Production Occupations

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Occupational Oulook Handbook, 2004-05 Edition

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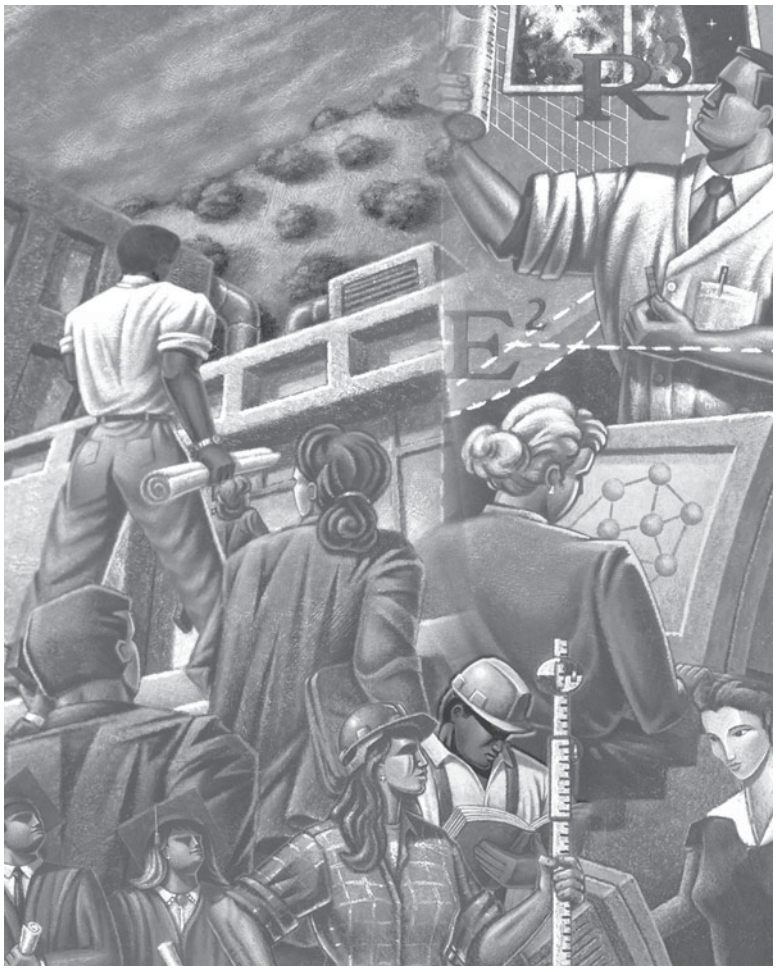


Occupations Included in this Reprint

Assemblers and fabricators
Bookbinders and bindery workers
Computer control programmers and operators
Dental laboratory technicians
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
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

(0*NET 51-2011.01, 51.2011.02, 51-2011.03, 51-2021.00, 51-2022.00, 51-2023.00, 51-2031.00, 51-2041.01, 51-2041.02, 51-2091.00, 51-2092.00, 51-2093.00, 51-2099.99)

Significant Points

- A decline in employment is expected, reflecting increasing automation and the shift of assembly to countries with lower labor costs.
- Work areas may be noisy, and many assemblers may have to sit or stand for long periods.
- A high school diploma is preferred for most positions; specialized training is required for some assembly jobs.

Nature of the Work

Assemblers and fabricators produce a wide range of finished goods from manufactured parts or subassemblies. They produce intricate manufactured products, such as aircraft, automobile engines, computers, and electrical and electronic components.

Assemblers may work on subassemblies or the final assembly of an array of finished products or components. For example, *electrical and electronic equipment assemblers* put together or modify missile control systems, radio or test equipment, computers, machine-tool numerical controls, radar, or sonar, and prototypes of these and other products. *Electromechanical equipment assemblers* prepare and test equipment or devices such as appliances, dynamometers, or ejection-seat mechanisms. *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 office, agricultural, construction, oilfield, rolling mill, textile, woodworking, paper, and food-wrapping machinery. *Aircraft structure, surfaces, rigging, and systems assemblers* put together and install parts of airplanes, space vehicles, or missiles, such as landing gear. *Structural metal fabricators and fitters* cut, align, and fit structural metal parts according to detailed specifications prior to welding or riveting.

Assemblers and fabricators involved in product development read and interpret engineering specifications from text, drawings, and computer-aided drafting systems. They also may use a variety of tools and precision measuring instruments. Some experienced assemblers work with engineers and technicians, assembling prototypes or test products.

As technology changes, so too does the manufacturing process. For example, automated manufacturing systems include applications of robotics, computers, programmable motion control, and various sensing technologies. These systems change the way in which goods are made and affect the jobs of those who make them.

The concept of "lean" manufacturing, for example, places a greater premium on teamwork and communication within "cells" of workers than it does on the assembly line process. *Team assemblers* perform all of the assembly tasks assigned to their teams, rotating through the different tasks, rather than specializing in a single task. They also may decide how the work is to be assigned and how different tasks are to be performed. This worker flexibility helps companies to cover for absent workers, and increases their 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 number of workers involved, while individual workers perform more stages of the assembly process. Some aspects of lean production, such as rotating tasks, are becoming more common to all assembly and fabrication occupations.

Working Conditions

The working conditions for assemblers and fabricators vary from plant to plant and from industry to industry. Work areas may be noisy, and many assemblers may have to sit or stand for long periods. Both electronic and electromechanical equipment assemblers, for example, sit at tables to perform much of their work, although their surroundings are generally clean, well-lit, and free from dust. Some electrical and electronics assemblers come in contact with soldering fumes, but ventilation systems and fans normally minimize this problem. Assemblers of equipment that is vulnerable to dust and dirt, such as transmissions, may work in clean rooms that are designed to minimize contamination. Aircraft assemblers, however, usually come in contact with oil and grease, and their working areas may be quite noisy. They also may have to lift and fit heavy objects. In many cases, improvements in workstation design and the increased use of overhead cranes and other power-lifting equipment have improved working conditions.

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

Employment

Most of the 2.1 million assembler and fabricator jobs in 2002 were in manufacturing; most of the 7 percent who were employed by employment services firms also worked in manufacturing plants. Team assemblers, the largest specialty, accounted for 55 percent of assembler and fabricator jobs. The distribution of employment among the various types of assemblers was as follows:

Team assemblers	1,174,000
Electrical and electronic equipment assemblers	281,000
Structural metal fabricators and fitters	89,000
Electromechanical equipment assemblers	60,000
Engine and other machine assemblers	50,000
Fiberglass laminators and fabricators	37,000
Coil winders, tapers, and finishers	36,000
Aircraft structure, surfaces, rigging, and systems assemblers	27,000
Timing device assemblers, adjusters, and calibrators	6,500
All other assemblers and fabricators	361,000

Most assemblers and fabricators work in manufacturing.

Manufacturing industries employ 80 percent of assemblers and fabricators. Assembly of computers and electronic products accounted for 13 percent of all jobs. Assembly of transportation equipment, such as aircraft, autos, trucks, and buses accounted for 19 percent of all jobs. Other industries that employ many assemblers and fabricators were 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 wage and salary employment in manufacturing industries employing the most assemblers and fabricators in 2002.

Transportation equipment manufacturing	397,000
Computer and electronic product manufacturing	285,000
Machinery manufacturing	209,000
Electrical equipment, appliance, and component manufacturing	160,000
Fabricated metal product manufacturing	155,000

Training, Other Qualifications, and Advancement

New assemblers and fabricators are normally entry-level employees. The ability to do accurate work at a rapid pace and to follow detailed instructions are key job requirements. A high school diploma is preferred for most positions. Following detailed assembly instructions requires basic reading skills, although many instructions rely on pictures and diagrams.

Applicants need specialized training for some assembly jobs. For example, employers may require that applicants for electrical or electronic assembler jobs be technical school graduates or have equivalent military training. Other positions require only on-the-job training, sometimes including employer-sponsored classroom instruction, in the broad range of assembly duties that employees may be required to perform.

Good eyesight, with or without glasses, is required for assemblers and fabricators who work with small parts. Plants that make electrical and electronic products may test applicants for color vision, because many of their products contain many differently colored wires. Manual dexterity and the ability to carry out complex, repetitive tasks quickly and methodically also are important.

As assemblers and fabricators become more experienced, they may progress to jobs that require greater skill and 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 articles 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.

Job Outlook

Employment of assemblers and fabricators is expected to decline through the year 2012, reflecting increasing automation and the shift of assembly to countries with lower labor costs. As manufacturers strive to improve precision and productivity, automated machinery increasingly will be used to perform work more economically and more efficiently. Technological advances should continue raising the productivity of assembly workers and adversely affecting their employment. Many job openings will result from the need to replace workers leaving this large occupational group.

The effects of automation will be felt more among some types of assemblers and fabricators than among others. Automated manufacturing systems are expensive, and a large volume of repetitive work is required to justify their purchase. Also, where the assembly parts involved are irregular in size or location, new technology only now is beginning to make inroads. For example, much 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; as a result, aircraft assemblers will not be easily replaced by automated processes, although employment of aircraft assemblers is still expected to decline due to the projected employment decline in the aerospace industry. On the other hand, automation increasingly will be used in the precision assembly of electronic goods, in which a significant number of electronics assemblers are employed.

Many producers send their assembly functions to countries where labor costs are lower. This trend in assembly, promoted by more liberal trade and investment policies, results in shifts in the composition of America's manufacturing workforce. Decisions by American corporations to move assembly to other nations should limit employment growth for assemblers in some industries, such as electronics assembly, but a free trade environment also may lead to growth in the export of goods assembled in the United States.

Earnings

Earnings vary by industry, geographic region, skill, educational level, and complexity of the machinery operated. In 2002, median hourly earnings were $ 18.71 for aircraft structure, surfaces, rigging, and systems assemblers; $14.02 for engine and other machine assemblers; $11.07 for coil winders, tapers, and finishers; $11.83 for fiberglass laminators and finishers; $11.63 for timing device assemblers, calibrators, and adjusters; $12.15 for electromechanical equipment assemblers; and $11.00 for all other assemblers.

Median hourly earnings of team assemblers were $10.90 in 2002. The middle 50 percent earned between $8.81 and $13.84. The lowest 10 percent earned less than $7.41, and the highest 10 percent earned $17.73. Median hourly earnings in the manufacturing industries employing the largest numbers of team assemblers in 2002 are shown below:

Motor vehicle parts manufacturing	$12.36
Other wood product manufacturing	10.44
Plastics product manufacturing	10.24
Other miscellaneous manufacturing	9.58
Employment services	8.30

Median hourly earnings of electrical and electronic equipment assemblers were $11.03 in 2002. The middle 50 percent earned between $9.02 and $13.84. The lowest 10 percent earned less than $7.57, and the highest 10 percent earned more than $17.38. Median hourly earnings in the manufacturing industries employing the largest numbers of electrical and electronic equipment assemblers in 2002 are shown below:

Navigational, measuring, electromedical, and control instruments manufacturing	$12.21
Computer and peripheral equipment manufacturing	12.01
Electrical equipment manufacturing	11.95
Communications equipment manufacturing	10.87
Semiconductor and other electronic component manufacturing	10.77

Many assemblers and fabricators are members of labor unions. These unions include the International Association of Machinists and Aerospace Workers; the United Electrical, Radio and Machine Workers of America; 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. Assemblers and fabricators also are responsible for some quality control and product testing, as is the case for 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

(0*NET 51-5011.01, 51-5011.02, 51-5012.00)

Significant Points

- Most bookbinders and bindery workers train on the job.
- Employment is expected to decline, reflecting increasingly productive bindery operations, changing business practices, and competition from imports.
- Opportunities for hand bookbinders are limited because only a small number of establishments do this highly specialized work.

Nature of the Work

The process of combining printed sheets into finished products such as books, magazines, catalogs, folders, directories, or product packaging is known as "binding." Binding involves cutting, folding, gathering, gluing, stapling, stitching, trimming, sewing, wrapping, and other finishing operations. Bindery workers setup, operate, and maintain the machines that perform these various tasks.

Job duties depend on the kind of material being bound. In firms that do *edition binding*, for example, workers bind books produced in large numbers, or "runs." *Job binding* workers bind books produced in smaller quantities. In firms specializing in *library binding*, workers repair books and provide other specialized binding services to libraries. *Pamphlet binding* workers produce leaflets and folders, and *manifold binding* workers bind business forms such as ledgers and books of sales receipts. *Blankbook binding* workers bind blank pages to produce notebooks, checkbooks, address books, diaries, calendars, and note pads.

Some types of binding and finishing 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.

Bookbinders and bindery workers assemble books and magazines from large, flat, printed sheets of paper. Skilled workers operate machines that first fold printed sheets into "signatures," which are groups of pages arranged sequentially. Bookbinders then sew, stitch, or glue the assembled signatures together, 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.

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. The work requires creativity, knowledge of binding materials, and a thorough background in the history of binding. Hand bookbinding gives individuals the opportunity to work in the greatest variety of bindery jobs.

Bookbinders and bindery workers in small shops may perform many binding tasks, while those in large shops usually are assigned only one or a few operations, such as running complicated manual or electronic guillotine papercutters or folding machines. Others specialize in adjusting and preparing equipment, and may perform minor repairs as needed.

Working Conditions

Binderies often are noisy and jobs can be fairly strenuous, requiring considerable lifting, standing, and carrying. The jobs also may require stooping, kneeling, and crouching. Binding often resembles an assembly line on which workers perform repetitive tasks.

Employment

In 2002, bookbinders and bindery workers held about 98,400 jobs, including 7,400 as skilled bookbinders and 91,000 as bindery workers. Nearly one in ten work in the employment services industry, which contracts them out as temporary employees to companies that need their services .

Although some advertising agencies, and book, magazine, and newspaper publishers have their own bindery operations, employing some bookbinders and bindery workers, the majority of jobs are in commercial printing plants. The largest employers of bindery workers are bindery trade shops—these companies specialize in providing binding services for printers without binderies or whose printing production exceeds their binding capabilities. Few publishers maintain their own manufacturing facilities, so most contract out the printing and assembly of books to commercial printing plants or bindery trade shops.

Training, Other Qualifications, and Advancement

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. As workers gain experience, they advance to more difficult tasks, such as embossing and adding holograms, and learn to operate one or more pieces of equipment. Usually, it takes 1 to 3 months to learn to operate the simpler machines but it can take up to 1 year to become completely familiar with more complex equipment, such as computerized binding machines.

Formal apprenticeships are not as common as they used to be, but still are offered by some employers. Apprenticeships provide a more structured program that enables workers to acquire the high levels of specialization and skill needed for some bindery jobs. For example, a 4-year apprenticeship usually is necessary to teach workers how to restore rare books and to produce valuable collectors' items.

High school students interested in bindery careers should take shop courses or attend a vocational-technical high school. Occupational skill centers, usually operated by labor unions, also provide

Bindery work requires careful attention to detail because these workers are responsible for the final assembly of printed materials.

an introduction to a bindery career. To keep pace with changing technology, retraining is increasingly important for bindery workers. Students with computer skills and mechanical aptitude are especially in demand.

Bindery workers need basic mathematics and language skills. Bindery work requires careful attention to detail; accuracy, patience, neatness, and good eyesight also are important. Manual dexterity is essential in order to count, insert, paste, and fold. Mechanical aptitude is needed to operate the newer, more automated equipment. Artistic ability and imagination are necessary for hand bookbinding.

Training in graphic arts 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. Some updating and retraining programs require students to have bindery experience; other programs are made available by unions to their members. Four-year colleges also offer programs, but their emphasis is on preparing people for careers as graphic artists, educators, or managers in the graphic arts field.

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

Job Outlook

Overall employment of bookbinders and bindery workers is expected to decline through 2012 as demand for printed material slows and productivity in bindery operations increases. Contributing to this situation is the trend toward outsourcing of work to firms in foreign countries, where books and other materials with long leadtimes can be produced more cheaply. Most job openings, however, will result from the need to replace experienced workers who leave the occupation, many of whom will be retiring in the next decade.

Computers have caused binding to become increasingly automated. New computer-operated "in-line" equipment performs a number of operations in sequence, beginning with raw stock and ending with a finished product. Technological advances such as automatic tabbers, counters, palletizers, and joggers reduce labor and improve the appearance of the finished product. These improvements are inducing printing companies to acquire in-house binding and finishing equipment that allows printing machine operators to perform bindery work during "downtimes."

Growth in demand for specialized bindery workers who assist skilled bookbinders will be slowed as binding machinery continues to become more efficient. New technology requires a considerable investment in capital expenditures and employee training, so computer skills and mechanical aptitude are increasingly important for bindery workers.

Because the number of establishments that do hand bookbinding is small, opportunities for hand bookbinders will be limited. Experienced workers will continue to have the best opportunities for these specialist jobs.

Earnings

Median hourly earnings of bookbinders were $13.31 in 2002. The middle 50 percent earned between $9.88 and $17.73 an hour. The lowest 10 percent earned less than $7.84, and the highest 10 percent earned more than $21.90.

