Production Occupations

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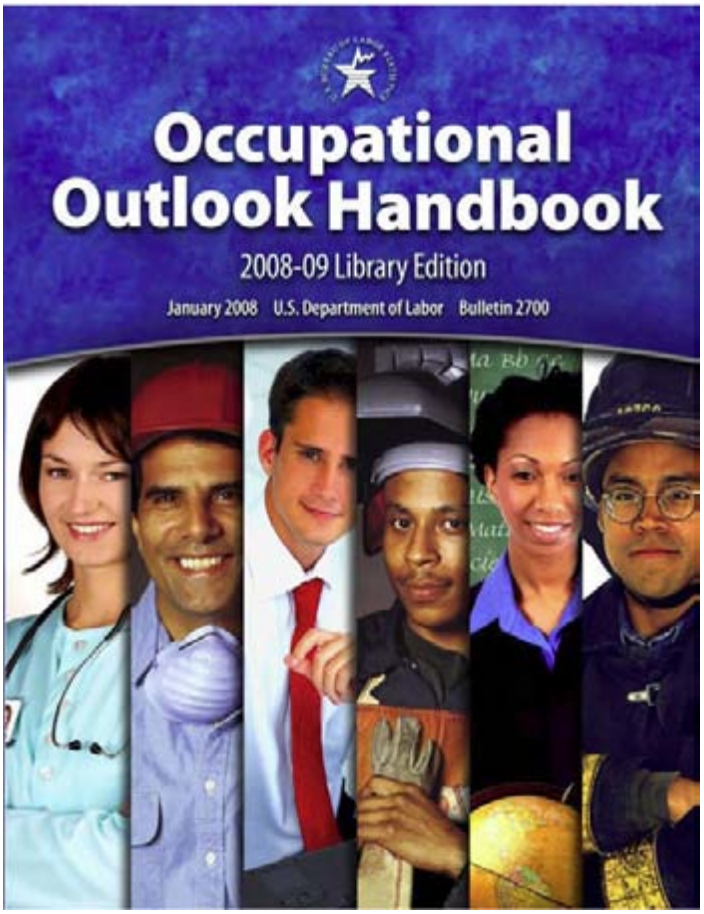


Occupations Included in this Reprint

Assemblers and fabricators
Bookbinders and bindery workers
Computer control programmers and operators
Food processing occupations
Inspectors, testers, sorters, samplers, and weighers
Jewelers and precious stone and metal workers
Machine setters, operators, and tenders—metal and plastic
Machinists
Medical, dental, and ophthalmic laboratory technicians
Painting and coating workers, except construction and maintenance
Photographic process workers and processing machine operators
Power plant operators, distributors, and dispatchers
Prepress technicians and workers
Printing machine operators
Semiconductor processors
Stationary engineers and boiler operators
Textile, apparel, and furnishings occupations
Tool and die makers
Water and liquid waste treatment plant and system operators
Welding, soldering, and brazing workers
Woodworkers

Assemblers and Fabricators

(O*NET 51-2011.00, 51-2021.00, 51-2022.00, 51-2023.00, 51-2031.00, 51-2041.00, 51-2091.00, 51-2092.00, 51-2093.00, 51-2099.99)

Significant Points

- Most assemblers work on teams, making good communication skills and the ability to get along with others important.
- A high school diploma is sufficient for most jobs, but experience and extra training is needed for more advanced assembly work.
- Employment is projected to decline slowly.
- Job opportunities are expected to be good for qualified applicants in the manufacturing sector, particularly in jobs needing more training.

Nature of the Work

Assemblers and fabricators play an important role in the manufacturing process. They assemble both finished products and the pieces that go into them. The products they assemble using tools, machines, and their hands range from entire airplanes to intricate timing devices. They fabricate and assemble household appliances, automobiles and automobile engines and parts, computers, electronic devices, and more.

Changes in technology have transformed the manufacturing and assembly process. Automated manufacturing systems now use robots, computers, programmable motion control devices, and various sensing technologies. These systems change the way in which goods are made and affect the jobs of those who make them. The more advanced assemblers must be able to work with these new technologies and use them to produce goods.

The job of an assembler or fabricator ranges from very easy to very complicated, requiring a range of knowledge and skills. Skilled assemblers putting together complex machines, for example, begin by reading detailed schematics or blueprints that show how to assemble the machine. After determining how parts should connect, they use hand or power tools to trim, shim, cut, and make other adjustments to fit components together and align properly. Once the parts are properly aligned, they connect them with bolts and screws or by welding or soldering pieces together.

Careful quality control is important throughout the assembly process, so assemblers look for faulty components and mistakes in the assembly process. They help to fix problems before more defective products are produced.

Manufacturing techniques are evolving away from traditional assembly line systems toward "lean" manufacturing systems, which are causing the nature of assemblers' work to change. Lean manufacturing uses teams of workers to produce entire products or components. *Team assemblers* may still work on an assembly line, but they rotate through different tasks, rather than specializing in a single task. The team also may decide how the work is assigned and how different tasks are performed. This worker flexibility helps companies cover for absent workers, improves productivity, and increases companies' ability to respond to changes in demand by shifting labor from one product line to another. For example, if demand for a product drops, companies may reduce the total number of workers producing it, asking the remaining workers to perform more stages of the assembly process. Some aspects of lean production, such as rotating tasks and seeking worker input on improving the assembly process, are common to all assembly and fabrication occupations.

Although more than half of all assemblers and fabricators are classified as "team assemblers," others specialize in producing one type of product or perform the same or similar functions throughout the assembly process. These workers are classified according to the products they assemble or produce. *Electrical and electronic equipment assemblers*, for example, build products such as electric motors, computers, electronic control devices, and sensing equipment. Automated systems have eliminated much of the mass production work in electronic assembly, so a growing amount of the work of electrical and electronic assemblers is manual assembly during the small-scale production of electronic devices used in avionic systems, military systems, and medical equipment.

Electrical and electronics assemblers solder electronic parts together.

Electromechanical equipment assemblers assemble and modify electromechanical devices such as household appliances, dynamometers, actuators, or vending machines. *Coil winders, tapers, and finishers* wind wire coil used in resistors, transformers, generators, and electric motors. *Engine and other machine assemblers* construct, assemble, or rebuild engines and turbines, and machines used in agriculture, construction, mining, and almost all manufacturing industries, including rolling mills, textiles, paper, and food processing. *Aircraft structure, surfaces, rigging, and systems assemblers* assemble, fit, fasten, and install parts of airplanes, space vehicles, or missiles, including tails and wings, landing gear, and heating and ventilation systems. *Structural metal fabricators and fitters* cut, align, and fit together structural metal parts prior to welding or riveting. *Fiberglass laminators and fabricators* create products made of fiberglass, mainly boat decks and hulls and automobile body parts. *Timing device assemblers, adjusters, and calibrators* perform precision assembling or adjusting of timing devices within very narrow tolerances.

It has become more common to involve assemblers and fabricators in product development. Designers and engineers consult manufacturing workers during the design stage to improve product reliability and manufacturing efficiency. For example, an assembler may tell a designer that the dash of a new car design will be too difficult to install quickly and consistently. The designer could then redesign the dash to make it easier to install.

Some experienced assemblers work with designers and engineers to build prototypes or test products. These assemblers must be able to read and interpret complex engineering specifications from text, drawings, and computer-aided drafting systems. They also may need to use a variety of tools and precision measuring instruments.

Work environment. The working environment for assemblers and fabricators is improving, but varies by plant and by industry. Many physically difficult tasks have been made much easier through the use of hydraulic and electromechanical equipment, such as manually tightening massive bolts or moving heavy parts into position. Assembly work, however, may still involve long periods of standing or sitting.

Most factories today are generally clean, well-lit, and well-ventilated, and depending on what type of work is being performed, they may also need to be dirt and dust-free. Electronic and electromechanical assemblers particularly must work in environments free of dust that could affect the operation of the products they build. Some assemblers may also come into contact with potentially harmful chemicals or fumes, but ventilation systems and other safety precautions normally minimize any harmful effects. Other assemblers may come in contact with oil and grease, and their working areas may be quite noisy.

Most full-time assemblers work a 40-hour week, although overtime and shift work is common in some industries. Work schedules of assemblers may vary at plants with more than one shift.

Training, Other Qualifications, and Advancement

The education level and qualifications needed to enter these jobs vary depending on the industry and employer. While a high school diploma or GED is sufficient for most jobs, experience and extra training is needed for more advanced assembly work.

Education and training. Most applicants for assembler positions need only a high school diploma or GED. However, some employers may require specialized training or an associate degree for the most skilled assembly jobs. For example, jobs with electrical, electronic, and aircraft and motor vehicle products manufacturers typically require more education and experience. Other positions may require only brief on-the-job training, sometimes including employer-sponsored classroom instruction.

Other qualifications. Assembly workers must be able to follow instructions carefully, which may require some basic reading skills and the ability to follow diagrams and pictures. Manual dexterity and the ability to carry out complex, repetitive tasks quickly and methodically also are important. For some positions, the ability to lift heavy objects may be needed. Team assemblers also need good interpersonal and communication skills to be able to work well with their teammates. Good eyesight is necessary for assemblers and fabricators who work with small parts. Plants that make electrical and electronic products may test applicants for color vision because their products often contain many differently colored wires.

Advancement. As assemblers and fabricators become more experienced, they may progress to jobs that require greater skill and may be given more responsibility. Experienced assemblers may become product repairers if they have learned the many assembly operations and understand the construction of a product. These workers fix assembled pieces that operators or inspectors have identified as defective. Assemblers also can advance to quality control jobs or be promoted to supervisor. Experienced assemblers and fabricators also may become members of research and development teams, working with engineers and other project designers to design, develop, and build prototypes, and test new product models. In some companies, assemblers can become trainees for one of the skilled trades, such as machinist. Those with a background in math, science, and computers may advance to become programmers or operators of more highly automated production equipment.

Employment

Assemblers and fabricators held nearly 2.1 million jobs in 2006. They worked in almost every industry, but 3 out of 4 worked in manufacturing. Within the manufacturing sector, assembly of transportation equipment, such as aircraft, autos, trucks, and buses, accounted for 19 percent of all jobs. Assembly of computers and electronic products accounted for another 11 percent of all jobs. Other industries that employ many assemblers and fabricators are machinery manufacturing: heating and air-conditioning equipment; agriculture, construction, and mining machinery; and engine, turbine, and power transmission equipment; electrical equipment, appliance, and component manufacturing: lighting, household appliances, and electrical equipment; and fabricated metal products.

The following tabulation shows the employment of assemblers and fabricators in the manufacturing industries that employed the most workers in 2006:

Motor vehicle parts manufacturing 145,000
Motor vehicle manufacturing 106,000
Semiconductor and other electronic component manufacturing 88,000
Navigational, measuring, electromedical, and control instruments manufacturing 76,000
Architectural and structural metals manufacturing 74,000

Assemblers and fabricators also work in many other nonmanufacturing industries. Twelve percent were employed by employment services firms, mostly as temporary workers; most of these temporary workers were likely assigned to manufacturing plants. Wholesale and retail trade firms employed the next highest number of assemblers and fabricators. Many of these assemblers perform the final assembly of goods before the item is delivered to the customer. For example, most imported furniture is shipped in pieces and assemblers for furniture wholesalers and retailers put together the furniture prior to delivery.

Team assemblers, the largest specialty, accounted for 61 percent of assembler and fabricator jobs. The distribution of employment among the various types of assemblers was as follows in 2006:

Team assemblers 1,274,000
Electrical and electronic equipment assemblers 213,000
Structural metal fabricators and fitters 103,000
Electromechanical equipment assemblers 60,000
Engine and other machine assemblers 45,000
Fiberglass laminators and fabricators 33,000
Aircraft structure, surfaces, rigging, and systems assemblers 28,000
Coil winders, tapers, and finishers 23,000
Timing device assemblers, adjusters, and calibrators 2,500
Assemblers and fabricators, all other 292,000

Job Outlook

Employment of assemblers and fabricators is projected to decline slowly, primarily reflecting productivity growth and strong foreign competition in manufacturing. Job opportunities are expected to be good for qualified applicants in the manufacturing sector, particularly in jobs needing more training.

Employment change. Employment of assemblers and fabricators is expected to decline slowly by 4 percent between 2006 and 2016. Within the manufacturing sector, employment of assemblers and fabricators will be determined largely by the growth or decline in the production of certain manufactured goods. In general, despite projected growth in the output of manufactured goods, employment overall is expected to decline as the whole sector becomes more automated and is able to produce more with fewer workers. However, some individual industries are projected to have more jobs than others. The aircraft products and parts industry is projected to gain jobs over the decade as demand for new commercial and military planes grows significantly. Thus, the need for aircraft structure, surfaces, rigging, and systems assemblers is expected to grow. In addition, because much of the assembly in the aerospace industry is done in hard-to-reach locations—inside airplane fuselages or gear boxes, for example—which are unsuited to robots, aircraft assemblers will not be as easily replaced by automated processes.

In most other manufacturing industries, employment of assemblers and fabricators will be negatively affected by increasing automation, improving productivity, and the shift of assembly to countries with lower labor costs. The effects of automation, though, will be felt more among some types of assemblers and fabricators than among others. Automation will replace workers in operations with a large volume of repetitive work. Automation will have less effect on the assembly of parts that are irregular in size or location.

The use of team production techniques has been one factor in the continuing success of the manufacturing sector, boosting productivity and improving the quality of goods. Thus, while the number of assemblers overall is expected to decline in manufacturing, the number of team assemblers will grow or remain stable as more manufacturing plants convert to using team production techniques.

Other manufacturers have sent their assembly functions to countries where labor costs are lower. Decisions by U.S. corporations to move assembly to other nations should limit employ-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Assemblers and fabricators	51-2000	2,075,000	1,982,000	-93,000	-4
Aircraft structure, surfaces, rigging, and systems assemblers	51-2011	28,000	32,000	3,600	13
Electrical, electronics, and electromechanical assemblers	51-2020	297,000	227,000	-70,000	-23
Coil winders, tapers, and finishers	51-2021	23,000	16,000	-7,000	-30
Electrical and electronic equipment assemblers	51-2022	213,000	156,000	-57,000	-27
Electromechanical equipment assemblers	51-2023	60,000	55,000	-5,500	-9
Engine and other machine assemblers	51-2031	45,000	41,000	-3,900	-9
Structural metal fabricators and fitters	51-2041	103,000	103,000	-200	0
Miscellaneous assemblers and fabricators	51-2090	1,602,000	1,579,000	-23,000	-1
Fiberglass laminators and fabricators	51-2091	33,000	35,000	2,100	6
Team assemblers	51-2092	1,274,000	1,275,000	700	0
Timing device assemblers, adjusters, and calibrators	51-2093	2,500	2,300	-200	-8
Assemblers and fabricators, all other	51-2099	292,000	266,000	-25,000	-9

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

ment growth for assemblers in some industries, but a free trade environment also may lead to growth in the export of goods assembled in the United States.

The largest increase in the number of assemblers and fabricators is projected to be in the employment services industry, which supplies temporary workers to various industries. Temporary workers are gaining in importance in the manufacturing sector and elsewhere as companies strive for a more flexible workforce to meet the fluctuations in the market. There will also be more jobs for assemblers and fabricators in the wholesale and retail sectors of the economy. As more goods come unassembled from foreign countries to save on shipping costs, wholesalers and retailers are increasingly assembling products before selling them to their customers.

Job prospects. Job opportunities for assemblers are expected to be good for qualified applicants in the manufacturing sector, particularly in jobs needing more training. Some employers report difficulty finding qualified applicants looking for manufacturing employment. The best opportunities should be with smaller manufacturers as large, high-profile companies tend to attract more applicants. In addition to new jobs stemming from growth in this occupation, many job openings will result from the need to replace workers leaving or retiring from this large occupational group. For example, foreign automobile manufacturers who built plants in the 1980s are expecting a large number of retirements in the next decade and a surge in demand for team assemblers.

Earnings

Earnings vary by industry, geographic region, skill, educational level, and complexity of the machinery operated. Median hourly wage-and-salary earnings of team assemblers were $11.63 in May 2006. The middle 50 percent earned between $9.22 and $14.93. The lowest 10 percent earned less than $7.69, and the highest 10 percent earned more than $19.14. Median hourly wage-and-salary earnings in the manufacturing industries employing the largest numbers of team assemblers were as follows:

Motor vehicle manufacturing	$21.60
Motor vehicle parts manufacturing	13.06
Other wood products manufacturing	11.11
Plastics products manufacturing	10.64
Employment services	9.20

Median hourly wage-and-salary earnings of electrical and electronic equipment assemblers were $12.29 in May 2006. The middle 50 percent earned between $9.84 and $15.80. The lowest 10 percent earned less than $8.25, and the highest 10 percent earned more than $19.81. Median hourly wage-and-salary earnings in the manufacturing industries employing the largest numbers of electrical and electronic equipment assemblers were as follows:

Navigational, measuring, electromedical, and control instruments manufacturing	$13.42
Electrical equipment manufacturing	13.05
Computer and peripheral equipment manufacturing	12.80
Communications equipment manufacturing	11.96
Semiconductor and other electronic component manufacturing	11.45

In May 2006, other assemblers and fabricators had the following median hourly wage-and-salary earnings:

Aircraft structure, surfaces, rigging, and systems assemblers	$21.83
Engine and other machine assemblers	15.99
Structural metal fabricators and fitters	14.56
Timing device assemblers, adjusters, and calibrators	13.86
Electromechanical equipment assemblers	13.25
Coil winders, tapers, and finishers	12.64
Fiberglass laminators and fabricators	12.49
Assemblers and fabricators, all other	12.85

Many assemblers and fabricators are members of labor unions. These unions include the International Association of Machinists and Aerospace Workers; the United Automobile, Aerospace and Agricultural Implement Workers of America; the International Brotherhood of Electrical Workers; and the United Steelworkers of America.

Related Occupations

Other occupations that involve operating machines and tools and assembling products include welding, soldering, and brazing workers and machine setters, operators, and tenders—metal and plastic. Also, both millwrights and tool and die makers assemble complex manufacturing equipment. Assemblers and fabricators also are responsible for some quality control and product testing, as are inspectors, testers, sorters, samplers, and weighers.

Sources of Additional Information

Information about employment opportunities for assemblers is available from local offices of the State employment service and from locals of the unions mentioned earlier.

Bookbinders and Bindery Workers

(O*NET 51-5011.00, 51-5012.00)

Significant Points

- Employment is expected to decline rapidly, reflecting the use of more productive machinery and the growth of imports of bound printed material.
- Opportunities for hand bookbinders are limited because only a small number of establishments do this highly specialized work.
- Most bookbinders and bindery workers train on the job.

Nature of the Work

The process of combining printed sheets into finished products such as books, magazines, catalogs, folders, and directories is known as “binding.” When a publication or advertising supplement has been printed, it must then be folded, glued, stitched, stapled, or otherwise turned into the finished product that will be seen by the public. *Bindery workers* set up, operate, and

maintain the machines that perform these various tasks, while *bookbinders* perform highly skilled hand finishing operations.

Job duties depend on the material being bound. Some types of binding and finishing jobs consist of only one step. Preparing leaflets or newspaper inserts, for example, requires only folding. Binding of books and magazines, on the other hand, requires a number of steps. Bindery workers first assemble the books and magazines from large, flat, printed sheets of paper. They then operate machines that first fold printed sheets into "signatures," which are groups of pages arranged sequentially. They then assemble the signatures in sequence and join them by means of a saddle-stitch process or perfect binding (where no stitches are used). In firms that do "edition binding", workers bind books produced in large numbers, or "runs."

In libraries where repair work on rare books is needed, bookbinders sew, stitch, or glue the assembled printed sheets, shape the book bodies with presses and trimming machines, and reinforce them with glued fabric strips. Covers are created separately and glued, pasted, or stitched onto the book bodies. The books then undergo a variety of finishing operations, often including wrapping in paper jackets. In establishments that print new books, this work is done mechanically.

A small number of bookbinders work in hand binderies. These highly skilled workers design original or special bindings for limited editions, or restore and rebind rare books. Some binders repair books and provide other specialized binding services to libraries.

Bookbinders and bindery workers in small shops may perform many binding tasks, while those in large shops tend to specialize. Tasks may include performing perfect binding or operating laminating machinery. Others specialize as folder operators or cutter operators, and may perform adjustments and minor repairs to equipment as needed.

Work environment. Binderies often are noisy and jobs can be strenuous, requiring considerable lifting, standing, and carrying. Binding often resembles an assembly line on which workers perform repetitive tasks. The jobs also may require stooping, kneeling, and crouching, but equipment that minimizes such activity is now widely available.

Bookbinders pay careful attention to detail to avoid binding pages incorrectly.

Bookbinders and bindery workers normally work 40 hours per week, although weekend and holiday hours may be necessary if production on a job is behind schedule. Many large printers operate around the clock, so some bindery workers may work on shifts. Part-time workers made up 11 percent of this occupation in 2006.

Training, Other Qualifications, and Advancement

On-the-job training remains the most common form of training for entry level bindery workers, but new technology will require workers to obtain more formal training. Attention to detail and mechanical aptitude are important for these jobs.

Education and training. High school students interested in bindery careers should take shop courses or attend a vocational-technical high school. Occupational skill centers also provide an introduction to bindery work and bookbinding. For entry-level positions, most employers look for high school graduates or those with associate degrees.

Training in graphic communications also can be an asset. Vocational-technical institutes offer postsecondary programs in the graphic arts, as do some skill-updating or retraining programs and community colleges. Other programs are made available by unions to their members. Four-year colleges also offer programs related to printing and publishing, but their emphasis is on preparing people for careers as graphic artists, educators, or managers in the graphic arts field.

While postsecondary education is available, most bookbinders and bindery workers learn the craft through on-the-job training. Inexperienced workers usually are assigned simple tasks such as moving paper from cutting machines to folding machines. They learn basic binding skills, including the characteristics of paper and how to cut large sheets of paper into different sizes with the least amount of waste. Usually, it takes one to three months to learn to operate the simpler machines but it can take up to one year to become completely familiar with more complex equipment, such as computerized binding machines. As workers gain experience, they learn to operate more types of equipment. To keep pace with changing technology, retraining is increasingly important for bindery workers.

Formal apprenticeships are not as common as they used to be, but still are offered by some employers. Apprenticeships allow beginners to acquire skills by working alongside skilled workers while also taking classes. The more structured program provided by an apprenticeship enables workers to acquire the high levels of specialization and skill needed for some bindery and bookbinding jobs.

Other qualifications. Bindery work requires careful attention to detail. Accuracy, patience, neatness, and good eyesight are all important. Mechanical aptitude is necessary to operate the newer, more automated equipment, and workers with computer skills will increasingly be in demand. Manual dexterity is needed in order to count, insert, and fold. In addition, creativity and artistic ability are necessary for hand bookbinding.

Certification and advancement. With experience, binders can expect increased salaries and more responsibility. Completion of a formal certification program can further advancement

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Bookbinders and bindery workers	51-5010	72,000	57,000	-15,000	-21
Bindery workers	51-5011	65,000	51,000	-14,000	-22
Bookbinders	51-5012	7,200	6,000	-1,200	-17

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

opportunities. Without additional training, advancement opportunities outside of bindery work are limited. In large binderies, experienced bookbinders or bindery workers may advance to supervisory positions.

Employment

In 2006, bookbinders and bindery workers held about 72,000 jobs, including 7,200 as skilled bookbinders and 65,000 as bindery workers. More than 3 out of 4 bookbinding and bindery jobs are in printing and related support activities. Traditionally, the largest employers of bindery workers were bindery trade shops, which are companies that specialize in providing binding services for printers without binderies or whose printing production exceeds their binding capabilities. However, this type of binding is now being done increasingly in-house, and is now called "in-line finishing."

The publishing industry employed less than 1 in 10 bindery workers. Other bindery workers were found in the employment services industry, which supplies temporary workers to companies that require their services.

Job Outlook

Employment of bookbinders and bindery workers is projected to decline rapidly between 2006 and 2016, but opportunities should be good because many job openings are created by bindery workers who transfer to other occupations.

Employment change. Overall employment of bookbinders and bindery workers is expected to decline rapidly by 21 percent between 2006 and 2016. Over this period, demand for domestic bindery workers will slow as productivity in printing and bindery operations increases. Computers have caused binding to become increasingly automated, and coupled with other technological advances, have reduced labor requirements. Consequently, more printing companies are expected to perform bindery services in-house rather than send the work to specialized binding shops. Also, some bindery jobs will be lost because of outsourcing of work to firms in foreign countries where books and other materials that take a long time to make can be produced more cheaply.

More efficient binding machinery will slow growth in demand for specialized bindery workers who assist skilled bookbinders. The number of establishments that do hand bookbinding is small, also limiting growth.

Job prospects. Bindery workers generally face favorable job opportunities because many workers leave these jobs and there is a recurring need to replace them. However, improvements in binding machinery mean fewer will be replaced than leave. Additionally, many skilled bookbinders are older and will likely retire in the next decade. Experienced workers will continue to have the best opportunities for these skilled jobs. Prospects for all bindery jobs will be best for workers who have completed training or certification programs, internships, or who have experience in a related production occupation.

Earnings

Median hourly earnings of bookbinders were $14.55 in May 2006, compared to $13.16 per hour for all production occupations. The middle 50 percent earned between $10.48 and $19.34 an hour. The lowest 10 percent earned less than $8.30, and the highest 10 percent earned more than $22.69.

Median hourly earnings of bindery workers were $12.29 in May 2006. The middle 50 percent earned between $9.67 and $16.02 an hour. The lowest 10 percent earned less than $7.93, and the highest 10 percent earned more than $20.14.

Related Occupations

Other workers who set up and operate production machinery include prepress technicians and workers; printing machine operators; machine setters, operators, and tenders—metal and plastic; and various other precision machine operators.

Sources of Additional Information

Information about apprenticeships and other training opportunities may be obtained from local printing industry associations, local bookbinding shops, local offices of the Graphic Communications Conference or local offices of the State employment service. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: (877) 282-5627.

For general information on bindery occupations, write to:

➤ Graphic Communications Conference of the International Brotherhood of Teamsters, 1900 L St.NW., Washington, DC 20036-5007.

For information on careers and training programs in printing and the graphic arts, contact:

➤ Graphic Arts Education and Research Foundation, 1899 Preston White Dr., Reston, VA 20191-5468.
Internet: **http://www.makeyourmark.org**

➤ Printing Industries of America/Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143.

➤ NPES The Association for Suppliers of Printing Publishing, and Converting Technologies, 1899 Preston White Dr., Reston, VA 20191-4367.
Internet: **http://www.npes.org/education/index.html**

Computer Control Programmers and Operators

(O*NET 51-4011.00, 51-4012.00)

Significant Points

- Manufacturing industries employ almost all of these workers.
- Workers learn in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools; many entrants have previously worked as machinists or machine setters, operators, and tenders.
- Despite the projected slow decline in employment, job opportunities should be excellent, as employers are expected to continue to have difficulty finding qualified workers.

Nature of the Work

Computer control programmers and operators use computer numerically controlled (CNC) machines to cut and shape precision products, such as automobile, aviation, and machine parts. CNC machines operate by reading the code included in a computer-controlled module, which drives the machine tool and performs the functions of forming and shaping a part formerly done by machine operators. CNC machines include machining tools such as lathes, multi-axis spindles, milling machines, laser cutting machines, and wire electrical discharge machines. CNC machines cut away material from a solid block of metal or plastic—known as a workpiece—to form a finished part. Computer control programmers and operators normally produce large quantities of one part, although they may produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with CNC programming to design and carry out the operations needed to make machined products that meet precise specifications.

CNC programmers—also referred to as *numerical tool and process control programmers*—develop the programs that run the machine tools. They review three-dimensional computer aided/automated design (CAD) blueprints of the part and determine the sequence of events that will be needed to make the part. This may involve calculating where to cut or bore into the workpiece, how fast to feed the metal into the machine, and how much metal to remove.

Next, CNC programmers turn the planned machining operations into a set of instructions. These instructions are translated into a computer aided/automated manufacturing (CAM) program containing a set of commands for the machine to follow. These commands normally are a series of numbers (hence, numerical control) that describes where cuts should occur, what type of cut should be used, and the speed of the cut. After the program is developed, CNC programmers and operators check the programs to ensure that the machinery will function properly and that the output will meet specifications. Because a problem with the program could damage costly machinery and cutting tools or simply waste valuable time and materials, computer simulations may be used to check the program before a trial run. If errors are found, the program must be changed and retested until the problem is resolved. In addition, growing connectivity between CAD/CAM software and CNC machine tools is raising productivity by automatically translating designs into instructions for the computer controller on the machine tool. These new CAM technologies enable programs to be easily modified for use on other jobs with similar specifications.

After the programming work is completed, *CNC setup operators*—also referred to as computer-controlled machine tool operators, metal and plastic—set up the machine for the job. They download the program into the machine, load the proper cutting tools into the tool holder, position the workpiece (piece of metal or plastic that is being shaped) on the CNC machine tool—spindle, lathe, milling machine, or other machine—and then start the machine. During the test run of a new program, the setup operator, who may also have some programming skills, or the CNC programmer closely monitors the machine for signs of problems, such as a vibrating work piece, the breakage of cutting tools, or an out-of-specification final product. If a problem is detected, a setup operator or CNC programmer will modify the program using the control module to eliminate the problems or to improve the speed and accuracy of the program.

Once a program is completed, the operation of the CNC machine may move from the more experienced setup operator to a less-skilled machine operator. Operators load workpieces and cutting tools into a machine, press the start button, monitor the machine for problems, and measure the parts produced to check that they match specifications. If they encounter a problem that requires modification to the cutting program, they shut down the machine and wait for a more experienced CNC setup operator to fix the problem. Many CNC operators start at this basic level and gradually perform more setup tasks as they gain experience.

Regardless of skill level, all CNC operators detect some problems by listening for specific sounds—for example, a dull cutting tool that needs changing or excessive vibration. Machine tools rotate at high speeds, which can create problems with harmonic vibrations in the workpiece. Vibrations cause the machine tools to make minor cutting errors, hurting the quality of the product. Operators listen for vibrations and then adjust the cutting speed to compensate. CNC operators also ensure that the workpiece is being properly lubricated and cooled, because the machining of metal products generates a significant amount of heat.

Since CNC machines can operate with limited input from the operator, a single operator may monitor several machines simultaneously. Typically, an operator might monitor two machines cutting relatively simple parts from softer materials, while devoting most of his or her attention to a third machine cutting a much more difficult part from hard metal, such as stainless steel. Operators are often expected to carefully schedule their work so that all of the machines are always operating.

Computer control operators reprogram computer numerically controlled machines.

Work environment. Most machine shops are clean, well lit, and ventilated. Most modern CNC machines are partially or totally enclosed, minimizing the exposure of workers to noise, debris, and the lubricants used to cool workpieces during machining. Nevertheless, working around machine tools can be noisy and presents certain dangers, and workers must follow safety precautions. Computer-controlled machine tool operators, metal and plastic, wear protective equipment, such as safety glasses to shield against bits of flying metal and earplugs to dampen machinery noise. They also must exercise caution when handling hazardous coolants and lubricants. The job requires stamina because operators stand most of the day and, at times, may need to lift moderately heavy workpieces.

Numerical tool and process control programmers work on desktop computers in offices that typically are near, but separate from, the shop floor. These work areas usually are clean, well lit, and free of machine noise. Numerical tool and process control programmers occasionally need to enter the shop floor to monitor CNC machining operations. On the shop floor, CNC programmers encounter the same hazards and exercise the same safety precautions as do CNC operators.

Many computer control programmers and operators work a 40-hour week. CNC operators increasingly work evening and weekend shifts as companies justify investments in more expensive machinery by extending hours of operation. Overtime is common during peak production periods.

Training, Other Qualifications, and Advancement

Computer control programmers and operators train in various ways—in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools. In general, the more skills needed for the job, the more education and training are needed to qualify. Many entrants have previously worked as machinists or machine setters, operators, and tenders.

