Aerospace Product and Parts Manufacturing

(NAICS 3364)

SIGNIFICANT POINTS

- Skilled production, professional, and managerial jobs comprise the bulk of employment.
- Earnings are substantially higher, on average, than in most other manufacturing industries.

Nature of the Industry

The aerospace industry comprises companies producing aircraft, guided missiles, space vehicles, aircraft engines, propulsion units, and related parts. Aircraft overhaul, rebuilding, and parts also are included.

Firms producing transport aircraft make up the largest segment of the civil (non-military) aircraft portion of the industry. Civil transport aircraft are produced for air transportation businesses such as airlines and cargo transportation companies. These aircraft range from small turboprops to jumbo jets and are used to move people and goods all over the world. Another segment of civil aircraft is general aviation aircraft. General aviation aircraft range from the small two-seaters designed for leisure use to corporate jets designed for business transport. Civil helicopters, one of the smallest segments of civil aircraft, are commonly used by police departments, emergency medical services, and businesses such as oil and mining companies that need to transport people to remote worksites.

Military aircraft and helicopters are purchased by governments to meet national defense needs, such as delivering weapons to military targets and transporting troops and equipment around the globe. Some of these aircraft are specifically designed to deliver a powerful array of ordnance to military targets with tremendous maneuverability and low detectability. Aircraft engine manufacturers, not the aircraft manufacturers, produce the engines used in civil and military aircraft. These manufacturers design and build engines according to the aircraft design and performance specifications of the aircraft manufacturers. Aircraft manufacturers may use engines designed by different companies on the same type of aircraft.

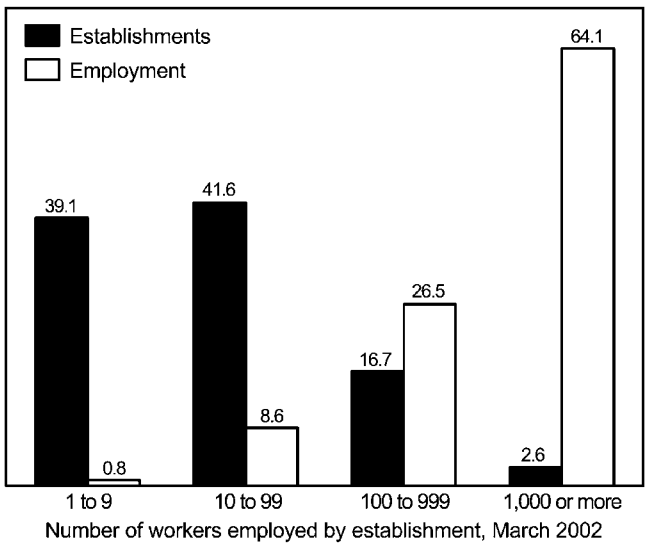
Firms producing guided missiles and missile propulsion units sell primarily to military and government organizations. Although missiles are viewed predominantly as offensive weapons, improved guidance systems have led to their increased use as defensive systems. This part of the industry also produces space vehicles and the rockets for launching them into space. Consumers of spacecraft include the National Aeronautics and Space Administration (NASA), the U.S. Department of Defense (DOD), telecommunications companies, television networks, and news organizations. Firms producing space satellites are discussed with the computer and electronic product manufacturing industry in this publication because satellites are primarily electronic products.

In 2002, about 2,800 establishments made up the aerospace industry. In the aerospace parts industry, most establishments were subcontractors that manufacture parts and employ fewer than 100 workers. Nevertheless, 64 percent of the jobs in aerospace manufacturing were in large establishments that employed 1,000 or more workers (see chart).

The Federal Government traditionally has been the aerospace industry's biggest customer. The vast majority of Government contracts to purchase aerospace equipment are awarded by DOD. NASA also is a major purchaser of the industry's products and services, mainly for space vehicles and launch services.