Median hourly earnings of bindery workers were $10.51 in 2002. The middle 50 percent earned between $8.27 and $13.86 an hour. The lowest 10 percent earned less than $6.95, and the highest 10 percent earned more than $17.95. Workers covered by union contracts usually had higher earnings.

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 International Union, or local offices of the State employment service.

For general information on bindery occupations, write to:

➤ Bindery Industries Association, International, 100 Daingerfield Road, Alexandria, VA 22314.

➤ Graphic Communications International Union, 1900 L St. NW., Washington, DC 20036. Internet: **http://www.gciu.org**

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

➤ Graphic Communications Council, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.npes.org/edcouncil/index.html**

➤ Printing Industries of America, 100 Daingerfield Rd., Alexandria, VA 22314. Internet:
http://www.gain.org/servlet/gateway/PIA_GATF/non_index.html

➤ Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.gatf.org**

Computer-Control Programmers and Operators

(0*NET 51-4011.01, 51-4012.00)

Significant Points

- 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.
- 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 parts, machine parts, and compressors. CNC machines include machining tools such as lathes, multiaxis spindles, milling machines, and electrical discharge machines (EDM), but the functions formerly performed by human operators are performed by a computer-control module. CNC machines cut away material from a solid block of metal, plastic, or glass—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.

Before CNC programmers—also referred to as numerical tool and process control programmers—machine a part, they must carefully plan and prepare the operation. First, these workers review three-dimensional computer aided/automated design (CAD) blueprints of the part. Next, they calculate where to cut or bore into the workpiece, how fast to feed the metal into the machine, and how much metal to remove. They then select tools and materials for the job and plan the sequence of cutting and finishing operations.

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. CNC programmers and operators check new 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, computer simulations may be used to check the program instead of 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 operators—also referred to as computer-controlled machine tool operators, metal and plastic—perform the necessary machining operations. The CNC operators transfer the commands from the server to the CNC control module using a computer network link or floppy disk. Many advanced control modules are conversational, meaning that they ask the operator a series of questions about the nature of the task. CNC operators position the metal stock on the CNC machine tool—spindle, lathe, milling machine, or other—set the controls, and let the computer make the cuts. Heavier objects may be loaded with the assistance of other workers, autoloaders, a crane, or a forklift. During the machining process, computer-control operators constantly monitor the readouts from the CNC control module, checking to see if any problems exist. Machine tools have unique characteristics, which can be problematic. During a machining operation, the operator modifies the cutting program to account for any problems encountered. Unique, modified CNC programs are saved for every different machine that performs a task.

CNC operators detect some problems by listening for specific sounds—for example, a dull cutting tool or excessive vibration. Dull cutting tools are removed and replaced. 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. In older, slower machine tools, the cutting speed would be reduced to eliminate the vibrations, but the amount of time needed to finish the product would increase as a result. In newer, high-speed CNC machines, increasing the cutting speed normally eliminates the vibrations and reduces production time. 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.

Working Conditions

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 high-speed machine tools 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.

Using specialized control modules, computer control programmers and operators make adjustments to the machining process.

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.

Most 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.

Employment

Computer-control programmers and operators held about 151,000 jobs in 2002, mostly working in machine shops, plastics products manufacturing, or machinery manufacturing. Although computer-control programmers and operators work in all parts of the country, jobs are most plentiful in the areas where manufacturing is concentrated.

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. Due to a shortage of qualified applicants, many employers teach introductory courses, which provide a basic understanding of metalworking machines, safety, and blueprint reading. A basic knowledge of computers and electronics also is helpful. Experience with machine tools is extremely important. 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.

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. A growing number of computer-control programmers and operators receive most of their formal training from community or technical colleges. Less skilled CNC operators may need only a couple of weeks of on-the-job training.

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 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 a NIMS credential that provides formal recognition of competency in a metalworking field. Completion of a formal certification program provides expanded career opportunities.

Qualifications for CNC programmers vary widely depending upon the complexity of the job. Employers often prefer skilled machinists or those with technical school training. 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 entering CNC programming directly, a basic knowledge of computers and electronics is necessary, and experience with machine tools is extremely helpful. Classroom training includes an introduction to computer numerical control, the basics of programming, and more complex topics, such as computer-aided manufacturing. Trainees start writing simple programs under the direction of an experienced programmer. Although machinery manufacturers are trying to standardize programming languages, there are numerous languages in use. Because of this, computer-control programmers and operators should be able to learn new programming languages.

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.

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.

Job Outlook

Computer-control programmers and operators should have excellent job opportunities. 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. Employment of computer-controlled machine tool operators is projected to grow more slowly than the average for all occupations through 2012, but employment of numerical tool and process control programmers is expected to grow about as fast as the average for all occupations through 2012. Job growth in both occupations will be driven by the increasing use of CNC machine tools. Advances in CNC machine tools and manufacturing technology will further automate production, boosting CNC operator productivity and limiting employment growth. The demand for computer-control programmers will be negatively affected by the increasing use of software that automatically translates part and product designs into CNC machine tool instructions.

Employment levels of computer-control programmers and operators are influenced by economic cycles—as the demand for machined goods falls, programmers and operators involved in production may be laid off or forced to work fewer hours.

Earnings

Median hourly earnings of computer-controlled machine tool operators, metal and plastic, were $13.97 in 2002. The middle 50 percent earned between $11.07 and $17.43. The lowest 10 percent earned less than $9.14, whereas the top 10 percent earned more than $21.27. Median hourly earnings in the manufacturing industries employing the largest numbers of computer-controlled machine tool operators, metal and plastic, in 2002 were:

Metalworking machinery manufacturing	$15.97
Other fabricated metal product manufacturing	15.14
Machine shops; turned product; and screw, nut, and bolt manufacturing	13.82
Motor vehicle parts manufacturing	13.08
Plastics product manufacturing	11.00

Median hourly earnings of numerical tool and process control programmers were $18.04 in 2002. The middle 50 percent earned between $14.52 and $22.23. The lowest 10 percent earned less than $11.53, while the top 10 percent earned more than $27.37.

Related Occupations

Occupations most closely related to computer-control programmers and operators are other metal worker 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**

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

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

For general occupational information, including a list of training programs, contact:

➤ Precision Metalforming Association Educational Foundation, 6363 Oak Tree Blvd., Independence, OH 44131-2500. Internet: **http://www.pmaef.org**

Dental Laboratory Technicians

(0*NET 51-9081.00)

Significant Points

- Employment should increase slowly, as the public's improving dental health requires fewer dentures but more bridges and crowns.
- Dental laboratory technicians need artistic aptitude for detailed and precise work, a high degree of manual dexterity, and good vision.

Nature of the Work

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 (mold) of the patient's mouth or teeth. 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. Next, 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. They use this wax model 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*.

Working Conditions

Dental laboratory technicians generally work in clean, well-lighted, and well-ventilated areas. 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 technicians have computer-aided milling equipment to assist them with creating artificial teeth.

The work is extremely delicate and time consuming. Salaried technicians usually work 40 hours a week, but self-employed technicians frequently work longer hours.

Employment

Dental laboratory technicians held about 47,000 jobs in 2002. Around 7 out of 10 jobs were in medical equipment and supply manufacturing laboratories, which usually are small, privately owned businesses with fewer than five employees. However, some laboratories are large; a few employ more than 50 technicians.

Some dental laboratory technicians work in offices of dentists. Others work for hospitals providing dental services, including U.S. Department of Veterans Affairs hospitals. Some technicians work in dental laboratories in their homes, in addition to their regular job.

Training, Other Qualifications, and Advancement

Most dental laboratory technicians learn their craft on the job. They begin with 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.

Training in dental laboratory technology also is available through community and junior colleges, vocational-technical institutes, and the U.S. Armed Forces. Formal training programs vary greatly both in length and in the level of skill they impart.

In 2002, 25 programs in dental laboratory technology were approved (accredited) by the Commission on Dental Accreditation in conjunction with the American Dental Association (ADA). 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.

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, can be obtained in five specialty areas: Crowns and bridges, ceramics, partial dentures, complete dentures, and orthodontic appliances.

Dental laboratory technicians need a high degree of manual dexterity, good vision, and the ability to recognize very fine color shadings and variations in shape.

In large dental laboratories, technicians may become supervisors or managers. Experienced technicians may teach or may take jobs with dental suppliers in such areas as product development, marketing, and sales. Still, for most technicians, opening one's own laboratory is the way toward advancement and higher earnings.

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

Job Outlook

Job opportunities for dental laboratory technicians should be favorable, despite expected slower-than-average growth in the occupation through the year 2012. Employers have difficulty filling trainee positions, probably because entry-level salaries are relatively low and because the public is not familiar with the occupation.

The overall dental health of the population has improved because of fluoridation of drinking water, which has reduced the incidence of dental cavities, and greater emphasis on preventive dental care since the early 1960s. As a result, full dentures will be less common, as most people will need only a bridge or crown. However, 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.

Earnings

Median hourly earnings of dental laboratory technicians were $13.70 in 2002. The middle 50 percent earned between $10.51 and $18.40 an hour. The lowest 10 percent earned less than $8.16, and the highest 10 percent earned more than $23.65 an hour. Median hourly earnings of dental laboratory technicians in 2002 were $13.78 in medical equipment and supplies manufacturing and $12.98 in offices of dentists.

Technicians in large laboratories tend to specialize in a few procedures, and, therefore, tend to be paid a lower wage than those employed in small laboratories who perform a variety of tasks.

Related Occupations

Dental laboratory technicians manufacture artificial teeth, crowns and bridges, and orthodontic appliances, following specifications and instructions provided by dentists. Other workers who make and repair medical devices include dispensing opticians, ophthalmic laboratory technicians, orthotists and prosthetists, and precision instrument and equipment repairers.

Sources of Additional Information

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, contact:

➤ National Board for Certification in Dental Technology, 1530 Metropolitan Blvd., Tallahassee, FL 32308. Internet: **http://www.nadl.org/html/certification.html**

For information on career opportunities in commercial laboratories, contact:

➤ National Association of Dental Laboratories, 1530 Metropolitan Blvd., Tallahassee, FL 32308. Internet: **http://www.nadl.org**

General information on grants and scholarships is available from dental technology schools.

Food Processing Occupations

51-3091.00, 51-3092.00, 51-3093.00)

Significant Points

- Workers in meatpacking plants have among the highest incidences of injury and illness of all workers.
- Most employees in manual food-processing jobs require little or no training prior to being hired.
- Job growth will be concentrated among lower skilled workers, who are found mostly in manufacturing plants.

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 or 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.

Butchers and meat, poultry, and fish cutters and trimmers are employed at different stages in the process by which animal carcasses are converted into manageable pieces of meat, known as boxed meat, that are suitable for sale to wholesalers and retailers. Meat, poultry, and fish cutters and trimmers commonly work in animal slaughtering and processing plants, while butchers and meatcutters usually are employed at the retail level. As a result, the nature of these jobs varies significantly.

In animal slaughtering and processing plants, *slaughterers and meatpackers* slaughter cattle, hogs, goats, and sheep and cut the carcasses into large wholesale cuts, such as rounds, loins, ribs, and chucks, to facilitate the handling, distribution, and marketing of meat. In some of these plants, slaughterers and meatpackers also further process the large parts into cuts that are ready for retail use. These workers also produce hamburger meat and meat trimmings, which are used to prepare sausages, luncheon meats, and other fabricated meat products. Slaughterers and meatpackers 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, they use knives, cleavers, meat saws, bandsaws, or other, often dangerous, equipment.

In grocery stores, wholesale establishments that supply meat to restaurants, and institutional food service facilities, *butchers and meatcutters* separate wholesale cuts of meat into retail cuts or individually sized servings. They cut meat into steaks and chops, shape and tie roasts, and grind beef for sale as chopped meat. Boneless cuts are prepared with the use of knives, slicers, or power cutters, while bandsaws are required to carve bone-in pieces. Butchers and meatcutters 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.

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. As in the animal slaughtering and processing industry, most poultry cutters and trimmers perform routine cuts on poultry as it moves along production lines.

Unlike some of the other occupations just listed, *fish cutters and trimmers,* also called *fish cleaners*, are likely to be employed in both manufacturing and retail establishments. 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, they may also wait on customers and clean fish to order.

Meat, poultry, and fish cutters and trimmers also prepare ready-to-heat foods. This often entails filleting meat or fish or cutting it into bite-sized pieces, preparing and adding vegetables, or applying sauces, marinades, or breading.

Bakers mix and bake ingredients in accordance with 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. 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, or manufacturer's outlets.

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 process food in preparation for canning. Some

Food batchmakers set up and operate equipment that mixes, blends, or cooks ingredients used in the manufacture of food products

of the machines that are used include hearth ovens, kiln driers, roasters, char kilns, steam ovens, and vacuum drying equipment.

Working Conditions

Working conditions vary by type and size of establishment. In animal slaughtering and processing plants and large retail food establishments, butchers and meatcutters work in large meatcutting 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 must be kept clean and sanitary.

Butchers and meatcutters, poultry and fish cutters and trimmers, and slaughterer and meatpackers often work in cold, damp rooms, which are refrigerated to prevent meat from spoiling and 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 and meat, poultry, and fish cutters are more susceptible to injury than are most other workers. In fact, meatpacking plants had one of the highest incidences of work-related injury and illness of any industry in 2002. Nearly 1 in 7 employees in such plants experienced a work-related injury or illness that year.

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 so that steps can be taken to prevent further injury. Nevertheless, workers in the occupation still face the serious threat of disabling injuries.

Most traditional bakers work in bakeries, cake shops, hot-bread shops, hotels, restaurants, and cafeterias. They also may work in the bakery departments of supermarkets and cruise ships. Bakers may work under hot and noisy conditions. Also, bakers typically work under strict order deadlines and critical time-sensitive baking requirements, both of which can induce stress. Bakers usually work in shifts and may work early mornings, evenings, weekends, and holidays. While many bakers often work as part of a team, they also may work alone when baking particular items. They may supervise assistants and teach apprentices and trainees. Bakers in retail establishments may be required to serve customers.

Other food-processing workers, such as food batchmakers, food and tobacco roasting, baking, and drying machine operators, and food cooking machine operators and tenders, 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.

Employment

Food-processing workers held 757,000 jobs in 2002. Employment among the various types of food-processing occupations was distributed as follows:

Bakers	173,000
Meat, poultry, and fish cutters and trimmers	154,000
Butchers and meat cutters	132,000
Slaughterers and meat packers	128,000
Food batchmakers	74,000
All other food processing workers	42,000
Food cooking machine operators and tenders	34,000
Food and tobacco roasting, baking, and drying machine operators and tenders	19,000

About 36 percent of all food-processing workers were employed in animal slaughtering and processing plants. Another 21 percent were employed at grocery stores. Most of the remainder worked in food manufacturing. Butchers, meatcutters, 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.

Training, Other Qualifications, and Advancement

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

Most butchers and poultry and fish cutters and trimmers acquire their skills on the job through formal and informal 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 to learn. The training period for highly skilled butchers at the retail level may be 1 or 2 years.

Generally, on-the-job 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 and how to prepare various cuts of meat. After demonstrating skill with various meatcutting 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 the safety of meats has led employers to offer numerous safety seminars and extensive training in food safety to employees.

Skills that are important to meat, poultry, and fish cutters and trimmers include manual dexterity, good depth perception, color discrimination, and good hand-eye coordination. Physical strength often is needed 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.

Bakers often start as apprentices or trainees. Apprentice bakers usually start in craft bakeries, while in-store bakeries, such as those in supermarkets, often employ trainees. Bakers need to be skilled in baking, icing, and decorating. They also need to be able to follow instructions, have an eye for detail, and communicate well with others. Knowledge of bakery products and ingredients, as well as mechanical mixing and baking equipment, is 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 also is a useful tool for training. The complexity of the skills required for certification as a baker often is underestimated. Bakers need to know about applied chemistry, ingredients and nutrition, government health and sanita-

tion regulations, business concepts, and production processes, including how to operate and maintain machinery. Modern food plants typically use high-speed, automated equipment that often is operated by computers.

Food-machine operators and tenders usually are trained on the job. 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 the appropriate area—dairy processing for those working in diary 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.

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 open their own markets or bakeries. In processing plants, workers may advance to supervisory positions or become team leaders.

Job Outlook

Overall employment in the food-processing occupations is expected to grow as fast as average for all occupations through 2012. Increasingly, cheaper meat imports from abroad will have a negative effect on domestic employment in many food-processing occupations. Job growth will be concentrated at the manufacturing level, as more cutting and processing of meat shifts from retail stores to food-processing plants. Nevertheless, job opportunities should be available at all levels of the occupation due to the need to replace experienced workers who transfer to other occupations or leave the labor force.

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 meatpackers.