Education and training. The amount and type of education and training needed depends on the type of job. Entry-level CNC machine operators may need only a couple of weeks of on-the-job training to reach proficiency. Setup operators and programmers, however, may need years of experience or formal training to write or modify programs. Programmers and operators can receive their training in various ways—in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools. A growing number of computer control programmers and more skilled operators receive their formal training from community or technical colleges. For some specialized types of programming, such as that needed to produce complex parts for the aerospace or shipbuilding industries, employers may prefer individuals with a degree in engineering.

For those interested in becoming computer control programmers or operators, high school or vocational school courses in mathematics (trigonometry and algebra), blueprint reading, computer programming, metalworking, and drafting are recommended. Apprenticeship programs consist of shop training and related classroom instruction. In shop training, apprentices learn filing, handtapping, and dowel fitting, as well as the operation of various machine tools. Classroom instruction includes math, physics, programming, blueprint reading, CAD software, safety, and shop practices. Skilled computer control programmers and operators need an understanding of the machining process, including the complex physics that occur at the cutting point. Thus, most training programs teach CNC operators and programmers to perform operations on manual machines prior to operating CNC machines.

As new automation is introduced, computer control programmers and operators normally receive additional training to update their skills. This training usually is provided by a representative of the equipment manufacturer or a local technical school. Many employers offer tuition reimbursement for job-related courses.

Certification and other qualifications. Employers prefer to hire workers who have a basic knowledge of computers and electronics and experience with machine tools. In fact, many entrants to these occupations have previously worked as machinists or machine setters, operators, and tenders. Persons interested in becoming computer control programmers or operators should be mechanically inclined and able to work independently and do highly accurate work.

To boost the skill level of all metalworkers and to create a more uniform standard of competency, a number of training facilities and colleges have recently begun implementing curriculums by incorporating national skills standards developed by the National Institute of Metalworking Skills (NIMS). After completing such a curriculum and passing a performance requirement and written exam, trainees are granted an NIMS credential that provides formal recognition of competency in a metalworking field. Completion of a formal certification program provides expanded career opportunities.

Advancement. Computer control programmers and operators can advance in several ways. Experienced CNC operators may become CNC programmers, and some are promoted to supervisory or administrative positions in their firms. A few open their own shops.

Employment

Computer control programmers and operators held about 158,000 jobs in 2006. About 89 percent were computer-con-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16 Number	Change, 2006-16 Percent
Computer control programmers and operators	51-4010	158,000	153,000	-5,700	-4
Computer-controlled machine tool operators, metal and plastic	51-4011	141,000	136,000	-4,200	-3
Numerical tool and process control programmers	51-4012	18,000	16,000	-1,500	-8

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

trolled machine tool operators, metal and plastic, and about 11 percent were numerical tool and process control programmers. Manufacturing employs almost all of these workers. Employment was concentrated in fabricated metal products manufacturing, machinery manufacturing, plastics products manufacturing, and transportation equipment manufacturing making mostly aerospace and automobile parts. Although computer control programmers and operators work in all parts of the country, jobs are most plentiful in the areas where manufacturing is concentrated.

Job Outlook

Despite the projected slow decline in employment of computer control programmers and operators, job opportunities should be excellent, as employers are expected to continue to have difficulty finding qualified workers.

Employment change. Employment of computer control programmers and operators is expected to decline slowly by 4 percent through 2016. While CNC machine tools will be increasingly used, advances in CNC machine tools and manufacturing technology will further automate the production process, boosting CNC operator productivity and limiting employment. The demand for computer control programmers also will be negatively affected by the increasing use of software (CAD/CAM) that automatically translates part and product designs into CNC machine tool instructions.

Job prospects. Computer control programmers and operators should have excellent job opportunities despite the projected slow decline in employment. Due to the limited number of people entering training programs, employers are expected to continue to have difficulty finding workers with the necessary skills and knowledge.

Earnings

Median hourly earnings of computer-controlled machine tool operators, metal and plastic, were $15.23 in May 2006. The middle 50 percent earned between $12.10 and $18.84. The lowest 10 percent earned less than $9.91, whereas the top 10 percent earned more than $22.45. Median hourly earnings in the manufacturing industries employing the largest numbers of computer-controlled machine tool operators, metal and plastic, in May 2006 were:

Metalworking machinery manufacturing	$17.45
Other fabricated metal product manufacturing	15.34
Machine shops; turned product; and screw, nut, and bolt manufacturing	14.85
Motor vehicle parts manufacturing	14.12
Plastics product manufacturing	12.32

Median hourly earnings of numerical tool and process control programmers were $20.42 in May 2006. The middle 50 percent earned between $16.14 and $25.61. The lowest 10 percent earned less than $13.11, while the top 10 percent earned more than $31.85.

Many employers, especially those with formal apprenticeship programs, offer tuition assistance for training classes.

Related Occupations

Occupations most closely related to computer control programmers and operators are other metal and plastic working occupations, which include machinists; tool and die makers; machine setters, operators, and tenders—metal and plastic; and welding, soldering, and brazing workers. Numerical tool and process control programmers apply their knowledge of machining operations, metals, blueprints, and machine programming to write programs that run machine tools. Computer programmers also write detailed programs to meet precise specifications.

Sources of Additional Information

For general information about computer control programmers and operators, contact:

➤ Precision Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141-3292.
Internet: **http://www.pmpa.org/industry-careers/**

For a list of training centers and apprenticeship programs, contact:

➤ National Tooling and Metalworking Association, 9300 Livingston Rd., Fort Washington, MD 20744.

For more information on credential standards and apprenticeship, contact:

➤ The National Institute for Metalworking Skills, 10565 Fairfax Blvd., Suite 203, Fairfax, VA 22030.
Internet: **http://www.nims-skills.org/home/index.htm**

Food Processing Occupations

(O*NET ,51-3011.00, 51-3021.00, 51-3022.00, 51-3023.00, 51-3091.00, 51-3092.00, 51-3093.00, 35-1011.00)

Significant Points

- Most workers in manual food processing jobs require little or no training prior to being hired.
- As more jobs involving cutting and processing meat shift from retail stores to food processing plants, job growth will be concentrated among lesser skilled workers, who are employed primarily in manufacturing.
- Highly skilled bakers should be in demand.

Nature of the Work

Food processing occupations include many different types of workers who process raw food products into the finished goods sold by grocers, wholesalers, restaurants, or institutional food services. These workers perform a variety of tasks and are responsible for producing many of the food products found in every household. Some of these workers are bakers, others process meat, and still others operate food processing equipment.

Bakers mix and bake ingredients according to recipes to produce varying quantities of breads, pastries, and other baked goods. Bakers commonly are employed in grocery stores and specialty shops and produce small quantities of breads, pastries, and other baked goods for consumption on premises or for sale as specialty baked goods. While the quantities are often small, the varieties of bread usually are not. Specialty handcrafted—or artisan—bread, comes with seeds, nuts, fruits, olives, and cheese, which can be included in a crusty loaf, round loaf, flat or even focaccia bread. Bakers can also add a variety of flavors, too, such as rosemary, pecan, fig, garlic, red pepper, sesame, and anise.

In manufacturing, bakers produce goods in large quantities, using high-volume mixing machines, ovens, and other equipment. Goods produced in large quantities usually are available for sale through distributors, grocery stores, supermarkets, or manufacturers' outlets.

Other food processing workers convert animal carcasses into manageable pieces of meat, known as boxed meat or case-ready meat, suitable for sale to wholesalers and retailers. The nature of their jobs varies significantly depending on the stage of the process in which they are involved. Butchers and meat cutters, for example, work primarily in groceries and wholesale establishments that provide meat to restaurants and other retailers; whereas, meat, poultry, and fish cutters and trimmers commonly work in animal slaughtering and processing plants.

In animal slaughtering and processing plants, slaughterers and *meat packers* slaughter cattle, hogs, goats, and sheep, and cut the carcasses into large wholesale cuts, such as rounds, loins, ribs, tenders, and chucks, to facilitate the handling, distribution, marketing, and sale of meat. In most plants, some slaughterers and meat packers further process the large parts into cuts that are ready for retail stores. Retailers and grocers increasingly prefer such prepackaged meat products because a butcher isn't needed to display and sell them. Slaughterers and meat packers also produce hamburger meat and meat trimmings, preparing sausages, luncheon meats, and other fabricated meat products. They usually work on assembly lines, with each individual responsible for only a few of the many cuts needed to process a carcass. Depending on the type of cut, these workers use knives; cleavers; meat saws; bandsaws; or other potentially dangerous equipment.

Poultry cutters and trimmers slaughter and cut up chickens, turkeys, and other types of poultry. Although the poultry processing industry is becoming increasingly automated, many jobs, such as trimming, packing, and deboning, are still done manually. Most poultry cutters and trimmers perform routine cuts on poultry as it moves along production lines.

Meat, poultry, and fish cutters and trimmers also prepare ready-to-heat foods, usually at processing plants. This preparation often entails filleting meat, poultry, or fish; cutting it into bite-sized pieces or tenders; preparing and adding vegetables; and applying sauces and flavorings, marinades, or breading. These case-ready products are gaining in popularity as they offer quick and easy preparation for consumers while, in many cases, also offering a healthier option.

Manufacturing and retail establishments are likely to employ fish cutters and trimmers, also called *fish cleaners*. These workers primarily scale, cut, and dress fish by removing the head, scales, and other inedible portions and cutting the fish into steaks or fillets. In retail markets, these workers may also wait on customers and clean fish to order.

Butchers and meat cutters process meat at later stages of production. Those who work for large grocery stores, wholesale establishments that supply meat to restaurants, or institutional food service facilities separate wholesale cuts of meat into retail cuts or smaller pieces, known as primals. These butchers cut meat into steaks and chops, shape and tie roasts, and grind beef for sale as chopped meat. Boneless cuts are prepared using knives, slicers, or power cutters, while bandsaws and cleavers are required to cut bone-in pieces of meat. Butchers and meat cutters in retail food stores also may weigh, wrap, and label the cuts of meat; arrange them in refrigerated cases for display; and prepare special cuts to fill unique orders by customers.

Others in food processing occupations include *food batchmakers*, who set up and operate equipment that mixes, blends, or cooks ingredients used in the manufacture of food products according to formulas or recipes; *food cooking machine operators and tenders*, who operate or tend cooking equipment, such as steam-cooking vats, deep-fry cookers, pressure cookers, kettles, and boilers to prepare food products, such as meat, sugar, cheese, and grain; and *food and tobacco roasting, baking, and drying machine operators and tenders*, who use equipment to reduce the moisture content of food or tobacco products or to prepare food for canning. The machines they use include hearth ovens, kiln driers, roasters, char kilns, steam ovens, and vacuum drying equipment.

Work environment. Working conditions vary by type and size of establishment. Most traditional bakers work in bakeries, cake shops, hot-bread shops, hotels, restaurants, cafeterias, and in the bakery departments of supermarkets. Bakers may work under hot and noisy conditions. They typically work under strict order deadlines and critical time-sensitive baking requirements, both of which can induce stress.

Although many bakers often work as part of a team, they also may work alone when baking particular items. These workers may supervise assistants and teach apprentices and trainees. Bakers in retail establishments may be required to serve customers. Bakers usually work odd hours in shifts and may work early mornings, evenings, weekends, and holidays.

In animal slaughtering and processing plants and in large retail food establishments, butchers and meat cutters work in large meat cutting rooms equipped with power machines and conveyors. In small retail markets, the butcher or fish cleaner may work in a cramped space behind the meat or fish counter. To prevent viral and bacterial infections, work areas are kept clean and sanitary.

In large grocery stores, butchers and meat cutters separate wholesale cuts of meat into retail cuts or individually sized servings.

Butchers and meat cutters, poultry and fish cutters and trimmers, and slaughterers and meatpackers often work in cold, damp rooms. Refrigerated work areas prevent meat from spoiling; they are damp because meat cutting generates large amounts of blood, condensation, and fat. Cool, damp floors increase the likelihood of slips and falls. In addition, cool temperatures, long periods of standing, and repetitious physical tasks make the work tiring. As a result, butchers as well as meat, poultry, and fish cutters and trimmers are more susceptible to injury than are most other workers.

Injuries include cuts and occasional amputations, which occur when knives, cleavers, or power tools are used improperly. Also, repetitive slicing and lifting often lead to cumulative trauma injuries, such as carpal tunnel syndrome. To reduce the incidence of cumulative trauma injuries, some employers have reduced employee workloads, added prescribed rest periods, redesigned jobs and tools, and promoted increased awareness of early warning signs as steps to prevent further injury. Nevertheless, workers in the occupation still face the serious threat of disabling injuries.

Workers who operate food processing machinery typically work in production areas that are specially designed for food preservation or processing. Food batchmakers, in particular, work in kitchen-type, assembly-line production facilities. Because this work involves food, work areas must meet governmental sanitary regulations. The ovens, as well as the motors of blenders, mixers, and other equipment, often make work areas very warm and noisy. There are some hazards, such as burns, created by the equipment that these workers use.

Food batchmakers; food and tobacco roasting, baking, and drying machine operators; and food cooking machine operators and tenders spend a great deal of time on their feet and generally work a regular 40-hour week that may include evening and night shifts.

Training, Other Qualifications, and Advancement

Training varies widely among food processing occupations. However, most manual food processing workers require little or no training before being hired.

Education and training. Bakers often start as apprentices or trainees. Apprentice bakers usually start in craft bakeries, while trainees usually begin in store bakeries, such as those in supermarkets. Bakers need to become skilled in baking, icing, and decorating. Knowledge of bakery products and ingredients, as well as mechanical mixing and baking equipment, is also important. Many apprentice bakers participate in correspondence study and may work towards a certificate in baking. Working as a baker's assistant or at other activities that involve handling food is also a useful way to train.

The skills needed to be a baker are often underestimated. Bakers need to know about ingredients and nutrition, government health and sanitation regulations, business concepts, applied chemistry—including how ingredients combine and how they are affected by heat, and production processes, including how to operate and maintain machinery. Computers often operate high-speed automated equipment typically found in modern food plants.

Most butchers as well as poultry and fish cutters and trimmers acquire their skills through on-the-job training programs. The length of training varies significantly. Simple cutting operations require a few days to learn, while more complicated tasks, such as eviscerating slaughtered animals, generally require several months of training. The training period for highly skilled butchers at the retail level may be 1 or 2 years.

Generally, trainees begin by doing less difficult jobs, such as making simple cuts or removing bones. Under the guidance of experienced workers, trainees learn the proper use and care of tools and equipment, while also learning how to prepare various cuts of meat. After demonstrating skill with various meat cutting tools, trainees learn to divide carcasses into wholesale cuts and wholesale cuts into retail and individual portions. Trainees also may learn to roll and tie roasts, prepare sausage, and cure meat. Those employed in retail food establishments often are taught operations, such as inventory control, meat buying, and recordkeeping. In addition, growing concern about food-borne pathogens in meats has led employers to offer numerous safety seminars and extensive training in food safety to employees.

On-the-job training is common among food machine operators and tenders. They learn to run the different types of equipment by watching and helping other workers. Training can last anywhere from a month to a year, depending on the complexity of the tasks and the number of products involved. A degree in an appropriate area—dairy processing for those working in dairy product operations, for example—is helpful for advancement to a lead worker or a supervisory role. Most food batchmakers participate in on-the-job training, usually from about a month to a year. Some food batchmakers learn their trade through an approved apprenticeship program.

Other qualifications. Bakers need to be able to follow instructions, have an eye for detail, and communicate well with others.

Meat, poultry, and fish cutters and trimmers need manual dexterity, good depth perception, color discrimination, and good hand-eye coordination. They also need physical strength to lift and move heavy pieces of meat. Butchers and fish cleaners who wait on customers should have a pleasant personality,

a neat appearance, and the ability to communicate clearly. In some States, a health certificate is required for employment.

Certification and advancement. Bakers have the option of obtaining certification through the Retails Bakers of America. While not mandatory, obtaining certification assures the public and prospective employers that the baker has sufficient skills and knowledge to work at a retail baking establishment.

The Retail Bakers of America offer certification for four levels of competence with a focus on several broad areas, including baking sanitation, management, retail sales, and staff training. Those who wish to become certified must satisfy a combination of education and experience requirements prior to taking an examination. The education and experience requirements vary by the level of certification desired. For example, a certified journey baker requires no formal education but a minimum of 1 year of work experience. On the other hand, a certified master baker must have earned the certified baker designation, and must have completed 30 hours of sanitation coursework approved by a culinary school or government agency, 30 hours of professional development courses or workshops, and a minimum of 8 years of commercial or retail baking experience.

Food processing workers in retail or wholesale establishments may progress to supervisory jobs, such as department managers or team leaders in supermarkets. A few of these workers may become buyers for wholesalers or supermarket chains. Some food processing workers go on to open their own markets or bakeries. In processing plants, workers may advance to supervisory positions or become team leaders.

Employment

Food processing workers held 705,000 jobs in 2006. Employment among the various types of food processing occupations was distributed as follows:

Bakers	149,000
Meat, poultry, and fish cutters and trimmers	144,000
Butchers and meat cutters	131,000
Slaughterers and meat packers	122,000
Food batchmakers	95,000
Food cooking machine operators and tenders	44,000
Food and tobacco roasting, baking, and drying machine operators and tenders	19,000

Thirty-four percent of all food processing workers were employed in animal slaughtering and processing plants. Grocery stores employed another 24 percent. Most of the remainder worked in other food manufacturing industries. Butchers, meat cutters, and bakers are employed in almost every city and town in the Nation, while most other food processing jobs are concentrated in communities with food processing plants.

Job Outlook

Job opportunities should be available in all food processing specialties due to the need to replace experienced workers who transfer to other occupations or leave the labor force. Overall employment is expected to increase about as fast as average.

Employment change. Overall employment in the food processing occupations is projected to increase 8 percent during the 2006-16 decade, about as fast as the average for all occupations. Increasingly, cheaper meat imports from abroad will have a negative effect on domestic employment in many food processing occupations. As more jobs involving cutting and processing meat shift from retail stores to food processing plants, job growth will be concentrated among lesser skilled workers, who are employed primarily in manufacturing.

As the Nation's population grows, the demand for meat, poultry, and seafood should continue to increase. Successful marketing by the poultry industry is likely to increase demand for chicken and ready-to-heat products. Similarly, the development of prepared food products that are lower in fat and more nutritious promises to stimulate the consumption of red meat. The trend toward preparing case-ready meat at the processing level also should contribute to demand for animal slaughterers and meat packers, especially as those products become available at lower prices.

Lesser skilled meat, poultry, and fish cutters and trimmers—who work primarily in animal slaughtering and processing plants—should experience 11 percent growth, about as fast as the average for all occupations, and employment of slaughters and meat packers is expected to increase 13 percent, also about as fast as the average. With the growing popularity of labor-intensive, ready-to-heat poultry products, demand for poultry workers should rise steadily. Potentially offsetting growth will be increased automation and plant efficiency, although some technological breakthroughs may be years away. Fish cutters

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Food processing occupations	51-3000	705,000	764,000	59,000	8
Bakers	51-3011	149,000	164,000	15,000	10
Butchers and other meat, poultry, and fish processing workers	51-3020	398,000	431,000	34,000	8
Butchers and meat cutters	51-3021	131,000	134,000	2,500	2
Meat, poultry, and fish cutters and trimmers	51-3022	144,000	160,000	16,000	11
Slaughterers and meat packers	51-3023	122,000	138,000	16,000	13
Miscellaneous food processing workers	51-3090	158,000	169,000	10,000	7
Food and tobacco roasting, baking, and drying machine operators and tenders	51-3091	19,000	21,000	2,000	11
Food batchmakers	51-3092	95,000	105,000	10,000	11
Food cooking machine operators and tenders	51-3093	44,000	42,000	-2,100	-5

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

also will be in demand, as the task of preparing ready-to-heat fish goods gradually shifts from retail stores to processing plants. Advances in fish farming, or "aquaculture," should also help meet the growing demand for fish and produce job growth for fish cutters.

Employment of more highly skilled butchers and meat cutters, who work primarily in large supermarkets, is expected to grow 2 percent, which is considered little or no change in employment. The proliferation of case-ready meat products and automation in the animal slaughtering and processing industries are enabling employers to transfer employment from higher paid butchers to lower wage slaughterers and meat packers in meat packing plants. At present, most red meat arrives at grocery stores partially cut up, but a growing share of meat is being delivered prepackaged with additional fat removed to wholesalers and retailers. This trend is resulting in less work and, thus, fewer jobs for retail butchers.

While high-volume production equipment limits the demand for lesser skilled bakers in manufacturing, overall employment of bakers, particularly highly skilled bakers, should increase 10 percent, about as fast as the average for all occupations, due to growing numbers of bakers in stores, specialty shops, and traditional bakeries. In addition to the growing numbers of cookie, muffin, and cinnamon roll bakeries, the numbers of specialty bread and bagel shops have been growing, spurring demand for artisan bread and pastry bakers.

Employment of food batchmakers and food and tobacco cooking and roasting machine operators and tenders, are expected to grow 11 percent each, about as fast as the average for all occupations. However, as more of this work is being done at the manufacturing level rather than at the retail level, potential employment gains may be offset by productivity gains from automated blending and roasting equipment.

Employment of food cooking machine operators and tenders is expected to decline moderately, about 5 percent, as cooking equipment such as steam vats, deep fryers, kettles, and broilers is increasingly automated.

Job prospects. Jobs should be available in all food processing specialties because of the need to replace experienced workers who transfer to other occupations or leave the labor force. Highly skilled bakers should be especially in demand because of growing demand for specialty products and because of the time it takes to learn to make them.

Earnings

Earnings vary by industry, skill, geographic region, and educational level. Median annual earnings of bakers were $22,030 in May 2006. The middle 50 percent earned between $17,720 and $28,190. The highest 10 percent earned more than $35,380, and the lowest 10 percent earned less than $15,180. Median annual earnings in the industries employing the largest numbers of bakers in May 2006 are given in the following tabulation:

Bakeries and tortilla manufacturing	$22,580
Grocery stores	22,170
Specialty food stores	21,900
Full-service restaurants	20,770
Limited-service eating places	19,990

Median annual earnings of butchers and meat cutters were $26,930 in May 2006. The middle 50 percent earned between $20,630 and $35,240. The highest 10 percent earned more than $43,260 annually, while the lowest 10 percent earned less than $16,520. Butchers and meat cutters employed at the retail level typically earn more than those in manufacturing. Median annual earnings in the industries employing the largest numbers of butchers and meat cutters in May 2006 were:

Other general merchandise stores	$34,190
Grocery stores	27,830
Grocery and related product wholesalers	25,690
Specialty food stores	23,180
Animal slaughtering and processing	23,080

Meat, poultry, and fish cutters and trimmers typically earn less than butchers and meat cutters. In May 2006, median annual earnings for these lower skilled workers were $20,370. The middle 50 percent earned between $17,100 and $24,120. The highest 10 percent earned more than $29,070, while the lowest 10 percent earned less than $14,960. The following tabulation shows median annual earnings in the industries employing the largest numbers of meat, poultry, and fish cutters and trimmers in May 2006:

Other general merchandise stores	$25,150
Grocery stores	20,680
Animal slaughtering and processing	20,530
Specialty food stores	19,990
Seafood product preparation and packaging	18,180

Median annual earnings of food batchmakers were $23,100 in May 2006. The middle 50 percent earned between $17,730 and $30,120. The highest 10 percent earned more than $37,930, and the lowest 10 percent earned less than $15,060. The following tabulation presents median annual earnings in the industries employing the largest numbers of food batchmakers in May 2006:

Dairy product manufacturing	$28,570
Fruit and vegetable preserving and specialty food manufacturing	25,100
Other food manufacturing	23,550
Sugar and confectionery product manufacturing	22,370
Bakeries and tortilla manufacturing	21,720

In May 2006, median annual earnings for slaughterers and meat packers were $21,690. The middle 50 percent earned between $18,290 and $25,440. The highest 10 percent earned more than $28,570, and the lowest 10 percent earned less than $15,950. Median annual earnings in animal slaughtering and processing, the industry employing the largest number of slaughterers and meat packers, were $21,730 in May 2006.

Median annual earnings for food cooking machine operators and tenders were $21,280 in May 2006. The middle 50 percent earned between $17,160 and $27,140. The highest 10 percent earned more than $34,350, and the lowest 10 percent earned less than $14,600. Median annual earnings in grocery stores,

the industry employing the largest number of food cooking machine operators and tenders, were $19,400 in May 2006.

In May 2006, median annual earnings for food and tobacco roasting, baking, and drying machine operators and tenders were $23,510. The middle 50 percent earned between $18,820 and $31,540. The highest 10 percent earned more than $38,740, and the lowest 10 percent earned less than $15,910.

Food processing workers generally received typical benefits, including pension plans for union members or those employed by grocery stores. However, poultry workers rarely earned substantial benefits. In 2006, 21 percent of all food processing workers were union members or were covered by a union contract. Many food processing workers are members of the United Food and Commercial Workers International Union.

Related Occupations

Food processing workers must be skilled at both hand and machine work and must have some knowledge of processes and techniques that are involved in handling and preparing food. Other occupations that require similar skills and knowledge include chefs, cooks, and food preparation workers.

Sources of Additional Information

For information on various levels of certification as a baker, contact:

➤ Retail Bakers of America, 8201 Greensboro Dr., Suite 300, McLean, VA, 22102

State employment service offices can provide information about job openings for food processing occupations.

Inspectors, Testers, Sorters, Samplers, and Weighers

(O*NET 51-9061.00)

Significant Points

- Almost 7 in 10 are employed in manufacturing establishments.
- While a high school diploma is sufficient for basic testing of products, complex precision-inspecting positions are filled by experienced assemblers, machine operators, or mechanics who already have a thorough knowledge of the products and production processes.
- Employment is expected to decline slowly, reflecting the growth of automated inspection and the redistribution of quality-control responsibilities from inspectors to other production workers.

Nature of the Work

Inspectors, testers, sorters, samplers, and weighers ensure that your food will not make you sick, that your car will run properly, and that your pants will not split the first time you wear them. These workers monitor or audit quality standards for virtually all domestically manufactured products, including foods, textiles, clothing, glassware, motor vehicles, electronic components, computers, and structural steel. As product quality becomes increasingly important to the success of many manufacturing firms, daily duties of inspectors have changed. In some cases, the job titles of these workers also have been changed to *quality-control inspector* or a similar name, reflecting the growing importance of quality. (A separate statement on construction and building inspectors appears elsewhere in the *Handbook*.)

Regardless of title, all inspectors, testers, sorters, samplers, and weighers work to guarantee the quality of the goods their firms produce. Specific job duties also vary across the wide range of industries in which these workers are found. For example, materials inspectors may check products by sight, sound, feel, smell, or even taste to locate imperfections such as cuts, scratches, bubbles, missing pieces, misweaves, or crooked seams. These workers also may verify dimensions, color, weight, texture, strength, or other physical characteristics of objects. Mechanical inspectors generally verify that parts fit, move correctly, and are properly lubricated; check the pressure of gases and the level of liquids; test the flow of electricity; and do a test run to check for proper operation. Some jobs involve only a quick visual inspection; others require a longer, detailed one. Sorters may separate goods according to length, size, fabric type, or color, while samplers test or inspect a sample taken from a batch or production run for malfunctions or defects. Weighers weigh quantities of materials for use in production.

Inspectors, testers, sorters, samplers, and weighers are involved at every stage of the production process. Some inspectors examine materials received from a supplier before sending them to the production line. Others inspect components and assemblies or perform a final check on the finished product. Depending on their skill level, inspectors also may set up and test equipment, calibrate precision instruments, repair defective products, or record data.

Inspectors, testers, sorters, samplers, and weighers rely on a number of tools to perform their jobs. Although some still use hand held measurement devises such as micrometers, calipers, and alignment gauges, it is more common for them to operate electronic inspection equipment, such as coordinate measuring machines (CMMs). These machines use sensitive probes to measure a part's dimensional accuracy and allow the inspector to analyze the results using computer software. Inspectors testing electrical devices may use voltmeters, ammeters, and oscilloscopes to test insulation, current flow, and resistance. All the tools that inspectors use are maintained by calibration technicians, who ensure that they work properly and generate accurate readings.

Inspectors mark, tag, or note problems. They may reject defective items outright, send them for repair or correction, or fix minor problems themselves. If the product is acceptable, inspectors may screw a nameplate onto it, tag it, stamp it with a serial number, or certify it in some other way. Inspectors, testers, sorters, samplers, and weighers record the results of their inspections, compute the percentage of defects and other statistical measures, and prepare inspection and test reports. Some electronic inspection equipment automatically provides test reports containing these inspection results. When defects

are found, inspectors notify supervisors and help to analyze and correct the production problems.

The emphasis on finding the root cause of defects is a basic tenet of modern management and production philosophies. Industrial production managers (see the statement on this occupation elsewhere in the *Handbook*) work closely with the inspectors to reduce defects and improve quality. In the past, a certain level of defects was considered acceptable because variations would always occur. Current philosophies emphasize constant quality improvement through analysis and correction of the causes of defects. The nature of inspectors' work has changed from merely checking for defects to determining the cause of those defects.

Increased emphasis on quality control in manufacturing means that inspection is more fully integrated into the production process than in the past. Now, companies have integrated teams of inspection and production workers to jointly review and improve product quality. In addition, many companies now use self-monitoring production machines to ensure that the output is produced within quality standards. Self-monitoring machines can alert inspectors to production problems and automatically repair defects in some cases.

Some firms have completely automated inspection with the help of advanced vision inspection systems, using machinery installed at one or several points in the production process. Inspectors in these firms monitor the equipment, review output, and perform random product checks.

Inspectors, testers, sorters, samplers, and weighers often work in laboratories and may need a background in science.

Testers repeatedly test existing products or prototypes under real-world conditions. For example, they may purposely abuse a machine by not changing its oil to see when failure occurs. They may devise automated machines to repeat a basic task thousands of times, such as opening and closing a car door. Through these tests, companies determine how long a product will last, what parts will break down first, and how to improve durability.

Work environment. Working conditions vary by industry and establishment size. As a result, some inspectors examine similar products for an entire shift, whereas others examine a variety of items.

In manufacturing, it is common for most inspectors to remain at one workstation. Inspectors in some industries may be on their feet all day and may have to lift heavy objects, whereas in other industries, they sit during most of their shift and read electronic printouts with massive quantities of data. Workers in heavy manufacturing plants may be exposed to the noise and grime of machinery; in other plants, inspectors work in clean, air-conditioned environments suitable for carrying out controlled tests. Other inspectors rarely see the products they are inspecting and instead do the majority of their work examining electronic readouts in front of a computer.

Some inspectors work evenings, nights, or weekends. Shift assignments generally are made on the basis of seniority. Overtime may be required to meet production goals.

Training, Other Qualifications, and Advancement

Most inspectors, testers, sorters, samplers, and weighers enter the occupation after spending years at a particular company or in an industry. They usually get their training on the job.

Education and training. Training requirements vary, based on the responsibilities of the inspector, tester, sorter, sampler, or weigher. For workers who perform simple "pass/fail" tests of products, a high school diploma generally is sufficient, together with basic in-house training. Training for new inspectors may cover the use of special meters, gauges, computers and other instruments; quality-control techniques; blueprint reading; safety; and reporting requirements. There are some postsecondary training programs in testing, but many employers prefer to train inspectors on the job.

Chances of finding work in this occupation can be improved by studying industrial trades, including computer-aided design, in high school or in a postsecondary vocational program. Laboratory work in the natural or biological sciences may also improve one's analytical skills and enhance the ability to find work in medical or pharmaceutical labs where many of these workers are employed.

As companies implement more automated inspection techniques that require less manual inspection, workers in this occupation have to learn to operate and program more sophisticated equipment and learn software applications. Since this requires additional skills, the need for higher education may be necessary. To address this need, some colleges are offering associate degrees in fields such as quality control management.

Other qualifications. In general, inspectors, testers, sorters, samplers, and weighers need mechanical aptitude, math and communication skills, and good hand-eye coordination and vision. Another important skill is the ability to analyze and interpret blueprints, data, manuals, and other material to determine specifications, inspection procedures, formulas, and methods for making adjustments.

Certification and advancement. Complex inspection positions are filled by experienced assemblers, machine operators, or mechanics who already have a thorough knowledge of the products and production processes. To advance to these positions, experienced workers may need training in statistical process control, new automation, or the company's quality assurance policies. As automated inspection equipment and electronic recording of results is common, computer skills are also important.