The aerospace industry is dominated by a few large firms that contract to produce aircraft with Government and private businesses, usually airline and cargo transportation companies. These large firms, in turn, subcontract with smaller firms to produce specific systems and parts for their vehicles. Government purchases are largely related to defense. Typically, DOD announces its need for military aircraft or missile systems, specifying a multitude of requirements. Large firms specializing in defense products subsequently submit bids, detailing proposed technical solutions and designs, along with cost estimates, hoping to win the contract. Firms may also research and develop materials, electronics, and components relating to their bid, often at their own expense, in order to enhance their chance of winning the contract. Following a negotiation phase, a manufacturer is selected and a prototype vehicle is developed and built, and then tested and evaluated. If approved by DOD, the program enters production. This process usually takes many years.

Establishments employing 1,000 or more people account for most aerospace manufacturing jobs



Commercial airlines and private businesses typically identify their needs for a particular model of new aircraft based on a number of factors, including the routes they fly. After specifying requirements such as range, size, cargo capacity, type of engine, and seating arrangements, the airlines invite manufacturers of civil aircraft and aircraft engines to submit bids. Selection ultimately is based on a manufacturer's ability to deliver reliable aircraft that best fit the purchaser's stated market needs at the lowest cost and at favorable financing terms.

The way in which commercial and military aircraft are designed, developed, and produced is undergoing significant change in response to the need to cut costs and deliver products more quickly. Firms producing commercial aircraft have reduced development time drastically through computer-aided design (CAD), which allows firms to design an entire aircraft, including the individual parts, solely by computer. The drawings of these parts can be sent electronically to subcontractors who use them to program their machinery. Product development teams are increasingly being used through every phase of development, bringing customers, engineers, and production workers together to make decisions concerning the aircraft. Additionally, the military has changed its design philosophy, using available commercially available, off-the-shelf technology when appropriate, rather than developing new customized components.

Working Conditions

The average aerospace products and parts production employee worked 42.3 hours a week in 2002, compared with 40.5 hours a week throughout manufacturing and 33.9 hours a week across all industries.

Working conditions in aerospace manufacturing facilities vary. Many new plants, in contrast to older facilities, are spacious, well lit, and modern. Specific work environments usually depend on the occupation and age of the production line. Engineers, scientists, and technicians frequently work in office settings or laboratories, although production engineers may spend much of their time with production workers on the factory floor. Production workers, such as welders and other assemblers, may have to cope with high noise levels. Oil, grease, and grime often are present, and some workers may face exposure to volatile organic compounds found in solvents, paints, and coatings. Heavy lifting is required for many production jobs.

Cases of work-related injury and illness in the aircraft and parts sector were 5.7 per 100 full-time workers in 2001, higher than the 1.6 cases per 100 workers in the guided missiles sector. In comparison, cases of work-related injury and illness throughout the private sector averaged 5.3 per 100 workers.

Employment

Aerospace manufacturing provided 468,000 wage and salary jobs in 2002. The largest numbers of aerospace jobs were in Washington and California, although many also were located in Kansas, Texas, Connecticut, and Arizona.

Under the new North American Industry Classification System (NAICS), workers in research and development (R&D) establishments that are not part of a manufacturing facility are included in a separate industry—research and development in the physical, engineering, and life sciences. However, due to the importance of R&D work to the aerospace manufacturing industry, aerospace-related R&D is discussed here even though a large proportion of aerospace-related R&D workers are not included in the employment data.

Occupations in the Industry

The design and manufacture of the technologically sophisticated products of the aerospace industry require the input and skills of various workers. Skilled production, professional and related, and managerial jobs make up the bulk of employment. Those employed in managerial and administrative support occupations manage the design process and factory operations, coordinate the hundreds of thousands of parts that are assembled into an aircraft, and ensure compliance with Federal recordkeeping regulations. The aerospace industry has a larger proportion of workers with education beyond high school than the average for all industries.