Employment growth of lesser skilled meat, poultry, and fish cutters and trimmers—who work primarily in animal slaughtering and processing plants—is expected to increase about as fast as the average for all occupations in coming years. With the growing popularity of labor-intensive, ready-to-heat poultry products, demand for poultry workers should remain firm. Fish cutters also will be in demand, as the task of preparing ready-to-heat fish goods gradually shifts from retail stores to processing plants. Also, advances in fish farming, or "aquaculture," should help meet the growing demand for fish and produce opportunities for fish cutters.

Employment of more highly skilled butchers and meatcutters, who work primarily in retail stores, is expected to continue to decline. Automation and the consolidation of the animal slaughtering and processing industries are enabling employers to transfer employment from higher paid butchers to lower wage slaughterers and meatpackers in meatpacking 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 bakers in manufacturing, overall employment of bakers is expected to increase about as fast as average due to growing numbers of large wholesale bakers, in-store and 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 bread and pastry bakers.

Employment of food batchmakers, food and tobacco cooking and roasting machine operators and tenders, is expected to grow more slowly than average. As more of this work is being done at the manufacturing level rather than at the retail level, potential employment gains will be offset by productivity gains from automated cooking and roasting equipment. All other food processing workers should experience about as fast as average growth.

Earnings

Earnings vary by industry, skill, geographic region, and educational level. Median annual earnings of butchers and meatcutters were $25,500 in 2002. The middle 50 percent earned between $19,440 and $34,140. The highest-paid 10 percent earned more than $42,330 annually, while the lowest 10 percent earned less than $15,490. Butchers and meatcutters 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 meatcutters in 2002 were as follows:

Other general merchandise stores	$30,670
Grocery stores	27,230
Specialty food stores	22,280
Animal slaughtering and processing	20,630

Meat, poultry, and fish cutters and trimmers typically earn less than butchers and meatcutters. In 2002, median annual earnings for these lower skilled workers were $17,820. The middle 50 percent earned between $15,800 and $21,170. The highest 10 percent earned more than $24,840, while the lowest 10 percent earned less than $14,270. Median annual earnings in the industries employing the largest numbers of meat, poultry, and fish cutters and trimmers in 2002 are shown in the following tabulation:

Grocery stores	$20,900
Grocery and related product wholesalers	18,440
Animal slaughtering and processing	17,710
Seafood product preparation and packaging	15,660

Median annual earnings of bakers were $20,580 in 2002. The middle 50 percent earned between $16,420 and $26,610. The highest 10 percent earned more than $33,470, and the lowest 10 percent earned less than $14,100. Median annual earnings in the industries employing the largest numbers of bakers in 2002 are given in the following tabulation:

Bakeries and tortilla manufacturing	$22,030
Other general merchandise stores	21,650
Grocery stores	20,470
Full-service restaurants	19,650
Limited-service eating places	17,830

Median annual earnings of food batchmakers were $21,920 in 2002. The middle 50 percent earned between $16,720 and $28,740. The highest 10 percent earned more than $35,110, and the lowest

10 percent earned less than $13,930. Median annual earnings in the industries employing the largest numbers of food batchmakers in 2002 are presented in the following tabulation:

Dairy product manufacturing	$26,330
Fruit and vegetable preserving and specialty food manufacturing	22,980
Other food manufacturing	22,850
Bakeries and tortilla manufacturing	22,530
Sugar and confectionary product manufacturing	21,390

In 2002, median annual earnings for slaughterers and meatpackers were $20,370. The middle 50 percent earned between $17,650 and $22,900. The highest 10 percent earned more than $26,270, and the lowest 10 percent earned less than $15,350. Median annual earnings in animal slaughtering and processing, the industry employing the largest number of food processing workers, were $20,410 in 2002.

Median annual earnings for food cooking machine operators and tenders were $21,860 in 2002. The middle 50 percent earned between $16,900 and $28,160. The highest 10 percent earned more than $34,890, and the lowest 10 percent earned less than $14,380. Median annual earnings in fruit and vegetable preserving and specialty food manufacturing, the industry employing the largest number of food cooking machine operators and tenders, were $25,320 in 2002.

In 2002, median annual earnings for food and tobacco roasting, baking, and drying machine operators and tenders were $23,260 and for all other food processing workers, $19,410.

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 2002, 25 percent of all butchers and other meat, poultry, and fish processing workers were union members or were covered by a union contract. Sixteen percent of all bakers and 18 percent of all food batchmakers also 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

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

Inspectors, Testers, Sorters, Samplers, and Weighers

(0*NET 51-9061.01, 51-9061.02, 51-9061.03, 51-9061.04, 51-9061.05)

Significant Points

- Seven out of 10 worked in manufacturing establishments.
- For workers who perform relatively simple tests of products, a high school diploma is sufficient; experienced production workers fill more complex inspecting positions.
- Employment is expected to grow more slowly than average, 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 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. Job duties, even within one company, vary by the type of products produced or the stage of production. Specific job duties also vary across the wide range of industries in which these workers are found. For example, 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. Machinery testers 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. Many use micrometers, calipers, alignment gauges, and other instruments to check and compare the dimensions of parts against the parts' specifications. They also may operate electronic equipment, such as coordinate measuring machines (CMMs), which use sensitive probes to measure a part's dimensional accuracy and compare the results with a computerized blueprint. Inspectors testing electrical devices may use voltmeters, ammeters, and oscilloscopes to test insulation, current flow, and resistance.

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 on 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 older production philosophies, it was considered acceptable to simply throw away or repair defective parts, but the root cause of the defects remained. 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. Formerly, many companies considered quality control to be independent from the production work. 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. Many 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 calibrate and monitor the equipment, review output, and perform random product checks.

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,

Inspectors calibrate scales.

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.

Working Conditions

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; in transportation, some travel from place to place to do inspections. 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 do little strenuous work. 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.

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.

Employment

Inspectors, testers, sorters, samplers, and weighers held about 515,000 jobs in 2002. About 7 out of 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, architectural, engineering, and related services, wholesale trade, and government agencies.

Training, Other Qualifications, and Advancement

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. Simple jobs may be filled by beginners provided with in-house training. Training for new inspectors may cover the use of special meters, gauges, computers, or 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.

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. 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 becomes more common, computer skills are increasingly important.

In general, inspectors, testers, sorters, samplers, and weighers need mechanical aptitude, math and communication skills, and good hand-eye coordination and vision. Advancement for these workers frequently takes the form of higher pay. They also may advance to inspector of more complex products, supervisor, or related positions such as purchaser of materials and equipment.

Job Outlook

Like that of many other occupations concentrated in manufacturing industries, employment of inspectors, testers, sorters, samplers, and weighers is expected to grow more slowly than average through the year 2012. The slower than average growth stems primarily from the growing use of automated inspection and the redistribution of quality-control responsibilities from inspectors to production workers. Numerous job openings also will arise due to turnover in this large occupation. Many of these jobs, however, will be open only to experienced production workers with advanced skills.

Employment of inspectors, testers, sorters, samplers, and weighers will be positively affected by the increased focus on quality in American industry. The emphasis on improving quality and productivity has led manufacturers to invest in automated inspection equipment, hire more inspectors, 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 simple inspection tasks, increasing worker productivity and reducing the demand for inspectors.

Inspectors will continue to operate these automated machines and monitor the defects they detect. The increased emphasis on quality has increased the importance of inspection and the demand for inspectors. These two trends—increased emphasis on inspection and increased automation of inspection—have had opposite effects on the demand for inspectors.

Apart from automation, firms are integrating quality control into the production process. Many inspection duties are being redistributed from inspectors, testers, sorters, samplers, and weighers to other production workers who monitor quality at every stage of the 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.

In many industries, however, automation is not being aggressively pursued as an alternative to manual inspection. Where key inspection elements are oriented toward size, such as length, width, or thickness, automation may play some role in the future. But where taste, smell, texture, appearance, fabric complexity, or product performance is important, inspection will probably continue to be done by workers. Employment of inspectors, testers, sorters, samplers, and weighers is expected to increase in the rapidly growing employment services industry, as more manufacturers and industrial firms hire temporary inspectors to increase the flexibility of their staffing strategies.

Earnings

Median hourly earnings of inspectors, testers, sorters, samplers, and weighers were $13.01 in 2002. The middle 50 percent earned between $9.84 and $17.46 an hour. The lowest 10 percent earned less than $7.81 an hour, and the highest 10 percent earned more than $23.56 an hour. Median hourly earnings in the industries employing the largest numbers of inspectors, testers, sorters, samplers, and weighers in 2002 were:

Aerospace product and parts manufacturing	$18.24
Motor vehicle parts manufacturing	16.49
Semiconductor and other electronic component manufacturing	12.86
Plastics product manufacturing	11.94
Employment services	8.85

Related Occupations

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

Sources of Additional Information

For general information about inspection and testing, contact:

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

Jewelers and Precious Stone and Metal Workers

(0*NET 51-9071.01, 51-9071.02, 51-9071.03, 51-9071.04, 51-9071.05, 51-9071.06)

Significant Points

- About one-fourth of all jewelers were self-employed.
- Jewelers usually learn their trade in vocational or technical schools, through distance-learning centers, or on the job.
- Prospects for new jewelers should be excellent; many employers have difficulty finding and retaining workers with the right skills to replace those who retire or who leave the occupation for other reasons.

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; and repair or adjust rings, necklaces, bracelets, earrings, and other jewelry. 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 require 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. Others do finishing work, such as setting stones, polishing, or engraving. Typical repair work includes enlarging or reducing ring sizes, resetting stones, and replacing broken clasps and mountings.

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 using specialized tools, and *polishers* bring a finished luster to the final product.

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

Jewelers typically do the handiwork required to produce a piece of jewelry, while *gemologists* study the quality, characteristics, and value of gem stones. Gemologists usually sell jewelry and provide appraisal services. A few gemologists are employed by insurance companies that offer their own appraisal services for those customers who wish to insure certain pieces of jewelry. Many jewelers also study gemology in order to become familiar with the physical properties of the gem stones with which they work.

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 the jewelry.

Some manufacturing firms use computer-aided design and manufacturing (CAD/CAM) to facilitate product design and automate some steps in the mold- 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 wax-like 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 different retail establishments across the country. Similar techniques may be used in the retail setting, allowing individual customers to review their jewelry designs with the jeweler and make modifications before committing to the expense of a customized piece of jewelry.

Working Conditions

A jeweler's work involves a great deal of concentration and attention to detail. Working on precious stones and metals, while trying to satisfy customers' and employers' demands for speed and quality, can cause fatigue or stress. However, the use of more ergonomically correct jewelers' benches has eliminated most of the strain

Jewelers and precious stone and metal workers must have excellent hand-eye coordination.

and discomfort caused by spending long periods bending over a workbench in one position.

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.

Employment

Jewelers and precious stone and metal workers held about 40,000 jobs in 2002. About one-fourth of these workers were self-employed; many operated their own store or repair shop, and some specialized in designing and creating custom jewelry.

About 3 out of 10 jobs for jewelers and precious stone and metal workers were in other miscellaneous manufacturing, which includes jewelry and silverware manufacturing. Another 3 out of 10 jobs were in retail trade, primarily in jewelry, luggage, and leather goods stores. A small number of jobs were in miscellaneous durable goods merchant wholesalers and in repair shops providing personal and household goods repair and maintenance. Although jewelry stores and repair shops were found in every city and in many small towns, most jobs were in larger metropolitan areas. In 2002, many jewelers employed in manufacturing worked in Rhode Island, New York, or California.

Training, Other Qualifications, and Advancement

Jewelers usually learn their trade in vocational or technical schools, through distance-learning centers, or on the job. Colleges and art and design schools also offer programs that can lead to a Bachelor of Fine Arts or Master of Fine Arts degree in jewelry design. Formal training in the basic skills of the trade enhances one's employment and advancement opportunities. Many employers prefer jewelers with design, repair, and sales skills.

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 jewelry-making and -repairing skills, such as design, casting, stone setting, and polishing. Technical school courses also cover topics such as blueprint reading, math, and shop theory. To enter some technical school, 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. Because computer-aided design is used increasingly in the jewelry field, it is recommended that students—especially those interested in design and manufacturing—obtain training in CAD.

Various institutes offer courses and programs in gemology and jewelry manufacturing and design. Programs cover a wide range of topics, including the identification and grading of diamonds and gem stones.

Most employers feel that vocational- and technical-school graduates need several more years of supervised on-the-job training or apprenticeship, in order 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, or 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 3 to 4 years, depending on the difficulty of the specialty. Training usually focuses on casting, stone setting, modelmaking, or engraving. In recent years, a growing number of technical schools have begun to offer training designed for jewelers working in manufacturing. As a result, those in manufacturing now prefer graduates of these programs because they are familiar with the production process, requiring less on-the-job training.

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, 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.

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 takes the form of higher pay for doing 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 experience in selling, as well as knowledge of marketing and business management. Courses in these areas often are available from technical schools and community colleges.

Job Outlook

Employment of jewelers and precious stone and metal workers is expected to grow more slowly than the average through 2012. Employment opportunities, however, should be excellent, because jewelry sales are increasing. New jewelers also 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. Some technological advances have made jewelrymaking more efficient; however, many tasks cannot be fully automated. Jewelry work is a labor-intensive process that requires excellent handiwork.

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.

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. Because these marketers enjoy increases in sales, however, they will need highly skilled jewelers to make and repair the jewelry they sell.

Opportunities in jewelry stores and repair shops will be best for graduates from training programs for jewelers or gemologists. Despite an increase in sales by nontraditional jewelry marketers, traditional jewelers should not be affected greatly. Traditional jewelers have the advantage of being able to build client relationships based on trust. Many clients prefer to work directly with a jeweler, to ensure that the product is of the highest quality and meets their specifications. Many traditional jewelers expand their businesses as clients recommend their services to friends and relatives.

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. Also, many nontraditional vendors typically do not offer repair services.

Within manufacturing, increasing automation will adversely affect employment of low-skilled occupations, such as assemblers and polishers. Automation will have a lesser impact on more creative, highly skilled positions, such as mold- and modelmakers. Furthermore, small manufacturers, which typify the industry, will have an increasingly difficult time competing with the larger manufacturers when it comes to supplying large retailers. Because of recent international trade agreements, exports are increasing modestly as manufacturers become more competitive in foreign markets. However, imports from foreign manufacturers are increasing more rapidly than exports, due to these same agreements.

Earnings

Median annual earnings for jewelers and precious stone and metal workers were $26,260 in 2002. The middle 50 percent earned between $19,550 and $35,310. The lowest 10 percent earned less than $15,030, and the highest 10 percent earned more than $45,620. In 2002, median annual earnings in the industries employing the largest numbers of jewelers and precious stone and metal workers were $30,000 in jewelry, luggage, and leather goods stores and $22,650 in other miscellaneous manufacturing.

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, in addition to their base salary. 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 designers. Finally, some jewelers and precious stone and metal workers are involved in the buying and selling of stones and metals or of the finished piece 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 is available from:

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

General career information is available from:

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

To receive a list of accredited technical schools that have programs in jewelry design, 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

(0*NET 51-4021.00, 51-4022.00, 51-4023.00, 51-4031.01, 51-4031.02, 51-4031.03, 51-4031.04, 51-4032.00, 51-4033.01, 51-4033.02, 51-4034.00, 51-4035.00, 51-4051.00, 51-4052.00, 51-4061.00, 51-4062.00, 51-4071.00, 51-4072.01, 51-4072.02, 51-4072.03, 51-4072.04, 51-4072.05, 51-4081.01, 51-4081.02, 51-4191.01, 51-4191.02, 51-4191.03, 51-4192.00, 51-4193.01, 51-4193.02, 51-4193.03, 51-4193.04, 51-4194.00, 51-4199.99)

Significant Points

- Machine setters, operators, and tenders—metal and plastic operate powerful, high-speed machines that can be dangerous if strict safety rules are not observed.
- A few weeks of on-the-job training is sufficient for most workers to learn basic machine operations, but several years are required to become a highly skilled operator or setter.
- Overall employment growth in the various machine setter, operator, and tender occupations will be slower than average, although employment trends among these occupations will diverge over the 2002-12 period.

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 tool 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 tend the machines during production. Setup workers prepare the machines *prior* to production and may adjust the machinery during its operation. Operators and tenders primarily monitor the machinery *during* its operation, sometimes loading or unloading the machine or making 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. Newer production techniques, such as team-oriented "lean" manufacturing, require machine operators to rotate between different machines. Rotating assignments result in more varied work, but also require 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. They adjust the speed, feed, and other controls, choose the proper coolants and lubricants, and select the instruments or tools for each operation. Using micrometers, gauges, and other precision measuring instruments, they also may compare the completed work with the tolerance limits stated in the specifications.

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 machined products or presses that extrude 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 may watch one or more machines and make minor adjustments according to their instructions. Regardless of the type of machine they operate, machine tenders usually depend on skilled 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.

Machine setters, operators, and tenders operate some computer-controlled machines.

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 employed. 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.

