SPACE FOUNDATION

THE SPACE REPORT

2008

The Authoritative Guide to Global Space Activity

4.3 The U.S. Space Industry: National, State, and Local Labor Market Trends

The U.S. space industry draws on the expertise of more than a quarter of a million Americans across the country who directly contribute to the economic health of the national economy, many state economies, and local communities. Space industry labor market statistics demonstrate this point and show that concentrations of space industry enterprises are geographically dispersed across the United States, from Florida to Colorado to California.

A technician tests a manufactured aluminum panel as part of the Ares I upper stage barrel fabrication. The panels are built by AMRO Manufacturing located in El Monte, California. *Image Credit: NASA Marshall Space Flight Center*

The success of the U.S. space industry hinges on maintaining and cultivating a highly talented cadre of scientists and engineers who comprise the core of the space industry workforce.

The U.S. space industry needs everyone from astronauts to aerospace engineers to space scientists to succeed. Workers and professionals of great technical skill in their chosen disciplines will be required to implement the space exploration vision and other missions in the next five to fifteen years and continue benefiting the entire U.S. economy, state economies, and local communities.

One way to measure the importance of the space industry to the American economy is to examine labor market trends. This is critical because the U.S. space industry must maintain a workforce strategy for ensuring that it is able to target, attract, train, and retain the skilled personnel necessary to engage in space exploration.

Engineers run a test with the Autonomous Extravehicular Robotic Camera (AERCam) in the Navigation Systems Technology Laboratory at Johnson Space Center. The program is developing a small, free flying vehicle capable of performing inspection and viewing missions in support of International Space Station operations. *Image Credit: NASA*

There is deep concern that the future workforce required for the U.S. space industry to prosper is not being trained adequately. The present level of achievement in science and technology relative to other countries potentially places the U.S. space industry at risk, as it requires a highly skilled and technically trained workforce to thrive.

This workforce manufactures a range of space products such as space vehicle propulsion units and space vehicle parts. It also provides satellite

telecommunications services. Additionally, the space industry workforce detailed here includes those civilian government workers involved in space research and technology, working for agencies such as NASA.

The importance of space activity to the U.S. economy goes beyond direct space industry employment and the high wages paid to skilled space industry workers. The benefits of the U.S. space industry include:

- spawning numerous other industries
- generating billions of dollars for the American economy
- producing more than 1,500 documented products derived from activities related to space technology such as satellite radio and television, mobile phone technology, and global positioning navigation for the family car, providing an immeasurable return on America's investment in this important industry.[1]

Ultimately, the U.S. space industry produces such indirect benefits as new technologies, medical advances, and a host of fresh consumer products.

Workers at Launch Complex 17-B, Cape Canaveral Air Force Station, prepare for mating the second stage of the Delta II Heavy rocket to the first stage below. *Image Credit: NASA Kennedy Space Center*

The broader economic benefits produced by the nation's space sector are even more impressive when one considers that these advances are being driven by a cadre of just under 270,000 skilled workers directly employed in the core sectors that make up today's space industry. These workers constitute the heart of the vibrant U.S. space sector, and their ranks are growing. Almost 17,000 space industry jobs have been added nationwide since 2003, employment growth that is expected to continue.

Adding significance to this growth in core space industry employment, the U.S. space industry workforce is well compensated, due in part to the high skill and educational level of most space industry workers and to the demand for their skills. The U.S. space industry's annual average wage was $88,200 in 2006. This was more than double the 2006 private sector average wage of $42,400. The U.S. space industry payroll reached $23.5 billion in 2006.

Workers in technical occupations such as aerospace engineering support the work of the nation's space community. In 2006, there were almost 90,000 Americans working as aerospace engineers. Many of these engineers work in the space industry. These skilled and highly educated professionals earned an impressive average wage of $89,300 in 2006.

4.3.1 The Space Industry Workforce: The Methodology

This year, for the first time, *The Space Report* provides objective and comparable baseline labor market statistics on those core industry sectors that comprise the U.S. space industry. The analysis is based on data from 2006, the most recent information available at the time of writing. To provide the most accurate and verifiable statistics, our analysis is limited to

industries that directly produce space industry products and services. Broader industry categories were excluded because the U.S. government's industry classification coding system does not objectively identify portions of larger industries, such as aircraft manufacturing, specific to the production of space products and services.