The aerospace industry is on the leading edge of technology and constantly is striving to create new products and improve existing ones. The industry invests a great amount of time and money in research and development of aerospace products, and much of the work is performed by professional and related workers, who made up about 31 percent of the aerospace workforce in 2002 (table 1). In addition, thousands more aerospace-related professionals work in research and development in the physical, engineering, and life sciences industry. A bachelor's degree in a specialized field, such as engineering, is required for many of these jobs; a master's or doctoral degree is preferred for a few. Two years of technical training after high school is favored for many technician occupations.

Professionals and technicians develop new designs and make improvements to existing designs. *Aerospace engineers* are integral members of the teams that research, design, test, and produce aerospace vehicles. Some specialize in areas such as structural design, guidance, navigation and control, and instrumentation and communication. Electrical and electronics, industrial, and mechanical engineers also contribute to the research for and development and production of aerospace products. For example, *mechanical engineers* help design mechanical components and develop the specific tools and machines needed to produce aircraft, missile, and space vehicle parts, or they may design jet and rocket engines. *Engineering technicians* assist engineers, both in the research and development laboratory, and on the manufacturing floor. They may help build prototype versions of newly designed products, run tests and experiments, and perform a variety of other technical tasks. One of the earliest users of CAD, the aerospace industry continues to use the latest computer technology. *Computer scientists and systems analysts; database administrators; computer software engineers; computer programmers; computer support specialists*; and *network and computer systems administrators* are responsible for the design, testing, evaluation, and setup of computer systems that are used throughout the industry for design and manufacturing purposes.

Management, business, and financial occupations accounted for 16 percent of industry employment in 2002. Many advance to

these jobs from professional occupations. Many managers in the aerospace industry have a technical or engineering background, and supervise teams of engineers in activities such as testing and research and development. *Industrial production managers* oversee all workers and lower-level managers in a factory. They also coordinate all activities related to production. In addition to technical and production managers, *financial managers; purchasing managers, buyers, and purchasing agents; cost estimators*; and *accountants and auditors* are needed to negotiate with customers and subcontractors and to track costs.

Of all aerospace workers, 40 percent are employed in production; installation, maintenance, and repair; and transportation and material moving occupations. Many of these jobs are not specific to aerospace and can be found in other manufacturing industries. Many production jobs are open to persons with only a high school education; however, special vocational training after high school is preferred for some of the more highly skilled jobs.

Aircraft structure, surfaces, rigging, and systems assemblers usually specialize in one assembly task; hundreds of different assemblers may work at various times on producing a single aircraft. Assemblers may put together parts of airplanes, such as wings or landing gear, or install parts and equipment into the airplane itself. Those involved in assembling aircraft or systems must be skilled in reading and interpreting engineering specifications and instructions.

Machinists make parts that are needed in numbers too small to be mass produced. They follow blueprints and specifications and are highly skilled with machine tools and metalworking. *Tool and die makers* are responsible for constructing precision tools and metal forms, called dies, which are used to shape metal. Increasingly, as individual components are designed electronically, these highly skilled workers must be able to read electronic blueprints and setup and operate computer-controlled machines.

Inspectors, testers, sorters, samplers, and weighers perform numerous quality control and safety checks on aerospace parts throughout the production cycle. Their work is vital to ensure the safety of the aircraft.

The remaining jobs in the industry are in office and administrative support, service, and sales occupations. Most of these jobs can be entered without education beyond high school. Workers in office and administrative support occupations help coordinate the flow of materials to the worksite, draw up orders for supplies, keep records, and help with all of the other paperwork associated with keeping a business functioning. Those in service occupations are employed mostly as guards and janitors and other cleaning and maintenance workers. Sales workers are mostly wholesale and manufacturing sales representatives and sales workers supervisors.