Workers in three distinct specialties—setters, operators, and tenders—operate injection-molding machines. Most other types of plastic machines function in a similar manner. A typical injection-molding machine may have 25 different controls that can be adjusted. Setters or technicians set up the machines prior to their operation. These workers are responsible for repairing any major problem. Operators monitor the many gauges on injection-molding machines, adjusting different inputs, pressures, and speeds to maintain quality. Tenders remove the cooled plastic from the mold, loading the product into boxes.

Working Conditions

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.

Most workers in the occupation put in a 40-hour week, but overtime is common during periods of increased production. Because many metalworking and plastics working shops operate more than one shift daily, some operators work nights and weekends.

Employment

Machine setters, operators, and tenders—metal and plastic held about 1.3 million jobs in 2002. Approximately 9 of 10 jobs were found in manufacturing. About 38 percent of all employment was in these manufacturing industries: transportation equipment manufacturing, plastics and rubber products manufacturing, and machinery manufacturing. The following tabulation shows the distribution of employment of machine setters, operators, and tenders—metal and plastic by detailed occupation.

Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	283,000
Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	151,000
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	104,000
Multiple machine tool setters, operators, and tenders, metal and plastic	99,000
Extruding and drawing machine setters, operators, and tenders, metal and plastic	98,000
Lathe and turning machine tool setters, operators, and tenders, metal and plastic	75,000
Drilling and boring machine tool setters, operators, and tenders, metal and plastic	53,000
Forging machine setters, operators, and tenders, metal and plastic	45,000
Rolling machine setters, operators, and tenders, metal and plastic	44,000
Plating and coating machine setters, operators, and tenders, metal and plastic	44,000
Milling and planing machine setters, operators, and tenders, metal and plastic	31,000
Heat treating equipment setters, operators, and tenders, metal and plastic	29,000
Tool grinders, filers, and sharpeners	26,000
Foundry mold and coremakers	23,000
Metal-refining furnace operators and tenders	18,000
Pourers and casters, metal	13,000
Lay-out workers, metal and plastic	13,000
Model makers, metal and plastic	8,500
Patternmakers, metal and plastic	6,500
All other metal workers and plastic workers	104,000

Training, Other Qualifications, and Advancement

Machine setters, operators, and tenders—metal and plastic learn their skills on the job. Trainees begin by observing and assisting experienced workers, sometimes in formal training programs. 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 become responsible for their own machines.

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 they may need a year 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 operator classes. Other employers prefer to hire workers who have completed, or currently are enrolled in, a training program.

Setters or technicians normally need a thorough knowledge of the machinery and of the products being manufactured, because they often plan the sequence of work, make the first production run, and determine which adjustments need to be made. Strong analytical abilities are particularly important for this job. Some

companies have formal training programs for operators and setters; often, the programs combine classroom instruction with on-the-job training.

Although no special education is required for many jobs in the occupation, employers prefer to hire applicants with good basic skills. Many require employees to have a high school education and to read, write, and speak English. Because machinery is becoming more complex and shop-floor organization is changing, employers increasingly look for persons with good communication and interpersonal skills. Mechanical aptitude, manual dexterity, and experience working with machinery also are helpful. Those interested in becoming machine setters, operators, and tenders 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.

Job opportunities and advancement can be enhanced as well 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 a course approved by the organization 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. To achieve machine-operator certification, 2 years of experience operating a plastics-processing machine is recommended, and one must pass a computer-based exam.

Advancement for operators usually takes the form of higher pay, although there are some limited opportunities for operators to advance to new positions as well. For example, they can become multiple-machine operators, setup operators, or trainees for the more highly skilled position of machinist, tool and die maker, or computer-control programmer or operator. Some setup workers may advance to supervisory positions. (See the statements on machinists, computer-control programmers and operators, and tool and die makers elsewhere in the *Handbook*.)

Job Outlook

Overall employment growth in the various machine setter, operator, and tender occupations will be slower than average, although employment trends among these occupations will diverge over the 2002-12 period. In general, employment of workers in the occupation will be affected by the rate of technological implementation, the demand for the goods they produce, the effects of trade, and the reorganization of production processes. Employment of multiple-machine-tool operators; molding, coremaking, and casting-machine operators, metal and plastic; and a number of miscellaneous operating occupations is expected to grow. A decline in employment, however, is projected for some machine tool operators, including metal-refining furnace operators and tenders and pourers and casters, metal. Despite differing rates of employment change, a large number of machine setter, operator, and tender jobs will become available due to an expected surge in retirements as some baby boomers become eligible for retirement by the end of the decade.

One of the most important factors influencing employment change in this occupation is the implementation of labor-saving machinery. In order to remain competitive by improving quality and lowering production costs, many firms are adopting new technologies, such as computer-controlled machine tools and robots. 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 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 consumer and manufactured 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 opportunities for many 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.

Workers with a thorough background in machine operations, exposure to a variety of machines, and a good working knowledge of the properties of metals and plastics will be best 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 and operate more machines, the number of multiple-machine-tool operators, setters, and tenders—metal and plastic will continue to rise.

Earnings

Earnings for machine operators can vary by size of the company, union or nonunion 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 company-employed workers. The median hourly earnings in 2002 for a variety of machine setters, operators, and tenders—metal and plastic were as follows:

Model makers, metal and plastic	$18.27
Patternmakers, metal and plastic	16.09
Metal-refining furnace operators and tenders	14.79
Lay-out workers, metal and plastic	14.79
Lathe and turning machine tool setters, operators, and tenders, metal and plastic	14.55
Tool grinders, filers, and sharpeners	14.14
Milling and planing machine setters, operators, and tenders, metal and plastic	14.04
Multiple machine tool setters, operators, and tenders, metal and plastic	13.79
Rolling machine setters, operators, and tenders, metal and plastic	13.62
Heat treating equipment setters, operators, and tenders, metal and plastic	13.56
Pourers and casters, metal	13.40
Drilling and boring machine tool setters, operators, and tenders, metal and plastic	13.23
Forging machine setters, operators, and tenders, metal and plastic	12.64
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	12.56
Foundry mold and coremakers	12.55
Extruding and drawing machine setters, operators, and tenders, metal and plastic	12.44
Plating and coating machine setters, operators, and tenders, metal and plastic	12.22
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	11.81
Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	11.17
All other metal workers and plastic workers	13.65

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; 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 metal machine setters, operators, and tenders, contact any of the following organizations:

➤ 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, 1801 K St. NW., Suite 600K, Washington, DC 20006-1301. Internet: **http://www.socplas.org**

Machinists

(0*NET 51-4041.00)

Significant Points

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

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.

Before they machine a part, machinists must carefully plan and prepare the operation. These workers first review blueprints or written specifications for a job. Next, they calculate where to cut or bore into the workpiece (the piece of metal that is being shaped), how fast to feed the metal into the machine, and how much metal to remove. They then select tools and materials for the job, plan the sequence of cutting and finishing operations, and mark the metal stock to show where cuts should be made.

After this layout work is completed, machinists perform the necessary machining operations. They position the metal stock 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 being 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. Some rare but increasingly popular metals, such as titanium, are machined at extremely high temperatures.

Machinists detect some problems by listening for specific sounds—for example, 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). Frequently, machinists work with computer-control programmers to determine how the automated equipment will cut a part. (See the statement on computer control programmers and operators elsewhere in the *Handbook*.) The programmer may determine the path of the cut, while the machinist determines the type of cutting tool, the speed of the cutting tool, and the feed rate. 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. After the production process is designed, relatively simple and repetitive operations normally are performed by machine setters, operators, and tenders. (See the statement on machine setters, operators, and tenders—metal and plastic, elsewhere in the *Handbook*.)

Some manufacturing techniques employ automated parts loaders, automatic tool changers, and computer controls, allowing machine tools 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, and perform other tasks on several CNC machines that operate 24 hours a day (lights-out manufacturing). During lights-out manufacturing, a factory may need only a few machinists to monitor the entire factory.

Other machinists do maintenance work—repairing or making new parts for existing machinery. To repair a broken part, maintenance machinists may refer to blueprints and perform the same machining operations that were needed to create the original part.

Working Conditions

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 extensively employ autoloaders and overhead cranes, reducing heavy lifting.

Most machinists work a 40-hour week. Evening and weekend shifts are becoming more common as companies justify investments in more expensive machinery by extending hours of operation. However, this trend is somewhat offset by the increasing use of lights-out manufacturing. Overtime is common during peak production periods.

Employment

Machinists held about 387,000 jobs in 2002. Most machinists work in small machining shops or in manufacturing industries, such as machinery manufacturing and transportation equipment manufacturing (motor vehicle parts and aerospace products and parts). Main-

Machinists replace worn cutting tools.

tenance machinists work in most industries that use production machinery.

Training, Other Qualifications, and Advancement

Machinists train in apprenticeship programs, informally on the job, and in high schools, vocational schools, or community or technical colleges. Experience with machine tools is helpful. In fact, many entrants previously have worked as machine setters, operators, or tenders. Persons 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 1/10,000th of an inch) that requires concentration and physical effort.

High school or vocational school courses in mathematics (especially trigonometry), blueprint reading, metalworking, and drafting are highly recommended. Apprenticeship programs consist of 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 taught in cooperation with local community or vocational colleges. A growing number of machinists learn 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.

To boost the skill level of machinists and to create a more uniform standard of competency, a number of training facilities 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 a performance requirement and written exam, trainees are granted a NIMS credential, which provides formal recognition of competency in a metalworking field. Completing a recognized certification program provides a machinist with better career opportunities.

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.

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 shops.

Job Outlook

Despite projected slower-than-average employment growth, job opportunities for machinists should continue to be excellent. Many young people with the necessary educational and personal qualifications needed to obtain machining skills may prefer to attend college or may not wish to enter production occupations. Therefore, the number of workers obtaining the skills and knowledge necessary to fill machinist jobs is expected to be less than the number of job openings arising each year from employment growth and from the need to replace experienced machinists who transfer to other occupations or retire.

Employment of machinists is expected to grow more slowly than the average for all occupations over the 2002-12 period because of rising productivity among these workers. 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 previously performed by more workers. Technology is not expected to affect the employment of machinists as significantly as that of most other production occupations, 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.

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 remain critical to manufacturing operations, even when production levels fall.

Earnings

Median hourly earnings of machinists were $15.66 in 2002. The middle 50 percent earned between $12.15 and $19.45. The lowest 10 percent earned less than $9.57, while the top 10 percent earned more than $23.17. Median hourly earnings in the manufacturing industries employing the largest number of machinists in 2002 were:

Metalworking machinery manufacturing	$16.75
Other general purpose machinery manufacturing	15.91
Machine shops; turned product; and screw, nut, and bolt manufacturing	15.45
Motor vehicle parts manufacturing	15.18
Employment services	9.41

Related Occupations

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

Sources of Additional Information

For general information about machinists, contact:

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

For general occupational information and a list of training programs, contact:

➤ Precision Metalforming Association Educational Foundation, 6363 Oak Tree Blvd., Independence, OH 44131-2500. Internet: **http://www.pmaef.org**

Ophthalmic Laboratory Technicians

(0*NET 51-9083.01, 51-9083.02)

Significant Points

- Nearly all ophthalmic laboratory technicians learn their skills on the job.
- Employment is expected to grow more slowly than the average, reflecting the increasing use of automated machinery.
- Only a limited number of job openings will be created each year, because the occupation is small.

Nature of the Work

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 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 statements 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.

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.

Working Conditions

Ophthalmic laboratory technicians work in relatively clean and well-lighted laboratories and have limited contact with the public. Their surroundings are relatively quiet despite the humming of machines. At times, technicians wear goggles to protect their eyes, and they may spend a great deal of time standing.

Most ophthalmic laboratory technicians work a 5-day, 40-hour week, which may include weekends, evenings, or, occasionally, some overtime. Some work part time.

Ophthalmic laboratory technicians need to take precautions against the hazards associated with cutting glass, handling chemicals, and working near machinery.

Employment

Ophthalmic laboratory technicians held about 33,000 jobs in 2002. Around 34 percent were in health and personal care stores, such as optical goods stores that manufacture and sell prescription glasses and contact lenses. About 29 percent were in medical equipment and supplies manufacturing, working for ophthalmic goods manufacturers that produce eyewear and contact lenses for sale by retail stores, as well as by ophthalmologists and optometrists. Most of the rest were in offices of other health practitioners, professional and commercial equipment and supplies merchant wholesalers, offices of physicians, employment services, or in commercial and service industry machine manufacturing firms that produce lenses for other optical instruments, such as telescopes and binoculars.

Although some lenses are still produced by hand, ophthalmic laboratory technicians increasingly use automated equipment to make lenses.

Training, Other Qualifications, and Advancement

Nearly all ophthalmic laboratory technicians learn their skills on the job. 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.

Technician trainees producing lenses by hand start on simple tasks, such as marking or blocking lenses for grinding, and then progress to grinding, cutting, edging, and beveling lenses, and, finally, to assembling the eyeglasses. Depending on individual aptitude, it may take up to 6 months to become proficient in all phases of the work.

Technicians using automated systems will find computer skills valuable. Training is completed on the job and varies in duration, depending on the type of machinery and the worker's aptitude.

A very small number of 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.

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

Job Outlook

Overall employment of ophthalmic laboratory technicians is expected to grow more slowly than the average for all occupations through the year 2012, reflecting the increasing use of automated machinery. Most job openings will arise from the need to replace technicians who transfer to other occupations or who leave the labor force. Only a limited number of job openings will be created each year, because the occupation is small.

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.

Fashion also influences demand. Frames come in a variety of styles and colors, encouraging people to buy more than one pair. Demand is expected to grow as well in response to the availability of new technologies that improve the quality and look of corrective lenses, such as antireflective coatings and bifocal lenses without the line that is visible in traditional bifocals.

Earnings

Median hourly earnings of ophthalmic laboratory technicians were $10.46 in 2002. The middle 50 percent earned between $8.73 and $13.05 an hour. The lowest 10 percent earned less than $7.56, and the highest 10 percent earned more than $16.40 an hour. In 2002, median hourly earnings of ophthalmic laboratory technicians were $10.68 in medical equipment and supplies manufacturing and $10.15 in health and personal care stores.

Related Occupations

Workers in other precision production occupations include dental laboratory technicians; opticians, dispensing; orthotists and prosthetists; and precision instrument and equipment repairers.

Sources of Additional Information

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

➤ Commission on Opticianry Accreditation, P.O. Box 3073, Merrifield, VA 22116-3073.

State employment service offices can provide information about job openings for ophthalmic laboratory technicians.

Painting and Coating Workers, Except Construction and Maintenance

(0*NET 51-9121.01, 51-9121.02, 51-9122.00, 51-9123.00)

Significant Points

- Nearly 70 percent of jobs are in manufacturing establishments.
- Most workers acquire their skills on the job; for most operators, training lasts from a few days to several months, but becoming skilled in all aspects of automotive painting usually requires 1 to 2 years.
- Employment growth for highly skilled transportation painters and automotive refinishers is projected to be faster than for lesser skilled painting, coating, and spraying machine operators, whose jobs are subject to automation.

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. Often, the protection provided by the paint or coating is essential to the product, as with the coating of insulating material covering wires and other electrical and electronic components. Many paints and coatings have dual purposes; for example, the paint finish on an automobile heightens the visual appearance of the vehicle while providing protection from corrosion.

Painting, coating, and spraying machine setters, operators, and tenders control the machinery that applies these paints and coatings to a wide range of manufactured products. 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. Similarly, *tumbling barrel painters* deposit articles made of porous materials in a barrel of paint, varnish, or other coating, which is then rotated to ensure thorough coverage.

Another familiar technique is spraying products with a solution of paint or some other coating. *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 equipment's tanks with a mixture of paints or chemicals, adding prescribed amounts of solution. They adjust nozzles on the spray guns to obtain the proper dispersion of the spray and hold or position the guns 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. Individuals who paint, coat, or decorate articles such as furniture, glass, pottery, toys, and books are known as *painting, coating, and decorating workers.*

Painting workers use various types of machines to coat a range of products. Frequently, their job title reflects the specialized nature of the machine or the coating being applied. For example, *enrobing machine operators* coat, or "enrobe," confectionery, bakery, and other food products with melted chocolate, cheese, oils, sugar, or other substances. *Paper coating machine operators* spray "size" on rolls of paper to give it its gloss or finish. *Silvering applicators* spray silver, tin, and copper solutions on glass in the manufacture of mirrors.

In response to concerns about air pollution and worker safety, manufacturers increasingly are using new types of paints and coatings on their products, instead of high-solvent paints. Water-based paints and powder coatings are two of the most common. These compounds do not emit as many volatile organic compounds into the air and can be applied to a variety of products. Powder coatings are sprayed much as are liquid paints and then are heated to melt and cure the coating.

The adoption of new types of paints often is accompanied by a conversion to more automated painting equipment that the operator sets and monitors. When using these machines, 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 that prepares the paint for application. During operation, these workers tend painting machines, observe gauges on the control panel, and randomly check articles for evidence of any variation from specifications. The operator then uses a spray gun to "touch up" spots where necessary.