Our conservative approach likely results in understating the overall size of the space industry. For that reason, the labor market statistics presented in this section should be seen as a lower boundary, particularly since this definition does not include any additional space-enabling industries. These conservative statistics on the U.S. space industry labor market establish a reliable and comparative baseline that fills the previous void and will enable us to track industry labor trends into the future. This is because the U.S. government requires each space industry workplace, or establishment, to report its employment and wage data for workers covered by state unemployment insurance laws. These government statistics are part of an annual census of virtually the entire U.S. workforce.[2]

EXHIBIT 4e. Space-Related Industries Included in this Analysis

NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (NAICS) CATEGORY	PRODUCTS AND SERVICES
Search, detection, and navigation instruments manufacturing*	Includes the manufacturing of such products as aircraft instruments (except engines), flight recorders, navigational instruments and systems, and radar systems and equipment.
Guided missile and space vehicle manufacturing	Includes the manufacturing of complete guided missiles and space vehicles and/or developing and making prototypes of guided missiles or space vehicles.
Space vehicle propulsion units and parts manufacturing	Includes the manufacturing of guided missile and/or space vehicle propulsion units and propulsion unit parts and/or developing and making prototypes of guided missile and space vehicle propulsion units and propulsion unit parts.
Other guided missile and space vehicle parts manufacturing	Includes the manufacturing of guided missile and space vehicle parts and auxiliary equipment (except guided missile and space vehicle propulsion units and propulsion unit parts) and/or developing and making prototypes of guided missile and space vehicle parts and auxiliary equipment.
Satellite telecommunications	Includes telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications.
Space research and technology	Includes government establishments primarily engaged in the administration and operations of space flights, space research, and space exploration. Included in this industry are government establishments operating space flight centers.

**Search, detection, and navigation instrument manufacturing is included in this definition even though a significant portion of this industry manufactures products for the broader aerospace industry. The NAICS industry classification system does not allow us to parse those segments of this industry specific only to space manufacturing. Source: Office of Management and Budget*

Comprehensive government-collected employment and wage data makes possible an apples-to-apples comparison of the space industry labor market at the national level and in states and local communities across the nation and permits an examination of space industry labor market trends.

This chapter also provides data from an occupational perspective. The U.S. government's occupational employment survey provides statistics on key space occupational groups such as aerospace engineers, avionics technicians, atmospheric and space scientists, and aerospace engineering and operations technicians at the national and state level.[3] The U.S. survey does not include additional private sector data sources or supplementary data culled directly from space industry companies themselves.

State and local economic development agencies often use additional data based on their unique knowledge of the local economy when analyzing the economic impact of an industry in their region. One important challenge in analyzing state and local space industry statistics

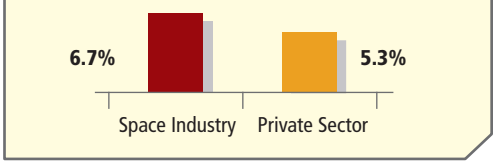
A Pratt & Whitney Rocketdyne technician is taking precise measurements of a small engine thrust chamber. *Image Credit: Ross Pakka/ Pratt & Whitney Rocketdyne*

involves the U.S. government's requirement that company data must be kept confidential. For instance, to prevent disclosure of individual company data, the government withholds data for those states or metropolitan areas where three or fewer space industry employers are located, or if any single employer provides more than 80% of the jobs in an industry. These confidentiality requirements lead to considerable data suppression at the state and local level. As a result, it is likely that the space industry is undercounted in many medium and smaller states or metropolitan areas because comprehensive data for those areas is not always available.

4.3.2 The Space Industry Definition

The space industry sectors covered in this analysis are based on the U.S. government's North American Industry Classification System (NAICS) codes.[4] For purposes of employment statistics, the space industry is comprised of companies that manufacture such products as radar systems, guided missiles and space vehicles, and space vehicle propulsion units, along with businesses that provide satellite telecommunications services. The core of the space industry also covers government establishments directly involved in space research and technology such as NASA and other government space flight operations. Civilians working for NASA and its space and research centers such as Ames Research Center in California, Glenn Research Center in Ohio, and the Kennedy Space Center in Florida are included in this analysis under space research and technology.