Training and Advancement

Because employers need well-informed, knowledgeable employees who can keep up with the rapid technological advancements in aerospace manufacturing, the industry provides substantial support for the education and training of its workers. Firms provide on-site, job-related training to upgrade the skills of technicians, production workers, and engineers. Classes teaching

Table 1. Employment of wage and salary workers in aerospace manufacturing by occupation, 2002 and projected change, 2002-12
(Employment in thousands)

Occupation	Employment, 2002 Number	Employment, 2002 Percent	Percent change, 2002-12
All occupations	468	100.0	-17.6
Management, business, and financial occupations	76	16.2	-14.7
Industrial production managers	5	1.0	-15.8
Engineering managers	9	1.8	-15.8
Buyers and purchasing agents	9	2.0	-17.5
Management analysts	11	2.4	-15.8
Financial specialists	6	1.3	-16.1
Professional and related occupations	144	30.7	-15.2
Computer software engineers	8	1.7	-6.4
Computer systems analysts	7	1.6	-9.4
Aerospace engineers	46	9.7	-15.8
Industrial engineers, including health and safety	10	2.1	-15.8
Mechanical engineers	9	1.5	-21.5
Engineering technicians, except drafters	16	3.4	-15.8
Service occupations	5	1.1	-21.3
Sales and related occupations	5	1.0	-16.2
Office and administrative support occupations	42	9.0	-26.2
Production, planning, and expediting clerks	8	1.7	-15.8
Secretaries and administrative assistants	8	1.6	-29.6
Office clerks, general	5	1.1	-26.7
Construction and extraction occupations	8	1.8	-14.8
Installation, maintenance, and repair occupations	37	8.0	-8.6
Avionics technicians	5	1.1	-5.2
Aircraft mechanics and service technicians	15	3.1	-1.2
Industrial machinery installation, repair, and maintenance workers	7	1.5	-15.0
Production occupations	141	30.0	-21.5
First-line supervisors/managers of production and operating workers	11	2.3	-15.8
Aircraft structure, surfaces, rigging, and systems assemblers	21	4.5	-15.8
Miscellaneous assemblers and fabricators	15	3.3	-24.7
Computer control programmers and operators	8	1.6	-17.7
Machine tool cutting setters, operators, and tenders, metal and plastic	14	2.9	-24.2
Machinists	15	3.2	-22.0
Inspectors, testers, sorters, samplers, and weighers	15	3.1	-25.6
Transportation and material moving occupations	10	2.2	-20.6

NOTE: May not add to totals due to omission of occupations with small employment

computer skills and blueprint reading are common. Some firms reimburse employees for educational expenses at colleges and universities, emphasizing 4-year degrees and postgraduate studies.

Professionals, such as engineers and scientists, require a bachelor's degree in a specialized field. For some jobs, particularly in research and development, a master's or doctoral degree may be preferred.

Production workers may enter the aerospace industry with minimal skills. Mechanical aptitude and good hand-eye coordination usually are necessary. A high school diploma or equivalent is required, and some vocational training in electronics or mechanics also is favored.

Unskilled production workers typically start by being shown how to perform a simple assembly task. Through experience, on-the-job instruction provided by other workers, and brief, formal training sessions, they expand their skills. Their pay increases as they advance into more highly skilled or responsible jobs. For example, machinists may take additional training to become numerical tool and process control programmers or tool and die makers. Inspectors usually are promoted from assembly, machine operation, and mechanical occupations.

Due to the reliance on computers and computer-operated equipment, classes in computer skills are common. With training, production workers may be able to advance to supervisory or technician jobs.

To enter some of the more highly skilled production occupations, workers must go through a formal apprenticeship. Machinists and electricians complete apprenticeships that can last up to 4 years. Apprenticeships usually include classroom instruction and shop training.

Entry-level positions for technicians usually require a degree from a technical school or junior college. Companies sometimes retrain technicians to upgrade their skills or to teach different specialties. They are taught traditional as well as new production technology skills, such as computer-aided design and manufacturing and statistical process control methods.

Earnings

Production workers in the aerospace industry earn higher pay than the average for all industries. Weekly earnings for production workers averaged $934 in aerospace product parts manufacturing in 2002, compared with $619 in all manufacturing and $506 in all private industry. Above-average earnings reflect, in part, the high levels of skill required by the industry and the need to motivate workers to concentrate on maintaining high quality standards in their work. Nonproduction workers, such as engineering managers, engineers, and computer specialists, generally command higher pay due to their advanced education and training (table 2).