Although the majority of these workers are employed in manufacturing, the best known group refinishes old and damaged cars, trucks, and buses in automotive body repair and paint shops. *Transportation equipment* or *automotive painters* 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.

To prepare a vehicle for painting, painters or their helpers use power sanders and sandpaper to remove the original paint or rust and then fill small dents and scratches with body filler. They also remove or mask parts they do not want to paint, such as chrome trim, headlights, windows, and mirrors. Automotive painters use a spray gun to apply several coats of paint. They apply lacquer, enamel, or water-based primers to vehicles with metal bodies and flexible primers to newer vehicles with plastic body parts. Controlling the spray gun by hand, they apply successive coats until the finish of the repaired sections of the vehicle matches that of the original, undamaged portions. To speed drying between coats, they may place the freshly painted vehicle under heat lamps or in a special infrared oven. After each coat of primer dries, they sand the surface to remove any irregularities and to improve the adhesion of

Spraying machine operators use spray guns to coat a variety of products and surfaces.

the next coat. Final sanding of the primers may be done by hand with a fine grade of sandpaper. A sealer then is applied and allowed to dry, followed by the final topcoat. When lacquer is used, painters or their helpers usually polish the finished surface after the final coat has dried.

Working Conditions

Painting and coating workers typically work indoors and may be exposed to dangerous fumes from paint and coating solutions. Although painting usually is done in special ventilated booths, many operators wear masks or respirators that cover their noses and mouths. In addition, Federal legislation has led to a decrease in workers' exposure to hazardous chemicals by regulating emissions of volatile organic compounds from paints and other chemicals. This legislation also has led to increasing use of more sophisticated paint booths and fresh-air systems that provide a safer work environment.

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. Most operators work a normal 40-hour week, but self-employed automotive painters sometimes work more than 50 hours a week, depending on the number of vehicles customers want repainted.

Employment

Painting and coating workers held about 187,000 jobs in 2002. Lesser skilled coating, painting, and spraying machine setters, operators, and tenders accounted for about 103,000 jobs, while more skilled transportation equipment painters constituted about 50,000. About 34,000 workers were painting, coating, and decorating workers.

Nearly seventy percent of jobs for salaried workers were found in manufacturing establishments, where the workers applied coatings to items such as fabricated metal products, motor vehicles and related equipment, industrial machines, household and office furniture, and plastics, wood, and paper products. Other workers included automotive painters employed by independent automotive repair shops and body repair and paint shops operated by retail motor vehicle dealers. About 8 percent of painting workers were self-employed; most of these were transportation equipment painters.

Training, Other Qualifications, and Advancement

Most painting and coating workers acquire their skills on the job, usually by watching and helping other, more experienced workers. For most setters, operators, and tenders, as well as painting, coating, and decorating workers, training lasts from a few days to several months. Coating, painting, and spraying machine setters, operators, and tenders who modify the operation of computer-controlled equipment while it is running may require additional training in computer operations and minor programming.

Similarly, most transportation equipment painters start as helpers and gain their skills informally on the job. Becoming skilled in all aspects of automotive painting usually requires 1 to 2 years of on-the-job training. Beginning helpers usually remove trim, clean and sand surfaces to be painted, mask surfaces that 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.

Painters should have keen eyesight and a good sense of color. The completion of high school generally is not required, but is advantageous. Additional instruction is offered at many community colleges and vocational or technical schools. Such programs enhance one's employment prospects and can speed promotion to the next level.

Some employers sponsor training programs to help their workers become more productive. This training is available from manufacturers of chemicals, paints, or equipment or from other private sources. It may include safety and quality tips and impart knowledge of products, equipment, and general business practices. Some automotive painters are sent to technical schools to learn the intricacies of mixing and applying different types of paint.

Voluntary certification by the National Institute for Automotive Service Excellence 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 painting and refinishing may substitute for up to 1 year of experience. To retain their 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. Those who acquire practical experience, college, or other formal training may become sales or technical representatives for chemical or paint companies. Eventually, some automotive painters open their own shops.

Job Outlook

Overall employment of painting and coating workers is expected to grow about as fast as the average for all occupations through the year 2012. Employment growth for highly skilled transportation painters and automotive refinishers is projected to be faster than for lesser skilled painting, coating, and spraying machine operators. In addition to jobs arising from growth, some jobs will become available each year as employers replace experienced operators who transfer to other occupations or leave the labor force.

An increasing population demanding more manufactured goods will spur employment growth among coating, painting, and spraying machine operators. Similarly, increasing demand for hand-painted tiles and related specialty products will lead to growth among painting, coating, and decorating workers. Employment growth will be limited, however, by improvements in the automation of paint and coating applications that will raise worker productivity. For example, operators will be able to coat goods more rapidly as they use sophisticated industrial robots that move and aim spray guns increasingly as humans do; as the cost of robots continues to fall, they will be more widely used. Legislation has set limits on the emissions of ozone-forming volatile organic compounds and is expected to impede job growth among operators in manufacturing; as these firms switch to water-based and powder coatings to comply with the law, they will introduce more efficient automation.

Because the detailed work of refinishing automobiles in collision repair shops and motor vehicle dealerships does not lend itself to automation, painters employed in these establishments are projected to experience faster employment growth. As the demand for refinishing continues to grow, slower productivity growth among these workers will lead to employment increases that are more in line with the growing demand for their services.

The number of job openings for painting and coating workers may fluctuate from year to year due to cyclical changes in economic conditions. When demand for manufactured goods lessen, production may be suspended or reduced, and workers may be laid off or face a shortened workweek. Automotive painters, by contrast, can expect relatively steady work because automobiles damaged in accidents require repair and refinishing regardless of the state of the economy.

Earnings

Median hourly earnings of coating, painting, and spraying machine setters, operators, and tenders were $12.16 in 2002. The middle 50 percent earned between $9.81 and $15.17 an hour. The lowest 10 percent earned less than $8.11, and the highest 10 percent earned more than $18.73 an hour.

Median hourly earnings of transportation equipment painters were $16.13 in 2002. The middle 50 percent earned between $12.31 and $21.40 an hour. The lowest 10 percent earned less than $9.70, and the highest 10 percent earned more than $26.48 an hour. Median hourly earnings of transportation equipment painters were $15.86 in automotive repair and maintenance shops and $23.23 in motor vehicle manufacturing.

Median hourly earnings of painting, coating, and decorating workers were $10.19 in 2002. The middle 50 percent earned between $8.16 and $13.08 an hour. The lowest 10 percent earned less than $7.04, and the highest 10 percent earned more than $16.72 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 Brotherhood of Painters and Allied Trades, the Sheet Metal Workers International Association, and the International Brotherhood of Teamsters. Most union operators work for manufacturers and large motor vehicle dealers.

Related Occupations

Other occupations in which workers apply paints and coatings include painters and paperhangers, woodworkers, and machine setters, operators, and tenders—metal and plastic.

Sources of Additional Information

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

Information on how to become a certified automotive painter is available from:

➤ National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Leesburg, VA 20175. Internet: **http://www.asecert.org**

Photographic Process Workers and Processing Machine Operators

(0*NET 51-9131.01, 51-9131.02, 51-9131.03, 51-9131.04, 51-9132.00)

Significant Points

- Little or no employment growth is expected as digital photography becomes commonplace.
- Most receive on-the-job training from their companies, manufacturers' representatives, and experienced workers.
- 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 and prints to emphasize or correct specific features.

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 a developer solution. This brings out the latent image. The next steps include immersing the negative in a stop-bath to halt the developer action, transferring it to a hyposolution to fix the image, and then immersing 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.

Working Conditions

Photographic process workers and processing machine operators generally spend their work hours in clean, appropriately lighted, well-ventilated, and air-conditioned offices, photofinishing laboratories, or 1-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 at a rapid pace without any loss of accuracy. Photographic process workers do detailed tasks, such as airbrushing and spotting, which can contribute to eye fatigue.

Many photo laboratory employees work a 40-hour week, including evenings and weekends, and may work overtime during peak seasons. Almost one-fourth work part time.

Employment

Photographic process workers held about 28,000 jobs in 2002. Almost one in four photographic process workers were employed in photofinishing laboratories and 1-hour minilabs. More than one in six worked for portrait studios or commercial laboratories that specialize in processing the work of professional photographers for advertising and other industries. An additional one in six were employed by general merchandise stores, and one in ten in the printing, publishing, and motion picture industries.

Photographic processing machine operators held about 54,000 jobs in 2002. About four in ten worked in retail establishments, primarily in general merchandise stores and drug stores. About three in ten worked in photofinishing laboratories and 1-hour minilabs. Small numbers were employed in the printing industry and in portrait studios and commercial laboratories that process the work of professional photographers.

Employment fluctuates somewhat over the course of the year. Typically, employment peaks during school graduation and summer vacation periods, and again during the winter holiday season.

Film process technicians operate machines that develop exposed photographic film to produce negative or positive images.

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.

Employers prefer applicants who are high school graduates or those 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.

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

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

Job Outlook

Slower-than-average growth is expected for photographic process workers and processing machine operators through the year 2012. Most openings will result from replacement needs, which are higher for machine operators than for photographic process workers.

In recent years, the use of digital cameras, which use electronic memory rather than film to record images, has grown rapidly among professional photographers and advanced amateurs. As the cost of digital photography drops, the use of such cameras will become more widespread among amateur photographers, reducing the demand for traditional photographic processing machine operators. However, conventional cameras, which use film to record images, are expected to continue to be the camera of choice among most casual photographers. Population growth and the popularity of amateur and family photography will contribute to a continuing need for photographic processing machine operators to process the film used in conventional cameras, including increasingly sophisticated disposable cameras. This need will prevent what otherwise would be even slower growth in the number of these workers.

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 will be able to download and view pictures on their computer, as well as 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. Moreover, not all consumers will want to invest in the software. Job opportunities will be best for individuals with experience using computers and digital technology.

Earnings

Earnings of photographic process workers vary greatly depending on skill level, experience, and geographic location. Median hourly earnings for photographic process workers were $9.72 in 2002. The middle 50 percent earned between $7.84 and $13.08. The lowest 10 percent earned less than $6.79, and the highest 10 percent earned more than $17.43. Median hourly earnings were $9.75 in photofinishing laboratories, the largest employer of photographic process workers.

Median hourly earning for photographic processing machine operators were $9.05 in 2002. The middle 50 percent earned between $7.53 and $11.63. The lowest 10 percent earned less than $6.53, and the highest 10 percent earned more than $15.60. Median hourly earnings in the two industries employing the largest numbers of photographic processing machine operators were $10.15 in photofinishing laboratories and $7.20 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.

Power Plant Operators, Distributors, and Dispatchers

(0*NET 51-8011.00, 51-8012.00, 51-8013.01, 51-8013.02)

Significant Points

- Most entry-level workers start as helpers or laborers, and several years of training and experience are required to become fully qualified.
- Applicants are expected to encounter keen competition for jobs.
- Opportunities will be best for operators with training in computers and automated equipment.

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* and *control room operator trainees* or *assistants*. In older plants, the controls for the equipment are not centralized, and *swtchboard operators* control the flow of electricity from a central point, whereas *auxiliary equipment operators* work throughout the plant, operating and monitoring valves, switches, and gauges.

The Nuclear Regulatory Commission (NRC) licenses operators of nuclear power plants. *Reactor operators* are authorized to control equipment that affects the power of the reactor in a nuclear power plant. In addition, an NRC-licensed *senior reactor operator* must be on duty during each shift to act as the plant supervisor and supervise the operation of all controls in the control room.

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 electric needs. 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, 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.

Working Conditions

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

Employment

Power plant operators, distributors, and dispatchers held about 51,000 jobs in 2002. Jobs were located throughout the country. About 86 percent of jobs were in utility companies and government agencies that produced electricity. Others worked for manufacturing establishments that produced electricity for their own use.

Training, Other Qualifications, and Advancement

Employers seek high school graduates for entry-level operator, distributor, and dispatcher positions. Candidates with strong mathematics and science skills are preferred. College-level courses or prior experience in a mechanical or technical job may be helpful. With computers now used to keep records, generate reports, and track maintenance, employers are increasingly requiring computer proficiency. Most entry-level workers start as helpers or laborers. Depending on the results of aptitude tests, their own preferences, and the availability of openings, workers may be assigned to train for one of many utility positions.

Workers selected for training as a fossil-fueled power plant operator or distributor undergo extensive on-the-job and classroom instruction. Several years of training and experience are required to become a fully qualified control room operator or power plant distributor. With further training and experience, workers may advance to shift supervisor. Utilities generally promote from within; therefore, opportunities to advance by moving to another employer are limited.

A power plant dispatcher uses a computer to control the flow of electricity.

Extensive training and experience are necessary to pass the NRC examinations for reactor operators and senior reactor operators. To maintain their license, licensed reactor operators must pass an annual practical plant operation exam and a biennial written exam administered by their employers. Training may include simulator and on-the-job training, classroom instruction, and individual study. Entrants to nuclear power plant operator trainee jobs must have strong mathematics and science skills. Experience in other power plants or with Navy nuclear propulsion plants also is helpful. With further training and experience, reactor operators may advance to senior reactor operator positions.

In addition to receiving preliminary training as a power plant operator, distributor, or dispatcher, most workers are given periodic refresher training—frequently in the case of 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.

Job Outlook

People who want to become power plant operators, distributors, and dispatchers are expected to encounter keen competition for these high-paying jobs. Declining employment and very low replacement needs in the occupation will result in few job opportunities. The slow pace of construction of new plants also will limit opportunities for power plant operators, distributors, and dispatchers. In addition, the increasing use of automatic controls and more computerized equipment should boost productivity and decrease the demand for operators. As a result, individuals with training in computers and automated equipment will have the best job prospects.

A decline in employment of power plant operators, distributors, and dispatchers is expected through the year 2012, as the utilities industry continues to restructure in response to deregulation and increasing competition. The Energy Policy Act of 1992 continues to have an impact on the organization of the industry. The Act aims at increasing competition in power-generating utilities by allowing independent producers to sell power directly to industrial and other wholesale customers. Consequently, utilities, which historically operated as regulated local monopolies, are restructuring their operations in order to reduce costs and compete effectively; as a result, the number of jobs is decreasing.

Earnings

Median annual earnings of power plant operators were $49,920 in 2002. The middle 50 percent earned between $40,090 and $58,690. The lowest 10 percent earned less than $31,290, and the highest 10 percent earned more than $67,950. Median annual earnings of power plant operators in 2002 were $52,410 in electric power generation, transmission, and distribution and $44,200 in local government.

Median annual earnings of nuclear power reactor operators were $61,060 in 2002. The middle 50 percent earned between $53,060 and $70,580. The lowest 10 percent earned less than $48,060, and the highest 10 percent earned more than $79,880.

Median annual earnings of power distributors and dispatchers were $54,120 in 2002. The middle 50 percent earned between $43,750 and $65,390. The lowest 10 percent earned less than $34,640, and the highest 10 percent earned more than $75,420.

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 wastewater treatment plant and system operators.

Sources of Additional Information

For information about employment opportunities, contact local electric utility companies, locals of 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.

Prepress Technicians and Workers

(0*NET 51.5021.00, 51-5022.01, 51-5022.02, 51-5022.03, 51-5022.04, 51-5022.05, 51-5022.06, 51-5022.07, 51-5022.08, 51-5022.09, 51-5022.10, 51-5022.11, 51-5022.12, 51-5022.13)

Significant Points

- Most workers train on the job; some complete formal graphics arts programs or other postsecondary programs in printing technology.
- Most employers prefer to hire workers with experience in the printing industry.
- Employment is projected to decline as the increased use of computers in typesetting and page layout eliminates many prepress jobs.

Nature of the Work

The printing process has three stages—prepress, press, and binding or postpress. In small print shops, *job printers* may be responsible for all three stages. They do the composition and page layout of the material received from the customer, check proofs for errors and print clarity and correct mistakes, print the job, and attach each copy's pages together. In most printing firms, however, each of the stages is the responsibility of a specialized group of workers. *Prepress technicians and workers* are responsible for the first stage, preparing the material for printing presses. They perform a variety of tasks involved with transforming text and pictures into finished pages and making printing plates of the pages.

