Logistics Commanders/DOC Bearing Study - June 1986

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