EXHIBIT 4f. Employment Growth of the Space Industry Compared to the Private Sector, 2003-2006



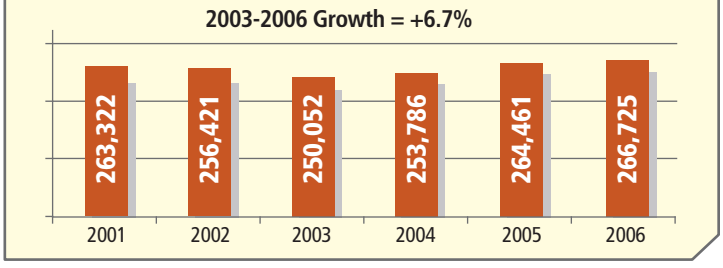
Source: U.S. Bureau of Labor Statistics

Among the enabling industries not included in this conservative definition of the space industry are the broader aerospace manufacturing industry and the larger telecommunications industry. Consequently, the employment statistics cited here are more conservative than other studies that capture these and other industries as part of their analysis.

4.3.3 U.S. Space Industry "Core" Employment

Space industry core employment totaled 266,700 jobs in 2006, a substantial increase of nearly 17,000 space industry jobs from 2003. That increase of nearly 7% in just three years outpaced the 5.3% increase from 2003 to 2006 in overall U.S. private sector employment.

EXHIBIT 4g. U.S. Space Industry Core Employment, 2001-2006



Source: U.S. Bureau of Labor Statistics

As these statistics demonstrate, employment within an industry can change rapidly. The low point in space industry core employment over the

EXHIBIT 4h. Space Industry Employment by Sector, 2003 and 2006

SPACE INDUSTRY SECTOR	2003	2006	NUMERIC CHANGE, 2003-2006	PERCENTAGE CHANGE, 2003-2006
Search, detection, and navigation instruments	145,667	157,245	11,578	8%
Guided missile and space vehicle manufacturing	50,778	53,513	2,735	5%
Federal space research and technology	17,381	18,371	990	6%
Satellite telecommunications	17,190	16,384	-806	-5%
Space vehicle propulsion units and parts manufacturing	12,410	13,817	1,407	11%
Other guided missile and space vehicle parts	6,626	7,395	769	12%
Space Industry Employment Total	**250,052**	**266,725**	**16,673**	**7%**

Source: U.S. Bureau of Labor Statistics

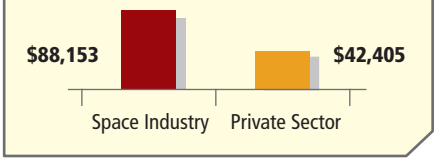
past five years came in 2003 with industry employment at 250,000 jobs. Since then, space industry employment has increased every year. If the United States continues to invest in its space infrastructure and if private sector space activity continues to grow one can expect space industry employment growth to continue in the years ahead.

By space industry sector, the largest employment segment was search, detection, and navigation instruments manufacturing, with 157,200 jobs in 2006. This industry sector added nearly 11,600 jobs between 2003 and 2006, with employment rising by 8%. The second largest industry sector was guided missile and space vehicle manufacturing with 53,500 jobs in 2006, up by some 2,700 jobs, or a 5.4% increase, over the past three years. The federal government's civilian space research and technology workforce totaled 18,400 in 2006, a rise of approximately 1,000 jobs since 2003, representing a jump in employment of nearly 6%.

4.3.4 U.S. Space Industry Wages

Along with growing space industry employment, the U.S. space industry workforce is well compensated. In 2006, the U.S. space industry paid an annual average wage of $88,200 to its workers. This was more than double the private sector average wage of $42,400 in 2006.