Training has become more formalized with the advent of standards from the International Organization for Standardization. As a result, certification as a quality inspector, offered by the American Society for Quality, is designed to certify that someone is trained in the field and may enable workers to advance within the occupation. To take the exam for certification, two years of on the job experience in mechanical inspection or a related field is required.

Advancement for workers with the necessary skills frequently takes the form of higher pay. They may also advance to inspector of more complex products, supervisor, or related positions such as purchaser of materials and equipment.

Employment

Inspectors, testers, sorters, samplers, and weighers held about 491,000 jobs in 2006. About 7 in 10 worked in manufacturing establishments that produced such products as motor vehicle parts, plastics products, semiconductor and other electronic components, and aerospace products and parts. Inspectors, testers, sorters, samplers, and weighers also were found in employment services, wholesale trade, architectural, engineering, and related services, and government agencies.

Job Outlook

Like that of many other occupations concentrated in manufacturing industries, employment of inspectors, testers, sorters, samplers, and weighers is expected to decline moderately through the year 2016. The decline stems primarily from the growing use of automated inspection and the redistribution of some quality-control responsibilities from inspectors to production workers. Additionally, as manufacturing companies continue to move some production offshore, the need for these workers will lessen.

Employment change. Employment of inspectors, testers, sorters, samplers, and weighers is expected to decline moderately by 7 percent between 2006 and 2016. Because the majority of inspectors, testers, sorters, samplers, and weighers work in the manufacturing sector, their outlook is greatly affected by what happens to manufacturing companies. As this sector becomes more automated and productive and as some production moves offshore, the number of inspectors, testers, sorters, samplers, and weighers is expected to decline. However, the continuing emphasis on producing quality goods and the need for accuracy in the growing medical and biotechnology fields will positively affect this occupation and moderate the decline.

In some industries, however, automation is not a feasible alternative to manual inspection. Where key inspection elements are oriented toward size, such as length, width, or thickness, automation will become more important in the future. But where taste, smell, texture, appearance, fabric complexity, or product performance is important, inspection will continue to be done by workers. Employment of inspectors, testers, sorters, samplers, and weighers is expected to increase faster than average in the employment services industry, as manufacturers and industrial firms hire more temporary inspectors to increase the flexibility of their staffing.

The emphasis on improving quality and productivity has led manufacturers to invest in automated inspection equipment and to take a more systematic approach to quality inspection. Continued improvements in technologies, such as spectrophotometers and computer-assisted visual inspection systems, allow firms to effectively automate inspection tasks, increasing workers' productivity and reducing the demand for inspectors. Inspectors will continue to operate these automated machines and monitor the defects they detect. Thus, while the growing emphasis on quality has increased the importance of inspection, the increased automation of inspection has limited the demand for inspectors.

Apart from automation, firms are integrating quality control into the production process. Many inspection duties are being redistributed from specialized inspectors to fabrication and assembly workers who monitor quality at every stage of the production process. In addition, the growing implementation of statistical process control is resulting in "smarter" inspection. Using this system, firms survey the sources and incidence of defects so that they can better focus their efforts on reducing production of defective products.

Job prospects. Although numerous job openings will arise due to the need to replace workers who move out of this large occupation, many of these jobs will be open only to experienced workers with advanced skills.

Earnings

Median hourly earnings of inspectors, testers, sorters, samplers, and weighers were $14.14 in May 2006. The middle 50 percent earned between $10.84 and $18.79 an hour. The lowest 10 per-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Inspectors, testers, sorters, samplers, and weighers	51-9061	491,000	457,000	-35,000	-7

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

cent earned less than $8.65 an hour, and the highest 10 percent earned more than $24.85 an hour. Median hourly earnings in the industries employing the largest numbers of inspectors, testers, sorters, samplers, and weighers in May 2006 were:

Aerospace product and parts manufacturing	$20.62
Motor vehicle parts manufacturing	16.74
Semiconductor and other electronic component manufacturing	13.32
Plastics product manufacturing	12.85
Employment services	11.12

Related Occupations

Other workers who conduct inspections include agricultural inspectors, construction and building inspectors, fire inspectors and investigators, occupational health and safety specialists and technicians, and transportation inspectors.

Sources of Additional Information

For general information about inspection, testing, and certification, contact:

➤ American Society for Quality, 600 North Plankinton Ave., Milwaukee, WI 53203. Internet: **http://www.asq.org**

Jewelers and Precious Stone and Metal Workers

(O*NET 51-9071.00, 51-9071.01, 51-9071.06, 51-9071.07)

Significant Points

- About half of all jewelers are self-employed.
- Jewelers usually learn their trade in vocational or technical schools, through distance-learning centers, or on the job.
- Prospects for bench jewelers and other skilled jewelers should be favorable; keen competition is expected for lower-skilled manufacturing jobs, such as assemblers and polishers.

Nature of the Work

Jewelers and precious stone and metal workers use a variety of common and specialized handtools and equipment to design and manufacture new pieces of jewelry; cut, set, and polish gem stones; repair or adjust rings, necklaces, bracelets, earrings, and other jewelry; and appraise jewelry, precious metals, and gems. Jewelers usually specialize in one or more of these areas and may work for large jewelry manufacturing firms, for small retail jewelry shops, or as owners of their own businesses. Regardless of the type of work done or the work setting, jewelers need a high degree of skill, precision, and attention to detail.

Some jewelers design or make their own jewelry. Following their own designs or those created by designers or customers, they begin by shaping the metal or by carving wax to make a model for casting the metal. The individual parts then are soldered together, and the jeweler may mount a diamond or other gem or may engrave a design into the metal. Other jewelers do finishing work, such as setting stones, polishing, or engraving, or make repairs. Typical repair work includes enlarging or reducing ring sizes, resetting stones, and replacing broken clasps and mountings.

Bench jewelers usually work in jewelry retailers. They perform a wide range of tasks, from simple jewelry cleaning and repair to moldmaking and fabricating pieces from scratch. In larger manufacturing businesses, jewelers usually specialize in a single operation. *Mold and model makers* create models or tools for the jewelry that is to be produced. *Assemblers* solder or fuse jewelry and their parts; they also may set stones. *Engravers* etch designs into the metal with specialized tools, and *polishers* bring a finished luster to the final product.

Jewelers typically do the handiwork required to produce a piece of jewelry, while *gemologists* and laboratory graders analyze, describe, and certify the quality and characteristics of gem stones. Gemologists may work in gemological laboratories or as quality control experts for retailers, importers, or manufacturers. After using microscopes, computerized tools, and other grading instruments to examine gem stones or finished pieces of jewelry, they write reports certifying that the items are of a particular quality. Many jewelers also study gemology to become familiar with the physical properties of the gem stones with which they work.

Jewelry appraisers carefully examine jewelry to determine its value, after which they write appraisal documents. They determine the value of a piece by researching the jewelry market, using reference books, auction catalogs, price lists, and the Internet. They may work for jewelry stores, appraisal firms, auction houses, pawnbrokers, or insurance companies. Many gemologists also become appraisers.

In small retail stores or repair shops, jewelers and appraisers may be involved in all aspects of the work. Those who own or manage stores or shops also hire and train employees; order, market, and sell merchandise; and perform managerial duties.

New technology is helping to produce jewelry of higher quality at a reduced cost and in a shorter amount of time. For example, lasers are often used for cutting and improving the quality of stones, for applying intricate engraving or design work, and for inscribing personal messages or identification on jewelry. Jewelers also use lasers to weld metals together in milliseconds with no seams or blemishes, improving the quality and appearance of jewelry.

Some manufacturing firms use computer-aided design and manufacturing (CAD/CAM) to facilitate product design and automate some steps in the moldmaking and modelmaking process. CAD allows jewelers to create a virtual-reality model of a piece of jewelry. Using CAD, jewelers can modify the design, change the stone, or try a different setting and see the changes on a computer screen before cutting a stone or performing other costly steps. Once they are satisfied with the model, CAM produces it in a waxlike or other material. After the mold of the model is made, it is easier for manufacturing

firms to produce numerous copies of a given piece of jewelry, which are then distributed to retail establishments across the country. Similar techniques may be used in the retail setting, allowing customers to review their jewelry designs with the jeweler and make modifications before committing themselves to the expense of a customized piece of jewelry.

Work environment. A jeweler's work involves a great deal of concentration and attention to detail. Trying to satisfy customers' and employers' demands for speed and quality while working on precious stones and metal can cause fatigue or stress. However, the use of more ergonomically correct jewelers' benches has eliminated most of the strain and discomfort caused by spending long periods over a workbench.

Lasers require both careful handling to avoid injury and steady hands to direct precision tasks. In larger manufacturing plants and some smaller repair shops, chemicals, sharp or pointed tools, and jewelers' torches pose safety threats and may cause injury if proper care is not taken. Most dangerous chemicals, however, have been replaced with synthetic, less toxic products to meet safety requirements.

In repair shops, jewelers usually work alone with little supervision. In retail stores, they may talk with customers about repairs, perform custom design work, and even do some selling. Because many of their materials are valuable, jewelers must observe strict security procedures, including working behind locked doors that are opened only by a buzzer, working on the other side of barred windows, making use of burglar alarms, and, in larger jewelry establishments, working in the presence of armed guards.

Jewelers usually learn their trade in vocational or technical schools, through distance-learning centers, or on the job.

Training, Other Qualifications, and Advancement

Jewelers usually learn their trade in vocational or technical schools, through distance-learning centers, or on the job. Formal training enhances employment and advancement opportunities.

Education and training. Jewelers usually learn their trade in vocational or technical schools, through distance-learning centers, or on the job. For those interested in working in a jewelry store or repair shop, vocational and technical training or courses offered by public and private colleges are the best sources of training. In these programs, which can vary in length from 6 months to 1 year, students learn the use and care of jewelers' tools and machines and basic jewelrymaking and jewelry-repairing skills, such as designing, casting, and setting and polishing stones.

Technical school courses also cover topics such as blueprint reading, math, and shop theory. To enter some technical school programs and most college programs, a high school diploma or its equivalent is required. However, some schools specializing in jewelry training do not require graduation from high school.

Colleges and art and design schools offer programs that can lead to the degree of bachelor of fine arts, or master of fine arts, in jewelry design. Various institutes offer courses and programs in gemology. Programs cover a wide range of topics, including the identification and grading of diamonds and gem stones.

Computer-aided design is becoming increasingly common, and students—especially those interested in design and manufacturing—may wish to obtain training in it; however, most employers will provide such training.

Most employers feel that vocational school and technical school graduates need up to a year of additional supervised on-the-job training or an apprenticeship to refine their repair skills and learn more about the operation of the store or shop. In addition, some employers encourage workers to improve their skills by enrolling in short-term technical school courses such as fabricating, jewelry design, jewelry manufacturing, wax carving, and gemology. Employers may pay all or part of the cost of this additional training.

In jewelry manufacturing plants, workers traditionally develop their skills through informal apprenticeships and on-the-job training. The apprenticeship or training period lasts up to 1 year, depending on the difficulty of the specialty. Training usually focuses on casting, setting stones, making models, or engraving. In recent years, a growing number of technical schools have begun to offer training designed for jewelers working in manufacturing. Employers in manufacturing may prefer graduates of these programs because they are familiar with the production process and require less on-the-job training.

Other qualifications. The precise and delicate nature of jewelry work requires finger and hand dexterity, good hand-eye coordination, patience, and concentration. Artistic ability and fashion consciousness are major assets, particularly in jewelry design and jewelry shops, because jewelry must be stylish and attractive. Those who work in jewelry stores have frequent contact with customers and should be neat, personable, and knowledgeable about the merchandise. In addition, employers require workers of good character because jewelers work with valuable materials.

Certification and advancement. Jewelers of America offers four credentials, ranging from Certified Bench Jeweler Technician to Certified Master Bench Jeweler, for bench jewelers who pass a written and practical exam. Certification is not required to work as a bench jeweler, but it may help jewelers to show expertise and to advance.

Advancement opportunities are limited and depend greatly on an individual's skill and initiative. In manufacturing, some jewelers advance to supervisory jobs, such as master jeweler or head jeweler, but for most, advancement means earning higher pay for the same job. Jewelers who work in jewelry stores or repair shops may become managers; some open their own businesses.

Those interested in starting their own business should first establish themselves and build a reputation for their work within the jewelry trade. Once they obtain sufficient credit from jewelry suppliers and wholesalers, they can acquire the necessary inventory. Also, because the jewelry business is highly competitive, jewelers who plan to open their own store should have sales experience and knowledge of marketing and business management. Courses in these subjects are often available from technical schools and community colleges.

Employment

Jewelers and precious stone and metal workers held about 52,000 jobs in 2006. About 51 percent of these workers were self-employed; many operated their own store or repair shop, and some specialized in designing and creating custom jewelry.

About 22 percent of wage-and-salary jobs for jewelers and precious stone and metal workers were in retail trade, primarily in jewelry, luggage, and leather goods stores. Another 17 percent of jobs were in jewelry and silverware manufacturing. A small number of jobs were with merchant wholesalers of miscellaneous durable goods and in repair shops providing repair and maintenance of personal and household goods. Although jewelry stores and repair shops were found in every city and in many small towns, most jobs were in larger metropolitan areas. Many jewelers employed in manufacturing worked in Rhode Island, New York, Chicago, Dallas, Florida, or California.

Job Outlook

Employment of jewelers and precious stone and metal workers is expected to experience little or no change. Prospects for bench jewelers and other skilled jewelers should be favorable; keen competition is expected for lower-skilled manufacturing jobs, such as assemblers and polishers.

Employment change. Employment of jewelers and precious stone and metal workers is expected to experience little or no change, declining 2 percent between 2006 and 2016.

The increasing numbers of affluent individuals, working women, double-income households, and fashion-conscious men are expected to keep jewelry sales strong. The population aged 45 and older, which accounts for a major portion of jewelry sales, also is on the rise. However, most jewelry manufacturing has already moved abroad, and this trend is expected to continue.

Nontraditional jewelry marketers, such as discount stores, mail-order and catalogue companies, television shopping networks, and Internet retailers, have expanded the number of buying options and increased their sales volume. However, these establishments require fewer sales staff, limiting employment opportunities for jewelers and precious stone and metal workers who work mainly in sales.

Traditional jewelers may continue to lose some of their market share to nontraditional outlets, but they will maintain a large customer base. Many buyers prefer to see and try on jewelry before purchasing it or enjoy the experience of shopping in a store. Jewelry stores also have the advantage of being able to offer personalized service and build client relationships. Additionally, new jewelry sold by nontraditional retailers will create demand for skilled jewelers for sizing, cleaning, and repair work. There may also be increased demand for bench jewelers as baby boomers seek customization and repair of heirloom jewelry.

Job prospects. Despite little or no change in employment, opportunities should be favorable for bench jewelers and other skilled jewelers. New jewelers will be needed to replace those who retire or who leave the occupation for other reasons. When master jewelers retire, they take with them years of experience that require substantial time and financial resources to replace. Many employers have difficulty finding and retaining jewelers with the right skills and the necessary knowledge. Opportunities in jewelry stores and repair shops will be best for graduates from training programs for jewelers or gemologists.

Keen competition is expected for lower-skilled manufacturing jobs that are amenable to automation, such as assemblers and polishers. Jewelry designers who wish to create their own jewelry lines should expect intense competition. Although demand for customized and boutique jewelry is strong, it is difficult for independent designers to establish themselves.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Jewelers and precious stone and metal workers	51-9071	52,000	51,000	-1,200	-2

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

The jewelry industry can be cyclical. During economic downturns, demand for jewelry products and for jewelers tends to decrease. However, demand for repair workers should remain strong even during economic slowdowns because maintaining and repairing jewelry is an ongoing process. In fact, demand for jewelry repair may increase during recessions, as people repair or restore existing pieces rather than purchase new ones.

Earnings

Median annual wage-and-salary earnings for jewelers and precious stone and metal workers were $29,750 in May 2006. The middle 50 percent earned between $22,390 and $40,160. The lowest 10 percent earned less than $17,760, and the highest 10 percent earned more than $54,940.

Most jewelers start out with a base salary, but once they become more proficient, they may begin charging by the number of pieces completed. Jewelers who work in retail stores may earn a commission for each piece of jewelry sold. Many jewelers also enjoy a variety of benefits, including reimbursement from their employers for work-related courses and discounts on jewelry purchases.

Related Occupations

Jewelers and precious stone and metal workers do precision handwork. Other skilled workers who do similar jobs include precision instrument and equipment repairers; welding, soldering, and brazing workers; and woodworkers. Some jewelers and precious stone and metal workers create their own jewelry designs. Other occupations that require visual arts abilities include artists and related workers, and various designers—commercial and industrial, fashion, floral, graphic, and interior. Finally, some jewelers and precious stone and metal workers are involved in the buying and selling of stones, metals, or finished pieces of jewelry. Similar occupations include retail salespersons and sales representatives in wholesale trade.

Sources of Additional Information

Information on job opportunities and training programs for jewelers and gemologists is available from:

➤ Gemological Institute of America, 5345 Armada Dr., Carlsbad, CA 92008. Internet: **http://www.gia.edu**

For more information about bench jeweler certification and careers in jewelry design and retail, including different career paths, training options, and schools, contact:

➤ Jewelers of America, 52 Vanderbilt Ave., 19th Floor, New York, NY 10017. Internet: **http://www.jewelers.org**

For information on jewelry design and manufacturing, training, and schools offering jewelry-related programs and degrees by State, contact:

➤ Manufacturing Jewelers and Suppliers of America, 45 Royal Little Dr., Providence, RI 02904.
Internet: **http://www.mjsa.org**

To receive a list of accredited technical schools that have programs in gemology, contact:

➤ Accrediting Commission of Career Schools and Colleges of Technology, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: **http://www.accsct.org**

Machine Setters, Operators, and Tenders—Metal and Plastic

(O*NET 51-4021.00, 51-4022.00, 51-4023.00, 51-4031.00, 51-4032.00, 51-4033.00, 51-4034.00, 51-4035.00, 51-4051.00, 51-4052.00, 51-4061.00, 51-4062.00, 51-4071.00, 51-4072.00, 51-4081.00, 51-4191.00, 51-4192.00, 51-4193.00, 51-4194.00, 51-4199.99)

Significant Points

- Manufacturing industries employ more than 90 percent of workers.
- A few weeks of on-the-job training is sufficient for most workers to learn basic machine operations, but a year or more is required to become a highly skilled operator or setter.
- Overall employment of machine setters, operators, and tenders is projected to decline rapidly over the 2006-16 period as a result of productivity improvements and competition for jobs from abroad.
- Those who can operate multiple machines will have the best opportunities for advancement and for gaining jobs with more long-term potential.

Nature of the Work

Consider the parts of a toaster, such as the metal or plastic housing or the lever that lowers the toast. These parts, and many other metal and plastic products, are produced by machine setters, operators, and tenders—metal and plastic. In fact, machine operators in the metalworking and plastics industries play a major role in producing most of the consumer products on which we rely daily.

In general, these workers can be separated into two groups—those who set up machines for operation and those who operate the machines during production. Setup workers prepare the machines *prior* to production, perform initial test runs producing a part, and may adjust and make minor repairs to the machinery *during* its operation. Operators and tenders primarily monitor the machinery during its operation; sometimes they load or unload the machine or make minor adjustments to the controls. Many workers both set up and operate equipment. Because the setup process requires an understanding of the entire production process, setters usually have more training and are more highly skilled than those who simply operate or tend machinery. As new automation simplifies the setup process, however, less skilled workers also are increasingly able to set up machines for operation.

Setters, operators, and tenders usually are identified by the type of machine with which they work. Some examples of specific titles are drilling- and boring-machine toolsetters, milling- and planing-machine tenders, and lathe- and turning-machine tool operators. Job duties usually vary with the size of the firm and the type of machine being operated. Although some workers specialize in one or two types of

machinery, many are trained to set up or operate a variety of machines. Increasing automation allows machine setters to operate multiple machines simultaneously. In addition, newer production techniques, such as team-oriented "lean" manufacturing, require machine operators to rotate between different machines. Rotating assignments results in more varied work, but also requires workers to have a wider range of skills.

Machine setters, operators, and tenders—metal set up and tend machines that cut and form all types of metal parts. Setup workers plan and set up the sequence of operations according to blueprints, layouts, or other instructions. Often this involves loading a computer program with instructions into the machine's computer controls. On all machines, including those with computer controls, setup workers respond to problems during operation by adjusting the speed, feed and other variables. They also choose the proper coolants and lubricants and select the instruments or tools for each operation. Using micrometers, gauges, and other precision measuring instruments, setup workers compare the completed work within the required tolerances.

Although there are many different types of metalworking machine tools that require specific knowledge and skills, most operators perform similar tasks. Whether tending grinding machines that remove excess material from the surface of solid piece of metal or presses that extrude molten metal through a die to form wire, operators usually perform simple, repetitive operations that can be learned quickly. Typically, these workers place metal stock in a machine on which the operating specifications have already been set. They watch one or more machines and make adjustments to the machines based on either reading from computers and gauges or measuring the resulting product. Regardless of the type of machine they operate, machine operators usually depend on more skilled and experienced setup workers for major adjustments when the machines are not functioning properly.

Machine setters, operators, and tenders—plastic set up and tend machines that transform plastic compounds—chemical-based products that can be produced in powder, pellet, or syrup form—into a wide variety of consumer goods such as toys, tubing, and auto parts. These products are manufactured by various methods, of which injection molding is the most common. The injection-molding machine heats and liquefies a plastic compound and forces it into a mold. After the part has cooled and hardened, the mold opens and the part is released. Many common kitchen products are produced with this method. To produce long parts, such as pipes or window frames, an extruding machine usually is used. These machines force a plastic compound through a die that contains an opening with the desired shape of the final product. Blow molding is another common plasticsworking technique. Blow-molding machines force hot air into a mold that contains a plastic tube. As the air moves into the mold, the tube is inflated to the shape of the mold, and a plastic container is formed. The familiar 2-liter soft-drink bottles are produced by this method.

Work environment. Most machine setters, operators, and tenders—metal and plastic work in areas that are clean, well lit, and well ventilated. Nevertheless, many operators require stamina, because they are on their feet much of the day and may do moderately heavy lifting. Also, these workers operate powerful, high-speed machines that can be dangerous if strict safety rules are not observed. Most operators wear protective equipment, such as safety glasses and earplugs, to protect against flying particles of metal or plastic and against noise from the machines. However, many modern machines are enclosed, minimizing the exposure of workers to noise, dust, and lubricants used during machining. Other required safety equipment varies by work setting and machine. For example, those in the plastics industry who work near materials that emit dangerous fumes or dust must wear face masks or self-contained breathing apparatus.

Machine setters, operators, and tenders operate a wide range of machine tools.

Overtime is common during periods of increased production for most machine setters, operators, and tenders—metal and plastic, but they usually work a 40-hour week. Because many metalworking and plastics working shops operate more than one shift daily, some operators work nights and weekends.

Training, Other Qualifications, and Advancement

A few weeks of on-the-job training is sufficient for most workers to learn basic machine operations, but a year or more is required to become a highly skilled operator or setter.

Education and training. Employers generally prefer workers who have a high school diploma or equivalent for jobs as machine setters, operators, and tenders. Being able to read, write, and speak English is important. Those interested in this occupation can improve their employment opportunities by completing high school courses in shop and blueprint reading and by gaining a working knowledge of the properties of metals and plastics. A solid math background, including courses in algebra, geometry, trigonometry, and basic statistics, also is useful, along with experience working with computers.

Trainees begin by observing and assisting experienced workers, sometimes in formal training programs or apprenticeships. Under supervision, they may start as tenders, supplying materials, starting and stopping the machine, or removing finished products from it. Then they advance to the

more difficult tasks performed by operators, such as adjusting feed speeds, changing cutting tools, or inspecting a finished product for defects. Eventually, they develop the skills and experience to setup machines and assist newer operators.

The complexity of the equipment largely determines the time required to become an operator. Most operators learn the basic machine operations and functions in a few weeks, but a year or more may be needed to become skilled operators or to advance to the more highly skilled job of setter. Although many operators learn on the job, some community colleges and other educational institutions offer courses and certifications in operating metal and plastics machines. In addition to providing on-the-job training, some employers send promising machine tenders to classes. Other employers prefer to hire workers who have completed, or currently are enrolled in, a training program.

Setters or technicians often plan the sequence of work, make the first production run, and determine which adjustments need to be made. As a result, these workers need a thorough knowledge of the machinery and of the products being manufactured. Strong analytical abilities are particularly important for this job. Some companies have formal training programs for operators and setters, which often combine classroom instruction with on-the-job training. For some positions, such as grinders and rolling or pressing setup workers, formal apprenticeships are available. These programs require 300-600 hours of classroom training, and 2000-4000 hours of on-the-job experience. Workers complete these programs in about 2 to 4 years, depending upon the program.

Other qualifications. As the machinery in manufacturing plants becomes more complex and with changes to shop-floor organization that require more teamwork among employees, employers increasingly look for persons with good communication and interpersonal skills. Mechanical aptitude, manual dexterity, and experience working with machinery also are helpful.

Certification and advancement. Job opportunities and advancement can be enhanced by becoming certified in a particular machining skill. The National Institute for Metalworking Skills has developed standards for machine setters, operators, and tenders—metal. After taking an approved course and passing a written exam and performance requirement, the worker is issued a credential that signifies competence in a specific machining operation. The Society of Plastics Industry, the national trade association representing plastics manufacturers, also certifies workers in that industry. Certifications vary greatly depending upon the skill level involved. Both organizations offer multiple levels of operator and setter certifications. Certifications allow operators and setters to switch jobs more easily because they can prove their skills to a potential employer.

Advancement for operators usually takes the form of higher pay and a wider range of responsibilities, eventually than can advance to be setup workers. With experience and training they can become multiple-machine operators, or trainees for more highly skilled positions, such as, machinists, tool and die makers, or computer-control programmers. (See the statements on machinists, computer control programmers and operators, and tool and die makers elsewhere in the *Handbook*.) Some setup workers may advance to supervisory positions.

Employment

Machine setters, operators, and tenders—metal and plastic held about 1.1 million jobs in 2006. More than 90 percent of jobs were found in manufacturing, primarily in fabricated metal product manufacturing, plastics and rubber products manufacturing, primary metal manufacturing, machinery manufacturing, and motor vehicle parts manufacturing.

Job Outlook

Overall employment in the various machine setter, operator, and tender occupations is expected to decline rapidly during the projection period. Those who can operate multiple machines will have the best opportunities for advancement and for gaining jobs with more long-term potential.

Employment change. Overall employment in the various machine setter, operator, and tender occupations is expected to decline rapidly by 15 percent from 2006 to 2016. In general, employment growth of these workers will be affected by technological advances, changing demand for the goods they produce, foreign competition, and the reorganization of production processes.

One of the most important factors influencing employment change in this occupation is the implementation of labor-saving machinery. Many firms are adopting new technologies, such as computer-controlled machine tools and robots in order to improve quality, lower production costs, and remain competitive. Computer-controlled equipment allows operators to tend a greater number of machines simultaneously and often makes setup easier, thereby reducing the amount of time setup workers spend on each machine. Robots are being used to load and unload parts from machines. The lower-skilled manual machine tool operators and tenders jobs are more likely to be eliminated by these new technologies, because the functions they perform are more easily automated.

The demand for machine setters, operators, and tenders—metal and plastic largely mirrors the demand for the parts they produce. The consumption of plastic products has grown as they have been substituted for metal goods in many products in recent years. The process is likely to continue and should result in stronger demand for machine operators in plastics than in metal.

Both the plastics and metal industries, however, face stiff foreign competition that is limiting the demand for domestically produced parts. One way in which larger U.S. producers have responded to this competition is by moving production operations to other countries where labor costs are lower. These moves are likely to continue and will further reduce employment growth for machine operators, setters, and tenders—metal and plastic in the United States. Another way domestic manufacturers compete with low-wage foreign competition is by increasing their use of automated systems, which can make manufacturing establishments more competitive by improving their productivity. However, increased automation also limits employment growth.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Machine setters, operators, and tenders—metal and plastic	—	1,141,000	975,000	-166,000	-15
Forming machine setters, operators, and tenders, metal and plastic	51-4020	161,000	140,000	-20,000	-13
Extruding and drawing machine setters, operators, and tenders, metal and plastic	51-4021	94,000	87,000	-6,700	-7
Forging machine setters, operators, and tenders, metal and plastic	51-4022	31,000	22,000	-9,400	-30
Rolling machine setters, operators, and tenders, metal and plastic	51-4023	36,000	32,000	-4,200	-12
Machine tool cutting setters, operators, and tenders, metal and plastic	51-4030	513,000	425,000	-88,000	-17
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	51-4031	272,000	231,000	-40,000	-15
Drilling and boring machine tool setters, operators, and tenders, metal and plastic	51-4032	43,000	33,000	-9,500	-22
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	51-4033	101,000	85,000	-16,000	-16
Lathe and turning machine tool setters, operators, and tenders, metal and plastic	51-4034	68,000	52,000	-16,000	-23
Milling and planing machine setters, operators, and tenders, metal and plastic	51-4035	29,000	23,000	-6,100	-21
Metal furnace and kiln operators and tenders	51-4050	33,000	27,000	-6,100	-18
Metal-refining furnace operators and tenders	51-4051	18,000	15,000	-3,500	-19
Pourers and casters, metal	51-4052	15,000	12,000	-2,600	-17
Model makers and patternmakers, metal and plastic	51-4060	16,000	15,000	-1,000	-6
Model makers, metal and plastic	51-4061	8,800	8,200	-600	-6
Patternmakers, metal and plastic	51-4062	7,400	7,000	-400	-5
Molders and molding machine setters, operators, and tenders, metal and plastic	51-4070	171,000	148,000	-23,000	-14
Foundry mold and coremakers	51-4071	15,000	11,000	-3,300	-23
Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	51-4072	157,000	137,000	-20,000	-13
Multiple machine tool setters, operators, and tenders, metal and plastic	51-4081	97,000	97,000	300	0
Miscellaneous metalworkers and plastic workers	51-4190	150,000	122,000	-28,000	-18
Heat treating equipment setters, operators, and tenders, metal and plastic	51-4191	27,000	23,000	-4,000	-15
Lay-out workers, metal and plastic	51-4192	10,000	8,100	-2,000	-20
Plating and coating machine setters, operators, and tenders, metal and plastic	51-4193	42,000	37,000	-5,100	-12
Tool grinders, filers, and sharpeners	51-4194	22,000	18,000	-4,200	-19
Metal workers and plastic workers, all other	51-4199	49,000	36,000	-12,000	-25

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

Job prospects. Despite the overall rapid employment decline, a large number of machine setter, operator, and tender jobs will become available because of an expected surge in retirements, primarily baby boomers, by the end of the decade. Workers with a thorough background in machine operations, certifications from industry associations, exposure to a variety of machines, and a good working knowledge of the properties of metals and plastics will be better able to adjust to the changing environment. In addition, new shop-floor arrangements will reward workers with good basic mathematics and reading skills, good communication skills, and the ability and willingness to learn new tasks. As workers adapt to team-oriented production methods, those who can operate multiple machines will have the best opportunities for advancement and for gaining jobs with more long-term potential.

Earnings

Earnings for machine operators can vary by size of the company, union status, industry, and skill level and experience of the operator. Also, temporary employees, who are being hired in greater numbers, usually get paid less than permanently employed workers. The median hourly earnings in May 2006 for a variety of machine setters, operators, and tenders—metal and plastic were:

Model makers, metal and plastic $20.22
Patternmakers, metal and plastic 17.01
Lay-out workers, metal and plastic 16.15
Metal-refining furnace operators and tenders 15.69
Lathe and turning machine tool setters, operators, and tenders, metal and plastic 15.46
Milling and planing machine setters, operators, and tenders, metal and plastic 15.18
Rolling machine setters, operators, and tenders, metal and plastic 14.93
Heat treating equipment setters, operators, and tenders, metal and plastic 14.83
Tool grinders, filers, and sharpeners 14.73
Multiple machine tool setters, operators, and tenders, metal and plastic 14.68
Drilling and boring machine tool setters, operators, and tenders, metal and plastic 14.36
Pourers and casters, metal 14.22
Forging machine setters, operators, and tenders, metal and plastic 13.94
Foundry mold and coremakers 13.82
Extruding and drawing machine setters, operators, and tenders, metal and plastic 13.58
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic 13.50
Plating and coating machine setters, operators, and tenders, metal and plastic 13.21
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic 12.66
Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic 12.29
Metal workers and plastic workers, all other 16.69

Related Occupations

Workers in occupations closely related to machine setters, operators, and tenders—metal and plastic include machinists; tool and die makers; assemblers and fabricators; computer control programmers and operators; painting and coating workers, except construction and maintenance; and welding, soldering, and brazing workers. Often, machine operators are responsible for checking the quality of parts being produced, work similar to that of inspectors, testers, sorters, samplers, and weighers.