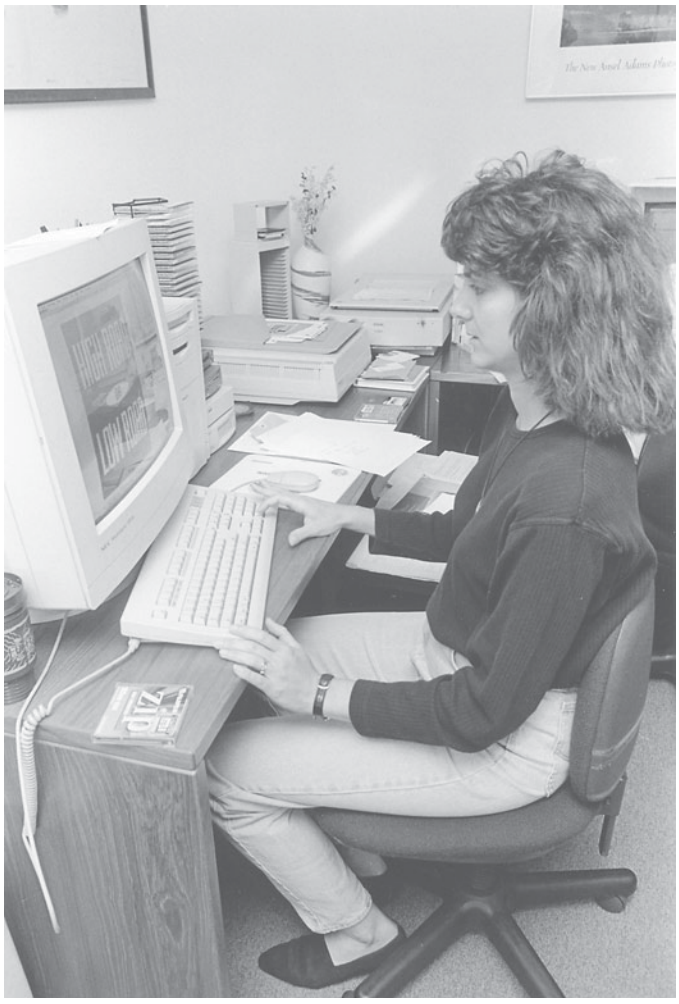
Typesetting and page layout have been greatly affected by technological changes over the years and, today, advances in computer software and printing technology continue to change prepress work. The old "hot type" method of text composition—in which molten lead was used to create individual letters, which were placed in frames to produce paragraphs and full pages of text—has become rare. Its successor, phototypesetting or "cold type" technology, is still used for some composition work, but it, in turn, is being rapidly replaced by computerized digital imaging technology. Customers today are able to provide printers with pages of material that look like the desired finished product they want printed and bound in volume. Using a process called "desktop publishing," customers are increasingly using their own computers to do much of the typesetting and page layout work formerly done by prepress technicians. Many regular customers employ workers called desktop publishers to do this work. (A separate statement on desktop publishers appears elsewhere in the *Handbook*.) Other customers employ in-house graphic designers who do desktop publishing as part of their work, or send the work out to freelance graphic designers. (Graphic designers are discussed in the statement on designers elsewhere in the *Handbook*.) It is increasingly common for prepress technicians or other printing workers to receive files from the customer on a computer disk or submitted by e-mail, that contains typeset material already laid out in pages.

The printing industry is doing more prepress work using complete "digital imaging." Using this technology, prepress technicians called "preflight technicians" take material received on computer disks from customers, check it for completeness, and format it into pages using electronic page layout systems; even though the pages may already be laid out, they still may have to be formatted to fit the dimensions of the paper stock to be used. When color printing is required, the technicians use digital color page-makeup systems to electronically produce an image of the printed pages, then use off-press color proofing systems to 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 gives the "OK to print," technicians use laser "imagesetters" to expose digital images of the pages directly onto thin aluminum printing plates.

Some customers continue to provide material to printers that is more suitable for cold type prepress technology. Cold type processing, which describes any of a variety of methods to create a printing plate without molten lead, has traditionally used "phototypesetting" to prepare text and pictures for printing. Although this method has many variations, all use photography to create images on paper. The images are assembled into page format and rephotographed to create film negatives from which the actual printing plates are made.

In one common form of phototypesetting, printed text received from the customer must first be entered into a computer programmed to hyphenate, space, and create columns of text. Typesetters or data entry clerks may do the keyboarding of text at the printing establishment. (See the *Handbook* statement on data entry and information processing workers.) The coded text then is transferred to a typesetting machine, which uses photography, a cathode-ray tube, or a laser to create an image on typesetting paper or film. Once it has been developed, the paper or film is sent to a lithographer who makes the actual printing plate.

With traditional photolithographic processes, the material to be printed is arranged and typeset, and then passed on to workers who



Using computer software to design publications, a growing number of prepress technicians work in offices.

further prepare it for the presses. *Camera operators* start the process of making a lithographic plate by photographing and developing film negatives or positives of the material to be printed. They adjust light and expose film for a specified length of time, and then develop the film in a series of chemical baths. They may load exposed film in machines that automatically develop and fix the image. The lithographic printing process requires that images be made up of tiny dots coming together to form a picture. Photographs cannot be printed without them. When normal "continuous-tone" photographs need to be reproduced, camera operators use halftone cameras to separate the photograph into an image containing the dots of varying sizes corresponding to the values of the original photograph

Color separation photography is more complex. In this process, camera operators produce four-color separation negatives from a continuous-tone color print or transparency. Because this is a complicated and time-consuming process, most of this separation work is instead being done electronically on scanners. *Scanner operators* use computerized equipment to capture photographs or art as digital data, or to create film negatives or positives of photographs or art. The computer controls the color separation of the scanning process and, with the help of the operator, corrects for mistakes or compensates for deficiencies in the original color print or transparency. Each scan produces a dotted image, or halftone, of the original in 1 of 4 primary printing colors—yellow, magenta, cyan, and black. The images are used to produce printing plates that print each of these colors, with transparent colored inks, one at a time. Superimposition of the images on the photos produces "secondary" color combinations of red, green, blue, and black that approximate the colors and hues of the original photograph.

Where this process is still being used, *film strippers* cut the film of text and images to the required size and arrange and tape the negatives onto "flats"—or layout sheets used by platemakers to make press plates. When completed, flats resemble large film negatives of the text in its final form. Platemakers use a photographic process to make printing plates. The flat is placed on top of a thin metal plate coated with a light-sensitive resin. Exposure to ultraviolet light activates the chemical in parts of the plate not protected by the film's dark areas. The plate then is developed in a solution that removes the unexposed nonimage area, exposing bare metal. The chemical on areas of the plate exposed to the light hardens and becomes water repellent. The hardened parts of the plate form the text and images to be printed.

During the printing process, the plate is first covered with a thin coat of water. The water adheres only to the bare metal nonimage areas, and is repelled by the hardened areas that were exposed to light. Next, the plate comes in contact with a rubber roller covered with oil-based ink. Because oil and water do not mix, the ink is repelled by the water-coated area and sticks to the hardened areas. The ink covering the hardened text is transferred to paper.

Working Conditions

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 musculoskeletal problems such as backaches. Platemakers, who still work with toxic chemicals, face the hazard of skin irritations. Workers often are subject to stress and the pressures of short deadlines and tight work schedules.

Prepress employees usually work an 8-hour day. Some workers—particularly those employed by newspapers—work night shifts, weekends, and holidays.

Employment

Prepress technicians and workers overall held about 148,000 jobs in 2002. Of these, approximately 56,000 were employed as job printers; the remainder was employed as prepress technicians and other prepress workers. 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, and prepress jobs are found throughout the country. However, jobs are concentrated in large metropolitan cities such as New York; Chicago; Los Angeles; Philadelphia; Washington, DC; and Dallas.

Training, Other Qualifications, and Advancement

Traditionally, prepress technicians and workers started as helpers and were trained on the job, the length of training varying by occupation. Some jobs required years of experience performing the detailed handwork to become skillful enough to perform even difficult tasks quickly. Instead of painstakingly taping pieces of photographic negatives to flats, today's prepress technicians increasingly use computer software skills to electronically modify and lay out the material; in some cases, the first time the material appears on paper is when the final product rolls off the printing press. As this digital imaging technology increasingly replaces cold type print technology, persons seeking to enter prepress technician jobs will require formal graphic communications training in the various types of computer software used in digital imaging.

Postsecondary graphic communications programs are available from a variety of sources. For beginners, 2-year associate degree programs offered by community and junior colleges and technical schools, and some 4-year bachelor's degree programs in graphic design colleges teach the latest prepress skills and allow students to practice applying them. However, bachelor's programs usually are intended for students who may eventually move into management positions in printing or design jobs. Community and junior colleges, 4-year colleges and universities, vocational-technical institutes, industry-sponsored update and retraining programs, and private trade and technical schools all also offer prepress-related courses for workers who do not wish to enroll in a degree program. Many workers with experience in other printing jobs take a few college graphic communications courses to upgrade their skills and qualify for prepress jobs. Prepress training designed to train skilled workers already employed in the printing industry also is offered through unions in the printing industry. Many employers view individuals with a combination of experience in the printing industry and formal training in the new digital technology as the best candidates for prepress jobs. The experience of these applicants in printing press operator or other jobs provides them with an understanding of how printing plants operate, familiarizes them with basic prepress functions, and demonstrates their reliability and interest in advancing in the industry.

Employers prefer workers with good communication skills, both oral and written, for prepress jobs. Prepress technicians and workers should be able to deal courteously with people because, when prepress problems arise, they sometimes have to contact the customer to resolve them. Also, in small shops, they may take customer orders. Persons interested in working for firms using advanced printing technology need to know the basics of electronics and computers. Mathematical skills also are essential for operating many of the software packages used to run modern, computerized prepress equipment. At times, prepress personnel may have to perform computations in order to estimate job costs.

Prepress technicians and workers need good manual dexterity, and they must be able to pay attention to detail and work independently. Good eyesight, including visual acuity, depth perception, field of view, color vision, and the ability to focus quickly, also are assets. Artistic ability is often a plus. Employers also seek persons who possess an even temperament and an ability to adapt, important qualities for workers who often must meet deadlines and learn how to use new software or operate new equipment.

Job Outlook

Overall employment of prepress technicians and workers is expected to decline through 2012. The number of job printers, however, is expected to grow, though at a rate slower than average. 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 increased use of computers in desktop publishing will contribute to the elimination of many jobs for prepress technicians.

Technological advances will have a varying effect on employment among the prepress occupations. This reflects the increasing proportion of page layout and design that will be performed using computers. Thus, the need for preflight technicians will remain strong. However, most prepress technicians and workers such as pasteup, composition and typesetting, photoengraving, platemaking, film stripping, and camera operator occupations are expected to experience declines as handwork becomes automated. Computer software that allows office workers to specify text typeface and style, and to format pages at a desktop computer terminal, already has eliminated most typesetting and composition jobs; more jobs will disappear in the years ahead.

Job prospects also will vary by industry. Changes in technology have shifted many prepress functions away from the traditional printing plants into advertising and public relations agencies, graphic design firms, and large corporations. Many companies are turning to in-house desktop publishing as page layout and graphic design capabilities of computer software have improved and become less expensive and more user-friendly. Some firms are finding it more profitable to prepare their own newsletters and other reports than to send them out to trade shops. At newspapers, writers and editors also are doing more composition using publishing software.

Some new jobs for prepress technicians and workers are expected to emerge in commercial printing establishments. New equipment should reduce the time needed to complete a printing job, and allow commercial printers to make inroads into new markets that require fast turnaround. Because small establishments predominate, commercial printing should provide the best opportunities for inexperienced workers who want to gain a good background in all facets of printing.

Employers in the printing industry prefer to hire workers experienced in all facets of printing. Among persons without experience, however, opportunities should be best for those with computer backgrounds who have completed postsecondary programs in printing technology or graphic communications. Many employers prefer graduates of these programs because the comprehensive training that they receive helps them to learn the printing process and to adapt more rapidly to new processes and techniques.

Earnings

Median hourly earnings of prepress technicians and workers were $14.98 in 2002. The middle 50 percent earned between $11.25 and $19.68 an hour. The lowest 10 percent earned less than $8.68, and the highest 10 percent earned more than $24.36 an hour.

For job printers, median hourly earnings were $14.47 in 2002. The middle 50 percent earned between $10.98 and $18.91 an hour. The lowest 10 percent earned less than $8.59, while the highest 10 percent earned more than $23.06 an hour.

Median hourly earnings in commercial printing, the industry employing the largest number of prepress technicians and workers, were $16.05 in 2002, while the figure for these workers in the newspaper, periodical, and book publishing industry was $13.07 an hour. For job printers, median hourly earnings in commercial printing in 2002 were $14.84, while in the newspaper, periodical, and book publishing industry median hourly earnings were $13.98.

Wage rates for prepress technicians and workers vary according to occupation, level of experience, training, location, size of firm, and union membership status.

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.

In addition to typesetters, other workers who operate machines equipped with keyboards include data entry and information processing workers. Prepress technicians' work also is tied in closely with that of printing machine operators, including job printers.

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:

➤ Printing Industries of America, 100 Daingerfield Rd., Alexandria, VA 22314. Internet: **http://www.gain.net**

➤ Graphic Communications Council, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.teched.vt.edu/gcc**

➤ Graphic Communications International Union, 1900 L St. NW., Washington, DC 20036. Internet: **http://www.gciu.org**

➤ Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.gatf.org**

Printing Machine Operators

(0*NET 51-5023.01, 51-5023.02, 51-5023.03, 51-5023.04, 51-5023.05, 51-5023.06, 51-5023.07, 51-5023.08, 51-5023.09)

Significant Points

- Most are trained informally on the job.
- Employment growth will be slowed by the increasing use of new, more efficient computerized printing presses that will facilitate movement towards printing-on-demand.
- Opportunities should be best for persons who qualify for formal apprenticeship training or who complete postsecondary training programs in printing.

Nature of the Work

Printing machine operators prepare, operate, and maintain the printing presses in a pressroom. Duties of printing machine operators vary according to the type of press they operate—offset lithography, gravure, flexography, screen printing, letterpress, and digital. Offset lithography, which transfers an inked impression from a rubber-covered cylinder to paper or other material, is the dominant printing process. With gravure, the recesses on an etched plate or cylinder are inked and pressed to paper. Flexography is a form of rotary printing in which ink is applied to a surface by a flexible rubber printing plate with a raised image area. Use of gravure and flexography should increase over the next decade, but letterpress, in which an inked, raised surface is pressed against paper, remains in existence only as specialty printing. In addition to the major 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, usually by quick and in-house printing shops, and increasingly by commercial printers for short-run jobs and variable data printing.

To prepare presses for printing, machine operators install and adjust the printing plate, adjust pressure, ink the presses, load paper, and adjust the press to the paper size. Press operators ensure that paper and ink meet specifications, and adjust margins and the flow of ink to the inking rollers accordingly. They then feed paper through the press cylinders and adjust feed and tension controls.

While printing presses are running, press operators monitor their operation and keep the paper feeders well stocked. They make adjustments to correct uneven ink distribution, speed, and temperatures in the drying chamber, if the press has one. If paper jams or tears 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, making quick corrections to avoid expensive losses of paper and ink. Throughout the run, operators may occasionally pull sheets to check for any printing imperfections, though much of this checking for quality is now being done by computers.

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

Machine operators' jobs differ from one shop to another because of differences in the kinds and sizes of presses. Small commercial shops are operated by one person and tend to have relatively small presses, which print only one or two colors at a time. Operators who work with large presses have assistants and helpers. Large newspaper, magazine, and book printers use giant "in-line web" presses that require a crew of several press operators and press assistants. These presses are fed paper in big rolls, called "webs," up to 50 inches or more in width. Presses print the paper on both sides; trim, assemble, score, and fold the pages; and count the finished sections as they come off the press.

Most plants have or will soon have installed printing presses with computers and sophisticated instruments to control press operations, making it possible to set up for jobs in less time. Computers allow press operators to perform many of their tasks electronically. With this equipment, press operators monitor the printing process on a control panel or computer monitor, which allows them to adjust the press electronically.

Working Conditions

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 protectors. Working with press machinery can be hazardous, but accidents can be avoided when press operators follow safe work practices. The threat of accidents has decreased with newer computerized presses because operators make most adjustments from a control panel. Many press operators, particularly those who work for newspapers, work weekends, nights, and holidays. They also may work overtime to meet deadlines.

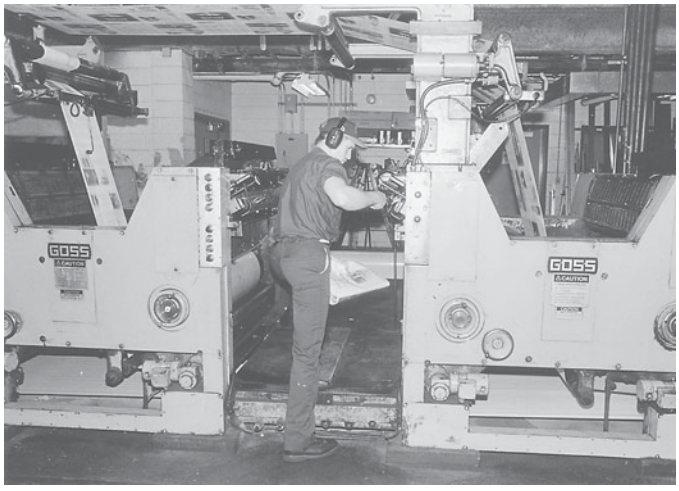
Employment

Printing machine operators held about 199,000 jobs in 2002. Nearly one-half of operator jobs were in the printing industry, but newspaper publishers and paper product manufacturers also were large employers, having each about 10 percent of all printing machine operator jobs. Additional jobs were in the "in-plant" section of organizations and businesses that do their own printing—such as banks, insurance companies, government agencies, and universities.