EXHIBIT 4i. Space Industry Annual Average Wage Compared to Private Sector Annual Average Wage, 2006



Source: U.S. Bureau of Labor Statistics

The highest average wage was in the guided missile and space vehicle manufacturing sector, at $97,900 in 2006. The second highest wages were paid to federal space research and technology workers. They received an annual average wage of

EXHIBIT 4j. Space Industry Annual Average Wages by Sector, 2006

Source: U.S. Bureau of Labor Statistics

$93,200 in 2006. Even the lowest annual average wage in 2006 within the space sector, paid by the space vehicle propulsion units and parts manufacturing industry, was slightly more than $70,000. All space industry wages are well above the average private sector wage.

4.3.5 U.S. Space Industry Payroll

The U.S. space industry payroll, consisting of all wages and salaries, including bonuses, paid to employees by their employers, reached $23.5 billion in 2006, up from $20.9 billion in 2003, adjusted for inflation to 2006 dollars. The payroll for the U.S. space industry increased by 12.5% between 2003 and 2006, substantially outpacing the 8.6% growth in payroll for the entire private sector, adjusted for inflation.

4.3.6 U.S. Space Industry Establishments

There were 2,300 individual establishments, or workplaces, engaged in space activities located throughout the United States in 2006.[5] In fact, the number of space industry establishments nationwide has been increasing every year since 2003, rising by 9.4% during that period. An individual establishment does not necessarily represent a single company because a company can have multiple locations, or establishments, where it produces space products or services.

EXHIBIT 4k. Top Five States by Space Industry Annual Average Wages, 2006

STATE	SPACE INDUSTRY WAGE	PRIVATE SECTOR WAGE	WAGE DIFFERENTIAL
District of Columbia	$118,435	$65,423	81%
Colorado	$102,146	$43,664	134%
Maryland	$97,847	$44,527	120%
Massachusetts	$97,606	$52,789	85%
California	$96,412	$47,796	102%

Source: U.S. Bureau of Labor Statistics

4.3.7 State Space Industry Rankings

The national space industry workforce is geographically dispersed, with thriving space industries located in states such as California, Colorado, Arizona, Florida, and Texas. The importance of the space industry to a state's economy is reflected in the high wages it pays its skilled workforce.

A technician prepares a model of the Ares I launch vehicle for supersonic testing in the Unitary Plan Wind Tunnel at Langley Research Center. *Image Credit: NASA Langley Research Center.*

The highest-paid space industry workers were in the District of Columbia, where the annual average wage was $118,400 in 2006. This was 81% more than the average private sector wage in the District of Columbia for the same year.

Colorado's space industry workers posted the second highest wages in the nation for the space sector, with an annual average wage of $102,100 in 2006, more than double the state's average private sector wage of $43,700. In fact, space industry workers in Colorado were paid 134% more than the average private sector worker in the state in 2006, the highest wage differential among the top five states by this measure.

The high wages paid to Colorado's space industry workers reflect the demand for space-related skills as a critical part of the larger aerospace industry cluster located in Colorado. This cluster includes companies that develop space products and systems such as the recently formed United Launch Alliance. According to a recent report by the Metro Denver Economic

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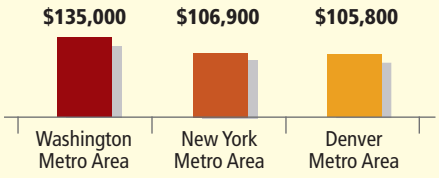
Development Corporation, Colorado's aerospace industry cluster employs 26,650 private aerospace industry workers.[6] Without a doubt, Colorado's space industry benefits from being part of this larger cluster of aerospace companies.

EXHIBIT 4l. Space Industry Wages by Leading Metropolitan Areas, 2006



Source: U.S. Bureau of Labor Statistics

Maryland, Massachusetts, and California rounded out the top five states for space industry wages in 2006, with annual average wages of $97,800, $97,600, and $96,400, respectively.

California led the nation in other space industry categories such as number of establishments and payroll. More than 700 space industry establishments are located in California, representing one-third of all space establishments in the United States. California's space industry payroll reached $7.8 billion in 2006, representing one-third of all space industry payroll nationwide.