Sources of Additional Information

For general information about careers and companies employing metal machine setters, operators, and tenders, contact:

➤ National Tooling and Machining Association, 9300 Livingston Rd., Fort Washington, MD 20744.
Internet: **http://www.ntma.org**

➤ Precision Metalforming Association Educational Foundation, 6363 Oak Tree Blvd., Independence, OH 44131.
Internet: **http://www.pmaef.org**

➤ Precision Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141-3292.
Internet: **http://www.pmpa.org**

For information on schools and employers with training programs in plastics, contact:

➤ Society of Plastics Industry, 1667 K St.NW., Suite 1000, Washington, DC 20006. Internet:
http://www.plasticsindustry.org/outreach/careers.htm

Machinists

(O*NET 51-4041.00)

Significant Points

- Machinists learn in apprenticeship programs, informally on the job, in vocational high schools, and in community or technical colleges.
- Many entrants previously have worked as machine setters, operators, or tenders.
- Although employment is projected to decline, job opportunities are expected to be good.

Nature of the Work

Machinists use machine tools, such as lathes, milling machines, and machining centers, to produce precision metal parts. Although they may produce large quantities of one part, precision machinists often produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with machine tools to plan and carry out the operations needed to make machined products that meet precise specifications.

Machinists first review electronic or written blueprints or specifications for a job before they machine a part. Next, they calculate where to cut or bore into the workpiece—the piece of steel, aluminum, titanium, plastic, silicon or any other material that is being shaped. They determine how fast to feed the workpiece into the machine and how much material to remove. They then select tools and materials for the job, plan the sequence of cutting and finishing operations, and mark the workpiece to show where cuts should be made.

After this layout work is completed, machinists perform the necessary machining operations. They position the workpiece on the machine tool—drill press, lathe, milling machine, or other type of machine—set the controls, and make the cuts. During the machining process, they must constantly monitor the feed rate and speed of the machine. Machinists also ensure that the workpiece is properly lubricated and cooled because the machining of metal products generates a significant amount of heat. The temperature of the workpiece is a key concern because most metals expand when heated; machinists must adjust the size of their cuts relative to the temperature.

During the cutting process, machinists detect problems by listening for specific sounds—for example, that of a dull cutting tool or excessive vibration. Dull cutting tools are removed and replaced. Cutting speeds are adjusted to compensate for harmonic vibrations, which can decrease the accuracy of cuts, particularly on newer high-speed spindles and lathes. After the work is completed, machinists use both simple and highly sophisticated measuring tools to check the accuracy of their work against blueprints.

Some machinists, often called production machinists, may produce large quantities of one part, especially parts requiring the use of complex operations and great precision. Many modern machine tools are computer numerically controlled (CNC).

CNC machines, following a computer program, control the cutting tool speed, change dull tools, and perform all of the necessary cuts to create a part. Frequently, machinists work with computer control programmers to determine how the automated equipment will cut a part. (See the section on computer control programmers and operators elsewhere in the *Handbook*.) The machinist determines the cutting path, speed of the cut and the feed rate, and the programmer converts path, speed, and feed information into a set of instructions for the CNC machine tool.

Because most machinists train in CNC programming, they may write basic programs themselves and often modify programs in response to problems encountered during test runs. Modifications, called offsets, not only fix problems, but they also improve efficiency by reducing manufacturing time and tool wear. After the production process is designed, computer control operators implement it by performing relatively simple and repetitive operations.

Some manufacturing techniques employ automated parts loaders, automatic tool changers, and computer controls, allowing machines to operate without anyone present. One production machinist, working 8 hours a day, might monitor equipment, replace worn cutting tools, check the accuracy of parts being produced, adjust offsets, and perform other tasks on several CNC machines that operate 24 hours a day. In the off-hours, during what is known as "lights-out manufacturing," a factory may need only a few machinists to monitor the entire factory.

Maintenance machinists repair or make new parts for existing machinery. After an industrial machinery mechanic or maintenance worker discovers the broken part of a machine, they give the broken part to the machinist. (See the section on industrial machinery mechanics and maintenance workers elsewhere in the *Handbook*.) To replace broken parts, maintenance machinists refer to blueprints and perform the same machining operations that were needed to create the original part. While production machinists are concentrated in a few industries, maintenance machinists work in many manufacturing industries.

Because the technology of machining is changing rapidly, machinists must learn to operate a wide range of machines. Some newer machines use lasers, water jets, or electrified wires to cut the workpiece. While some of the computer controls are similar to other machine tools, machinists must understand the unique cutting properties of these different machines. As engineers create new types of machine tools and new materials to machine, machinists must constantly learn new machining properties and techniques.

Work environment. Today, most machine shops are relatively clean, well lit, and ventilated. Many computer-controlled machines are partially or totally enclosed, minimizing the exposure of workers to noise, debris, and the lubricants used to cool workpieces during machining. Nevertheless, working around machine tools presents certain dangers, and workers must follow safety precautions. Machinists wear protective equipment, such as safety glasses to shield against bits of flying metal and earplugs to dampen machinery noise. They also must exercise caution when handling hazardous coolants and lubricants, although many common water-based lubricants present little hazard. The job requires stamina because machinists stand most of the day and, at times, may need to lift moderately heavy workpieces. Modern factories use autoloaders and overhead cranes to reduce heavy lifting.

Machinsts change worn cutting tools on computer-controlled machines.

Many machinists work a 40-hour week. Evening and weekend shifts are becoming more common as companies extend hours of operation to make better use of expensive machines. However, this trend is somewhat offset by lights-out manufacturing that uses fewer machinists and the use of machine operators for less desirable shifts. Overtime is common during peak production periods.

Training, Other Qualifications, and Advancement

Machinists train in apprenticeship programs, vocational schools, or community or technical colleges, or informally on the job. Many entrants previously have worked as machine setters, operators, or tenders.

Education and training. There are many different ways to become a skilled machinist. Many entrants previously have worked as machine setters, operators, or tenders. In high school, students should take math courses, especially trigonometry, and, if available, courses in blueprint reading, metalworking, and drafting. After high school, some machinists learn entirely on the job, but most acquire their skills in a mix of classroom and on-the-job training. Formal apprenticeship programs, typically sponsored by a union or manufacturer, are an excellent way to learn the job of machinist, but are often hard to get into. Apprentices usually must have a high school diploma, GED, or the equivalent, and most have taken algebra and trigonometry classes.

Apprenticeship programs consist of paid shop training and related classroom instruction lasting up to 4 years. In shop training, apprentices work almost full time and are supervised by an experienced machinist while learning to operate various machine tools. Classroom instruction includes math, physics, materials science, blueprint reading, mechanical drawing, and quality and safety practices. In addition, as machine shops have increased their use of computer-controlled equipment, training in the operation and programming of CNC machine tools has become essential. Apprenticeship classes are often taught in cooperation with local community colleges or vocational-tech-

nical schools. A growing number of machinists are learning the trade through 2-year associate degree programs at community or technical colleges. Graduates of these programs still need significant on-the-job experience before they are fully qualified.

Certification and other qualifications. People interested in becoming machinists should be mechanically inclined, have good problem-solving abilities, be able to work independently, and be able to do highly accurate work (tolerances may reach 50/1,000,000ths of an inch) that requires concentration and physical effort. Experience working with machine tools is helpful. In fact, many entrants have worked as machine setters, operators, or tenders.

To boost the skill level of machinists and to create a more uniform standard of competency, a number of training facilities, State apprenticeship boards, and colleges are implementing curriculums that incorporate national skills standards developed by the National Institute of Metalworking Skills (NIMS). After completing such a curriculum and passing practical and written exams, trainees are granted a NIMS credential. Completing a recognized certification program provides a machinist with better career opportunities and helps employers better judge the abilities of new hires. Journeyworker certification can be obtained from State apprenticeship boards after completing an apprenticeship.

As new automation is introduced, machinists normally receive additional training to update their skills. This training usually is provided by a representative of the equipment manufacturer or a local technical school. Some employers offer tuition reimbursement for job-related courses.

Advancement. Machinists can advance in several ways. Experienced machinists may become CNC programmers, tool and die makers, or mold makers, or be promoted to supervisory or administrative positions in their firms. A few open their own machine shops.

Employment

Machinists held about 397,000 jobs in 2006. About 78 percent of machinists work in manufacturing industries, such as machine shops and machinery, motor vehicle and parts, aerospace products and parts, and other transportation equipment manufacturing. Maintenance machinists work in most industries that use production machinery.

Job Outlook

Although employment of machinists is projected to decline slowly, job prospects are expected to be good.

Employment change. Employment of machinists is projected to decline slowly by 3 percent over the 2006-16 decade because of rising productivity among these workers and strong foreign competition in the manufacture of goods. Machinists will become more efficient as a result of the expanded use of and improvements in technologies such as CNC machine tools, autoloaders, and high-speed machining. This allows fewer machinists to accomplish the same amount of work. Technology is not expected to affect the employment of machinists as significantly as that of some other production workers, however, because machinists monitor and maintain many automated systems. Due to modern production techniques, employers prefer workers, such as machinists, who have a wide range of skills and are capable of performing almost any task in a machine shop.

Job prospects. Despite the projected decline in employment, job opportunities for machinists should continue to be good as employers value the wide-ranging skills of these workers. Also, many young people with the necessary educational and personal qualifications needed to become machinists prefer to attend college or may not wish to enter production occupations. Therefore, the number of workers learning to be machinists is expected to be less than the number of job openings arising each year from the need to replace experienced machinists who retire or transfer to other occupations.

Employment levels in this occupation are influenced by economic cycles—as the demand for machined goods falls, machinists involved in production may be laid off or forced to work fewer hours. Employment of machinists involved in plant maintenance, however, often is more stable because proper maintenance and repair of costly equipment remains critical to manufacturing operations, even when production levels fall.

Earnings

Median hourly wage-and-salary earnings of machinists were $16.71 in May 2006. The middle 50 percent earned between $13.14 and $20.82. The lowest 10 percent earned less than $10.29, while the top 10 percent earned more than $25.31. Median hourly wage-and-salary earnings in the manufacturing industries employing the largest number of machinists were:

Aerospace product and parts manufacturing	$18.46
Motor vehicle parts manufacturing	18.27
Metalworking machinery manufacturing	17.36
Machine shops; turned product; and screw, nut, and bolt manufacturing	16.24
Employment services	11.98

Apprentices earn much less than experienced machinists, but earnings increase quickly as they improve their skills. Also most employers pay for apprentices' training classes.

Related Occupations

Occupations most closely related to that of machinist are other machining occupations, which include tool and die makers;

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16 Number	Change, 2006-16 Percent
Machinists	51-4041	397,000	384,000	-12,000	-3

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

machine setters, operators, and tenders—metal and plastic; and computer control programmers and operators. Maintenance machinists work closely with industrial machinery mechanics and maintenance workers.

Sources of Additional Information

For general information about a career in machining, contact:

➤ Precision Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141. Internet: **http://www.pmpa.org**

For a list of training centers and apprenticeship programs, contact:

➤ National Tooling and Machining Association, 9300 Livingston Rd., Fort Washington, MD 20744.

For more information on credential standards and apprenticeship, contact:

➤ The National Institute for Metalworking Skills, 10565 Fairfax Blvd., Suite 203, Fairfax, VA 22030.
Internet: **http://www.nims-skills.org/home/index.htm**

Information on the registered apprenticeship system with links to State apprenticeship programs may also be found on the U.S. Department of Labor's Web site: **http://www.doleta.gov/atels_bat** Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

Medical, Dental, and Ophthalmic Laboratory Technicians

(O*NET 51-9081.00, 51-9082.00, 51-9083.00)

Significant Points

- Around 55 percent of salaried jobs were in medical equipment and supply manufacturing laboratories, which usually are small, privately owned businesses with fewer than 5 employees.
- Most technicians learn their craft on the job, but many employers prefer to hire those with formal training.
- Slower-than-average employment growth is expected for dental and ophthalmic laboratory technicians, while average employment growth is expected for medical appliance technicians.
- Job opportunities should be favorable because few people seek these positions.

Nature of the Work

When patients require a medical device to help them see clearly, chew and speak well, or walk, their health care providers send requests to medical, dental, and ophthalmic laboratory technicians. These technicians produce a variety of implements to help patients.

Medical appliance technicians construct, fit, maintain, and repair braces, artificial limbs, joints, arch supports, and other surgical and medical appliances. They follow prescriptions or detailed instructions from podiatrists or orthotists, who request braces, supports, corrective shoes, or other devises; prosthetists, who order prostheses—replacement limbs, such as an arm, leg, hand, or foot—for patients who need them due to a birth defect, accident, or amputation; or other health care professionals. Medical appliance technicians who work with these types of devices are called orthotic and prosthetic technicians. Other medical appliance technicians work with appliances that help correct other medical problems, such as hearing aids.

Creating medical devices takes several steps. To make arch supports, for example, technicians first make a wax or plastic impression of the patient's foot. Then they bend and form a material so that it conforms to prescribed contours required to fabricate structural components. If a support is mainly required to correct the balance of a patient with legs of different lengths, a rigid material is used. If the support is primarily intended to protect those with arthritic or diabetic feet, a soft material is used. Supports and braces are polished with grinding and buffing wheels. Technicians may cover arch supports with felt to make them more comfortable.

For prostheses, technicians construct or receive a plaster cast of the patient's limb to use as a pattern. Then, they lay out parts and use precision measuring instruments to measure them. Technicians may use wood, plastic, metal, or other material for the parts of the artificial limb. Next, they carve, cut, or grind the material using hand or power tools. Then, they drill holes for rivets and glue, rivet, or weld the parts together. They are able to do very precise work using common tools. Next, technicians use grinding and buffing wheels to smooth and polish artificial limbs. Lastly, they may cover or pad the limbs with rubber, leather, felt, plastic, or another material. Also, technicians may mix pigments according to formulas to match the patient's skin color and apply the mixture to the artificial limb.

After fabrication, medical appliance technicians test devices for proper alignment, movement, and biomechanical stability using meters and alignment fixtures. They also may fit the appliance on the patient and adjust them as necessary. Over time the appliance will wear down, so technicians must repair and maintain the device. They also may service and repair the machinery used for the fabrication of orthotic and prosthetic devices.

Dental laboratory technicians fill prescriptions from dentists for crowns, bridges, dentures, and other dental prosthetics. First, dentists send a specification of the item to be manufactured, along with an impression or mold of the patient's mouth or teeth. With new technology, a technician may receive a digital impression rather than a physical mold. Then dental laboratory technicians, also called dental technicians, create a model of the patient's mouth by pouring plaster into the impression and allowing it to set. They place the model on an apparatus that mimics the bite and movement of the patient's jaw. The model serves as the basis of the prosthetic device. Technicians examine the model, noting the size and shape of the adjacent teeth, as well as gaps within the gumline. Based upon these observations and the dentist's specifications, technicians build and shape a wax tooth or teeth model, using small hand instruments called wax spatulas and wax carvers. The wax model is used to cast the metal framework for the prosthetic device.

After the wax tooth has been formed, dental technicians pour the cast and form the metal and, using small hand-held tools, prepare the surface to allow the metal and porcelain to bond. They then apply porcelain in layers, to arrive at the precise shape and color of a tooth. Technicians place the tooth in a porcelain furnace to bake the porcelain onto the metal framework, and then adjust the shape and color, with subsequent grinding and addition of porcelain to achieve a sealed finish. The final product is a nearly exact replica of the lost tooth or teeth.

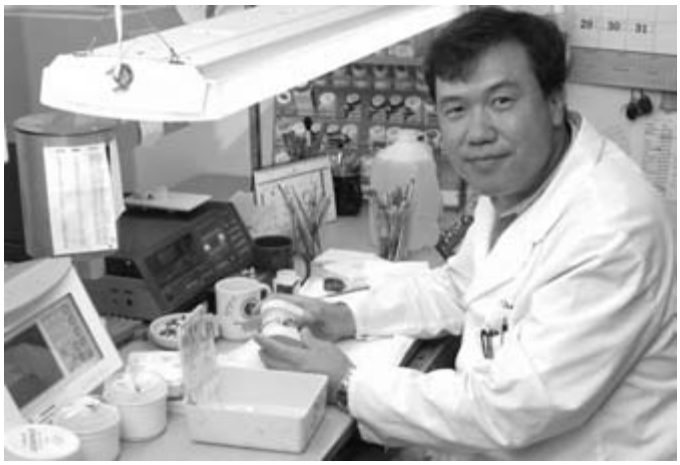
In some laboratories, technicians perform all stages of the work, whereas in other labs, each technician does only a few. Dental laboratory technicians can specialize in 1 of 5 areas: orthodontic appliances, crowns and bridges, complete dentures, partial dentures, or ceramics. Job titles can reflect specialization in these areas. For example, technicians who make porcelain and acrylic restorations are called *dental ceramists*.

Ophthalmic laboratory technicians—also known as manufacturing opticians, optical mechanics, or optical goods workers—make prescription eyeglass or contact lenses. Prescription lenses are curved in such a way that light is correctly focused onto the retina of the patient's eye, improving his or her vision. Some ophthalmic laboratory technicians manufacture lenses for other optical instruments, such as telescopes and binoculars. Ophthalmic laboratory technicians cut, grind, edge, and finish lenses according to specifications provided by dispensing opticians, optometrists, or ophthalmologists and may insert lenses into frames to produce finished glasses. Although some lenses still are produced by hand, technicians are increasingly using automated equipment to make lenses.

Ophthalmic laboratory technicians should not be confused with workers in other vision care occupations. Ophthalmologists and optometrists are "eye doctors" who examine eyes, diagnose and treat vision problems, and prescribe corrective lenses. Ophthalmologists are physicians who also perform eye surgery. Dispensing opticians, who also may do the work of ophthalmic laboratory technicians, help patients select frames and lenses, and adjust finished eyeglasses. (See the statement on physicians and surgeons, which includes ophthalmologists, as well as the statement on optometrists and opticians, dispensing, elsewhere in the *Handbook*.)

Ophthalmic laboratory technicians read prescription specifications, select standard glass or plastic lens blanks, and then mark them to indicate where the curves specified on the prescription should be ground. They place the lens in the lens grinder, set the dials for the prescribed curvature, and start the machine. After a minute or so, the lens is ready to be "finished" by a machine that rotates it against a fine abrasive, to grind it and smooth out rough edges. The lens is then placed in a polishing machine with an even finer abrasive, to polish it to a smooth, bright finish.

Next, the technician examines the lens through a lensometer, an instrument similar in shape to a microscope, to make sure that the degree and placement of the curve are correct. The technician then cuts the lenses and bevels the edges to fit the frame, dips each lens into dye if the prescription calls for tinted or coated lenses, polishes the edges, and assembles the lenses and frame parts into a finished pair of glasses.



Dental laboratory technicians create models of a patient's mouth, and use those models to create dental prosthetics such as dentures.

In small laboratories, technicians usually handle every phase of the operation. In large ones, in which virtually every phase of the operation is automated, technicians may be responsible for operating computerized equipment. Technicians also inspect the final product for quality and accuracy.

Work environment. Medical, dental, and ophthalmic laboratory technicians generally work in clean, well-lighted, and well-ventilated laboratories. They have limited contact with the public. Salaried laboratory technicians usually work 40 hours a week, but some work part time. At times, technicians wear goggles to protect their eyes, gloves to handle hot objects, or masks to avoid inhaling dust. They may spend a great deal of time standing.

Dental technicians usually have their own workbenches, which can be equipped with Bunsen burners, grinding and polishing equipment, and hand instruments, such as wax spatulas and wax carvers. Some dental technicians have computer-aided milling equipment to assist them with creating artificial teeth.

Training, Other Qualifications, and Advancement

Most medical, dental, and ophthalmic laboratory technicians learn their craft on the job; however, many employers prefer to hire those with formal training.

Education and training. High school students interested in becoming medical appliance technicians should take mathematics, metal and wood shop, and drafting. Medical appliance technicians usually begin as helpers and gradually learn new skills as they gain experience.

Formal training is also available. In 2006, there were four orthotic and prosthetic technician programs accredited by the National Commission on Orthotic and Prosthetic Education (NCOPE). These programs offer either an associate degree or a 1-year certificate for orthotic or prosthetic technicians. The programs instruct students on human anatomy and physiology, orthotic and prosthetic equipment and materials, and applied biomechanical principles to customize orthotics or prostheses. The programs also include clinical rotations to provide hands-on experience.

Dental laboratory technicians begin by learning simple tasks, such as pouring plaster into an impression, and progress to

more complex procedures, such as making porcelain crowns and bridges. Becoming a fully trained technician requires an average of 3 to 4 years, depending upon the individual's aptitude and ambition, but it may take a few years more to become an accomplished technician. High school students interested in becoming dental laboratory technicians should take courses in art, metal and wood shop, drafting, and sciences. Courses in management and business may help those wishing to operate their own laboratories.

Training in dental laboratory technology also is available through community and junior colleges, vocational-technical institutes, and the Armed Forces. Formal training programs vary greatly both in length and in the level of skill they impart. In 2006, 20 programs in dental laboratory technology were accredited by the Commission on Dental Accreditation in conjunction with the American Dental Association. These programs provide classroom instruction in dental materials science, oral anatomy, fabrication procedures, ethics, and related subjects. In addition, each student is given supervised practical experience in a school or an associated dental laboratory. Accredited programs normally take 2 years to complete and lead to an associate degree. A few programs take about 4 years to complete and offer a bachelor's degree in dental technology. Graduates of 2-year training programs need additional hands-on experience to become fully qualified.

Each dental laboratory owner operates in a different way, and classroom instruction does not necessarily expose students to techniques and procedures favored by individual laboratory owners. Students who have taken enough courses to learn the basics of the craft usually are considered good candidates for training, regardless of whether they have completed a formal program. Many employers will train someone without any classroom experience.

Ophthalmic laboratory technicians start on simple tasks if they are training to produce lenses by hand. They may begin with marking or blocking lenses for grinding; then, they progress to grinding, cutting, edging, and beveling lenses; finally, they are trained in assembling the eyeglasses. Depending on individual aptitude, it may take up to 6 months to become proficient in all phases of the work.

Employers filling trainee jobs prefer applicants who are high school graduates. Courses in science, mathematics, and computers are valuable; manual dexterity and the ability to do precision work are essential. Technicians using automated systems will find computer skills valuable.

A few ophthalmic laboratory technicians learn their trade in the Armed Forces or in the few programs in optical technology offered by vocational-technical institutes or trade schools. These programs have classes in optical theory, surfacing and lens finishing, and the reading and applying of prescriptions. Programs vary in length from 6 months to 1 year and award certificates or diplomas.

Other qualifications. A high degree of manual dexterity, good vision, and the ability to recognize very fine color shadings and variations in shape also are necessary for dental technicians. An artistic aptitude for detailed and precise work also is important.

Certification and advancement. Voluntary certification for orthotic and prosthetic technicians is available through the American Board for Certification in Orthotics and Prosthetics (ABC). Applicants are eligible for an exam after completing a program accredited by NCOPE or obtaining 2 years of experience as a technician under the direct supervision of an ABC-certified practitioner. After successfully passing the appropriate exam, technicians receive the Registered Orthotic Technician, Registered Prosthetic Technician, or Registered Prosthetic-Orthotic Technician credential. Certification may help those orthotic and prosthetic technicians seeking to advance.

With additional formal education, medical appliance technicians who make orthotics and prostheses can advance to become orthotists or prosthetists, technicians who work with patients who need braces, artificial limbs, or related devices and help to determine the specifications for those devices.

In large dental laboratories, dental technicians may become supervisors or managers. Experienced technicians may teach or take jobs with dental suppliers in such areas as product development, marketing, and sales. Opening one's own laboratory is another, and more common, way to advance and earn more.

The National Board for Certification, an independent board established by the National Association of Dental Laboratories, offers certification in dental laboratory technology. Certification, which is voluntary except in three states, can be obtained in five specialty areas: crowns and bridges, ceramics, partial dentures, complete dentures, and orthodontic appliances. Certification may increase chances of advancement.

Ophthalmic laboratory technicians can become supervisors and managers. Some become dispensing opticians, although further education or training generally is required in that occupation.

Employment

Medical, dental, and ophthalmic laboratory technicians held about 95,000 jobs in 2006. About 55 percent of salaried jobs were in medical equipment and supply manufacturing laboratories, which usually are small, privately owned businesses with fewer than 5 employees. However, some laboratories are large; a few employ more than 1,000 workers. The following tabulation shows employment by detailed occupation:

Dental laboratory technicians	53,000
Opthalmic laboratory technicians	29,000
Medical appliance technicians	12,000

In addition to manufacturing laboratories, many medical appliance technicians worked in health and personal care stores, while others worked in public and private hospitals, professional and commercial equipment and supplies merchant wholesalers, or consumer goods rental centers. Some were self-employed.

In addition to manufacturing laboratories, many dental laboratory technicians worked in offices of dentists. Some dental laboratory technicians open their own offices.

Most ophthalmic laboratory technician jobs were in medical equipment and supplies manufacturing laboratories, about 29 percent. Another 29 percent of jobs were in health and personal care stores, such as optical goods stores that manufacture and

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Medical, dental, and ophthalmic laboratory technicians	51-9080	95,000	100,000	5,000	5
Dental laboratory technicians	51-9081	53,000	55,000	2,000	4
Medical appliance technicians	51-9082	12,000	13,000	1,200	9
Ophthalmic laboratory technicians	51-9083	29,000	31,000	1,900	7

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

sell prescription glasses and contact lenses. Some jobs were in offices of optometrists or ophthalmologists, while others worked at professional and commercial equipment and supplies merchant wholesalers. A few worked in commercial and service industry machine manufacturing firms that produce lenses for other optical instruments, such as telescopes and binoculars.

Job Outlook

Overall, slower-than-average growth is expected for employment of medical, dental, and ophthalmic laboratory technicians. However, job opportunities should be favorable because few people seek these positions.

Employment change. Overall employment for these occupations is expected to grow five percent from 2006 to 2016, slower than the average for all occupations.

Medical appliance technicians will grow at nine percent, about as fast as the average for all occupations, because of the increasing prevalence of the two leading causes of limb loss—diabetes and cardiovascular disease. In addition, advances in technology may spur demand for prostheses that allow for greater movement.

Employment of dental laboratory technicians is expected to grow more slowly than average, at four percent. During the last few years, demand has arisen from an aging public that is growing increasingly interested in cosmetic prostheses. For example, many dental laboratories are filling orders for composite fillings that are the same shade of white as natural teeth to replace older, less attractive fillings. However, job growth for dental laboratory technicians will be limited. The overall dental health of the population has improved because of fluoridation of drinking water and greater emphasis on preventive dental care, which has reduced the incidence of dental cavities. As a result, full dentures will be less common, as most people will need only a bridge or crown.

Ophthalmic laboratory technicians are expected to experience employment growth of seven percent, about as fast as the average for all occupations. Demographic trends make it likely that many more Americans will need vision care in the years ahead. Not only will the population grow, but also the proportion of middle-aged and older adults is projected to increase rapidly. Middle age is a time when many people use corrective lenses for the first time, and elderly persons usually require more vision care than others. However, the increasing use of automated machinery will temper job growth for ophthalmic laboratory technicians.

Job prospects. Job opportunities for medical, dental, and ophthalmic laboratory technicians should be favorable, despite expected slower-than-average growth. Few people seek these jobs, reflecting the relatively limited public awareness and low starting wages. In addition to openings from job growth, many job openings also will arise from the need to replace technicians who transfer to other occupations or who leave the labor force.

Earnings

Median hourly earnings of wage-and-salary medical appliance technicians were $14.99 in May 2006. The middle 50 percent earned between $11.34 and $19.65 an hour. The lowest 10 percent earned less than $8.93, and the highest 10 percent earned more than $27.00 an hour

Median hourly earnings of wage-and-salary dental laboratory technicians were $15.67 in May 2006. The middle 50 percent earned between $11.61 and $20.57 an hour. The lowest 10 percent earned less than $9.16, and the highest 10 percent earned more than $26.13 an hour. In the two industries that employed the most dental laboratory technicians, medical equipment and supplies manufacturing and offices of dentists, median hourly earnings were $15.09 and $17.74, respectively.

Median hourly earnings of wage-and-salary ophthalmic laboratory technicians were $12.24 in May 2006. The middle 50 percent earned between $9.86 and $15.82 an hour. The lowest 10 percent earned less than $8.38, and the highest 10 percent earned more than $19.98 an hour. Median hourly earnings were $11.63 in medical equipment and supplies manufacturing and $11.49 in health and personal care stores, the two industries that employ the most ophthalmic laboratory technicians.

Related Occupations

Medical, dental, and ophthalmic laboratory technicians manufacture and work with the same devices that are used by dispensing opticians and orthotists and prosthetists. Other occupations that work with or manufacture goods using similar tools and skills are precision instrument and equipment repairers and textile, apparel, and furnishings occupations.

Sources of Additional Information

For information on careers in orthotics and prosthetics, contact:

➤ American Academy of Orthotists and Prosthetists, 526 King St., Suite 201, Alexandria, VA 22314.
Internet: **http://www.opcareers.org**

For a list of accredited programs for orthotic and prosthetic technicians, contact:

➤ National Commission on Orthotic and Prosthetic Education, 330 John Carlyle St., Suite 200, Alexandria, VA 22314.
Internet: **http://www.ncope.org**

For information on requirements for certification of orthotic and prosthetic technicians, contact:

➤ American Board for Certification in Orthotics and Prosthetics, 330 John Carlyle St., Suite 210, Alexandria, VA 22314. Internet: **http://www.abcop.org**

For a list of accredited programs in dental laboratory technology, contact:

➤ Commission on Dental Accreditation, American Dental Association, 211 E. Chicago Ave., Chicago, IL 60611. Internet: **http://www.ada.org**

For information on requirements for certification of dental laboratory technicians, contact:

➤ National Board for Certification in Dental Technology, 325 John Knox Rd., L103, Tallahassee, FL 32303. Internet: **http://www.nbccert.org**

For information on career opportunities in commercial dental laboratories, contact:

➤ National Association of Dental Laboratories, 325 John Knox Rd., L103, Tallahassee, FL 32303. Internet: **http://www.nadl.org**

For information on an accredited program in ophthalmic laboratory technology, contact:

➤ Commission on Opticianry Accreditation, P.O. Box 4342, Chapel Hill, NC 27515.

General information on grants and scholarships is available from individual schools. State employment service offices can provide information about job openings for medical, dental, and ophthalmic laboratory technicians.

Painting and Coating Workers, Except Construction and Maintenance

(O*NET 51-9121.00, 51-9122.00, 51-9123.00)

Significant Points

- About 7 out of 10 jobs are in manufacturing establishments.
- Most workers acquire their skills on the job; training usually lasts from a few days to several months, but becoming skilled in all aspects of painting can require 1 to 2 years of training.
- Overall employment is projected to decline, but employment change will vary by specialty.
- Good job prospects are expected for those with painting experience.

Nature of the Work

Millions of items ranging from cars to candy are covered by paint, plastic, varnish, chocolate, or some other type of coating solution. Painting or coating is used to make a product more attractive or protect it from the elements. The paint finish on an automobile, for example, makes the vehicle more attractive and provides protection from corrosion. Achieving this end result is the work of painting and coating workers.

Before painting and coating workers can begin to apply the paint or other coating, they often need to prepare the surface. A metal, wood, or plastic part may need to be sanded or ground to correct imperfections or rough up a surface so that paint will stick to it. After preparing the surface, the product is carefully cleaned to prevent any dust or dirt from becoming trapped under the paint. Metal parts are often washed or dipped in chemical baths to prepare the surface for painting and protect against corrosion. If the product has more than one color or has unpainted parts, masking is required. Masking normally involves carefully covering portions of the product with tape and paper.