The printing and newspaper publishing industries are two of the most geographically dispersed in the United States, and press operators can find jobs throughout the country. However, jobs are concentrated in large printing centers such as Dallas, Chicago, Los Angeles, New York, Philadelphia, and Washington, DC.

Training, Other Qualifications, and Advancement

Although completion of a formal apprenticeship or a postsecondary program in printing equipment operation continues to be the best



Operating newer printing presses requires some computer skills and continual retraining.

way to learn the trade, most printing machine operators are trained informally on the job while they work as assistants or helpers to experienced operators. Beginning press operators load, unload, and clean presses. With time, they move up to operating one-color sheet-fed presses and eventually advance to multicolor presses. Operators are likely to gain experience on many kinds of printing presses during the course of their career.

Apprenticeships for press operators in commercial shops take 4 years. In addition to on-the-job instruction, apprenticeships include related classroom or correspondence school courses. Once the dominant method for preparing for this occupation, apprenticeships are becoming less prevalent.

In contrast, formal postsecondary programs in printing equipment operation offered by technical and trade schools and community colleges are growing in importance. Some postsecondary school programs require 2 years of study and award an associate degree, but most programs can be completed in 1 year or less. Postsecondary courses in printing are increasingly important because they provide the theoretical knowledge needed to operate advanced equipment.

Persons who wish to become printing machine operators need mechanical aptitude to make press adjustments and repairs. Oral and writing 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. Because of technical developments in the printing industry, courses in chemistry, electronics, color theory, and physics are helpful.

Technological changes have had a tremendous effect on the skills needed by printing machine operators. New presses now require operators to possess basic computer skills. Even experienced operators 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.

Printing machine operators may advance in pay and responsibility by working on a more complex printing press. Through experience and demonstrated ability, for example, a one-color sheet-fed press operator may become a four-color sheet-fed press operator. Others may advance to pressroom supervisor and become responsible for an entire press crew. Their understanding of the prepress requirements needed to run a press smoothly allows some operators with several years of experience to transfer to jobs as prepress technicians.

Job Outlook

Employment of printing machine operators is expected to grow more slowly than the average through 2012. Despite the slow growth, looming retirements of printing machine operators and the need for workers trained on increasingly computerized printing equipment will create many job openings over the next decade. Opportunities to become printing machine operators are likely to be favorable for persons who qualify for formal apprenticeship training or who complete postsecondary training programs in printing.

The demand for, and the output of, printed materials is expected to grow over the 2002-12 period. Demand for books and magazines will increase as school enrollments rise, and as substantial growth in the middle-aged and older population spurs adult education and leisure reading. Additional growth should stem from increased foreign demand for domestic trade publications, professional and scientific works, and mass-market books such as paperbacks. Demand for commercial printing also will be driven by increased expenditures for print advertising materials. New market research 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 newspaper inserts, catalogs, direct mail enclosures, and other kinds of print advertising. Other printing, such as newspapers, books, and greeting cards, also will continue to provide jobs.

Employment, however, will not grow in line with output because of the increased use of new computerized printing equipment. Also, new business practices within the publishing industry, such as printing-on-demand and electronic publishing, will cut into the production of printed materials. Printing-on-demand refers to the printing of materials as they are requested by customers, in contrast to printing thousands of publications prior to purchase, many of which are subsequently discarded. There are also expected to be fewer newspaper printing jobs as a result of mergers and consolidation within the industry.

Earnings

Median hourly earnings of printing machine operators were $ 13.95 in 2002. The middle 50 percent earned between $10.52 and $18.27 an hour. The lowest 10 percent earned less than $8.32, and the highest 10 percent earned more than $22.46 an hour. Median hourly earnings in the industries employing the largest numbers of printing machine operators in 2002 were:

Newspapers, periodicals, book, and directory publishers	$16.09
Commercial printing	15.02
Converted paper products	14.95
Plastic products	13.21
Business support services	10.60

The basic wage rate for a printing machine operator depends on the type of press being run and the geographic area in which the work is located. Workers covered by union contracts usually have higher earnings.

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 International Union, local affiliates of Printing Industries of America, or local offices of the State employment service.

For general information about press operators, write to:

➤ Graphic Communications International Union, 1900 L St. NW., Washington, DC 20036. Internet: **http://www.gciu.org**

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

➤ Printing Industries of America, 100 Daingerfield Rd., Alexandria, VA 22314. Internet: **http://www.gain.org/servlet/gateway/PIA_GATF/non_index.html**

➤ Graphic Communications Council, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.teched.vt.edu/gcc**

➤ Graphic Arts Technical Foundation, 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.gatf.org**

Semiconductor Processors

(0*NET 51-9141.00)

Significant Points

- Employment is expected to decline over the next 10 years because of rising imports of computer chips and increasing automation of fabrication plants in this country.
- An associate degree in a relevant curriculum is increasingly required.

Nature of the Work

Electronic semiconductors—also known as computer chips, microchips, or integrated circuits—are the miniature but powerful brains of high-technology equipment. Semiconductors are composed of a myriad of tiny aluminum or copper lines and electric switches, which manipulate the flow of electrical current. Semiconductor processors are responsible for many of the steps necessary in the manufacture of each semiconductor that goes into personal computers, missile guidance systems, and a host of other electronic equipment.

Semiconductor processors manufacture semiconductors in disks of varying sizes, generally eight to twelve inches wide. These disks, called wafers, are thin slices of silicon on which the circuitry of the microchips is layered. Each wafer is eventually cut into dozens or scores of individual chips.

Semiconductor processors make wafers by means of photolithography, a printing process for creating patterns from photographic images. Operating automated equipment, workers imprint precise microscopic patterns of the circuitry on the wafers, etch out the patterns with acids, and replace the patterns with metals that conduct electricity. Then, the wafers receive a chemical bath to make them smooth, and the imprint process begins again on a new layer with the next pattern. Wafers usually have from 8 to 20 such layers of microscopic, three-dimensional circuitry.

Semiconductors are produced in semiconductor-fabricating plants, or "fabs." Within fabs, the manufacture and cutting of wafers to create semiconductors takes place in "cleanrooms"—production areas that must be kept free of any airborne matter, because the least bit of dust can damage a semiconductor. All semiconductor processors working in cleanrooms—both operators and technicians—must wear special lightweight outer garments known as "bunny suits." These garments fit over clothing to prevent lint and other particles from contaminating semiconductor-processing worksites.

Operators, who make up the majority of the workers in cleanrooms, start and monitor the sophisticated equipment that performs the various tasks during the many steps of the semiconductor production sequence. They spend a great deal of time at computer terminals, monitoring the operation of the equipment to ensure that each of the tasks in the production of the wafer is performed correctly. Operators also may transfer wafer carriers from one development station to the next; in newer fabs, the lifting of heavy wafer carriers and the constant monitoring for quality control are increasingly being automated.

Once begun, the production of semiconductor wafers is continuous. Operators work to the pace of the machinery that has largely automated the production process. Operators are responsible for keeping the automated machinery within proper operating parameters.

Technicians account for a smaller percentage of the workers in cleanrooms, but they troubleshoot production problems and make equipment adjustments and repairs. They also take the lead in assuring quality control and in maintaining equipment. 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.

Working Conditions

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 semiconductors during their production. Because the machinery sets operators' rate of work in the largely automated production process, workers maintain an easy-going 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 gauges. Sometimes, they must retrieve wafers from one station and take them to another.

The temperature in the cleanrooms must be kept within a narrow range: usually, it is set at a comfortable 72 degrees Fahrenheit. Al-

Semiconductor processors increasingly need at least an associate degree.

though bunny suits cover virtually the entire body, except perhaps the eyes (over which workers wear protective glasses), their lightweight fabric keeps the temperature inside fairly comfortable as well. Entry and exit of workers in bunny suits from the cleanroom are controlled to minimize contamination, and workers must be reclothed in a clean suit and decontaminated each time they return to the cleanroom.

Several highly toxic chemicals are used at various points in the process of manufacturing semiconductors. Workers who are exposed to such chemicals can be harmed. However, semiconductor fabrication plants are designed with safeguards to ensure that these chemicals are handled, used, and disposed of without exposure to 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. For this reason, 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 in shift. In some plants, managers allow workers to alternate schedules, thereby distributing the "graveyard" shift equitably.

Employment

Electronic semiconductor processors held approximately 46,000 jobs in 2002. Nearly all of them were employed in facilities that manufacture semiconductors and other electronic components and accessories, though a small percentage worked in plants that primarily manufacture computers and office equipment.

Training, Other Qualifications, and Advancement

People interested in becoming semiconductor processors—either operators or technicians—need a solid background in mathematics and the physical sciences. In addition to applying these disciplines to the complex manufacturing processes performed in fabs, math and science knowledge are essentials for pursuing higher education in semiconductor technology—and knowledge of both subjects is one of the best ways to advance in the semiconductor fabricating field.

Semiconductor processor workers must also be able to think analytically and critically to anticipate problems and avoid costly mistakes. Communication skills also are vital, as workers must be able to convey their thoughts and ideas both orally and in writing.

A high school diploma or equivalent is the minimum requirement for entry-level operator jobs in semiconductor fabrication plants. However, employers increasingly prefer persons who have completed associate degree programs for semiconductor processor jobs. While completion of a 1-year certificate program in semiconductor technology offered by some community colleges is an asset for most processor jobs, technicians must have at least an associate degree in electronics technology or a related field.

Degree or certificate candidates who get hands-on training while attending school look even more attractive to prospective employers. Semiconductor technology programs in a growing number of community colleges include an internship at a semiconductor fabricating plant; many students in these programs already hold full- or part-time jobs in the industry and work toward degrees in semiconductor technology in their spare time to update their skills or qualify for promotion to technician jobs. In addition, to ensure that operators and technicians keep their skills current, many employers provide 40 hours of formal training annually. Some employers also provide financial assistance to employees who want to earn associate and bachelor's degrees.Summer and part-time employment provide another option for getting started in the field for those who live near a semiconductor processing plant. Students often are hired to work during the summer, and some students are allowed to continue working part time during the school year. Students in summer and part-time semiconductor processor jobs learn what education they need to prosper in the field. They also gain valuable experience that may lead to full-time employment after graduation.

Some semiconductor processing technicians transfer to sales engineer jobs with suppliers of the machines that manufacture the semiconductors or become field support personnel.

Job Outlook

Between 2002 and 2012, employment of semiconductor processors is projected to decline. The two main reasons for this reversal are much higher productivity and rising imports. Companies are upgrading many of their older fabs to make larger 12" wafers, which produce twice as many chips as fabs making 8" wafers. These plants also are more automated, allowing them to sharply increase production with the same number of workers. A number of domestic companies also are building more fabs overseas, where costs are lower. In addition, imports of semiconductors from non-U.S. companies are on the rise and should continue to increase throughout the decade. Besides the creation of new jobs, additional openings will result from the need to replace workers who leave the occupation.

Despite the expected decline in employment of semiconductor processors, 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 telecommunications devices, and other equipment. Moreover, the advent of the new 64-bit microchip is expected to provide the power of computer servers or workstations, onto desktop computers and open up a wealth of new applications, particularly in medical devices.

Industry development of semiconductors made from better materials means that semiconductors will become even smaller, more powerful, and more durable. For example, the industry has begun producing a new generation of microchips made with copper rather than aluminum wires, which will better conduct electricity. Also, technology to develop chips based on plastic, rather than on silicon, will make computers durable enough to be used in a variety of applications in which they could not easily have been used previously.

Job prospects will be best for people with postsecondary education in electronics or semiconductor technology.

Earnings

Median hourly earnings of electronic semiconductor processors were $13.14 in 2002. The middle 50 percent earned between $10.76 and $16.39 an hour. The lowest 10 percent earned less than $9.28, and the top 10 percent earned more than $20.35 an hour.

Technicians with an associate degree in electronics or semiconductor technology generally start at higher salaries than those with less education. Between a fourth and a half of all electronic semiconductor processors belong to a union, considerably higher than the rate for all occupations.

Related Occupations

Electronic semiconductor processors do production work that resembles the work of precision assemblers and fabricators of electrical and electronic equipment. Also, many electronic semiconductor processors have academic training in semiconductor technology, which emphasizes scientific and engineering principles. Other oc-

cupations that require some college or postsecondary vocational training emphasizing such principles are engineering technicians, electrical and electronics engineers, and science technicians.

Sources of Additional Information

For more information on semiconductor processor careers, contact:

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

➤ Maricopa Advanced Technology Education Center (MATEC), 2323 West 14th St., Suite 540, Tempe, AZ 85281. Internet: **http://matec.org/ops/career.shtml**

Stationary Engineers and Boiler Operators

(0*NET 51-8021.01, 51-8021.02)

Significant Points

- Applicants may face competition for jobs; opportunities will be best for workers with training in computerized controls and instrumentation.
- Stationary engineers and boiler operators usually acquire their skills through a formal apprenticeship program, or on-the-job training supplemented by courses at a trade or technical school.
- Most States and cities have licensing requirements.

Nature of the Work

Heating, air-conditioning, refrigeration, and ventilation systems keep large buildings and other commercial facilities comfortable all year long. Industrial plants often have facilities to provide electrical power, steam, or other services. Stationary engineers and boiler operators operate 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 not in a moving vehicle.

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 and, if necessary, make adjustments. They also record relevant events and facts concerning the operation and maintenance of the equipment in a log. With regard to steam boilers, for example, they observe, control, and record the steam pressure, temperature, water level, chemistry, power output, fuel consumption, and emissions from the vessel. They watch and listen to machinery and routinely check safety devices, identifying and correcting any trouble that develops. They use hand and power tools to perform repairs and maintenance ranging from a complete overhaul to replacing defective valves, gaskets, or bearings. Service, troubleshooting, repair, and monitoring of modern systems require the use of sophisticated electrical and electronic test equipment.

Stationary engineers typically use computers to operate the mechanical, electrical, and fire safety systems of new buildings and plants. Engineers monitor, adjust, and diagnose these systems from a central location, using a computer linked into the buildings' communications network.

Routine maintenance, such as lubricating moving parts, replacing filters, and removing soot and corrosion that can reduce the boiler's operating efficiency, is a regular part of the work of stationary engineers and boiler operators. They 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 (as water or vapor) in a closed system of pipes. They also may check the air quality of the ventilation system and make adjustments to keep the operation of the boiler within mandated guidelines.

In a large building or industrial plant, a stationary engineer may be in charge of all mechanical systems in the building. Engineers may supervise the work of assistant stationary engineers, turbine operators, boiler tenders, and air-conditioning and refrigeration operators and mechanics. Most stationary engineers perform other maintenance duties, such as carpentry, plumbing, locksmithing, and electrical repairs. In a small building or industrial plant, there may be only one stationary engineer.

Working Conditions

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.

Engine rooms, power plants, boiler rooms, mechanical rooms, and electrical rooms usually are 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. General maintenance duties also may require contact with oil, grease, or smoke. Workers spend much of the time on their feet. They may also 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, noise, moving parts, and exposure to hazardous materials, such as asbestos or certain chemicals.

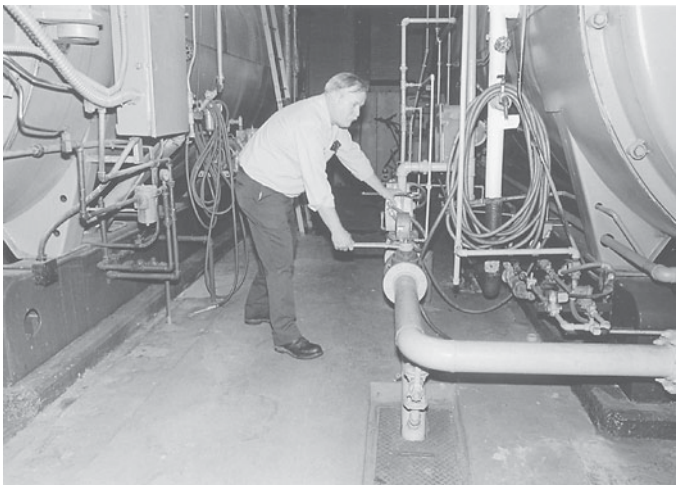
Employment

Stationary engineers and boiler operators held about 55,000 jobs in 2002. Jobs were dispersed throughout a variety of industries. The majority of jobs were in State and local government facilities; hospitals; educational services; manufacturing firms, such as pulp, paper, and paperboard mills; and electric power generation, transmission and distribution facilities. Other jobs were in architectural, engineering, and related services; traveler accommodation (hotels); and lessors of real estate (apartment and commercial buildings). Some were employed as contractors to a building or plant.