4.3.8 Metropolitan Area Space Industry Rankings

This section examines the space industry labor market from a metropolitan area perspective. These statistics are not directly comparable to the state-level information reported above

EXHIBIT 4m. Space-Related Occupations Used In This Analysis

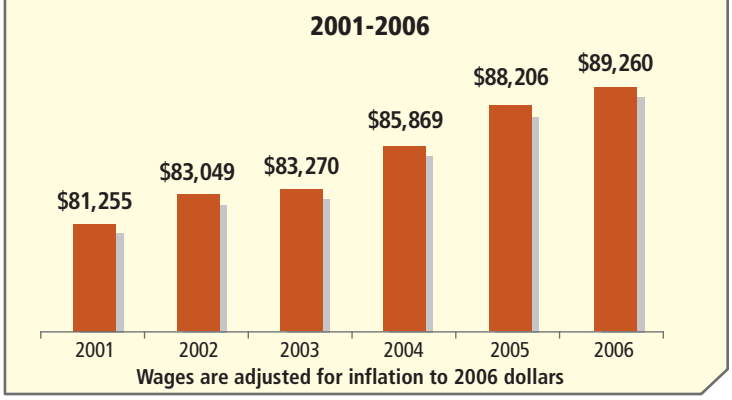
Aerospace Engineering and Operations Technicians	Operate, install, calibrate, and maintain integrated computer/communications systems consoles, simulators, and other data acquisition, test, and measurement instruments and equipment to launch, track, position, and evaluate air and space vehicles. May record and interpret test data.
Aerospace Engineers	Perform a variety of engineering work in designing, constructing, and testing aircraft, missiles, and spacecraft. May conduct basic and applied research to evaluate adaptability of materials and equipment to aircraft design and manufacture. May recommend improvements in testing equipment and techniques.
Astronomers	Observe, research, and interpret celestial and astronomical phenomena to increase basic knowledge and apply such information to practical problems.
Atmospheric and Space Scientists	Investigate atmospheric phenomena and interpret meteorological data gathered by surface and air stations, satellites, and radar to prepare reports and forecasts for public and other uses. Includes weather analysts and forecasters whose functions require the detailed knowledge of a meteorologist.
Postsecondary Atmospheric, Earth, Marine, and Space Sciences Teachers	Teach courses in the physical sciences, except chemistry and physics. Includes both teachers primarily engaged in teaching and those who do a combination of teaching and research.
Avionics Technicians	Install, inspect, test, adjust, and repair avionics equipment, such as radar, radio, navigation, and missile control systems in aircraft or space vehicles.
Chemical Engineers	Design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering.
Materials Engineers	Evaluate materials and develop machinery and processes to manufacture materials for use in products that must meet specialized design and performance specifications. Develop new uses for known materials. Includes those working with composite materials or specializing in one type of material, such as graphite, metal and metal alloys, ceramics, glass, plastics, polymers, and naturally occurring materials. Includes metallurgists, metallurgical engineers, ceramic engineers, and welding engineers.
Materials Scientists	Research and study the structures and chemical properties of various natural and manmade materials, including metals, alloys, rubber, ceramics, semiconductors, polymers, and glass. Determine ways to strengthen or combine materials or develop new materials with new or specific properties for use in a variety of products and applications. Includes glass scientists, ceramic scientists, metallurgical scientists, and polymer scientists.

Source: Occupational Employment Statistics

because these figures are based on metropolitan area numbers that sometimes involve more than one state. As previously noted, there is a tendency for space industry data at the local level to undercount economic impacts as compared to national and state data. In many instances, to protect the confidentiality of the local companies, governments must refrain from full disclosure of the space industry statistics in their area.

The metropolitan area space industry statistics show that the large Washington-Arlington-Alexandria metropolitan statistics area — covering the District of Columbia, parts of Northern Virginia, Maryland, and West Virginia — was the leader among metropolitan statistical areas in annual average space industry wages at $135,000.[7] Other leading metropolitan areas based on the annual average space wages were the New York-Northern New Jersey-Long Island metropolitan area at $106,900, followed by the Denver-Aurora metropolitan area, with an annual average space wage of $105,800 in 2006.