After the product is prepared for painting, coating, or varnishing, a number of techniques may be used to apply the paint. Perhaps the most straightforward technique is simply dipping an item in a large vat of paint or other coating. This is the technique used by *dippers*, who immerse racks or baskets of articles in vats of paint, liquid plastic, or other solutions by means of a power hoist.

Spraying products with a solution of paint or some other coating is also quite common. *Spray machine operators* use spray guns to coat metal, wood, ceramic, fabric, paper, and food products with paint and other coating solutions. Following a formula, operators fill the machine's tanks with a mixture of paints or chemicals, adding prescribed amounts of solution. Then they adjust nozzles on the spray guns to obtain the proper dispersion of the spray, and they hold or position the guns so as to direct the spray onto the article. Operators also check the flow and viscosity of the paint or solution and visually inspect the quality of the coating. When products are drying, these workers often must regulate the temperature and air circulation in drying ovens.

Some factories use automated painting systems that are operated by *coating, painting, and spraying machine setters, operators, and tenders*. When setting up the systems, operators position the automatic spray guns, set the nozzles, and synchronize the action of the guns with the speed of the conveyor carrying articles through the machine and drying ovens. The operator also may add solvents or water to the paint vessel to prepare the paint for application. During the operation of the painting machines, these workers tend the equipment, observe gauges on the control panel, and check articles for evidence of any variation from specifications. The operator uses a manual spray gun to "touch up" flaws.

Powder coating is another common technique for painting manufactured goods. Powder coating machines achieve a smooth finish on metal objects. Workers oversee machines that electrically charge the metal object so that it acts like a magnet. The object enters a powder room filled with powdered paint that is attracted to the magnetic object. After being covered in the powder, the object is baked in an oven where the paint melts into a smooth paint finish.

Individuals who paint, coat, or decorate articles such as furniture, glass, pottery, toys, cakes, and books are known as *painting, coating, and decorating workers*. Some workers coat confectionery, bakery, and other food products with melted chocolate, cheese, oils, sugar, or other substances. Paper

is often coated to give it its gloss or finish and silver, tin, and copper solutions are often sprayed on glass to make mirrors.

The best known group of painting and coating workers are those who refinish old or damaged cars, trucks, and buses in automotive body repair and paint shops. *Transportation equipment painters*, also called *automotive painters*, who work in repair shops are among the most highly skilled manual spray operators because they perform intricate, detailed work and mix paints to match the original color, a task that is especially difficult if the color has faded. The preparation work on an old car is similar to painting other metal objects. The paint is normally applied with a manually controlled spray gun.

Transportation equipment painters who work on new cars oversee several automated steps. A modern car is first dipped in an anti-corrosion bath, then painted with the color of the car, and then painted in several coats of clear paint. The clear paint prevents scratches from damaging the colored paint on the car.

Most other transportation equipment painters either paint equipment too large to paint automatically—such as ships or giant construction equipment—or perform touch-up work to repair flaws in the paint caused either by damage during assembly or flaws during the automated painting process.

Whatever object is being painted and in whatever method, the painting process is often repeated several times to achieve a thick, smooth, protective coverage.

Work environment. Painting and coating workers typically work indoors and may be exposed to dangerous fumes from paint and coating solutions, although in general, workers' exposure to hazardous chemicals has decreased because of regulations limiting emissions of volatile organic compounds and other hazardous air pollutants. Painting usually is done in special ventilated booths with workers typically wearing masks or respirators that cover their noses and mouths. More sophisticated paint booths and fresh-air systems are increasingly used to provide a safer work environment.

Transportation equipment painters work in well-ventilated paint rooms.

Operators have to stand for long periods, and when using a spray gun, they may have to bend, stoop, or crouch in uncomfortable positions to reach different parts of the article. Some painters work suspended from ropes to reach high places.

Most painting and coating workers work a normal 40-hour week, but automotive painters in repair shops can work more than 50 hours a week, depending on the number of vehicles that need repainting.

Training, Other Qualifications, and Advancement

Most workers acquire their skills on the job; training usually lasts from a few days to several months, but becoming skilled in all aspects of painting can require 1 to 2 years of training.

Education and training. Training for beginning painting and coating machine setters, operators, and tenders and for painting, coating, and decorating workers, may last from a few days to a couple of months. Coating, painting, and spraying machine setters, operators, and tenders who modify the operation of computer-controlled equipment may require additional training in computer operations and minor programming. Most transportation equipment painters start as helpers and also gain their skills informally on the job.

Becoming skilled in all aspects of painting usually requires 1 to 2 years of on-the-job training and sometimes requires some formal classroom instruction. Beginning helpers usually remove trim, clean, and sand surfaces to be painted; mask surfaces they do not want painted; and polish finished work. As helpers gain experience, they progress to more complicated tasks, such as mixing paint to achieve a good match and using spray guns to apply primer coats or final coats to small areas.

Additional instruction in safety, equipment, and techniques is offered at some community colleges and vocational or technical schools. Some automotive painters are sent to technical schools to learn the intricacies of mixing and applying different types of paint. Such programs can improve employment prospects and speed promotion. Employers also sponsor training programs to help their workers become more productive. Additional training is available from manufacturers of chemicals, paints, or equipment, explaining their products and giving tips about techniques.

Other qualifications. Painting and coating workers in factories need to be able to read and follow detailed plans or blueprints. Some workers also need artistic talent to paint furniture, decorate cakes, or make sure that the paint on a car or other object is the right color. Applicants should be able to breathe comfortably wearing a respirator.

Certification and advancement. Voluntary certification by the National Institute for Automotive Service Excellence (ASE) is recognized as the standard of achievement for automotive painters. For certification, painters must pass a written examination and have at least 2 years of experience in the field. High school, trade or vocational school, or community or junior college training in automotive refinishing that meets ASE standards may substitute for up to 1 year of experience. To retain the certification, painters must retake the examination at least every 5 years.

Experienced painting and coating workers with leadership ability may become team leaders or supervisors. Many become paint and coating inspectors. Those who get practical experience or formal training may become sales or technical representatives for chemical or paint companies. Some automotive painters eventually open their own shops.

Employment

Painting and coating workers held about 192,000 jobs in 2006. Coating, painting, and spraying machine setters, operators, and tenders accounted for about 106,000 jobs, while transportation equipment painters constituted about 54,000. Another 31,000 jobs were held by painting, coating, and decorating workers.

Approximately 7 out of 10 wage-and-salary workers were employed by manufacturing establishments, particularly those that manufacture fabricated metal products, transportation equipment, industrial machines, household and office furniture, and plastic, wood, and paper products. Outside of manufacturing, workers were employed by independent automotive repair shops and by motor vehicle dealers. Less than 4 percent were self-employed.

Job Outlook

Overall employment of painting and coating workers is expected to decline slowly, but employment change will vary by specialty. Good job prospects are expected for those with painting experience.

Employment change. Overall employment of painting and coating workers is expected to decline slowly by 4 percent from 2006 to 2016. Declining employment is expected because better spraying and coating machines and techniques allow fewer workers to produce the same amount of work. But employment change will vary by specialty.

Employment of coating, painting, and spraying machine setters, operators, and tenders is expected to decline 13 percent as improvements in the automation of paint and coating applications raise worker productivity, allowing fewer workers to accomplish the same work. For example, operators will be able to coat goods more rapidly as sophisticated industrial machinery moves and aims spray guns more efficiently.

Employment of transportation equipment painters is projected to grow 8 percent. Many transportation equipment painters work in autobody repair and the need for these workers is expected to increase as the number of cars on the road goes up. Growth in the ship building industry is expected to create additional openings for those who paint ships.

Painting, coating, and decorating workers are projected to grow 4 percent. Growth will be driven by growing employment in retail operations. In manufacturing, competition from imports and automation should reduce employment. However, the specialized skills required by these workers should limit job losses from automation.

Job prospects. Like many manufacturing occupations, employers report difficulty finding qualified workers. Opportunities should be good for those with painting experience. Excellent opportunities will exist for experienced painters in the oil and gas industry and the ship building industry over the next decade.

Earnings

Median hourly earnings of wage-and-salary coating, painting, and spraying machine setters, operators, and tenders were $12.90 in May 2006. The middle 50 percent earned between $10.34 and $16.28 an hour. The lowest 10 percent earned less than $8.67, and the highest 10 percent earned more than $19.87 an hour.

Median hourly earnings of wage-and-salary transportation equipment painters were $17.15 in May 2006. The middle 50 percent earned between $13.29 and $23.08 an hour. The lowest 10 percent earned less than $10.82, and the highest 10 percent earned more than $28.10 an hour. Median hourly earnings of transportation equipment painters were $17.15 in automotive repair and maintenance shops and $23.98 in motor vehicle manufacturing.

Median hourly earnings of wage-and-salary painting, coating, and decorating workers were $11.04 in May 2006. The middle 50 percent earned between $9.00 and $14.09 an hour. The lowest 10 percent earned less than $7.55, and the highest 10 percent earned more than $18.23 an hour.

Many automotive painters employed by motor vehicle dealers and independent automotive repair shops receive a commission based on the labor cost charged to the customer. Under this method, earnings depend largely on the amount of work a painter does and how fast it is completed. Employers frequently guarantee commissioned painters a minimum weekly salary. Helpers and trainees usually receive an hourly rate until they become sufficiently skilled to work on commission. Trucking companies, bus lines, and other organizations that repair and refinish their own vehicles usually pay by the hour.

Many painting and coating machine operators belong to unions, including the International Union of Painters and Allied Trades, the Sheet Metal Workers International Association,

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Painting workers	51-9120	192,000	184,000	-8,000	-4
Coating, painting, and spraying machine setters, operators, and tenders	51-9121	106,000	93,000	-14,000	-13
Painters, transportation equipment	51-9122	54,000	59,000	4,600	8
Painting, coating, and decorating workers	51-9123	31,000	32,000	1,100	4

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

the United Auto Workers, and the International Brotherhood of Teamsters. Most union operators work for manufacturers and large motor vehicle dealers.

Related Occupations

Other occupations similar to painting and coating workers include painters and paperhangers and machine setters, operators, and tenders—metal and plastic. Painters who work in auto body repair work closely with automotive body and related repairers.

Sources of Additional Information

For more details about work opportunities, contact local manufacturers, automotive body repair shops, motor vehicle dealers, vocational schools, locals of unions representing painting and coating workers, or the local offices of the State employment service. The State employment service also may be a source of information about training programs.

For a directory of certified automotive painting programs, contact:

➤ National Automotive Technician Education Foundation, 101 Blue Seal Dr., SE., Suite 101, Leesburg, VA 20175.
Internet: **http://www.natef.org**

Photographic Process Workers and Processing Machine Operators

(O*NET 51-9131.00, 51-9132.00)

Significant Points

- Most workers receive on-the-job training from their companies, manufacturers' representatives, and experienced workers.
- A rapid decline in employment is expected as digital photography becomes commonplace.
- Job opportunities will be best for individuals with experience using computers and digital technology.

Nature of the Work

Both amateur and professional photographers rely heavily on photographic process workers and processing machine operators to develop film, make prints or slides, and do related tasks, such as enlarging or retouching photographs. *Photographic processing machine operators* operate various machines, such as mounting presses and motion picture film printing, photographic printing, and film developing machines. *Photographic process workers* perform more delicate tasks, such as retouching photographic negatives, prints, and images to emphasize or correct specific features.

Processing machine operators who work with digital images first load the raw images onto a computer, either directly from the camera or, more commonly, from a storage device such as a flash card or CD. Most processing of the images is done automatically by software, but images may also be reviewed manually by the operator, who then selects the images the customer wants printed and the quantity. Some digital processors also upload images onto a Web site so that the customer can view them from a home computer and share them with others.

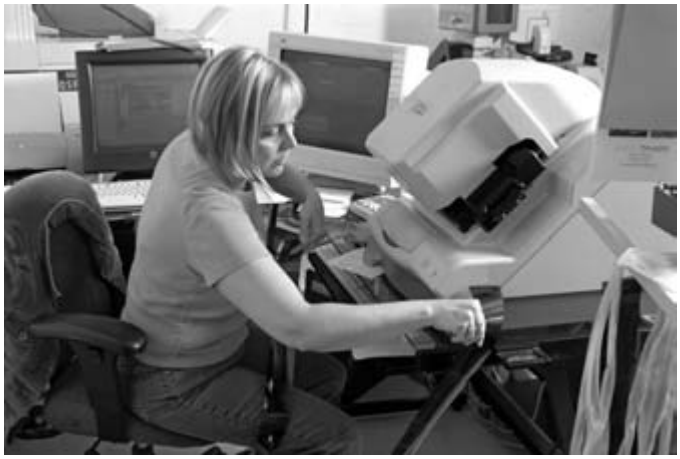
Photographic processing machine operators often have specialized jobs. *Film process technicians* operate machines that develop exposed photographic film or sensitized paper in a series of chemical and water baths to produce negative or positive images. First, technicians mix developing and fixing solutions, following a formula. They then load the film in the machine, which immerses the exposed film in the various solutions to bring out the image. Finally they rinse it in water to remove the chemicals. The technician then dries the film. In some cases, these steps are performed by hand.

Color printer operators control equipment that produces color prints from negatives. These workers read customer instructions to determine processing requirements. They load film into color printing equipment, examine negatives to determine equipment control settings, set controls, and produce a specified number of prints. Finally, they inspect the finished prints for defects, remove any that are found, and insert the processed negatives and prints into an envelope for return to the customer.

Photographic process workers, sometimes known as *digital imaging technicians*, use computer images of conventional negatives and specialized computer software to vary the contrast of images, remove unwanted background, or combine features from different photographs.

Although computers and digital technology are replacing much manual work, some photographic process workers, especially those who work in portrait studios, still perform many specialized tasks by hand directly on the photo or negative. *Airbrush artists* restore damaged and faded photographs, and may color or shade drawings to create photographic likenesses using an airbrush. *Photographic retouchers* alter photographic negatives, prints, or images to accentuate the subject. *Colorists* apply oil colors to portrait photographs to create natural, lifelike appearances. *Photographic spotters* remove imperfections on photographic prints and images.

Work environment. Photographic process workers and processing machine operators generally work in clean, appropri-



A rapid decline in employment of photographic process workers and processing maching operators is expected as digital photography becomes commonplace.

ately lighted, well-ventilated, and air-conditioned offices, photofinishing laboratories, or one-hour minilabs. In recent years, more commercial photographic processing has been done on computers than in darkrooms, and this trend is expected to continue.

Some photographic process workers and processing machine operators are exposed to the chemicals and fumes associated with developing and printing. These workers must wear rubber gloves and aprons and take precautions against these hazards. Those who use computers for extended periods may experience back pain, eyestrain, or fatigue.

Photographic processing machine operators must do repetitive work accurately and at a rapid pace. Photographic process workers do detailed tasks, such as airbrushing and spotting, which can contribute to eye fatigue.

Training, Other Qualifications, and Advancement

Most photographic process workers and processing machine operators receive on-the-job training from their companies, manufacturers' representatives, and experienced workers. New employees gradually learn to use the machines and chemicals that develop and print film and the computer techniques to process and print digital images.

Education and training. Employers prefer applicants who are high school graduates or who have some experience in the field. Familiarity with computers is essential for photographic processing machine operators. The ability to perform simple mathematical calculations also is helpful.

Photography courses that include instruction in film processing are valuable preparation. Such courses are available through high schools, vocational-technical institutes, private trade schools, and colleges and universities; some colleges offer degrees in photographic technology.

On-the-job training in photographic processing occupations can range from just a few hours for print machine operators to several months for photographic processing workers such as airbrush artists and colorists. Some workers attend periodic training seminars to maintain a high level of skill. With much of the processing and editing work now being done on computers, employees must continually learn new programs as they become available.

Other qualifications. Manual dexterity, good hand-eye coordination, and good vision, including normal color perception, are important qualifications for photographic process workers.

Advancement. Photographic process machine workers can sometimes advance from jobs as machine operators to supervisory positions in laboratories or to management positions within retail stores.

Employment

Photographic process workers held about 24,000 jobs in 2006. Photographic processing machine operators held about 49,000 jobs in 2006.

About 20 percent of photographic process workers were employed in photographic services. An additional 13 percent were employed by electronic and appliance stores and drug stores, and 14 percent worked in the publishing, internet services, and motion picture industries.

About 70 percent of photographic processing machine operators worked in retail establishments, primarily in general merchandise stores and drug stores Small numbers were employed in the printing industry and in portrait studios and commercial laboratories that process the work of professional photographers.

Job Outlook

A rapid decline in employment is expected for photographic process workers and processing machine operators through the year 2016. Job opportunities will be best for individuals with experience using computers and digital technology.

Employment change. Employment of photographic process workers and processing machine operators is expected to decline rapidly by 45 percent over the 2006-16 decade. Digital cameras, which use electronic memory rather than film to record images, have in recent years become standard among professional photographers. They are rapidly gaining in popularity among amateur photographers as well as the cost of these cameras continues to fall. This will continue to reduce the demand for traditional photographic processing machine operators. However, while many digital camera owners will choose to print their own pictures with their own equipment, a growing number of casual photographers are choosing not to acquire the needed equipment and skills to print the photos themselves. For them, self-service machines and online ordering services will be able to meet most of the demand, but there will still be some demand for professionals to print digital photos and operate the machines, as well as to develop and print photos from those who continue to use film cameras.

Digital photography also will reduce demand for photographic process workers. Using digital cameras and technology, consumers who have a personal computer and the proper software are able to download and view pictures on their computer, as well as to manipulate, correct, and retouch their own photographs. No matter what improvements occur in camera technology, though, some photographic processing tasks will still require skillful manual treatment.

Job prospects. Job opportunities will be best for individuals with experience using computers and digital technology. Em-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Photographic process workers and processing machine operators	51-9130	73,000	40,000	-33,000	-45
Photographic process workers	51-9131	24,000	15,000	-8,600	-36
Photographic processing machine operators	51-9132	49,000	25,000	-25,000	-50

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

ployment fluctuates somewhat over the course of the year, typically peaking during school graduation and summer vacation periods.

Earnings

Earnings of photographic process workers vary greatly depending on skill level, experience, and geographic location. Median hourly earnings for photographic process workers were $11.19 in May 2006. The middle 50 percent earned between $8.61 and $15.12. The lowest 10 percent earned less than $7.32, and the highest 10 percent earned more than $21.43. Median hourly earnings were $11.65 in photographic services.

Median hourly earning for photographic processing machine operators were $9.38 in May 2006. The middle 50 percent earned between $8.01 and $11.44. The lowest 10 percent earned less than $7.16, and the highest 10 percent earned more than $14.92. Median hourly earnings in the two industries employing the largest numbers of photographic processing machine operators were $9.58 in photographic services and $8.50 in health and personal care stores.

Related Occupations

Photographic process workers and processing machine operators need specialized knowledge of the photo developing process. Other workers who apply specialized technical knowledge include clinical laboratory technologists and technicians, computer operators, jewelers and precious stone and metal workers, prepress technicians and workers, printing machine operators, and science technicians.

Sources of Additional Information

For information about employment opportunities in photographic laboratories and schools that offer degrees in photographic technology, contact:

➤ Photo Marketing Association International, 3000 Picture Place, Jackson, MI 49201. Internet: **http://www.pmai.org**

Power Plant Operators, Distributors, and Dispatchers

(O*NET 51-8011.00, 51-8012.00, 51-8013.00)

Significant Points

- Job prospects are expected to be good as many workers retire and new plants are built.
- Most entry-level workers start as helpers or laborers, and several years of training and experience are required to become fully qualified.
- Familiarity with computers and a basic understanding of science and math is helpful for those entering the field.

Nature of the Work

Electricity is vital for most everyday activities. From the moment you flip the first switch each morning, you are connecting to a huge network of people, electric lines, and generating equipment. Power plant operators control the machinery that generates electricity. Power plant distributors and dispatchers control the flow of electricity from the power plant, over a network of transmission lines, to industrial plants and substations, and, finally, over distribution lines to residential users.

Power plant operators control and monitor boilers, turbines, generators, and auxiliary equipment in power-generating plants. Operators distribute power demands among generators, combine the current from several generators, and monitor instruments to maintain voltage and regulate electricity flows from the plant. When power requirements change, these workers start or stop generators and connect or disconnect them from circuits. They often use computers to keep records of switching operations and loads on generators, lines, and transformers. Operators also may use computers to prepare reports of unusual incidents, malfunctioning equipment, or maintenance performed during their shift.

Operators in plants with automated control systems work mainly in a central control room and usually are called *control room operators* or *control room operator trainees* or *assistants*. In older plants, the controls for the equipment are not centralized; *switchboard operators* control the flow of electricity from a central point, while *auxiliary equipment operators* work throughout the plant, operating and monitoring valves, switches, and gauges.

In nuclear power plants, most operators start working as *equipment operators* or *auxiliary operators*. They help the more senior workers with equipment maintenance and operation while learning the basics of plant operation. With experience and training they may be licensed by the Nuclear Regulatory Commission as *reactor operators* and authorized to control equipment that affects the power of the reactor in a nuclear power plant. *Senior reactor operators* supervise the operation of all controls in the control room. At least one senior operator must be on duty during each shift to act as the plant supervisor.

Power distributors and dispatchers, also called *load dispatchers* or *systems operators*, control the flow of electricity through transmission lines to industrial plants and substations that supply residential needs for electricity. They monitor and operate current converters, voltage transformers, and circuit breakers. Dispatchers also monitor other distribution equipment and record readings at a pilot board—a map of the transmission grid system showing the status of transmission circuits and connections with substations and industrial plants.

Dispatchers also anticipate power needs, such as those caused by changes in the weather. They call control room operators to start or stop boilers and generators, in order to bring production into balance with needs. Dispatchers handle emergencies such as transformer or transmission line failures and route current around affected areas. In substations, they also operate and monitor equipment that increases or decreases voltage, and they operate switchboard levers to control the flow of electricity in and out of the substations.

Work environment. Operators, distributors, and dispatchers who work in control rooms generally sit or stand at a control station. This work is not physically strenuous, but it does require constant attention. Operators who work outside the con-

Power plant operators spent most of their time monitoring systems for problems.

trol room may be exposed to danger from electric shock, falls, and burns.

Nuclear power plant operators are subject to random drug and alcohol tests, as are most workers at such plants. Additionally, they have to pass a medical examination every two years and may be exposed to small amounts of ionizing radiation as part of their jobs.

Because electricity is provided around the clock, operators, distributors, and dispatchers usually work one of three 8-hour shifts or one of two 12-hour shifts on a rotating basis. Shift assignments may change periodically, so that all operators share less desirable shifts. Work on rotating shifts can be stressful and fatiguing because of the constant change in living and sleeping patterns.

Training, Other Qualifications, and Advancement

Power plant operators, dispatchers, and distributors generally need a combination of education, on-the-job training, and experience. Candidates with strong computer and technical skills are generally preferred.

Education and training. Employers often seek recent high school graduates for entry-level operator, distributor, and dispatcher positions. Workers with college or vocational school degrees will have more advancement opportunities, especially in nuclear power plants. Although it is not a prerequisite, many senior reactor operators have a bachelor's degree in engineering or the physical sciences.

Workers selected for training as power plant operators or distributors undergo extensive on-the-job and classroom instruction. Several years of training and experience are required for a worker to become a fully qualified control room operator or power plant distributor.

In addition to receiving initial training to become fully qualified as a power plant operator, distributor, or dispatcher, most workers are given periodic refresher training—especially the nuclear power plant operators. Refresher training usually is taken on plant simulators designed specifically to replicate procedures and situations that might be encountered at the trainee's plant.

Licensure. Power plant operators, distributors, and dispatchers may need licenses depending on jurisdiction and specific job function. Requirements vary greatly from place to place and may be administered by State, county, or local governments.

Extensive training and experience are necessary to pass the Nuclear Regulatory Commission (NRC) examinations required for nuclear reactor operators and senior nuclear reactor operators. Before beginning training, a nuclear power plant worker must have 3 years of power plant experience. At least 6 months of this must be on-site at the nuclear power plant where the operator is to be licensed. Training generally takes at least 1 year, after which the worker must take an NRC-administered examination. To maintain their licenses, reactor operators must pass an annual practical plant operation exam and a biennial written exam administered by their employers. Reactor operators can upgrade their licenses to the senior reactor operator level after a year of licensed experience at the plant by taking another examination given by the NRC. Training may include simulator and on-the-job training, classroom instruction, and individual study. Experience in other power plants or with Navy nuclear propulsion plants also is helpful.

Advancement. Most entry-level workers start as helpers or laborers and advance to more responsible positions as they become comfortable in the plant. In many cases, there are mandatory waiting times between starting a position and advancing to the next level due to licensing requirements. With sufficient training and experience, workers can become shift supervisors or, in nuclear power plants, senior reactor operators.

Because power plants have different systems and safety mechanisms, it is often very difficult to advance by changing companies or plants. Most utilities promote from within; most workers advance within a particular plant or by moving to another plant owned by the same utility.

Employment

Power plant operators, distributors, and dispatchers held about 47,000 jobs in 2006, of which 3,800 were nuclear power plant operators, 8,600 were power distributors and dispatchers, and 35,000 were other power plant operators. Jobs were located throughout the country. About 70 percent of jobs were in electric power generation, transmission, and distribution. About 16 percent worked in government, mainly in local government. Others worked for manufacturing establishments that produced electricity for their own use.

Job Outlook

Employment of power plant operators, distributors, and dispatchers is projected to experience little or no employment change, but job opportunities are expected to be very good due to the large number of retiring workers who must be replaced, increased demand for energy, and recent legislation which paves the way for a number of new plants.

Employment change. Between 2006 and 2016, employment of power plant operators, distributors, and dispatchers is projected to experience little or no employment change, growing by about 2 percent. Electric utilities are expected to build new power plants in response to the Energy Policy Act of 2005, which provides a number of subsidies. Growth will be tempered by a continued emphasis on cost reduction and automation. Although new power plants will require fewer workers than their older counterparts, the machinery in the new plants

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16 Number	Change, 2006-16 Percent
Power plant operators, distributors, and dispatchers	51-8010	47,000	48,000	900	2
Nuclear power reactor operators	51-8011	3,800	4,200	400	11
Power distributors and dispatchers	51-8012	8,600	8,200	-400	-5
Power plant operators	51-8013	35,000	36,000	900	3

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

will be more technologically complex and environmental regulations will require much closer attention to emissions, so workers will be required to have higher skill levels.

Job prospects. Job opportunities are expected to be very good for people who are interested in becoming power plant operators, distributors, and dispatchers. During the 1990s, the emphasis on cost cutting among utilities led to hiring freezes and the laying off of younger workers. The result is an aging workforce, half of which is expected to retire within the next 10 years. Utilities have responded by setting up new education programs at community colleges and high schools throughout the country. Prospects should be especially good for people with computer skills and a basic understanding of science and mathematics.

Earnings

Median annual earnings of power plant operators were $55,000 in May 2006. The middle 50 percent earned between $45,110 and $65,460. The lowest 10 percent earned less than $35,590, and the highest 10 percent earned more than $75,240.

Median annual earnings of nuclear power reactor operators were $69,370 in May 2006. The middle 50 percent earned between $61,590 and $78,150. The lowest 10 percent earned less than $54,180, and the highest 10 percent earned more than $92,240.

Median annual earnings of power distributors and dispatchers were $62,590 in May 2006. The middle 50 percent earned between $52,510 and $73,920. The lowest 10 percent earned less than $42,370, and the highest 10 percent earned more than $85,740.

Related Occupations

Other workers who monitor and operate plant and system equipment include chemical plant and system operators; petroleum pump system operators, refinery operators, and gaugers; stationary engineers and boiler operators; and water and liquid waste treatment plant and system operators.

Sources of Additional Information

For information about employment opportunities, contact local electric utility companies, local unions, and State employment service offices.

For general information about power plant operators, nuclear power reactor operators, and power plant distributors and dispatchers, contact:

➤ American Public Power Association, 2301 M St.NW., Washington, DC 20037-1484.
Internet: **http://www.appanet.org**

➤ International Brotherhood of Electrical Workers, 1125 15th St.NW., Washington, DC 20005.
Internet: **http://www.ibew.org**

➤ National Association of Power Engineers, Inc., 1 Springfield St., Chicopee, MA 01013.

Information on licensing for nuclear reactor operators and senior reactor operators is available from:

➤ Nuclear Regulatory Commission, Washington, DC 20555-0001. Internet: **http://www.nrc.gov**

Prepress Technicians and Workers

(O*NET 51-5021.00, 51-5022.00)

Significant Points

- Most prepress technician jobs now require formal postsecondary graphic communications training in the various types of computer software used in digital imaging.
- Employment is projected to decline rapidly as the increased use of computers in typesetting and page layout requires fewer prepress technicians.

Nature of the Work

The printing process has three stages: prepress, press, and binding or finishing. While workers in small print shops are usually responsible for all three stages, in most printing firms, formatting print jobs and correcting layout errors before the job goes to print is the responsibility of a specialized group of workers. *Prepress technicians and workers* are responsible for this prepress work. They perform a variety of tasks to help transform text and pictures into finished pages and prepare the pages for print.

Prepress technicians receive images from in-house graphic designers or directly from customers and see the job through the process of preparing print-ready pages to create a finished printing plate. Printing plates are thin sheets of metal that carry the final image to be printed. Printing presses use this plate to copy the image to the printed products we see every day. Once a printing plate has been created, prepress technicians collaborate with printing machine operators to check for any potential printing problems. Several plates may be needed if a job requires color, but advanced printing technology does not require plates.

For a long time, prepress workers used a photographic process to make printing plates. This is a complex process involving ultraviolet light and chemical exposure through which the text and images of a print job harden on a metal plate and become water repellent. These hard, water repellent portions of the metal plate are in the form of the text and images that will be printed on paper. More recently, the printing industry has largely moved to technology known as "direct-to-plate", by which the prepress technicians send the data directly to a plating system, by-passing the need for the photographic technique.

The direct-to-plate technique is just one example of digital imaging technology that has largely replaced cold type print technology. Prepress technicians known as "preflight technicians" or production coordinators are using digital imaging technology to complete more and more print jobs. Using this technology, technicians take electronic files received from customers and check them for completeness. They then format the jobs using electronic page layout software in order to fit the pages to dimensions of the paper stock to be used. When color printing is required, the technicians produce an electronic image of the printed pages and then print a copy, or "proof," of the pages as they will appear when printed. The technician then has the proofs delivered or mailed to the customer for a final check. Once the customer approves the proofs, technicians use laser "imagesetters" to expose digital images of the pages directly onto the thin metal printing plates.

Advances in computer software and printing technology continue to change prepress work. Today, customers of print shops often use their own computers to do much of the typesetting and page layout work formerly done by prepress technicians. This process, called "desktop publishing," provides printers with pages of material that look like the desired finished product. This work is usually done by desktop publishers or graphic designers with knowledge of publishing software. (Sections on desktop publishers and graphic designers appear elsewhere in the *Handbook*.) As a result, prepress workers often receive files from customers on a computer disk or via e-mail that contain typeset material already laid out in pages. Other more advanced technologies now allow prepress technicians to send printing files directly to the printer and skip the plate-making process altogether. Despite the shortcuts that technological advancements allow, workers still need to understand the basic processes behind prepress, press, and finishing operations. Some workers, known as *job printers*, perform prepress and print operations. Job printers often are found in small establishments where work combines several job skills.

Work environment. Prepress technicians and workers usually work in clean, air-conditioned areas with little noise. Some workers may develop eyestrain from working in front of a video display terminal or other minor problems, such as backaches. Those platemakers who still work with toxic chemicals face the hazard of skin irritations. Workers are often subject to stress and the pressures of deadlines and tight work schedules.

Prepress employees usually work an 8-hour day. Some workers—particularly those employed by newspapers—work night shifts. Weekend and holiday work may be required, particularly when a print job is behind schedule. Part-time prepress technicians made up 12 percent of this occupation in 2006.

Prepress technicians and workers increasingly use direct-to-plate technologies that eliminate direct contact with ink and chemicals.