In 2002, 22 percent of all workers in the aerospace industry were union members or covered by union contracts, compared with about 15 percent of all workers throughout private industry. Some of the major aerospace unions include the International Association of Machinists and Aerospace Workers; the United Automobile, Aerospace, and Agricultural Implement Workers of America; the Society of Professional Engineering Employees in Aerospace (SPEEA); and the International Union of Allied Industrial Workers of America.

Table 2. Median hourly earnings of the largest occupations in aerospace product and parts manufacturing, 2002

Occupation	Aerospace product and parts manufacturing	All industries
Aerospace engineers	$34.09	$34.97
Mechanical engineers	31.33	30.23
Industrial engineers	30.59	29.88
Management analysts	28.96	29.01
First-line supervisors/managers of production and operating workers	26.86	20.64
Aircraft mechanics and service technicians	19.68	20.71
Aircraft structure, surfaces, rigging, and systems assemblers	19.66	18.71
Inspectors, testers, sorters, samplers, and weighers	18.24	13.01
Machinists	17.47	15.66
Team assemblers	13.20	10.90

Outlook

Employment in the aerospace products and parts manufacturing industry is expected to decrease by 18 percent over the 2002-2012 period, compared with the 16-percent growth projected for all industries combined. Employment in the aerospace industry has declined in the past few years due to a drastic reduction in commercial transport aircraft orders, and relatively little increase in orders is expected over the projection period. This decline in orders was caused by the reduction in air travel that resulted from the terrorist attacks on the United States, as well as severe financial problems many of the Nation's airlines have experienced. In addition, the industry will continue to experience strong foreign competition in the commercial transport market.

The outlook for the military aircraft and missiles portion of the industry is better. Growing concern for the Nation's security has increased the need for military aircraft and military aerospace equipment as well as for military aerospace personnel. Although new employment opportunities in the defense-related sector of the aerospace industry may not reach previous levels, the increased need for aerospace defense will boost the demand for employment within this sector.

Due to past reductions in defense expenditures and competition in the commercial aircraft sector, there have been and may continue to be mergers within the industry that sometimes result in layoffs. Even though the number of large firms performing final assembly of aircraft has been reduced, hundreds of smaller manufacturers and subcontractors will remain in this industry.

Despite an expected decline in employment of professional workers in the industry, there still may be a significant number of openings in the industry due to replacement needs, especially for engineers. Many engineers who entered the industry in the 1960s are approaching retirement. Overall, professionals in the aerospace manufacturing industry typically enjoy more employment stability than do other workers. During slowdowns in pro-

duction, companies prefer to keep technical teams intact to continue research and development activities, in anticipation of new business. Production workers, on the other hand, are particularly vulnerable to layoffs during downturns in the economy, when aircraft orders decline.

Sources of Additional Information

For additional information about the aerospace manufacturing industry, write to:

- Aerospace Industries Association of America, Communications Department, 1000 Wilson Boulevard, 17th Floor, Arlington, VA 22209. Internet: **http://www.aia-aerospace.org**
- American Institute of Aeronautics and Astronautics, Inc., Suite 500, 1801 Alexander Bell Dr., Reston, VA 20191-4344. Internet: **http://www.aiaa.org**
- Federal Aviation Administration, 800 Independence Ave., SW., Room 810, Washington, DC 20591. Internet: **http://www.faa.gov/education**

Information on the following occupations may be found in the 2004-05 edition of the *Occupational Outlook Handbook*.

- Aerospace engineers
- Aircraft and avionics equipment mechanics and service technicians
- Assemblers and fabricators
- Computer programmers
- Computer software engineers
- Computer systems analysts, database administrators, and computer scientists
- Electrical and electronics engineers, except computer
- Engineering managers
- Engineering technicians
- Industrial engineers, including health and safety
- Inspectors, testers, sorters, samplers, and weighers
- Machine setters, operators, and tenders—metal and plastic
- Machinists
- Mechanical engineers