EXHIBIT 4n. Annual Average Wages of U.S. Aerospace Engineers



Source: U.S. Bureau of Labor Statistics

4.3.9 Space Occupational Employment Statistics

This section examines those technical professions that contribute significantly to furthering space activities in the United States. These include such occupations as aerospace engineers, astronomers, atmospheric and space scientists, and avionics technicians.

The U.S. Bureau of Labor Statistics compiles statistics on some 800 occupations through its Occupational Employment Statistics survey based upon work performed, skills, education, training, and credentials.[8] The data reported in this section are not comparable to the industry employment and wage statistics presented in the previous part of this chapter.

Lockheed Martin's Space Based Infrared Systems team extensively tested the Highly Elliptical Orbit-1 (HEO) payload at Northrop Grumman's Azusa, California, facility prior to launch. The HEO payload will scan a larger region than the current system for ballistic missile launches. *Image Credit: Russ Underwood/ Lockheed Martin*

Of the hundreds of occupations, nine were identified as key occupations that boost the U.S. space industry. These occupational groups include aerospace engineers; atmospheric and space scientists; astronomers; chemical engineers; atmospheric, Earth, marine, and space scientists; and avionics technicians. In total, there were 188,400 Americans employed in one of these key space occupations in 2006.

The high level of pay in space-related occupations stems in part from the fact that many of these skilled occupations require well-trained workers that hold at least a bachelor's degree, and often advanced degrees. For instance, the nation's highly skilled and technically trained aerospace engineers — with 87% of all workers in this occupation holding at least a college degree — earned $89,300 in 2006. The elevated wages for aerospace engineers are the result of high demand for such workers

as space industry firms work to respond to competitive market pressures and advancing technologies. Today's new space technologies require the nation's aerospace engineering workforce to continuously work to update and improve space-related products and services. Well-trained engineers are a must for the U.S. space industry to grow and thrive. Indeed, aerospace engineers earned an average wage of $80,000 or more every year for the past five years, adjusted for inflation.[9] Almost 10% of the 86,700 aerospace engineers in the United States were employed by the federal government in 2006. Those civilian aerospace engineers working for the federal government earned an average wage of $97,500 in 2006, or $8,200 more than the overall average aerospace engineering wage.[10]

Workers in the Orbiter Processing Facility insert the liquid oxygen feedline for the 17-inch disconnect in the orbiter Discovery. The 17-inch liquid oxygen and liquid hydrogen disconnects provide the propellant feed an interface from the external tank to the orbiter main propulsion system and the three space shuttle main engines. *Image Credit: NASA Kennedy Space Center*

Overall, the average U.S. space occupational wage far exceeded the average occupational wage. In fact, U.S. space occupations paid more than double the average occupational wage in 2006, $79,900 compared to $39,200. The highest average annual occupational wage was paid to astronomers at $95,000, followed by aerospace engineers with an average annual wage of $89,300.

When averaging all space occupational employment wages, the highest average annual wages were earned by workers in Virginia at $97,200 in 2006. California ranked second by average annual space occupational wage at $91,700. Workers in Alabama were paid the nation's third highest average annual space occupational wage, at $86,400. Maryland, Colorado, and Massachusetts all had average annual space occupational wages that were more than $80,000 in 2006, with wages of $86,300, $84,400, and $83,500, respectively.

4.4 Labor Outlook

These statistics quantify the thousands of jobs nationwide that are supported by the U.S. space industry. Clearly, a strong space industry is beneficial to national, state, and local economies when measured by such objective indicators as employment and wages.

As described in this chapter, the American space industry depends on a qualified and highly skilled workforce to thrive. Shortages of these workers could undermine the ability of the nation's space industry to execute the portfolio of current and planned space programs. In addition, the complexity of space-related programs has increased, demanding more diverse engineering skill sets. An additional challenge for the space industry is that many new space programs demand a mix of skills that is forcing the industry to compete for talent in new areas. For instance, today's space industry must hire software or network engineers proficient in Internet protocols needed for transformational communications. In order to successfully compete in the labor market, the space industry must be able to continue to pay its employees well and offer them interesting tasks in order to attract the individuals who drive the process of innovation.

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