Training, Other Qualifications, and Advancement

Employers prefer workers with formal training in printing or publishing. Familiarity with the printing process, including the technology used, and attention to detail are the qualities that employers will seek most in job applicants.

Education and training. Many employers consider the best candidates for prepress jobs to be individuals with a combination of work experience in the printing industry and formal training in the new digital technology. The experience of these applicants provides them with an understanding of how printing plants operate and demonstrates their interest in advancing within the industry.

Traditionally, prepress technicians and workers started as helpers and were trained on the job. Some of these jobs required years of experience performing detailed manual work to become skillful enough to perform the most difficult tasks. Today, however, employers expect workers to have some formal postsecondary graphic communications training in the various types of computer software used in digital imaging and will train workers on the job as needed.

For beginners, 2-year associate degree programs offered by community colleges, junior colleges, and technical schools teach the latest prepress skills and allow students to practice applying them. There are also 4-year bachelor's degree programs in graphic design aimed primarily at students who plan to move into management positions in printing or design. For workers who do not wish to enroll in a degree program, prepress-related courses are offered at many community colleges, junior colleges, 4-year colleges and universities, vocational-technical institutes, and private trade and technical schools. Workers with experience in other printing jobs can take a few college-level graphic communications courses to upgrade their skills and qualify for prepress jobs.

Other qualifications. Employers prefer workers with good communication skills, both oral and written. When prepress

problems arise, prepress technicians and workers should be able to deal courteously with customers to resolve them. Also, in small shops, they may take customer orders. Persons interested in working for firms using advanced printing technology need to be comfortable with electronics and computers. At times, prepress personnel may have to perform computations in order to estimate job costs or operate many of the electronics used to run modern equipment.

Prepress technicians and workers need manual dexterity and accurate eyesight. Good color vision helps workers find mistakes and locate potential problems. It is essential for prepress workers to be able to pay attention to detail and work independently. Artistic ability is often a plus. Employers also seek persons who are comfortable with the pressures of meeting deadlines, using new software, and operating new equipment.

Advancement. Employers may send experienced technicians to industry-sponsored update and retraining programs to develop new skills or hone current ones. This kind of prepress training is sometimes offered in-house or through unions in the printing industry.

Employment

Prepress technicians and workers overall held about 119,000 jobs in 2006. Most prepress jobs are found in the printing industry, while newspaper publishing employs the second largest number of prepress technicians and workers.

The printing and publishing industries are two of the most geographically dispersed in the United States. While prepress jobs are found throughout the country, large numbers are concentrated in large printing centers such as Chicago, Los Angeles–Long Beach, New York City, Minneapolis–St. Paul, Philadelphia, Boston, and Washington, DC.

Job Outlook

Employment of prepress technicians and workers is projected to decline rapidly through 2016, because of improvements in printing technology that require fewer of these workers. Despite this, job prospects are good for prepress technicians with good computer and customer service skills.

Employment change. Overall employment of prepress technicians and workers is expected to decline by 16 percent over the 2006-2016 period. Demand for printed material should continue to grow, spurred by rising levels of personal income, increasing school enrollments, higher levels of educational attainment, and expanding markets. But the use of computers and publishing software—often by the clients of the printing company—will result in rising productivity of prepress technicians, and thus halting the creation of new jobs.

Computer software now allows office workers at a desktop computer terminal to specify text typeface and style and to format pages. This development shifts traditional prepress functions away from printing plants into advertising and public relations agencies, graphic design firms, and large corporations. As page layout and graphic design capabilities of computer software have become less expensive and more user-friendly, many companies are turning to in-house desktop publishing. Some firms also are finding it less costly to prepare their own newsletters and other reports. At newspapers, writers and editors also are doing more composition using publishing software. This rapid growth in the use of desktop publishing software has eliminated most prepress typesetting and composition technician jobs associated with the older printing technologies. In addition, new technology is increasing the amount of automation that printing companies can employ, which leaves less work for prepress workers. The duties of prepress workers will likely begin to merge with those of other printing industry workers—such as those of customer service representatives—which will also curb prepress job growth.

Job prospects. Despite a decline in the number of new prepress positions, opportunities will be favorable for workers with strong computer and customer service skills, such as preflight technicians who electronically check materials prepared by clients and adapt them for printing.

In order to compete in the desktop publishing environment, commercial printing companies are adding desktop publishing and electronic prepress work to the list of services they provide. Electronic prepress technicians, digital proofers, platemakers, and graphic designers are using new equipment and ever-improving software to design and lay out publications and complete their printing more quickly. The increasing range of services offered by printing companies using new digital technologies mean that opportunities in prepress work will be best for those with computer backgrounds who have completed postsecondary programs in printing technology or graphic communications. Workers with this background will be better able to adapt to the continuing evolution of publishing and printing technology.

Earnings

While wage rates for prepress technicians and workers depend on basic factors such as employer, education, and location, the median hourly earnings of prepress technicians and workers were $16.01 in May 2006, compared to $13.16 per hour for all production occupations. The middle 50 percent earned between $11.98 and $20.69 an hour. The lowest 10 percent earned less than $9.37, and the highest 10 percent earned more than $25.71 an hour. Median hourly earnings in printing and related sup-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Prepress technicians and workers	—	119,000	100,000	-19,000	-16
Job printers	51-5021	48,000	44,000	-4,500	-9
Prepress technicians and workers	51-5022	71,000	56,000	-15,000	-21

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

port activities, the industry employing the largest number of prepress technicians and workers, were $16.44 in May 2006, while workers in the newspaper, periodical, and book publishing industry earned $15.17 an hour.

For job printers, median hourly earnings were $15.58 in May 2006. The middle 50 percent earned between $12.15 and $19.83 an hour. The lowest 10 percent earned less than $9.56, and the highest 10 percent earned more than $24.70 an hour. Median hourly earnings in the industries employing the largest numbers of job printers May 2006 were $16.19 in the newspaper, periodical, and book publishing industry and $15.76 in printing and related support activities.

Related Occupations

Prepress technicians and workers use artistic skills in their work. These skills also are essential for artists and related workers, graphic designers, and desktop publishers. Moreover, many of the skills used in Web site design also are employed in prepress technology. Prepress technicians' work also is tied in closely with that of printing machine operators.

Sources of Additional Information

Details about training programs may be obtained from local employers such as newspapers and printing shops, or from local offices of the State employment service.

For information on careers and training in printing and the graphic arts, write to:

➤ Graphic Arts Education and Research Foundation, 1899 Preston White Dr., Reston, VA 20191-5468.
Internet: **http://www.makeyourmark.org**

➤ Graphic Communications Conference of the International Brotherhood of Teamsters, 1900 L St.NW., Washington, DC 20036-5007.

➤ Printing Industries of America/Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143-2324.

Printing Machine Operators

(O*NET 51-5023.00)

Significant Points

- Most printing machine operators are trained on the job.
- Retirements of older press operators are expected to create openings for skilled workers.
- Rising demand for customized print jobs will mean those skilled in digital printing operations will have the best job opportunities.

Nature of the Work

Printing machine operators, also known as press operators, prepare, operate, and maintain printing presses. Duties of printing machine operators vary according to the type of press they operate. Traditional printing methods, such as offset lithography, gravure, flexography, and letterpress, use a plate or roller that carries the final image that is to be printed and copies the image to paper. In addition to the traditional printing processes, plateless or nonimpact processes are coming into general use. Plateless processes—including digital, electrostatic, and ink-jet printing—are used for copying, duplicating, and document and specialty printing. Plateless processes usually are done by quick printing shops and smaller in-house printing shops, but increasingly are being used by commercial printers for short-run or customized printing jobs.

Machine operators' jobs differ from one shop to another because of differences in the types and sizes of presses. Small commercial shops can be operated by one person and tend to have relatively small presses, which print only one or two colors at a time. Large newspaper, magazine, and book printers use giant "in-line web" presses that require a crew of several press operators and press assistants.

After working with prepress technicians (who are covered in the *Handbook* statement on prepress technicians and workers) to identify and resolve any potential problems with a job, printing machine operators prepare machines for printing. To prepare presses, operators install the printing plate with the images to be printed and adjust the pressure at which the machine prints. Then they ink the presses, load paper, and adjust the press to the paper size. Operators ensure that paper and ink meet specifications, and adjust the flow of ink to the inking rollers accordingly. They then feed paper through the press cylinders and adjust feed and tension controls. New digital technology, in contrast, is able to automate much of this work.

While printing presses are running, printing machine operators monitor their operation and keep the paper feeders well stocked. They make adjustments to manage ink distribution, speed, and temperature in the drying chamber, if the press has one. If paper tears or jams and the press stops, which can happen with some offset presses, operators quickly correct the problem to minimize downtime. Similarly, operators working with other high-speed presses constantly look for problems, and when necessary make quick corrections to avoid expensive losses of paper and ink. Throughout the run, operators must regularly pull sheets to check for any printing imperfections. Most printers have, or will soon have, presses with

Printing machine operators execute production orders through an increasingly automated process.

computers and sophisticated instruments to control press operations, making it possible to complete printing jobs in less time. With this equipment, printing machine operators set up, monitor, and adjust the printing process on a control panel or computer monitor, which allows them to control the press electronically.

In most shops, machine operators also perform preventive maintenance. They oil and clean the presses and make minor repairs.

Work environment. Operating a press can be physically and mentally demanding, and sometimes tedious. Printing machine operators are on their feet most of the time. Often, operators work under pressure to meet deadlines. Most printing presses are capable of high printing speeds, and adjustments must be made quickly to avoid waste. Pressrooms are noisy, and workers in certain areas wear ear protection. Working with press machinery can be hazardous, but the threat of accidents has decreased with newer computerized presses that allow operators to make most adjustments from a control panel.

Many printing machine operators, particularly those who work for newspapers, work weekends, nights, and holidays as many presses operate continually. They also may work overtime to meet deadlines. The average operator worked 40 hours per week in 2006.

Training, Other Qualifications, and Advancement

Although employers prefer that beginners complete a formal apprenticeship or a postsecondary program in printing equipment operation, most printing machine operators are trained on the job. Attention to detail and familiarity with electronics and computers are essential for operators.

Education and training. Beginning printing machine operators load, unload, and clean presses. With time and training, they may become fully qualified to operate that type of press. Operators can gain experience on more than one kind of printing press during the course of their career.

Experienced operators will periodically receive retraining and skill updating. For example, printing plants that change from sheet-fed offset presses to digital presses have to retrain the entire press crew because skill requirements for the two types of presses are different.

Apprenticeships for printing machine operators, once the dominant method for preparing for this occupation, are becoming less prevalent. When they are offered by the employer, they include on-the-job instruction and some related classroom training or correspondence school courses.

Formal postsecondary programs in printing equipment operation offered by technical and trade schools, community colleges, and universities are growing in importance. Postsecondary courses in printing provide the theoretical and technical knowledge needed to operate advanced equipment that employers look for in an entry-level worker. Some postsecondary school programs require two years of study and award an associate degree.

Because of technical developments in the printing industry, courses in chemistry, electronics, color theory, and physics are helpful in secondary or postsecondary programs.

Other qualifications. Persons who wish to become printing machine operators need mechanical aptitude to make press adjustments and repairs. Workers need good vision and attention to detail to locate and fix problems with print jobs. Oral and written communication skills also are required. Operators should possess the mathematical skills necessary to compute percentages, weights, and measures, and to calculate the amount of ink and paper needed to do a job. Operators now also need basic computer skills to work with newer printing machines.

Certification and advancement. As printing machine operators gain experience, they may advance in pay and responsibility by working on a more complex printing press. For example, operators who have demonstrated their ability to work with a one-color sheet-fed press may be trained to operate a four-color sheet-fed press. Voluntarily earning a formal certification may also help advance a career in printing. An operator also may advance to pressroom supervisor and become responsible for an entire press crew. In addition, printing machine operators can draw on their knowledge of press operations to become cost estimators, providing estimates of printing jobs to potential customers.

Employment

Printing machine operators held about 198,000 jobs in 2006. Half of all operator jobs were in printing and related support activities. Paper manufacturers and newspaper publishers also were large employers. Additional jobs were in advertising agencies, employment services firms, and colleges and universities that do their own printing.

The printing and newspaper publishing industries are two of the most geographically dispersed in the United States. While printing machine operators can find jobs throughout the country, large numbers of jobs are concentrated in large printing centers such as Chicago, Los Angeles-Long Beach, New York, Minneapolis-St. Paul, Philadelphia, Boston, and Washington, DC.

Job Outlook

Employment of printing machine operators is projected to decline moderately through 2016, as newer printing presses require fewer operators. Despite this, job opportunities are expected to be favorable because a large number of these

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Printing machine operators	51-5023	198,000	186,000	-11,000	-6

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

workers are expected to retire over the next decade. The best opportunities will be available to skilled operators.

Employment change. Employment of printing machine operators is expected to decline moderately by six percent over the 2006-16 decade even as the output of printed materials is expected to increase. Employment will fall because of increasing automation in the printing industry and because of the outsourcing of some production to foreign countries.

Book and magazine circulation will increase as school enrollments rise and niche publications continue to enjoy success. Additional growth will also come from the increasing ability of the printing industry to profitably print smaller quantities, which should widen the market for printed materials as production costs decline.

Commercial printing will continue to be driven by increased expenditures for print advertising materials. New marketing techniques are leading advertisers to increase spending on messages targeted to specific audiences, and should continue to require the printing of a wide variety of catalogs, direct mail enclosures, newspaper inserts, and other kinds of print advertising.

However, employment will not grow at the same pace as output because increased use of new computerized printing equipment will require fewer operators. This will especially be true with the increasing automation of the large printing presses used in the newspaper industry. In addition, some companies are lowering their printing costs by having their work printed out of the country when it does not need to be completed quickly. New business practices within the publishing industry, such as printing-on-demand and electronic publishing, will reduce the size of print runs, further moderating output.

Job prospects. Opportunities for employment in printing machine operation should be favorable. Retirements of older printing machine operators and the need for workers trained on increasingly computerized printing equipment will create many job openings over the next decade. For example, small printing jobs will increasingly be run on sophisticated high-speed digital printing equipment that requires a complex set of operator skills, such as knowledge of database management software. Those who complete postsecondary training programs in printing and who are comfortable with computers will have the best employment opportunities.

Earnings

Median hourly earnings of printing machine operators were $14.90 in May 2006, as compared to $13.16 per hour for all production occupations. The middle 50 percent earned between $11.11 and $19.49 an hour. The lowest 10 percent earned less than $8.84, and the highest 10 percent earned more than $24.23 an hour. Median hourly earnings in the industries employing the largest numbers of printing machine operators in May 2006 were:

Newspaper, periodical, book, and directory publishers	$17.27
Converted paper product manufacturing	16.37
Printing and related support activities	15.55
Plastics product manufacturing	13.81
Advertising and related services	11.95

The basic wage rate for a printing machine operator depends on the geographic area in which the work is located and on the size and complexity of the printing press being operated.

Related Occupations

Other workers who set up and operate production machinery include machine setters, operators, and tenders—metal and plastic; bookbinders and bindery workers; and various precision machine operators.

Sources of Additional Information

Details about apprenticeships and other training opportunities may be obtained from local employers, such as newspapers and printing shops, local offices of the Graphic Communications Conference of the International Brotherhood of Teamsters, local affiliates of Printing Industries of America/Graphic Arts Technical Foundation, or local offices of the State employment service.

For general information about printing machine operators, contact:

➤ Graphic Communications Conference of the International Brotherhood of Teamsters, 1900 L St.NW., Washington, DC 20036-5007.

For information on careers and training in printing and the graphic arts contact:

➤ NPES The Association for Suppliers of Printing Publishing, and Converting Technologies, 1899 Preston White Dr., Reston, VA 20191-4367.
Internet: **http://www.npes.org/education/index.html**

➤ Printing Industry of America/Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143.

➤ Graphic Arts Education and Research Foundation, 1899 Preston White Dr., Reston, VA 20191-5468.
Internet: **http://www.makeyourmark.org**

Semiconductor Processors

(O*NET 51-9141.00)

Significant Points

- Employment is expected to decline over the next 10 years because of increasing automation and the building of many new plants abroad.
- Opportunities will be best for applicants who have an associate degree in a relevant subject.

Nature of the Work

Semiconductors are unique substances, which, under different conditions, can act as either conductors or insulators of electricity. Semiconductor processors turn one of these substances—silicon—into microchips, also known as integrated circuits. These microchips contain millions of tiny electronic components and are used in a wide range of products, from personal computers and cellular telephones to airplanes and missile guidance systems.

To manufacture microchips, *semiconductor processors* start with cylinders of silicon called ingots. First, the ingots are sliced into thin wafers. Using automated equipment, workers or robots polish the wafers, imprint precise microscopic patterns of the circuitry onto them using photolithography, etch out patterns with acids, and replace the patterns with conductors, such as aluminum or copper. The wafers then receive a chemical bath to make them smooth, and the imprint process begins again on a new layer with the next pattern. A complex chip may contain more than 20 layers of circuitry. Once the process is complete, wafers are then cut into individual chips, which are enclosed in a casing and shipped to equipment manufacturers.

The manufacturing and slicing of wafers to create semiconductors takes place in cleanrooms—production areas that are kept free of all airborne matter because the circuitry on a chip is so small that even microscopic particles can make it unusable. All semiconductor processors working in cleanrooms must wear special lightweight outer garments known as "bunny suits". These garments fit over clothing to prevent lint and other particles from contaminating the cleanroom.

There are two types of semiconductor processors: operators and technicians. *Operators* start and monitor the equipment that performs the various production tasks. They spend the majority of their time at computer terminals, monitoring the operation of equipment to ensure that each of the tasks in the production of the wafer is performed correctly. Operators may also transfer wafer carriers from one station to the next, though the lifting of heavy wafer carriers is done by robots in most new fabricating plants.

Technicians are generally more experienced workers who troubleshoot production problems and make equipment adjustments and repairs. They take the lead in assuring quality control and in maintaining equipment. They also test completed chips to make sure they work properly. To keep equipment repairs to a minimum, technicians perform diagnostic analyses and run computations. For example, technicians may determine if a flaw in a chip is due to contamination and peculiar to that wafer, or if the flaw is inherent in the manufacturing process.

Work environment. The work pace in cleanrooms is deliberately slow. Limited movement keeps the air in cleanrooms as free as possible of dust and other particles, which can destroy microchips during their production. Because the machinery sets the operators' rate of work, workers maintain a relaxed pace. Although workers spend some time alone monitoring equipment, operators and technicians spend much of their time working in teams.

Technicians are on their feet most of the day, walking through the cleanroom to oversee production activities. Operators spend a great deal of time sitting or standing at workstations, monitoring computer readouts and indicators.

The temperature in the cleanrooms must be kept within a narrow range and is generally comfortable for workers. Although bunny suits cover virtually the entire body, their lightweight fabric keeps the temperature inside fairly comfortable. Entry and exit of workers from the cleanroom are controlled to minimize contamination, and workers must be reclothed in a clean bunny suit and decontaminated each time they return to the cleanroom.

Semiconductor processors wear protective garments called "bunny suits" to avoid contaminating the chips they produce.

Several highly toxic chemicals are used at various points in the process of manufacturing microchips. Workers who are exposed to such chemicals can be seriously harmed. However, fabrication plants are designed with safeguards to ensure that these chemicals are handled, used, and disposed of without exposing workers or the surrounding environment. Toxic chemicals are applied to wafers by computer-controlled machine tools in sealed chambers, and there is normally little risk of workers coming into contact with them.

Semiconductor fabricating plants operate around the clock. Night and weekend work is common. In some plants, workers maintain standard 8-hour shifts, 5 days a week. In other plants, employees are on duty for 12-hour shifts to minimize the disruption of cleanroom operations brought about by changes. Managers may also allow workers to alternate schedules, thereby distributing the overnight shift equitably.

Training, Other Qualifications, and Advancement

People interested in becoming semiconductor processors—either operators or technicians—need strong technical skills, an ability to solve problems intuitively, and an ability to work in teams. Mathematics, including statistics, and physical science knowledge are also very useful. Communication skills and an understanding of manufacturing principles are also very important.

Education and training. For semiconductor processor jobs, employers prefer applicants who have completed an associate degree. However, experience plus completion of a 1-year certificate program in semiconductor technology, offered by some community colleges, may also be sufficient. Some semiconductor technology programs at community colleges include internships at semiconductor fabricating plants. Other applicants may qualify by completing a degree in high-tech manufacturing. Hands-on training is an important part of degree and certificate programs.

To ensure that operators and technicians keep their skills current, employers provide regular on-the-job training. Some employers also provide financial assistance to employees who want to earn an associate or bachelor's degree, especially if the employee is working toward becoming a technician.

Advancement. Workers advance as they become more comfortable with the equipment and better understand the manufac-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Semiconductor processors	51-9141	42,000	37,000	-5,500	-13

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

turing process. Employees train workers for several months, after which they become entry-level operators or technicians. After a few years, as they become more knowledgeable about the operations of the plant, they generally advance to the intermediate level. This entails greater responsibilities. Over time, usually 7 to 10 years, workers may become senior technicians, who lead teams of technicians and work directly with engineers to develop processes in the plant.

Employment

Semiconductor processors held approximately 42,000 jobs in 2006. Nearly all of them were employed in the computer and electronic product manufacturing industry.

Job Outlook

Employment of semiconductor processors is projected to decline through 2016. Opportunities will be best for those with a 2-year degree and experience working in high-tech manufacturing.

Employment change. Employment of semiconductor processors is projected to decline moderately, decreasing by 13 percent between 2006 and 2016. Although the demand for microchips is growing at a very rapid rate, employment levels in the industry will not increase over the next 10 years because of automation and the opening of fabricating plants in other countries. As the electrical components of chips become smaller, they become more sensitive. This means that chip manufacturers prefer precise robotics to human workers, who could potentially damage the chips. Additionally, there is a trend toward moving production to the areas where demand is most concentrated, thus, reducing the demand for U.S. exports of microchips. While this has not decreased U.S. production, fewer new plants are being constructed here.

Because of increased automation, most of the new positions created will be for technicians. While operator jobs will decline as older plants close and newer plants use more robotics, technician jobs will become more prevalent as the machinery becomes more complex and needs more monitoring. Technicians are responsible for understanding more of the fabrication process, so companies hiring new employees will expect a higher level of competency.

The demand for semiconductor chips remains very high, stemming from the many existing and future applications for semiconductors in computers, appliances, machinery, biotechnology, vehicles, cell phones, and other equipment.

Job prospects. Despite the decline in employment, some jobs will open up due to the need to replace workers who leave the occupation. Because specialized training is required to excel in this field, the number of openings is expected to remain in rough balance with the number of qualified job seekers. Prospects will be best for applicants with an associate degree and experience in high-tech manufacturing.

Earnings

Median annual earnings of wage-and-salary semiconductor processors were $32,860 in May 2006. The middle 50 percent earned between $26,680 and $40,620 an hour. The lowest 10 percent earned less than $21,700, and the top 10 percent earned more than $49,470 an hour.

Technicians with an associate degree in electronics or semiconductor technology generally start at higher salaries than those with less education.

Semiconductor processors generally received good benefits packages, including health care, disability plans and life insurance, stock options and retirement.

Related Occupations

Semiconductor processors do production work that resembles the work of precision assemblers and fabricators of other high-tech equipment. Also, many electronic semiconductor processors have academic training in semiconductor technology, which emphasizes scientific and engineering principles. Other occupations that require some college or postsecondary vocational training emphasizing such principles are engineering technicians, electrical engineers, and science technicians.

Sources of Additional Information

For more information on semiconductor processor careers, contact:

➤ Maricopa Advanced Technology Education Center, 2323 West 14th St., Suite 540, Tempe, AZ 85281.
Internet: **http://www.matec.org**

➤ **Semiconductor** Industry Association, 181 Metro Dr., Suite 450, San Jose., CA 95110. Internet: **http://www.sia-online.org**

Stationary Engineers and Boiler Operators

(O*NET 51-8021.00)

Significant Points

- Workers usually acquire their skills through a formal apprenticeship program or through on-the-job training supplemented by courses at a trade or technical school.
- Most workers need to be licensed, but licensing requirements vary across the Nation.
- Employment is projected to grow slowly, and applicants may face competition for jobs.
- Opportunities will be best for workers with training in computerized controls and instrumentation.

Nature of the Work

Most large office buildings, malls, warehouses, and other commercial facilities have extensive heating, ventilation, and air-conditioning systems that keep them comfortable all year long. Industrial plants often have additional facilities to provide electrical power, steam, or other services. Stationary engineers and boiler operators control and maintain these systems, which include boilers, air-conditioning and refrigeration equipment, diesel engines, turbines, generators, pumps, condensers, and compressors. The equipment that stationary engineers and boiler operators control is similar to equipment operated by locomotive or marine engineers, except that it is used to generate heat or electricity, rather than to move a train or ship.

Stationary engineers and boiler operators start up, regulate, repair, and shut down equipment. They ensure that the equipment operates safely, economically, and within established limits by monitoring meters, gauges, and computerized controls. Stationary engineers and boiler operators control equipment manually in many older buildings and, if necessary, make adjustments. They watch and listen to machinery and routinely check safety devices, identifying and correcting any trouble that develops.

In newer buildings, stationary engineers typically use computers to operate the mechanical, electrical, and fire safety systems. They monitor, adjust, and diagnose these systems from a central location, using a computer linked into the buildings' communications network.

Routine maintenance is a regular part of the work of stationary engineers and boiler operators. Engineers use hand and power tools to perform maintenance and repairs ranging from a complete overhaul to replacing defective valves, gaskets, or bearings. They lubricate moving parts, replace filters, and remove soot and corrosion that can reduce the boiler's operating efficiency. They also test the water in the boiler and add chemicals to prevent corrosion and harmful deposits. In most facilities, stationary engineers are responsible for the maintenance and balancing of air systems, as well as hydronic systems that heat or cool buildings by circulating fluid (such as water or water vapor) in a closed system of pipes. They may check the air quality of the ventilation system and make adjustments to keep the operation of the boiler within mandated guidelines. Servicing, troubleshooting, repairing, and monitoring modern systems all require the use of sophisticated electrical and electronic test equipment. Additionally, many stationary engineers perform other maintenance duties, such as carpentry, plumbing, locksmithing, and electrical repairs.

Stationary engineers and boiler operators keep a record of relevant events and facts concerning the operation and maintenance of the equipment. When working with steam boilers, for example, stationary engineers and boiler operators observe, control, and record steam pressure, temperature, water level, chemistry, power output, fuel consumption, and emissions from the boiler. They also note the date and nature of all maintenance and repairs.

In a large building or industrial plant, a senior stationary engineer may be in charge of all mechanical systems in the building and may supervise a team of assistant stationary engineers, turbine operators, boiler tenders, and air-conditioning and refrigeration operators and mechanics. In a small building or industrial plant, there may be only one stationary engineer.

Stationary engineers monitor boilers and make necessary adjustments and repairs.

Work environment. Engine rooms, power plants, boiler rooms, mechanical rooms, and electrical rooms are usually clean and well lighted. Even under the most favorable conditions, however, some stationary engineers and boiler operators are exposed to high temperatures, dust, dirt, and high noise levels from the equipment. Maintenance duties also may require contact with oil, grease, or smoke. Workers spend much of the time on their feet. They also may have to crawl inside boilers and work in crouching or kneeling positions to inspect, clean, or repair equipment.

Stationary engineers and boiler operators work around hazardous machinery, such as low- and high-pressure boilers and electrical equipment. They must follow procedures to guard against burns, electric shock, and noise, danger from moving parts, and exposure to hazardous materials, such as asbestos or toxic chemicals.

Stationary engineers and boiler operators generally have steady, year-round employment. The average workweek is 40 hours. In facilities that operate around the clock, engineers and operators usually work one of three daily 8-hour shifts on a rotating basis. Weekend and holiday work often is required.

Training, Other Qualifications, and Advancement

Many stationary engineers and boiler operators begin their careers in mechanic or helper positions and are trained on-the-job by more experienced engineers. Others begin by entering formal apprenticeships or training programs. After completing the required training, workers can become licensed, which allows them to work on boilers of a certain size without supervision.

Education and training. Most employers prefer to hire persons with at least a high school diploma or the equivalent for stationary engineers and boiler operator jobs. Workers primarily acquire their skills on the job and usually start as boiler ten-

ders or as helpers to more experienced workers. This practical experience may be supplemented by postsecondary vocational training in subjects such as computerized controls and instrumentation. Other workers complete formal apprenticeship programs. Becoming an engineer or operator without completing a formal apprenticeship program usually requires many years of work experience.

The International Union of Operating Engineers sponsors apprenticeship programs and is the principal union for stationary engineers and boiler operators. In selecting apprentices, most local labor-management apprenticeship committees prefer applicants with a basic understanding of mathematics, science, computers, mechanical drawing, machine shop practice, and chemistry. An apprenticeship usually lasts 4 years and includes 8,000 hours of on-the-job training. In addition, apprentices receive 600 hours of classroom instruction in subjects such as boiler design and operation, elementary physics, pneumatics, refrigeration, air-conditioning, electricity, and electronics.

Continuing education—such as vocational school or college courses—is becoming increasingly important for stationary engineers and boiler operators, in part because of the growing complexity of the equipment with which engineers and operators now work. In 2006, roughly half of all stationary engineers between the ages of 25 and 44 had at least some college coursework.

Most large and some small employers encourage and pay for skill-improvement training for their employees. These employers often realize major cost savings due to greater efficiency of their workers; improved maintenance, reliability, and effective lifespan of equipment; and a better safety record. Well-trained workers manage energy better, which can also greatly reduce an employer's energy costs. Training is almost always provided when new equipment is introduced or when regulations concerning some aspect of the workers' duties change.

Licensure. Most States and cities have licensing requirements for stationary engineers and boiler operators. Applicants for licensure usually must be at least 18 years of age, reside for a specified period in the State or locality in which they wish to work, meet experience requirements, and pass a written examination. A stationary engineer or boiler operator who moves from one State or city to another may have to pass an examination for a new license due to regional differences in licensing requirements.

There are several classes of stationary engineer licenses. Each class specifies the type and size of equipment the engineer is permitted to operate without supervision. A licensed first-class stationary engineer is qualified to run a large facility, supervise others, and operate equipment of all types and capacities. An applicant for this license may be required to have a high school education, have completed an apprenticeship or lengthy on-the-job training, and have several years of experience working with a lower class license. Licenses below first class limit the types or capacities of equipment the engineer may operate without supervision.

Other qualifications. In addition to training, stationary engineers and boiler operators need mechanical aptitude and manual dexterity. Being in good physical condition is also important.

Advancement. Stationary engineers and boiler operators advance by being placed in charge of larger, more powerful, or more varied equipment. Generally, engineers advance to these jobs as they obtain higher class licenses. Some stationary engineers and boiler operators advance to become boiler inspectors, chief plant engineers, building and plant superintendents, or building managers. A few obtain jobs as examining engineers or technical instructors.

Because most stationary engineering staffs are relatively small, workers may find it difficult to advance, especially within a company. Most high-level positions are held by experienced workers with seniority. Workers wishing to move up to these positions must often change employers or wait for older workers to retire before they can advance.

Employment

Stationary engineers and boiler operators held about 45,000 jobs in 2006. They worked throughout the country, generally in the more heavily populated areas in which large industrial and commercial establishments are located. Jobs were dispersed throughout a variety of industries. The majority of jobs were in State and local government, manufacturing, and hospitals.

Job Outlook

Employment in this occupation is expected to grow more slowly than the average through 2016. Applicants may face competition for jobs. Employment opportunities will be best for those with apprenticeship training and experience using computerized systems.

Employment change. Employment of stationary engineers and boiler operators is expected to grow by 3 percent between 2006 and 2016, which is more slowly than the average for all occupations. Continuing commercial and industrial development will increase the amount of equipment to be operated and maintained. However, automated systems and computerized controls are making newly installed equipment more efficient, thus reducing the number of jobs needed for its operation.

Job prospects. People interested in working as stationary engineers and boiler operators should expect to face competition for these relatively high-paying positions. Slow job growth coupled with the tendency of experienced workers to stay in a job for decades should continue to make openings scarce. While many workers will reach retirement age within the next decade, the number of workers who need to be replaced will be small relative to other occupations.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Stationary engineers and boiler operators	51-8021	45,000	47,000	1,600	3

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

Earnings

Median annual earnings of stationary engineers and boiler operators were $46,040 in May 2006. The middle 50 percent earned between $36,490 and $57,380. The lowest 10 percent earned less than $28,370, and the highest 10 percent earned more than $68,690.

Related Occupations

Workers who monitor and operate stationary machinery include chemical plant and system operators; gas plant operators; petroleum pump system operators, refinery operators, and gaugers; power plant operators, distributors, and dispatchers; and water and liquid waste treatment plant and system operators. Other workers who maintain the equipment and machinery in a building or plant are industrial machinery mechanics and maintenance workers, and millwrights.

Sources of Additional Information

Information about apprenticeships, vocational training, and work opportunities is available from State employment service offices, locals of the International Union of Operating Engineers, vocational schools, and State and local licensing agencies. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: (877) 282-5627.

Specific questions about this occupation should be addressed to:

➤ International Union of Operating Engineers, 1125 17th St. NW., Washington, DC 20036. Internet: **http://www.iuoe.org**

➤ National Association of Power Engineers, Inc., 1 Springfield St., Chicopee, MA 01013.
Internet: **http://www.powerengineers.com**

➤ Building Owners and Managers Institute International, 1521 Ritchie Hwy., Arnold, MD 21012.
Internet: **http://www.bomi-edu.org**

Textile, Apparel, and Furnishings Occupations

(O*NET 51-6011.00, 51-6021.00, 51-6031.00, 51-6041.00, 51-6042.00, 51-6051.00, 51-6052.00, 51-6061.00, 51-6062.00, 51-6063.00, 51-6064.00, 51-6091.00, 51-6092.00, 51-6093.00, 51-6099.99)

Significant Points

- Most workers learn through on-the-job training.
- This group ranks among the rapidly declining occupations because of increases in imports, offshore assembly, productivity gains from automation, and new fabrics that do not need as much processing.
- Earnings of most workers are low.

Nature of the Work

Textile, apparel, and furnishings workers produce fibers, cloth, and upholstery, and fashion them into a wide range of products that we use in our daily lives. Textiles are the basis of towels, bed linens, hosiery and socks, and nearly all clothing, but they also are a key ingredient in products ranging from roofing to tires. Jobs range from those that involve programming computers to those in which the worker operates large industrial machinery and to those that require substantial handwork.

Textile machine setters, operators, and tenders run machines that make textile products from fibers. The first step in manufacturing textiles is preparing the natural or synthetic fibers. *Extruding and forming machine operators, synthetic and glass fibers*, set up and operate machines that extrude or force liquid synthetic material such as rayon, fiberglass, or liquid polymers through small holes and draw out filaments. Other operators put natural fibers such as cotton, wool, flax, or hemp through carding and combing machines that clean and align them into short lengths collectively called "sliver." In making sliver, operators may combine different types of natural fibers and synthetics filaments to give the product a desired texture, durability, or other characteristic. *Textile winding, twisting, and drawing-out machine operators* take the sliver and draw out, twist, and wind it to produce yarn, taking care to repair any breaks.

Textile bleaching and dyeing machine operators control machines that wash, bleach, or dye either yarn or finished fabrics and other products. *Textile knitting and weaving machine operators* put the yarn on machines that weave, knit, loop, or tuft it into a product. Woven fabrics are used to make apparel and other goods, whereas some knitted products (such as hosiery) and tufted products (such as carpeting) emerge in near-finished form. Different types of machines are used for these processes, but operators perform similar tasks, repairing breaks in the yarn and monitoring the yarn supply while tending many machines at once. *Textile cutting machine operators* trim the fabric into various widths and lengths, depending on its intended use.

Apparel workers cut fabric and other materials and sew it into clothing and related products. Workers in a variety of occupations fall under the heading of apparel workers. *Tailors, dressmakers, and sewers* make custom clothing and alter and repair garments for individuals. However, workers in most apparel occupations are found in manufacturing, performing specialized tasks in the production of large numbers of garments that are shipped to retail establishments for sale.

Fabric and apparel patternmakers convert a clothing designer's original model of a garment into a pattern of separate parts that can be laid out on a length of fabric. After discussing the item with the designer, these skilled workers usually use a computer to outline the parts and draw in details to indicate the positions of pleats, buttonholes, and other features. (In the past, patternmakers laid out the parts on paper, using pencils and drafting instruments such as rulers.) Patternmakers then alter the size of the pieces in the pattern to produce garments of various sizes, and they may mark the fabric to show the best layout of pattern pieces to minimize waste of material.

Once an item's pattern has been made and marked, mass production of the garment begins. Cutters and trimmers take the patterns and cut out material, paying close attention to their work because mistakes are costly. Following the outline of the pattern, they place multiple layers of material on the cutting table and use an electric knife or other tools to cut out the various pieces of the garment; delicate materials may be cut by hand. In some companies, computer-controlled machines do the cutting.

Sewing machine operators join the parts of a garment together, reinforce seams, and attach buttons, hooks, zippers, and accessories to produce clothing. After the product is sewn, other workers remove lint and loose threads and inspect and package the garments.

Shoe and leather workers are employed either in manufacturing or in personal services. In shoe manufacturing, *shoe machine operators and tenders* operate a variety of specialized machines that perform cutting, joining, and finishing functions. In personal services, *shoe and leather workers and repairers* perform a variety of repairs and custom leatherwork for the general public. They construct, decorate, or repair shoes, belts, purses, saddles, luggage, and other leather products. They also may repair some products made of canvas or plastic. When making custom shoes or modifying existing footwear for people with foot problems or special needs, shoe and leather workers and repairers cut pieces of leather, shape them over a form shaped like a foot, and sew them together. They then attach soles and heels, using sewing machines or cement and nails. They also dye and polish the items, using a buffing wheel to produce a smooth surface and lustrous shine. When making luggage, they fasten leather to a frame and attach handles and other hardware. They also cut and secure linings inside the frames and sew or stamp designs onto the exterior of the luggage. In addition to performing all of the preceding steps, saddle makers often apply leather dyes and liquid topcoats to produce a glossy finish on a saddle. They also may decorate the surface of the saddle by hand stitching or by stamping the leather with decorative patterns and designs. Shoe and leather workers and repairers who own their own shops keep records and supervise other workers.

Upholsterers make, fix, and restore furniture that is covered with fabric. Using hammers and tack pullers, upholsterers who restore furniture remove old fabric and stuffing to get down to the springs and wooden frame. Then they reglue loose sections of the frame and refinish exposed wood. The springs sit on a cloth mat, called webbing, that is attached to the frame. Upholsterers replace torn webbing, examine the springs, and replace broken or bent ones.

Upholsterers who make new furniture start with a bare wooden frame. First, they install webbing, tacking it to one side of the frame, stretching it tight, and tacking it to the other side. Then, they tie each spring to the webbing and to its neighboring springs. Next, they cover the springs with filler, such as foam, a polyester batt, or similar fibrous batting material, to form a smooth, rounded surface. Then they measure and cut fabric for the arms, backs, seats, sides, and other surfaces, leaving as little waste as possible. Finally, sewing the fabric pieces together and attaching them to the frame with tacks, staples, or glue, they affix any ornaments, such as fringes, buttons, or rivets. Sometimes, upholsterers provide pickup and delivery of the furniture they work on. They also help customers select new coverings by providing samples of fabrics and pictures of finished pieces.

Laundry and drycleaning workers clean cloth garments, linens, draperies, blankets, and other articles. They also may clean leather, suede, furs, and rugs. When necessary, they treat spots and stains on articles before laundering or drycleaning. They tend machines during cleaning and ensure that items are not lost or misplaced with those of another customer. *Pressers, textile, garment, and related materials*, shape and remove wrinkles from items after steam pressing them or ironing them by hand. Workers then assemble each customer's items, box or bag them, and prepare an itemized bill for the customer.

Work environment. Most people in textile, apparel, and furnishings occupations work a standard 5-day, 35- to 40-hour week. Working on evenings and weekends is common for shoe and leather workers, laundry and drycleaning workers, and tailors, dressmakers, and sewers employed in retail stores. Many textile and fiber mills often use rotating schedules of shifts so that employees do not continuously work nights or days. But these rotating shifts sometimes cause workers to have sleep disorders and stress-related problems.

Although much of the work in apparel manufacturing still is based on a piecework system that allows for little interpersonal contact, some apparel firms are placing more emphasis on teamwork and cooperation. Under this new system, individuals work closely with one another, and each team or module often governs itself, increasing the overall responsibility of each operator.

Working conditions vary by establishment and by occupation. In manufacturing, machinery in textile mills is often noisy, as are areas in which sewing and pressing are performed in apparel factories; patternmaking and spreading areas tend to be much quieter. Many older factories are cluttered, hot, and poorly lit and ventilated, but more modern facilities usually have more workspace and are well lit and ventilated. Textile machinery operators use protective glasses and masks that cover their noses and mouths to protect against airborne particles. Many machines operate at high speeds, and textile machinery workers must be careful not to wear clothing or jewelry that could get caught in moving parts. In addition, extruding and forming machine operators wear protective shoes and clothing when working with certain chemical compounds.

Work in apparel production can be physically demanding. Some workers sit for long periods, and others spend many hours on their feet, leaning over tables and operating machinery. Operators must be attentive while running sewing machines, pressers, automated cutters, and the like. A few workers wear protective devices such as gloves. In some instances, new machinery and production techniques have decreased the physical demands on workers. For example, newer pressing machines

Textile machine setters, operators, and tenders tend machines that weave yarn into apparel.

are controlled by foot pedals or by computer and do not require much strength to operate.

Laundries and drycleaning establishments are often hot and noisy. Employees also may be exposed to harsh solvents, but newer environmentally-friendly and less toxic cleaning solvents are improving the work environment in these establishments. Areas in which shoe and leather workers make or repair shoes and other leather items can be noisy, and odors from leather dyes and stains frequently are present. Workers need to pay close attention when working with machines, to avoid punctures, lacerations, and abrasions.

Upholstery work is not dangerous, but upholsterers usually wear protective gloves and clothing when using sharp tools and lifting and handling furniture or springs. During most of the workday, upholsterers stand and may do a lot of bending and heavy lifting. They also may work in awkward positions for short periods.

Training, Other Qualifications, and Advancement

A high school diploma is sufficient for most jobs in textile, apparel, and furnishings occupations. Most people learn their jobs by working alongside more experienced workers.

Education and training. Most workers in these jobs have a high school diploma or less education. However, applicants with postsecondary vocational training or previous work experience may have a better chance of getting a more skilled job and advancing to a supervisory position.

Machine operators usually are trained on the job by more experienced employees or by machinery manufacturers' representatives. Operators begin with simple tasks and are assigned more difficult operations as they gain experience.

Precision shoe and leather workers and repairers generally also learn their skills on the job. Manual dexterity and the mechanical aptitude to work with handtools and machines are important in shoe repair and leatherworking. Shoe and leather workers who produce custom goods should have artistic ability as well. Beginners start as helpers for experienced workers, but, in manufacturing, they may attend more formal in-house training programs. Beginners gradually take on more tasks until they are fully qualified workers, a process that takes about 2 years in an apprenticeship program or as a helper in a shop. Other workers spend 6 months to a year in a vocational training program. Learning to make saddles takes longer. Shoe repairers need to keep their skills up to date to work with the rapidly changing footwear styles and materials. Some attend trade shows or specialized training seminars and workshops in custom shoemaking, shoe repair, and other leatherwork sponsored by associations.

Custom tailors, dressmakers, and sewers often have previous experience in apparel production, design, or alteration. Knowledge of fabrics, design, and construction is very important. Custom tailors sometimes learn these skills through courses in high school or a community college. Some experienced custom tailors open their own tailoring shop. Custom tailoring is a highly competitive field, however, and training in small-business operations can mean the difference between success and failure.

Laundry and dry cleaning workers usually learn on the job also. Although laundries and drycleaners prefer entrants with previous work experience, they routinely hire inexperienced workers.

Most upholsterers learn their skills on the job, but a few do so through apprenticeships. Inexperienced persons also may take training in basic upholstery in vocational schools and some community colleges. The length of training may vary from 6 weeks to 3 years. Upholsterers who work on custom-made pieces may train for 8 to 10 years.

Other qualifications. In manufacturing, textile and apparel workers need good hand-eye coordination, manual dexterity, physical stamina, and the ability to perform repetitive tasks for long periods. As machinery in the industry continues to become more complex, knowledge of the basics of computers and electronics will increasingly be an asset. In addition, the trends toward cross-training of operators and working in teams will increase the time needed to become fully trained on all machines and require interpersonal skills to work effectively with others.

Upholsterers should have manual dexterity, good coordination, and the strength needed to lift heavy furniture. An eye for detail, a flair for color, and the ability to use fabrics creatively also are helpful.

Advancement. Some production workers may become first-line supervisors, but most can advance only to more skilled operator jobs. Some in the shoemaking and leatherworking occupations begin as workers or repairers and advance to salaried supervisory and managerial positions. Some open their own shop. They are more likely to succeed if they understand business practices and management and offer good customer service in addition to their technical skills.

Upholsterers, too, can open their own shops. The upholstery business is highly competitive, however, so operating a shop successfully is difficult. Some experienced or highly skilled upholsterers may become supervisors or sample makers in large shops and factories.

Employment

Textile, apparel, and furnishings workers held 873,000 jobs in 2006. Employment in the detailed occupations that make up this group was distributed as follows:

Laundry and dry-cleaning workers	239,000
Sewing machine operators	233,000
Pressers, textile, garment, and related materials	77,000
Upholsterers	55,000
Tailors, dressmakers, and custom sewers	54,000
Textile winding, twisting, and drawing out machine setters, operators, and tenders	43,000
Textile knitting and weaving machine setters, operators, and tenders	40,000
Sewers, hand	23,000
Textile bleaching and dyeing machine operators and tenders	19,000
Textile cutting machine setters, operators, and tenders	19,000
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	18,000
Shoe and leather workers and repairers	16,000
Fabric and apparel patternmakers	9,200
Shoe machine operators and tenders	4,100
All other textile, apparel, and furnishings workers	24,000

Manufacturing jobs are concentrated in California, North Carolina, Georgia, New York, Texas, and South Carolina. Jobs in reupholstery, shoe repair and custom leatherwork, and laundry and drycleaning establishments are found in cities and towns throughout the Nation. Overall, about 12 percent of all workers in textile, apparel, and furnishings occupations were self-employed; however, about half of all tailors, dressmakers, and sewers and about a quarter of all upholsterers were self-employed.

Job Outlook

Overall employment of textile, apparel, and furnishings workers is expected to decline rapidly through 2016, but some openings will be created by the need to replace workers who leave the occupation.

Employment change. Employment in textile, apparel, and furnishing occupations is expected to decline by 11 percent between 2006 and 2016. Apparel workers have been among the most rapidly declining occupational groups in the economy. Increasing imports, the use of offshore assembly, and greater productivity through automation will contribute to additional job losses. Also, many new textiles require less production and processing.

Domestic production of apparel and textiles will continue to move abroad, and imports to the U.S. market are expected to increase. Fierce competition in the market for apparel will keep domestic apparel and textile firms under intense pressure to cut costs and produce more with fewer workers. Although the textile industry already is highly automated, it will continue to seek to increase worker productivity through the introduction of labor-saving machinery and the invention of new fibers and fabrics that reduce production costs. Technological developments, such as computer-aided marking and grading, computer-controlled cutters, semiautomatic sewing and pressing machines, and automated material-handling systems have increased output while reducing the need for some workers in larger firms.

Despite advances in technology, the apparel industry has had difficulty employing automated equipment for many assembly tasks because of the delicate properties of many textiles. Also, the industry produces a wide variety of apparel items that change frequently with changes in style and season. Even so, increasing numbers of sewing machine operator jobs are expected to be lost to low-wage workers abroad.

Outside of the manufacturing sector, tailors, dressmakers, and sewers—the most skilled apparel workers—are expected to experience little to no change in employment. Most of these workers are self-employed or work in clothing stores. The demand for custom home furnishings and tailored clothes is diminishing in general, but remains steady in upscale stores and by certain clients. Designer apparel and other handmade goods also appeal to people looking for one-of-a-kind items.

Employment of shoe and leather workers is expected to decline rapidly through 2016 as a result of growing imports of less expensive shoes and leather goods and of increasing productivity of U.S. manufacturers. Also, buying new shoes often is cheaper than repairing worn or damaged ones. However, declines might be offset somewhat as the population continues to age and more people need custom shoes for health reasons.

Employment of upholsterers is expected to decline moderately through 2016 as new furniture and automotive seats use more durable coverings and as manufacturing firms continue to

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Textile, apparel, and furnishings occupations	51-6000	873,000	777,000	-97,000	-11
Laundry and dry-cleaning workers	51-6011	239,000	262,000	23,000	10
Pressers, textile, garment, and related materials	51-6021	77,000	74,000	-3,400	-4
Sewing machine operators	51-6031	233,000	170,000	-63,000	-27
Shoe and leather workers	51-6040	20,000	17,000	-3,100	-16
Shoe and leather workers and repairers	51-6041	16,000	14,000	-1,600	-10
Shoe machine operators and tenders	51-6042	4,100	2,600	-1,500	-36
Tailors, dressmakers, and sewers	51-6050	77,000	76,000	-1,800	-2
Sewers, hand	51-6051	23,000	21,000	-2,900	-12
Tailors, dressmakers, and custom sewers	51-6052	54,000	55,000	1,000	2
Textile machine setters, operators, and tenders	51-6060	122,000	88,000	-34,000	-28
Textile bleaching and dyeing machine operators and tenders	51-6061	19,000	14,000	-5,900	-30
Textile cutting machine setters, operators, and tenders	51-6062	19,000	14,000	-5,100	-27
Textile knitting and weaving machine setters, operators, and tenders	51-6063	40,000	28,000	-12,000	-31
Textile winding, twisting, and drawing out machine setters, operators, and tenders	51-6064	43,000	33,000	-11,000	-24
Miscellaneous textile, apparel, and furnishings workers	51-6090	106,000	92,000	-14,000	-13
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	51-6091	18,000	15,000	-3,100	-18
Fabric and apparel patternmakers	51-6092	9,200	6,600	-2,600	-29
Upholsterers	51-6093	55,000	50,000	-4,900	-9
Textile, apparel, and furnishings workers, all other	51-6099	24,000	21,000	-3,600	-15

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

become more automated and efficient. Demand for the reupholstery of furniture also is expected to decline as the increasing manufacture of new, relatively inexpensive upholstered furniture causes many consumers simply to replace old, worn furniture. However, demand will continue to be steady for upholsterers who restore very valuable furniture. Most reupholstery work is labor intensive and not easily automated.

Job prospects. Even though the overall number of jobs in this occupation is decreasing, job openings do arise each year from the need to replace some of the many workers who transfer to other occupations, retire, or leave the occupation for other reasons.

Earnings

Earnings of textile, apparel, and furnishings workers vary by occupation. Because many production workers in apparel manufacturing are paid according to the number of acceptable pieces they produce, their total earnings depend on skill, speed, and accuracy. Workers covered by union contracts tend to have higher earnings. Median hourly earnings by occupation in May 2006 were as follows:

Fabric and apparel patternmakers	$15.74
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	13.78
Upholsterers	13.09
Textile knitting and weaving machine setters, operators, and tenders	11.68
Textile bleaching and dyeing machine operators and tenders	11.20
Textile winding, twisting, and drawing out machine setters, operators, and tenders	11.08
All other textile, apparel, and furnishings workers	11.03
Tailors, dressmakers, and custom sewers	11.01
Shoe machine operators and tenders	10.54
Textile cutting machine setters, operators, and tenders	10.39
Shoe and leather workers and repairers	9.83
Sewers, hand	9.79
Sewing machine operators	9.04
Laundry and dry-cleaning workers	8.58
Pressers, textile, garment, and related materials	8.56

Benefits vary by size of company and work that is done. Large employers typically offer all usual benefits. Apparel workers in retail trade also may receive a discount on their purchases from the company for which they work. In addition, some of the larger manufacturers operate company stores from which employees can purchase apparel products at significant discounts. Some small firms and drycleaning establishments, however, offer only limited benefits. Self-employed workers generally have to purchase their own insurance.

Related Occupations

Textile, apparel, and furnishings workers apply their knowledge of textiles and leathers to fashion products with the use of handtools and machinery. Others who produce products using handtools, machines, and their knowledge of the materials with which they work include assemblers and fabricators; food-processing workers; jewelers and precious stone and metal workers; and woodworkers.

Sources of Additional Information

Information about job opportunities in textile, apparel, and furnishings occupations is available from local employers and local offices of State employment services.

Tool and Die Makers

(O*NET 51-4111.00)

Significant Points

- Most tool and die makers need 4 or 5 years of classroom instruction and on-the-job training to become fully qualified.
- Employment is projected to decline because of strong foreign competition and advancements in automation.
- Despite the decline in employment, excellent job opportunities are expected.

Nature of the Work

Tool and die makers are among the most highly skilled workers in manufacturing. These workers produce and repair tools, dies, and special guiding and holding devices that enable machines to manufacture a variety of products we use daily—from clothing and furniture to heavy equipment and parts for aircraft.

Toolmakers craft precision tools and machines that are used to cut, shape, and form metal and other materials. They also produce jigs and fixtures—devices that hold metal while it is bored, stamped, or drilled—and gauges and other measuring devices. Die makers construct metal forms, called dies, that are used to shape metal in stamping and forging operations. They also make metal molds for diecasting and for molding plastics, ceramics, and composite materials. Some tool and die makers craft prototypes of parts, and then, working with engineers and designers, determine how best to manufacture the part. In addition to developing, designing, and producing new tools and dies, these workers also may repair worn or damaged tools, dies, gauges, jigs, and fixtures.

To perform these functions, tool and die makers employ many types of machine tools and precision measuring instruments. They also must be familiar with the machining properties, such as hardness and heat tolerance, of a wide variety of common metals, alloys, plastics, ceramics, and other composite materials. Tool and die makers are knowledgeable in machining operations, mathematics, and blueprint reading. In fact, tool and die makers often are considered highly specialized machinists. The main difference between tool and die makers and machinists is that machinists normally make a single part during the production process, while tool and die makers make many parts and assemble and adjust machines used in the production process. (See the section on machinists elsewhere in the *Handbook*.)

While many tools and dies are designed by engineers or tool designers, tool and die makers are also trained to design tools and often do. They may travel to a customer's plant to observe the operation and suggest ways in which a new tool could improve the manufacturing process.

Once a tool or die is designed, tool and die makers, working from blueprints, plan the sequence of operations necessary to manufacture the tool or die. They measure and mark the pieces of metal that will be cut to form parts of the final product. At this point, tool and die makers cut, drill, or bore the part as required, checking to ensure that the final product meets specifications. Finally, these workers assemble the parts and perform finishing jobs such as filing, grinding, and polishing surfaces. While manual machining has declined, it is still used for unique or low-quantity parts that are often required in building tools and dies.

Tool and die makers use computer-aided design (CAD) to develop products and parts. Specifications entered into computer programs can be used to electronically develop blueprints for the required tools and dies. Numerical tool and process control programmers use computer-aided design or computer-aided manufacturing (CAD/CAM) programs to convert electronic drawings into CAM-based computer programs that contain instructions for a sequence of cutting tool operations. (See the section on computer control programmers and operators elsewhere in the *Handbook*.) Once these programs are developed, computer numerically controlled (CNC) machines follow the set of instructions contained in the program to produce the part. Computer-controlled machine tool operators or machinists normally operate CNC machines, but tool and die makers are trained in both operating CNC machines and writing CNC programs, and they may perform either task. CNC programs are stored electronically for future use, saving time and increasing worker productivity.

After machining the parts, tool and die makers carefully check the accuracy of the parts using many tools, including coordinate measuring machines, which use sensor arms and software to compare the dimensions of the part to electronic blueprints. Next, they assemble the different parts into a functioning machine. They file, grind, shim, and adjust the different parts to properly fit them together. Finally, tool and die makers set up a test run using the tools or dies they have made to make sure that the manufactured parts meet specifications. If problems occur, they compensate by adjusting the tools or dies.

Work environment. Tool and die makers usually work in toolrooms that are normally quieter than typical manufacturing production floors because there are fewer machines running at once. Toolrooms also are generally kept clean and cool to minimize heat-related expansion of metal workpieces. To minimize the exposure of workers to moving parts, machines have guards and shields. Most computer-controlled machines are totally enclosed, minimizing workers' exposure to noise, dust, and the lubricants used to cool workpieces during machining. Tool and die makers also must follow safety rules and wear protective equipment, such as safety glasses to shield against bits of flying metal, earplugs to protect against noise, and gloves and masks to reduce exposure to hazardous lubricants and cleaners. These workers also need stamina because they often spend much of the day on their feet and may do moderately heavy lifting. Companies employing tool and die makers have traditionally operated only one shift per day. Overtime and weekend work are common, especially during peak production periods.

Tool and die makers use manual lathes to make custom parts or small batches of parts.

Training, Other Qualifications, and Advancement

It usually takes 4 or 5 years of classroom and paid on-the-job training to become a fully trained tool and die maker. Good math, problem-solving, and computer skills are important requirements for these workers.

Education and training. Most tool and die makers learn their trade through 4 or 5 years of education and training in formal apprenticeships or in other postsecondary programs offered at local community colleges or technical schools. These programs often include a mix of classroom instruction and paid hands-on experience. According to most employers, apprenticeship programs are the best way to learn all aspects of tool and die making. Most apprentices must have a high school diploma, GED, or equivalent, and high school mathematics and shop classes make it easier to get into an apprenticeship program.

Traditional apprenticeships usually require that the apprentice complete a specific number of work and classroom hours to complete the program, which typically takes 4 or 5 years. Some companies and State apprenticeship programs, however, are now shifting from time-based programs to competency-based programs. Under competency-based programs, apprentices can move ahead more quickly by passing a series of exams and demonstrating competency in a particular job skill.

While formal apprenticeship programs may be the best way to learn the job, many tool and die makers receive most of their formal classroom training from community and technical colleges while working for a company that often supports the employee's training goals and provides the needed on-the-job training less formally. These trainees often begin as machine operators and gradually take on more difficult assignments. Many machinists become tool and die makers.

During their training, tool and die maker trainees learn to operate milling machines, lathes, grinders, laser and water cutting machines, wire electrical discharge machines, and other machine tools. They also learn to use handtools for fitting and assembling gauges and other mechanical and metal-forming

equipment. In addition, they study metalworking processes, such as heat treating and plating. Classroom training usually consists of tool designing, tool programming, blueprint reading, and, if needed, mathematics courses, including algebra, geometry, trigonometry, and basic statistics. Tool and die makers must have good computer skills to work with CAD/CAM technology, CNC machine tools, and computerized measuring machines.

Even after completing a formal training program, tool and die makers still need years of experience to become highly skilled. Most specialize in making certain types of tools, molds, or dies.

Certification and other qualifications. State apprenticeship boards certify tool and die makers as journey workers after they have completed a licensed program. While a State certification is not necessary to work as a tool and die maker, it gives workers more flexibility in employment and is required by some employers. Apprentices usually must be at least 18 years old, in addition to having a high school education and high school mathematics classes.

Because tools and dies must meet strict specifications—precision to one ten-thousandth of an inch is common—the work of tool and die makers requires skill with precision measuring devices and a high degree of patience and attention to detail. Good eyesight is essential. People entering this occupation also should be mechanically inclined, able to work and solve problems independently, have strong mathematical skills, and be capable of doing work that requires concentration and physical effort. Tool and die makers who visit customers' plants need good interpersonal and sales skills.

Employers generally look for someone with a strong educational background as an indication that the person can more easily adapt to change, which is a constant in this occupation. As automation continues to change the way tools and dies are made, workers regularly need to update their skills to learn how to operate new equipment. Also, as materials such as alloys, ceramics, polymers, and plastics are increasingly used, tool and die makers need to learn new machining techniques to deal with the new materials.

Advancement. There are several ways for skilled workers to advance. Some move into supervisory and administrative positions in their firms or they may start their own shop. Others may take computer courses and become computer-controlled machine tool programmers. With a college degree, a tool and die maker can go into engineering or tool design.

Employment

Tool and die makers held about 101,000 jobs in 2006. Most worked in industries that manufacture metalworking machinery, transportation equipment such as motor vehicle parts, fabricated metal products, and plastics products. Although they are found throughout the country, jobs are most plentiful in the Midwest and the Northeast, where many of metalworking companies are located.

Job Outlook

Employment of tool and die makers is projected to decline rapidly. However, excellent job opportunities are expected as many employers report difficulty finding qualified applicants.

Employment change. Employment of tool and die makers is projected to decline rapidly by 10 percent over the 2006-16 decade because of strong foreign competition in manufacturing and advances in automation, including CNC machine tools and computer-aided design, that should improve worker productivity. On the other hand, tool and die makers play a key role in building and maintaining advanced automated manufacturing equipment, which makes them less susceptible to lay-offs than other less-skilled production workers. As firms invest in new equipment, modify production techniques, and implement product design changes more rapidly, they will continue to rely heavily on skilled tool and die makers for retooling.

Job prospects. Despite declining employment, excellent job opportunities are expected. Employers in certain parts of the country report difficulty attracting skilled workers and apprenticeship candidates with the necessary abilities to replace retiring workers and fill other openings. The number of workers receiving training in this occupation is expected to continue to be fewer than the number of openings created each year by tool and die makers who retire or transfer to other occupations. A major factor limiting the number of people entering the occupation is that many young people who have the educational and personal qualifications necessary to learn tool and die making usually prefer to attend college or do not wish to enter production occupations.

Earnings

Median hourly wage-and-salary earnings of tool and die makers were $21.29 in May 2006. The middle 50 percent earned between $17.29 and $26.77. The lowest 10 percent had earnings of less than $13.85, while the top 10 percent earned more than $32.41. Median hourly wage-and-salary earnings in the manufacturing industries employing the largest numbers of tool and die makers were as follows:

Motor vehicle parts manufacturing	$26.45
Plastics product manufacturing	20.79
Forging and stamping	20.24
Metalworking machinery manufacturing	20.08
Machine shops; turned product; and screw, nut, and bolt manufacturing	19.41

The pay of apprentices is tied to their skill level. As they gain more skills and reach specific levels of performance and experience, their pay increases.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Tool and die makers	51-4111	101,000	91,000	-9,700	-10

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

Related Occupations

The occupations most closely related to the work of tool and die makers are other machining occupations. These include machinists; computer control programmers and operators; and machine setters, operators, and tenders—metal and plastic. Another occupation that requires precision and skill in working with metal is welding, soldering, and brazing workers.

Like tool and die makers, assemblers and fabricators assemble and repair complex machinery. Millwrights and industrial machinery mechanics also repair and assemble manufacturing equipment. When measuring parts, tool and die makers use some of the same tools and equipment that inspectors, testers, sorters, samplers, and weighers use in their jobs.

Sources of Additional Information

For career information and to have inquiries on training and employment referred to member companies, contact:

➤ Precision Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141.
Internet: **http://www.pmpa.org**

For lists of schools and employers with tool and die apprenticeship and training programs, contact:

➤ National Tooling and Machining Association, 9300 Livingston Rd., Ft. Washington, MD 20744.
Internet: **http://www.ntma.org**

For information on careers, education and training, earnings, and apprenticeship opportunities in metalworking, contact:

➤ Precision Metalforming Association Educational Foundation, 6363 Oak Tree Blvd., Independence, OH 44131.
Internet: **http://www.pmaef.org**

➤ The National Institute for Metalworking Skills, 10565 Fairfax Boulevard, Suite 203, Fairfax, VA 22030.
Internet: **http://www.nims-skills.org**

Information on the registered apprenticeship system with links to State apprenticeship programs can be found on the U.S. Department of Labor's Web site: **http://www.doleta.gov/atels_bat** Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

Water and Liquid Waste Treatment Plant and System Operators

(O*NET 51-8031.00)

Significant Points

- Employment is concentrated in local government and private water, sewage, and other systems utilities.
- Because of a large number of upcoming retirements and the difficulty of filling these positions, job opportunities will be excellent.
- Completion of an associate degree or a 1-year certificate program increases an applicant's chances for employment and promotion.

Nature of the Work

Clean water is essential for everyday life. *Water treatment plant and system operators* treat water so that it is safe to drink. *Liquid waste treatment plant and system operators*, also known as wastewater treatment plant and system operators, remove harmful pollutants from domestic and industrial liquid waste so that it is safe to return to the environment.

Water is pumped from wells, rivers, streams, and reservoirs to water treatment plants, where it is treated and distributed to customers. Wastewater travels through customers' sewer pipes to wastewater treatment plants, where it is treated and either returned to streams, rivers, and oceans or reused for irrigation and landscaping. Operators in both types of plants control equipment and processes that remove or destroy harmful materials, chemicals, and microorganisms from the water. Operators also control pumps, valves, and other equipment that moves the water or wastewater through the various treatment processes, after which they dispose of the removed waste materials.

Operators read, interpret, and adjust meters and gauges to make sure that plant equipment and processes are working properly. Operators control chemical-feeding devices, take samples of the water or wastewater, perform chemical and biological laboratory analyses, and adjust the amounts of chemicals, such as chlorine, in the water. They employ a variety of instruments to sample and measure water quality, and they use common hand and power tools to make repairs to valves, pumps, and other equipment.

Water and wastewater treatment plant and system operators increasingly rely on computers to help monitor equipment, store the results of sampling, make process-control decisions, schedule and record maintenance activities, and produce reports. In some modern plants, operators also use computers to monitor automated systems and determine how to address problems.

Occasionally, operators must work during emergencies. A heavy rainstorm, for example, may cause large amounts of wastewater to flow into sewers, exceeding a plant's treatment capacity. Emergencies also can be caused by conditions inside a plant, such as chlorine gas leaks or oxygen deficiencies. To handle these conditions, operators are trained to make an emergency management response and use special safety equipment and procedures to protect public health and the facility. During these periods, operators may work under extreme pressure to correct problems as quickly as possible. Because working conditions may be dangerous, operators must be extremely cautious.

The specific duties of plant operators depend on the type and size of the plant. In smaller plants, one operator may control all of the machinery, perform tests, keep records, handle complaints, and perform repairs and maintenance. Operators in this type of plant may have to be on-call 24 hours a day in case of an emergency. In medium-sized plants, operators monitor the plant throughout the night by working in shifts. In large plants, operators may be more specialized and monitor only one process. They might work with chemists, engineers, laboratory technicians, mechanics, helpers, supervisors, and a superintendent.

Many water and liquid waste treatment plant and system operators work alone, managing small plants.

Water quality standards are largely set by two major Federal environmental statutes: the Safe Drinking Water Act, which specifies standards for drinking water, and the Clean Water Act, which regulates the discharge of pollutants. Industrial facilities that send their wastes to municipal treatment plants must meet certain minimum standards to ensure that the wastes have been adequately pretreated and will not damage municipal treatment facilities. Municipal water treatment plants also must meet stringent standards for drinking water. The list of contaminants regulated by these statutes has grown over time. As a result, plant operators must be familiar with the guidelines established by Federal regulations and how they affect their plant. In addition, operators must be aware of any guidelines imposed by the State or locality in which the plant operates.

Work environment. Water and wastewater treatment plant and system operators work both indoors and outdoors and may be exposed to noise from machinery and to unpleasant odors. Operators' work is physically demanding and often is performed in unclean locations; they must pay close attention to safety procedures because of the presence of hazardous conditions, such as slippery walkways, dangerous gases, and malfunctioning equipment.

Plants operate 24 hours a day, 7 days a week. In small plants, operators may work during the day and be on-call in the evening, nights and weekends. Medium and large plants that require constant monitoring may employ workers in three 8-hour shifts. Because larger plants require constant monitoring, weekend and holiday work is generally required. Operators may be required to work overtime.

Training, Other Qualifications, and Advancement

Employers usually hire high school graduates who are trained on-the-job, and later become licensed. Education after high school improves job prospects.

Education and training. A high school diploma usually is required for an individual to become a water or wastewater treatment plant operator. The completion of an associate degree or a 1-year certificate program in water quality and wastewater treatment technology increases an applicant's chances for employment and promotion because plants are becoming more complex. The majority of such programs are offered by trade associations, and can be found throughout the country. These programs provide a good general knowledge of water and wastewater treatment processes, as well as basic preparation for becoming an operator. In some cases, a degree or certificate program can be substituted for experience, allowing a worker to become licensed at a higher level more quickly.

Trainees usually start as attendants or operators-in-training and learn their skills on the job under the direction of an experienced operator. They learn by observing and doing routine tasks such as recording meter readings, taking samples of wastewater and sludge, and performing simple maintenance and repair work on pumps, electric motors, valves, and other plant equipment. Larger treatment plants generally combine this on-the-job training with formal classroom or self-paced study programs.

Most State drinking water and water pollution control agencies offer courses to improve operators' skills and knowledge. The courses cover principles of treatment processes and process control, laboratory procedures, maintenance, management skills, collection systems, safety, chlorination, sedimentation, biological treatment, sludge treatment and disposal, and flow measurements. Some operators take correspondence courses on subjects related to water and wastewater treatment, and some employers pay part of the tuition for related college courses in science or engineering.

Licensure. The Safe Drinking Water Act Amendments of 1996, enforced by the U.S. Environmental Protection Agency, specify national minimum standards for certification of public water system operators. Operators must pass an examination certifying that they are capable of overseeing water treatment operations. Mandatory certification is implemented at the State level, and licensing requirements and standards vary widely depending on the State. There are generally three to four different levels of certification, depending on the operator's experience and training. Higher levels qualify the operator to oversee a wider variety of treatment processes. Although relocation may mean having to become certified in a new jurisdiction, many States accept other States' certifications.

Other qualifications. Water and wastewater treatment plant operators need mechanical aptitude and the ability to solve problems intuitively. They should also be competent in basic mathematics, chemistry, and biology. They must have the ability to apply data to formulas that determine treatment requirements, flow levels, and concentration levels. Some basic familiarity with computers also is necessary, as operators generally use them to record data. Some plants also use computer-controlled equipment and instrumentation.

Certification and advancement. In addition to mandatory certifications required by law, operators can earn voluntary certifications that demonstrate their skills and knowledge. The Association of Boards of Certification offers several levels and types of certification to people who pass exams and have sufficient education and experience.

As operators are promoted, they become responsible for more complex treatment processes. Some operators are promoted to plant supervisor or superintendent; others advance by transfer-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Water and liquid waste treatment plant and system operators	51-8031	111,000	126,000	15,000	14

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

ring to a larger facility. Postsecondary training in water and wastewater treatment, coupled with increasingly responsible experience as an operator, may be sufficient to qualify a worker to become superintendent of a small plant, where a superintendent also serves as an operator. However, educational requirements are rising as larger, more complex treatment plants are built to meet new drinking water and water pollution control standards. With each promotion, the operator must have greater knowledge of Federal, State, and local regulations. Superintendents of large plants generally need an engineering or science degree.

A few operators get jobs as technicians with State drinking water or water pollution control agencies. In that capacity, they monitor and provide technical assistance to plants throughout the State. Vocational-technical school or community college training generally is preferred for technician jobs. Experienced operators may transfer to related jobs with industrial liquid waste treatment plants, water or liquid waste treatment equipment and chemical companies, engineering consulting firms, or vocational-technical schools.

Employment

Water and wastewater treatment plant and system operators held about 111,000 jobs in 2006. Almost 4 in 5 operators worked for local governments. Others worked primarily for private water, sewage, and other systems utilities and for private waste treatment and disposal and waste management services companies. Private firms are increasingly providing operation and management services to local governments on a contract basis.

Water and wastewater treatment plant and system operators were employed throughout the country, but most jobs were in larger towns and cities. Although nearly all operators worked full time, those in small towns may work only part time at the treatment plant, with the remainder of their time spent handling other municipal duties.

Job Outlook

Water and wastewater treatment plant and system operators jobs are expected to grow faster than the average for all occupations. Job opportunities should be excellent for qualified workers.

Employment change. Employment of water and wastewater treatment plant and system operators is expected to grow by 14 percent between 2006 and 2016, which is faster than the average for all occupations. An increasing population and the growth of the economy are expected to boost demand for water and wastewater treatment services. As new plants are constructed to meet this demand, new water and wastewater treatment plant and system operator new jobs will arise.

Local governments are the largest employers of water and wastewater treatment plant and system operators. Employment in privately owned facilities will grow faster, as Federal certification requirements have increased utilities' reliance on private firms specializing in the operation and management of water and wastewater treatment facilities.

Job prospects. Job opportunities should be excellent because the retirement of the baby boomer generation will require that many operators with years of experience be replaced. Further, the number of applicants for these jobs is normally low, due primarily to the physically demanding and unappealing nature of some of the work. Opportunities should be best for persons with mechanical aptitude and problem solving skills.

Earnings

Median annual earnings of water and wastewater treatment plant and system operators were $36,070 in May 2006. The middle 50 percent earned between $28,120 and $45,190. The lowest 10 percent earned less than $21,860, and the highest 10 percent earned more than $55,120. Median annual earnings of water and liquid waste treatment plant and systems operators in May 2006 were $36,200 in local government and $34,180 in water, sewage, and other systems.

In addition to their annual salaries, water and wastewater treatment plant and system operators usually receive benefits that may include health and life insurance, a retirement plan, and educational reimbursement for job-related courses.

Related Occupations

Other workers whose main activity consists of operating a system of machinery to process or produce materials include chemical plant and system operators; gas plant operators; petroleum pump system operators, refinery operators, and gaugers; power plant operators, distributors, and dispatchers; and stationary engineers and boiler operators.

Sources of Additional Information

For information on employment opportunities, contact State or local water pollution control agencies, State water and liquid waste operator associations, State environmental training centers, or local offices of the State employment service.

For information on certification, contact:

➤ Association of Boards of Certification, 208 Fifth St., Ames, IA 50010-6259. Internet: **http://www.abccert.org**

For educational information related to a career as a water or liquid waste treatment plant and system operator, contact:

➤ American Water Works Association, 6666 West Quincy Ave., Denver, CO 80235. Internet: **http://www.awwa.org**

➤ National Rural Water Association, 2915 S. 13th St., Duncan, OK 73533. Internet: **http://www.nrwa.org**

➤ Water Environment Federation, 601 Wythe St., Alexandria, VA 22314-1994. Internet: **http://www.wef.org**

Welding, Soldering, and Brazing Workers

(O*NET 51-4121.00, 51-4121.06, 51-4121.07, 51-4122.00)

Significant Points

- About 2 out of 3 jobs are in manufacturing industries.
- Training ranges from a few weeks of school or on-the-job training to several years of combined school and on-the-job training.
- Employment is projected to grow more slowly than average.
- Job prospects should be excellent as employers report difficulty finding enough qualified people.

Nature of the Work

Welding is the most common way of permanently joining metal parts. In this process, heat is applied to metal pieces, melting and fusing them to form a permanent bond. Because of its strength, welding is used in shipbuilding, automobile manufacturing and repair, aerospace applications, and thousands of other manufacturing activities. Welding also is used to join beams when constructing buildings, bridges, and other structures and to join pipes in pipelines, power plants, and refineries.

There are over 80 different welding processes that a welder can employ. Some are performed manually, and the work is entirely controlled by the welder. Others are semiautomatic, and the welder uses machinery, such as a wire feeder, to perform welding tasks.

One of the most common types of welding is arc welding. Standard arc welding involves two large metal alligator clips that carry a strong electrical current. One clip is attached to any part of the piece being welded. The second clip is connected to a thin welding rod. When the rod touches the piece, a powerful electrical circuit is created. The massive heat created by the electrical current causes both the piece and the steel core of the rod to melt together, cooling quickly to form a solid bond. The speed with which the welder works can affect the strength of the weld.

Two common and advanced types of arc welding are Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding. TIG welding often is used with stainless steel or aluminum. The welder holds the welding rod in one hand and an electric torch in the other hand. The torch is used to simultaneously melt the rod and the piece. MIG uses a spool of continuously fed wire instead of a rod, which allows the welder to join longer stretches of metal without stopping to replace a rod. The welder holds the wire feeder, which functions like the alligator clip in arc welding.

Like arc welders, soldering and brazing workers use molten metal to join two pieces of metal. However, the metal added during the soldering and brazing process has a melting point lower than that of the piece, so only the added metal is melted, not the piece. Soldering uses metals with a melting point below 800 degrees Fahrenheit; brazing uses metals with a higher melting point. Because soldering and brazing do not melt the piece, these processes normally do not create the distortions or weaknesses in the piece that can occur with welding. Soldering commonly is used to join electrical, electronic, and other small metal parts. Brazing produces a stronger joint than does soldering and often is used to join metals other than steel, such as brass. Brazing can also be used to apply coatings to parts to reduce wear and protect against corrosion.

Skilled welding, soldering, and brazing workers generally plan work from drawings or specifications and use their knowledge of welding processes and base metals to determine how best to join the parts. The difficulty of the weld is determined by its position—horizontal, vertical, overhead, or 6G (circular, such as in large pipes)—and by the type of metals to be fused. Highly skilled welders often are trained to work with a wide variety of materials, such as titanium, aluminum, or plastics, in addition to steel. Welders then select and set up welding equipment, execute the planned welds, and examine welds to ensure that they meet standards or specifications.

By observing problems during the welding process, welders can compensate by adjusting the speed, voltage, amperage, or feed of the rod. Some welders have more limited duties, however. They perform routine jobs that already have been planned and laid out and do not require extensive knowledge of welding techniques.

Welders inspect their work to ensure a strong bond.

Automated welding is used in an increasing number of production processes. In these instances, a machine or robot performs the welding tasks while being monitored by a welding machine operator. Welding, soldering, and brazing machine setters, operators, and tenders follow specified layouts, work orders, or blueprints. Operators must load parts correctly and constantly monitor the machine to ensure that it produces the desired bond.

The work of arc, plasma, and oxy-gas cutters is closely related to that of welders. However, instead of joining metals, cutters use the heat from an electric arc, a stream of ionized gas called plasma, or burning gases to cut and trim metal objects to specific dimensions. Cutters also dismantle large objects, such as ships, railroad cars, automobiles, buildings, or aircraft. Some operate and monitor cutting machines similar to those used by welding machine operators. Plasma cutting has been increasing in popularity because, unlike other methods, it can cut a wide variety of metals, including stainless steel, aluminum, and titanium.

Work environment. Welding, soldering, and brazing workers often are exposed to a number of hazards, including very hot materials and the intense light created by the arc. They wear safety shoes, goggles, hoods with protective lenses, and other devices designed to prevent burns and eye injuries and to protect them from falling objects. They normally work in well-ventilated areas to limit their exposure to fumes. Automated welding, soldering, and brazing machine operators are not exposed to as many dangers, and a face shield or goggles usually provide adequate protection for these workers.

Welders and cutters may work outdoors, often in inclement weather, or indoors, sometimes in a confined area designed to contain sparks and glare. Outdoors, they may work on a scaffold or platform high off the ground. In addition, they may be required to lift heavy objects and work in a variety of awkward positions, while bending, stooping, or standing to perform work overhead.

Although about 50 percent of welders, solderers, and brazers work a 40-hour week, overtime is common, and nearly 1 out of 5 welders work 50 hours per week or more. Welders also may work in shifts as long as 12 hours. Some welders, solderers, brazers, and machine operators work in factories that operate around the clock, necessitating shift work.

Training, Other Qualifications, and Advancement

Training for welding, soldering, and brazing workers can range from a few weeks of school or on-the-job training for low-skilled positions to several years of combined school and on-the-job training for highly skilled jobs.

Education and training. Formal training is available in high schools and postsecondary institutions, such as vocational-technical institutes, community colleges, and private welding schools. The U.S. Armed Forces operate welding schools as well. Although some employers provide training, they prefer to hire workers who already have experience or formal training. Courses in blueprint reading, shop mathematics, mechanical drawing, physics, chemistry, and metallurgy are helpful. An understanding of electricity also is very helpful, and knowledge of computers is gaining importance, especially for welding, soldering, and brazing machine operators, who are becoming more responsible for the programming of robots and other computer-controlled machines. Since understanding the welding process and inspecting welds is important for both welders and welding machine operators, companies hiring machine operators prefer workers with a background in welding.

Certification and other qualifications. Some welding positions require general certifications in welding or certifications in specific skills such as inspection or robotic welding. The American Welding Society certification courses are offered at many welding schools. Some employers have developed their own internal certification tests.

Welding, soldering, and brazing workers need good eyesight, hand-eye coordination, and manual dexterity. They should be able to concentrate on detailed work for long periods and be able to bend, stoop, and work in awkward positions. In addition, welders increasingly must be willing to receive training and perform tasks in other production jobs.

Advancement. Welders can advance to more skilled welding jobs with additional training and experience. For example, they may become welding technicians, supervisors, inspectors, or instructors. Some experienced welders open their own repair shops. Other welders, especially those who obtain a bachelor's degree, become welding engineers.

Employment

Welding, soldering, and brazing workers held about 462,000 jobs in 2006. About 2 of every 3 welding jobs were found in manufacturing. Jobs were concentrated in fabricated metal product manufacturing, transportation equipment manufacturing, machinery manufacturing, architectural and structural metals manufacturing, and construction.

Job Outlook

Employment of welding, soldering, and brazing workers is expected to grow more slowly than average. They will have excellent job opportunities as some welding employers report difficulty finding trained welders.

Employment change. Employment of welding, soldering, and brazing workers is expected to grow about 5 percent over

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Welding, soldering, and brazing workers	51-4120	462,000	484,000	22,000	5
Welders, cutters, solderers, and brazers	51-4121	409,000	430,000	21,000	5
Welding, soldering, and brazing machine setters, operators, and tenders	51-4122	53,000	54,000	1,600	3

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

the 2006-16 decade, slower than the average for all occupations. Welding has grown significantly over the long term because of advances that have allowed it to replace other joining technologies in many applications. Thus, demand for welders is increasing in the construction, manufacturing, and utilities industries. Despite overall employment declines in the manufacturing industry, the outlook for welders in manufacturing is far stronger than for other occupations. The basic skills of welding are the same across industries, so welders can easily shift from one industry to another depending on where they are needed most. For example, welders laid off in the auto industry have been able to find work in the booming oil and gas industry, although the shift may require relocating.

Automation is less of a threat to welders and welding machine operators than to other manufacturing occupations. Welding machines must still be operated by someone who is knowledgeable about welding and can inspect the weld and make adjustments. In custom applications, much of the work is difficult or impossible to automate. This includes manufacturing small batches of items, construction work, and making repairs in factories.

Job prospects. Retirements and job growth in the oil and gas and other industries are expected to create excellent opportunities for welders. Welding schools report that graduates have little difficulty finding work, and some welding employers report difficulty finding trained welders.

Earnings

Median wage-and-salary earnings of welders, cutters, solderers, and brazers were $15.10 an hour in May 2006. The middle 50 percent earned between $12.30 and $18.47. The lowest 10 percent had earnings of less than $10.08, and the top 10 percent earned over $22.50. The range of earnings of welders reflects the wide range of skill levels. Median hourly wage-and-salary earnings of welders, cutters, solderers, and brazers in the industries employing the largest numbers of them were:

Other general purpose machinery manufacturing	$15.43
Agriculture, construction, and mining machinery manufacturing	14.90
Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	14.59
Architectural and structural metals manufacturing	14.39
Motor vehicle body and trailer manufacturing	13.68

Median wage-and-salary earnings of welding, soldering, and brazing machine setters, operators, and tenders were $14.90 an hour in May 2006. The middle 50 percent earned between $12.02 and $18.90. The lowest 10 percent had earnings of less than $9.95, and the top 10 percent earned over $25.44. Their median wage-and-salary earnings in motor vehicle parts manufacturing, the industry employing them in the largest numbers, were $17.75 an hour in May 2006.

Many welders belong to unions. Among these are the International Association of Machinists and Aerospace Workers; the International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers and Helpers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the United Association of Journeymen and Apprentices of the Plumbing, Pipefitting, Sprinkler Fitting Industry of the United States and Canada; and the United Electrical, Radio, and Machine Workers of America.

Related Occupations

Welding, soldering, and brazing workers are skilled metal workers. Other skilled metal workers include machinists; machine setters, operators, and tenders—metal and plastic; computer control programmers and operators; tool and die makers; sheet metal workers; and boilermakers. Assemblers and fabricators of electrical and electronic equipment often assemble parts using soldering. Pipelayers, plumbers, pipefitters, and steamfitters also need welding skills.

Sources of Additional Information

For information on training opportunities and jobs for welding, soldering, and brazing workers, contact local employers, the local office of the State employment service, or schools providing welding, soldering, or brazing training.

Information on careers, certifications, and educational opportunities in welding is available from:

➤ American Welding Society, 550 N.W. Lejeune Rd., Miami, FL 33126. Internet: **http://www.aws.org**

Woodworkers

(O*NET 51-7011.00, 51-7021.00, 51-7031.00, 51-7032.00, 51-7041.00, 51-7042.00, 51-7099.99)

Significant Points

- Most woodworkers are trained on the job; basic machine operations may be learned in a few months, but becoming a skilled woodworker often requires several years of experience.
- Job prospects will be best for highly skilled woodworkers who produce customized work, which is less susceptible to automation and import competition, and for those who can operate computerized numerical control machines.
- Employment is highly sensitive to economic cycles; during economic downturns, workers are subject to layoffs or reductions in hours.

Nature of the Work

Despite the abundance of plastics and other materials, wood products continue to be useful and popular. Woodworkers help to meet the demand for wood products by creating finished products from lumber. Many of these products are mass produced, such as many types of furniture, kitchen cabinets, and musical instruments. Other products are crafted in small shops that make architectural woodwork, handmade furniture, and other specialty items.

Although the term woodworker often evokes images of a craftsman who builds ornate furniture using hand tools, the modern wood industry is highly technical. Some woodworkers still build by hand, but more often, handtools have been

replaced by power tools, and much of the work has been automated. Work is usually done on an assembly line, meaning that most individuals learn to perform a single part of a complex process. Different types of woodworkers are employed in every stage of the building process, from sawmill to finished product. Their activities vary greatly.

Many woodworkers use computerized numerical control (CNC) machines to operate factory tools. Using these machines, woodworkers can create complex designs with fewer human steps. This technology has raised worker productivity by allowing one operator to simultaneously tend a greater number of machines. The integration of computers with equipment has improved production speed and capability, simplified setup and maintenance requirements, and increased the demand for workers with computer skills.

Production woodworkers set up, operate, and tend all types of woodworking machines. In sawmills, *sawing machine operators and tenders* set up, operate, or tend wood-sawing machines that cut logs into planks, timbers, or boards. In manufacturing plants, woodworkers first determine the best method of shaping and assembling parts, working from blueprints, supervisors' instructions, or shop drawings that woodworkers themselves produce. Before cutting, they often must measure and mark the materials. They verify dimensions and may trim parts using handtools such as planes, chisels, wood files, or sanders to ensure a tight fit.

Woodworking machine operators and tenders set up, operate, or tend specific woodworking machines, such as drill presses, lathes, shapers, routers, sanders, planers, and wood-nailing machines. New operators may simply press a switch on a woodworking machine and monitor the automatic operation, but more highly skilled operators set up the equipment, cut and shape wooden parts, and verify dimensions using a template, caliper, or rule.

After wood parts are made, woodworkers add fasteners and adhesives and connect the pieces to form a complete unit. The product is then finish-sanded; stained, and, if necessary, coated with a sealer, such as lacquer or varnish. Woodworkers may perform this work in teams or be assisted by helpers.

Precision or custom woodworkers, such as *cabinetmakers and bench carpenters, modelmakers and patternmakers*, and *furniture finishers*, often build one-of-a-kind items. These highly skilled precision woodworkers usually perform a complete cycle of tasks—cutting, shaping, and preparing surfaces and assembling complex wood components into a finished wood product. Precision workers normally need substantial training and an ability to work from detailed instructions and specifications. In addition, they often are required to exercise independent judgment when undertaking an assignment. They may still use heavy machinery and power tools in their everyday work. As CNC machines have become less expensive, many smaller firms have started using them.

Work environment. Working conditions vary by industry and specific job duties. In logging and sawmills, for example, workers handle heavy, bulky material and often encounter excessive noise, dust, and other air pollutants. However, the use of earplugs and respirators may alleviate these problems. Safety precautions and computer-controlled equipment minimize risk of injury from rough wood stock, sharp tools, and power equipment.

Woodworkers use sophisticated equipment to make wood into furniture.

In furniture and kitchen cabinet manufacturing, employees who operate machinery also must wear ear and eye protection. They follow operating safety instructions and use safety shields or guards to prevent accidents. Those who work in areas where wood is cut or finishings applied often must wear an appropriate dust or vapor mask or a complete protective safety suit. Prolonged standing, lifting, and fitting of heavy objects are common characteristics of the job.

Training, Other Qualifications, and Advancement

Many woodworkers are highly skilled and require significant on-the-job training. Mathematics skills, especially geometry, are essential and computer skills are increasingly important,

Education and training. Employers seek applicants with a high school diploma or the equivalent because of the growing sophistication of machinery and the constant need for retraining. People seeking woodworking jobs can enhance their employment and advancement prospects by completing high school and receiving training in mathematics, science, and computer applications.

Woodworkers increasingly acquire skills through higher education. For many workers, this means earning a degree from a vocational or trade school. Others may attend colleges or universities that offer training in wood technology, furniture manufacturing, wood engineering, and production management. These programs prepare students for positions in production, supervision, engineering, and management and are increasingly important as woodworking technology advances.

Most woodworkers are trained on the job, however, picking up skills informally from experienced workers. They can learn basic machine operations and job tasks in a few months, but becoming a skilled woodworker often requires 2 or more years.

Beginners usually observe and help experienced machine operators. They may supply material to, or remove fabricated products from, machines. Trainees also do simple machine operating jobs while closely supervised by experienced workers. As beginners gain experience, they perform more complex jobs with less supervision. Some may learn to read blueprints, set up machines, and plan the sequence of the work.

Other qualifications. In addition to training, woodworkers need mechanical ability, manual dexterity, and the ability to pay attention to detail and safety. As the industry becomes more sophisticated, skill with computers and computer-controlled machinery is becoming more important.

Advancement. Advancement opportunities are often limited and depend on education and training, seniority, and a worker's skills and initiative. Sometimes experienced woodworkers become inspectors or supervisors responsible for the work of a group of woodworkers. Production workers can advance into these positions by assuming additional responsibilities and attending workshops, seminars, or college programs. Those who are highly skilled may set up their own woodworking shops.

Employment

Woodworkers held about 370,000 jobs in 2006. Self-employed woodworkers, mostly cabinetmakers and furniture finishers, accounted for 12 percent of these jobs.

Three out of 4 woodworkers were employed in manufacturing. About 2 out of 5 worked in establishments manufacturing household and office furniture and fixtures, and 1 in 3 worked in wood product manufacturing, producing a variety of raw, intermediate, and finished woodstock. Wholesale and retail lumber dealers, furniture stores, reupholstery and furniture repair shops, and construction firms also employ woodworkers.

Woodworking jobs are found throughout the country. However, lumber and wood products-related production jobs are concentrated in the Southeast, Midwest, and Northwest, close to the supply of wood. Furniture-making jobs are more prevalent in the Southeast. Custom shops can be found everywhere, but generally are concentrated in or near highly populated areas.

Job Outlook

Overall employment of woodworkers is expected to grow slower than average. Opportunities should be good for skilled applicants.

Employment change. Overall employment of woodworkers is expected to grow by 3 percent during the 2006-16 decade, which is slower than the average of all occupations. This slow growth will be a result of increased automation in the wood products manufacturing industry. Technology is becoming increasingly important to this industry, and automation has greatly reduced the number of people required to produce a finished product. Furthermore, international competition—especially from China—has led to a significant decline in domestic employment of these workers.

Employment of sawing and woodworking machine setters, operators, and tenders is expected to grow more slowly than the average through 2016. Import growth will lead to job losses in the U.S. industry. To remain competitive, some domestic firms are expected to move their production processes to foreign countries, further reducing employment. Firms that stay are increasingly using advanced technology, such as robots and CNC machinery. These developments will prevent employment from rising with the demand for wood products, particularly in the mills and manufacturing plants where many processes can be automated.

Employment of furniture finishers is expected to decline slowly. Since furniture is largely mass-produced, it is highly susceptible to import competition; the percentage of imported furniture sold in the United States has steadily increased over the years, a trend that is expected to continue. Labor is significantly less expensive in developing countries, so these forces will likely affect the industry for quite some time.

Employment of bench carpenters and cabinetmakers is expected to grow more slowly than average, while modelmakers and patternmakers are expected to decline rapidly. Other specialized woodworking occupations will experience little or now change in growth. Demand for these workers will stem from increases in population, personal income, and business expenditures and from the continuing need for repair and renovation of residential and commercial properties. Therefore, opportunities should be available for workers who specialize in items such as moldings, cabinets, stairs, and windows. Firms that focus on custom woodwork will be best able to compete against imports without transferring jobs offshore.

Job prospects. Despite slower than average employment growth, prospects should be good for qualified workers. Many experienced woodworkers will soon reach retirement age, and this will create a need for new workers. In general, opportunities for more highly skilled woodworkers will be better than for woodworkers in specialties susceptible to automation and competition from imported wood products. The need for woodworkers with technical skills to operate their increasingly ad-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Woodworkers	51-7000	370,000	380,000	11,000	3
Cabinetmakers and bench carpenters	51-7011	149,000	153,000	4,100	3
Furniture finishers	51-7021	31,000	30,000	-1,000	-3
Model makers and patternmakers, wood	51-7030	4,200	2,500	-1,700	-40
Model makers, wood	51-7031	1,900	1,100	-800	-41
Patternmakers, wood	51-7032	2,300	1,400	-900	-40
Woodworking machine setters, operators, and tenders	51-7040	165,000	173,000	8,800	5
Sawing machine setters, operators, and tenders, wood	51-7041	65,000	68,000	2,500	4
Woodworking machine setters, operators, and tenders, except sawing	51-7042	100,000	106,000	6,400	6
Woodworkers, all other	51-7099	20,000	21,000	300	2

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

vanced computerized machinery will be especially great. Custom workers and modelmakers and patternmakers who know how to create and execute designs on a computer may have the best opportunities. These jobs require an understanding of wood and a strong understanding of computers—a combination that can be somewhat difficult to find.

The number of new workers entering these occupations has declined greatly in recent years, as training programs become less available or popular. Competition for jobs is expected to be mild, and opportunities should be best for woodworkers who, through vocational education or experience, develop highly specialized woodworking skills or knowledge of CNC machine tool operation.

Employment in all woodworking specialties is highly sensitive to economic cycles. During economic downturns, workers are subject to layoffs or reductions in hours.

Earnings

Median annual wage-and-salary earnings of cabinetmakers and bench carpenters were $27,010 in May 2006. The middle 50 percent earned between $21,350 and $34,290. The lowest 10 percent earned less than $17,660, and the highest 10 percent earned more than $43,060.

Median annual wage-and-salary earnings of sawing machine setters, operators, and tenders, wood were $24,280. The middle 50 percent earned between $19,620 and $29,930. The lowest 10 percent earned less than $16,290, and the highest 10 percent earned more than $36,220.

Median annual wage-and-salary earnings of woodworking machine setters, operators, and tenders, except sawing were $23,940. The middle 50 percent earned between $19,460 and $29,480. The lowest 10 percent earned less than $16,410, and the highest 10 percent earned more than $35,950.

Median annual wage-and-salary earnings were $25,010 for furniture finishers and $22,580 for all other woodworkers.

Related Occupations

Like woodworkers, carpenters also work with wood. In addition, many woodworkers follow blueprints and drawings and use machines to shape and form raw wood into a final product. Workers who perform similar functions working with other materials include sheet metal workers; structural and reinforcing iron and metal workers; computer control programmers and operators; machinists; textile, apparel, and furnishings occupations; and tool and die makers.

Sources of Additional Information

For information about careers and education and training programs in woodworking, contact:

➤ WoodLINKS USA, P.O. Box 1153, Point Roberts, WA 98281.
Internet: **http://www.woodlinks.com/USA/home.html**