Stationary engineers and boiler operators worked throughout the country, generally in the more heavily populated areas in which large industrial and commercial establishments are located.

Training, Other Qualifications, and Advancement

Stationary engineers and boiler operators usually acquire their skills through a formal apprenticeship program, or on-the-job training supplemented by courses at a trade or technical school. In addition,



A stationary engineer adjusts a boiler's fuel pressure.

valuable experience can be obtained in the Navy or the merchant marine, because marine engineering plants are similar to many stationary power and heating plants. Most employers prefer to hire persons with at least a high school diploma or the equivalent, due to the increasing complexity of the equipment with which engineers and operators now work. Many stationary engineers and boiler operators have some form of continuing education including college. Mechanical aptitude, manual dexterity, and good physical condition also are important.

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 education or training in mathematics, computers, mechanical drawing, machine shop practice, physics, 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.

Those who acquire their skills on the job usually start as boiler tenders or helpers to experienced stationary engineers and boiler operators. This practical experience may be supplemented by postsecondary vocational training in computerized controls and instrumentation. However, becoming an engineer or operator without completing a formal apprenticeship program usually requires many years of work experience.

Most large and some small employers encourage and pay for skill-improvement training for their employees. Training almost always is provided when new equipment is introduced or when regulations concerning some aspect of the workers' duties change.

Most States and cities have licensing requirements for stationary engineers and boiler operators. Applicants usually must be at least 18 years of age, reside for a specified period in the State or locality, 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 can 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, apprenticeship or on-the-job training, and several years of experience. Licenses below first class limit the types or capacities of equipment the engineer may operate without supervision.

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 boiler inspectors, chief plant engineers, building and plant superintendents, or building managers. A few obtain jobs as examining engineers or technical instructors.

Job Outlook

Applicants may face competition for jobs as stationary engineers and boiler operators. Employment opportunities will be best for those with apprenticeship training or vocational school courses covering systems that are operated by computerized controls and instrumentation.

Employment of stationary engineers and boiler operators is expected to show little or no growth through the year 2012. 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. Furthermore, relatively few job openings will arise from the need to replace experienced workers who transfer to other occupations or leave the labor force. The low replacement rate in this occupation reflects its high wages.

Earnings

Median annual earnings of stationary engineers and boiler operators were $43,240 in 2002. The middle 50 percent earned between $33,860 and $54,550. The lowest 10 percent earned less than $26,340, and the highest 10 percent earned more than $65,290. Median annual earnings of stationary engineers and boiler operators in 2002 were $48,450 in local government and $40,800 in general medical and surgical hospitals.

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 installation, repair, and maintenance workers, as well as 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.

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.

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

Textile, Apparel, and Furnishings Occupations

(0*NET 51-6011.01, 51-6011.02, 51-6011.03, 51-6021.01, 51-6021.02, 51-6021.03, 51-6031.01, 51-6031.02, 51-6041.00, 51-6042.00, 51-6051.00, 51-6052.01, 51-6052.02, 51-6061.00, 51-6062.00, 51-6063.00, 51-6064.00, 51-6091.01, 51-6092.00, 51-6093.00, 51-6099.99)

Significant Points

- Most workers learn through on-the-job training.
- Employment is expected to decline in most detailed occupations in this group, due primarily to increased imports, the increased use of laborsaving machinery, and the creation of new fabrics that do not need as much processing.
- Earnings of most workers are low.

Nature of the Work

Textiles and leather clothe our bodies, cover our furniture, and adorn our homes. Textile, apparel, and furnishings workers produce these materials and fashion them into a wide range of products that we use in our daily lives. Jobs range from those which employ computers, to those in which the worker operates large industrial machinery and smaller power equipment, to those which involve substantial handwork.

Textile machine operators. Textile machine operators run machines that make textile products from fibers. Textiles are the basis of towels, bed linens, hosiery and socks, and nearly all clothing, but they also are a key ingredient of products ranging from roofing to tires. 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 out 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 called "sliver." When sliver is produced, different types of natural fibers and synthetics filaments may be combined to give the product a desired texture, durability, or other characteristics. *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, while 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. 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 to the public.

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 cutting 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. 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, s*hoe and leather workers and repairers* perform a variety of repairs and custom leatherwork for members of 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, utilizing a buffing wheel for 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

Shoe machine operators and other apparel and textile workers will see fewer jobs in the future as more work is outsourced abroad.

decorative patterns and designs. Shoe and leather workers and repairers who own their own shops keep records and supervise other workers.

Upholsterers. *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 back 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 pick up and deliver the furniture they work on. They also help customers pick new coverings by providing samples of fabrics and pictures of finished pieces.

Laundry and drycleaning workers. *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.

Working Conditions

Most persons in textile, apparel, and furnishings occupations work a standard 5-day, 35- to 40-hour week. Evenings and weekend work is common for shoe and leather workers, laundry and drycleaning workers, and tailors, dressmakers, and sewers employed in retail stores. In manufacturing, some employers add second shifts to justify the expense of new machinery. 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.

While 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 often is 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 materials. 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 upon workers. For example, newer pressing machines are operated by foot pedals or computer controls and do not require much strength to operate them.

Laundries and drycleaning establishments often are hot and noisy; those in retail stores, however, tend to be less noisy and more comfortable. 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, in order 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. Upholsterers stand most of the workday and may do a lot of bending and heavy lifting. They also may work in awkward positions for short periods.

Employment

Textile, apparel, and furnishings workers held over 1.1 million jobs in 2002. Employment in the detailed occupations that make up this group was distributed as follows:

Sewing machine operators	315,000
Laundry and drycleaning workers	231,000
Pressers, textile, garment, and related materials	91,000
Textile winding, twisting, and drawing out machine setters, operators, and tenders	66,000
All other textile, apparel, and furnishings workers	61,000
Upholsterers	56,000
Tailors, dressmakers, and sewers	53,000
Textile knitting and weaving machine setters, operators, and tenders	53,000
Textile cutting machine setters, operators, and tenders	34,000
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	27,000
Textile bleaching and dyeing machine operators and tenders	27,000
Shoe and leather workers and repairers	16,000
Fabric and apparel patternmakers	11,000
Shoe machine operators and tenders	6,600

Manufacturing jobs are concentrated in California, New York, North Carolina, Pennsylvania, Tennessee, and Georgia. Jobs in reupholstery, shoe repair and custom leatherwork, and laundry and drycleaning establishments are found in cities and towns throughout the Nation. Overall, about 10 percent of all workers in textile, apparel, and furnishings occupations were self-employed; however, more than one-third of tailors, dressmakers, and sewers and more than one-quarter of upholsterers were self-employed.

Training, Other Qualifications, and Advancement

Most employers prefer to hire high school graduates for jobs in textile, apparel, and furnishings occupations. Entrants with postsecondary vocational training or previous work experience in apparel production usually have a better chance of getting a job and advancing to a supervisory position. Regardless of the setting, workers usually begin by performing simple tasks.

In manufacturing, textile and apparel workers need good hand-eye coordination, manual dexterity, physical stamina, and the abil-

ity to perform repetitive tasks for long periods. Machine operators usually are trained on the job by more experienced employees or by machinery manufacturers' representatives. As they gain experience, these workers are assigned more difficult operations. Further advancement is limited, however. Some production workers may become first-line supervisors, but most can advance only to more skilled operator jobs. 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.

Retailers prefer to hire custom tailors, dressmakers, and sewers with previous experience in apparel manufacture, 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. A few private schools and colleges offer advanced training in sewing, draping, patternmaking, and design. 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. Although laundries and drycleaners prefer entrants with previous work experience, they routinely hire inexperienced workers.

Precision shoe and leather workers and repairers generally 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. In a vocational training program, it can take 6 months to a year. Learning to make saddles takes longer. Shoe repairers need to keep their skills up to date in order to work with the rapidly changing footwear styles and materials. Some do this by attending trade shows, while others attend specialized training seminars and workshops in custom shoe making, shoe repair, and other leatherwork sponsored by associations. Skilled workers who produce and modify prescription footwear may become certified as *pedorthists* by the Pedorthic Footwear Association after completing 120 hours of training and passing an examination. Some in the shoe and leather working occupations begin as workers or repairers and advance to salaried supervisory and managerial positions. Some open their own shop, but knowledge of business practices and management and a pleasant manner when dealing with customers are needed to stay in business.

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. 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. 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. The primary forms of advancement for upholsterers are opening their own shop or moving into management. The upholstery business is highly competitive, so operating a shop successfully is difficult. In large shops and factories, experienced or highly skilled upholsterers may become supervisors or samplemakers.

Job Outlook

Employment of textile, apparel, and furnishings workers is expected to decline through 2012. Apparel workers have been among the most rapidly declining occupational groups in the economy, and increasing imports, the use of offshore assembly, and greater productivity through new automation will contribute to additional job losses. Also, many new textiles require less production and processing. Because of the large size of this occupation, however, many thousands of job openings will arise each year from the need to replace persons who transfer to other occupations, retire, or leave the occupation for other reasons.

Employment in the domestic textile and apparel industries has declined in recent years as foreign producers have gained a greater share of the U.S. market. Domestic production—especially of apparel—will continue to move abroad, and imports to the U.S. market will increase. Declines in U.S. apparel production will cause reductions in domestic textile production because the apparel industry is the largest consumer of American-made textiles. 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.

The textile industry already is highly automated, but it will continue to seek to increase worker productivity through the introduction of laborsaving machinery and the invention of new fibers and fabrics that reduce production costs. Despite advances in technology, the apparel industry has had difficulty employing automated equipment extensively due to the soft properties of textile products. The industry produces a wide variety of apparel items that change frequently with changes in style and season. 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. However, assembly and sewing continues to be the most labor-intensive step in the production of apparel, and increasing numbers of sewing machine operator jobs are expected to be lost to lower wage workers abroad. Still, improvements in productivity will allow many of the presewing functions of design, patternmaking, marking, and cutting to continue be done domestically, and employment of workers who perform these functions will not be as adversely affected.

Outside of the manufacturing sector, tailors, dressmakers, and sewers—the most skilled apparel workers—also are expected to experience declining employment. Demand for their services will continue to lessen as consumers become increasingly likely to buy new, mass-produced apparel instead of purchasing custom-made apparel or having clothes altered or repaired.

Employment of shoe and leather workers is expected to decline through 2012 due to growing imports of less expensive shoes and leather goods, increasing productivity of U.S. manufacturers, and the more frequent tendency to buy new shoes rather than repair worn or damaged ones. However, declines are expected to be somewhat offset as more people invest in expensive leather shoes that they will want repaired. Also, as the population continues to age, more people will need custom shoes for health reasons.

Employment of upholsterers is expected to decline through 2012 as new furniture and automotive seats use more durable coverings and as manufacturing firms continue to 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 people 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

opportunities for experienced upholsterers should be good because few young people enter the occupation and few shops offer training.

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 or their group 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 2002 were as follows:

Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	$13.22
Fabric and apparel patternmakers	12.67
Upholsterers	11.86
Textile knitting and weaving machine setters, operators, and tenders	11.05
Tailors, dressmakers, and custom sewers	10.68
Textile winding, twisting, and drawing out machine setters, operators, and tenders	10.54
Textile bleaching and dyeing machine operators and tenders	10.00
Shoe machine operators and tenders	9.90
Textile cutting machine setters, operators, and tenders	9.77
Shoe and leather workers and repairers	9.14
All other textile, apparel, and furnishings workers	9.01
Sewers, hand	8.69
Sewing machine operators	8.39
Pressers, textile, garment, and related materials	8.21
Laundry and drycleaning workers	8.07

Benefits also vary. A few large employers, for example, include childcare in their benefits package. 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, however, offer only limited benefits.

Related Occupations

Textile, apparel, and furnishings workers apply their knowledge of textiles and leathers to fashion products with use of handtools and machinery. Other occupations that produce products by means of handtools, machines, and their knowledge of the materials with which they work include assemblers and fabricators, dental laboratory technicians, 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 the State employment service.

For general information on careers, technology, and trade regulations in the textile industry, contact

➤ American Textile Manufacturers Institute, Inc., 1130 Connecticut Ave. NW., Suite 1200, Washington, DC 20036-3954.

To receive a list of technical schools with accredited programs in upholstery, contact

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

Tool and Die Makers

(0*NET 51-4111.00)

Significant Points

- Most tool and die makers train for 4 or 5 years in apprenticeships or postsecondary programs; employers typically recommend apprenticeship training.
- Jobseekers with the appropriate skills and background should enjoy excellent opportunities and very high earnings.

Nature of the Work

Tool and die makers are among the most highly skilled workers in manufacturing. These workers produce 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 (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 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 and alloys. As a result, 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 parts and machines used in the production process. (See the statement on machinists elsewhere in the *Handbook*.)

Working from blueprints, tool and die makers first must plan the sequence of operations necessary to manufacture the tool or die. Next, 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.

Modern technology has changed the ways in which tool and die makers perform their jobs. Today, for example, these workers often use computer-aided design (CAD) to develop products and parts. Specifications entered into computer programs can be used to electronically develop drawings for the required tools and dies. Numerical tool and process control programmers use computer-aided manufacturing (CAM) programs to convert electronic drawings into computer programs that contain instructions for a sequence of cutting tool operations. (See the statement 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; however, 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 (CMM), which use software and sensor arms 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, the 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.

Working Conditions

Tool and die makers usually work in toolrooms. These areas are quieter than the production floor because there are fewer machines in use at one time. They also are generally kept clean and cool to minimize heat-related expansion of metal workpieces and to accommodate the growing number of computer-operated machines. To minimize the exposure of workers to moving parts, machines have guards and shields. Most computer-controlled machines are totally enclosed, minimizing the exposure of workers 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.

Employment

Tool and die makers held about 109,000 jobs in 2002. Most worked in industries that manufacture metalworking machinery, transportation equipment (such as motor vehicle parts and aerospace products), and fabricated metal products, as well as plastics product manufacturing. Although they are found throughout the country, jobs are most plentiful in the Midwest, Northeast, and West, where many of the metalworking industries are located.

Tool and die makers sometimes machine parts manually.

Training, Other Qualifications, and Advancement

Most tool and die makers learn their trade through 4 or 5 years of education and training in formal apprenticeships or postsecondary programs. Apprenticeship programs include a mix of classroom instruction and job experience and often require 10,400 hours, or about 5 years to complete. According to most employers these apprenticeship programs are the best way to learn all aspects of tool and die making. A growing number of tool and die makers receive most of their formal classroom training from community and technical colleges, sometimes in conjunction with an apprenticeship program.

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

Tool and die maker trainees learn to operate milling machines, lathes, grinders, 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 mechanical drawing, tool designing, tool programming, blueprint reading, and mathematics courses, including algebra, geometry, trigonometry, and basic statistics. Tool and die makers increasingly must have good computer skills to work with CAD technology, CNC machine tools, and computerized measuring machines.

Workers who become tool and die makers without completing formal apprenticeships generally acquire their skills through a combination of informal on-the-job training and classroom instruction at a vocational school or community college. They often begin as machine operators and gradually take on more difficult assignments. Many machinists become tool and die makers.

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. Persons entering this occupation also should be mechanically inclined, able to work and solve problems independently, and capable of doing work that requires concentration and physical effort.

There are several ways for skilled workers to advance. Some move into supervisory and administrative positions in their firms; many obtain their college degree and go into engineering or tool design; and some may start their own shops.

Job Outlook

Applicants with the appropriate skills and background should enjoy excellent opportunities for tool and die maker jobs. 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. As more of these highly skilled workers retire, employers in certain parts of the country report difficulty attracting well-trained applicants. 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 may prefer to attend college or may not wish to enter production-related occupations.

Despite expected excellent employment opportunities, little or no growth in employment of tool and die makers is projected over the 2002-12 period because advancements in automation, including CNC machine tools and computer-aided design, should improve worker productivity, thus limiting employment. On the other hand, tool and die makers play a key role in building and maintaining advanced automated manufacturing equipment. 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.

Earnings

Median hourly earnings of tool and die makers were $20.54 in 2002. The middle 50 percent earned between $16.33 and $25.64. The lowest 10 percent had earnings of less than $12.97, while the top 10 percent earned more than $30.74. Median hourly earnings in the manufacturing industries employing the largest numbers of tool and die makers in 2002 are shown below.

Motor vehicle parts manufacturing	$25.64
Metalworking machinery manufacturing	20.02
Forging and stamping	19.97
Plastics product manufacturing	19.79

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 complex machinery. 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 44141-3292. 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 44131-2500. Internet: **http://www.pmaef.org**

Water and Liquid Waste Treatment Plant and System Operators

(0*NET 51-8031.00)

Significant Points

- Employment is concentrated in local government and private water, sewage, and other systems utilities.
- The completion of an associate degree or 1-year certificate program is increasingly becoming an asset.
- Operators must pass exams certifying that they are capable of overseeing various treatment processes.
- Job prospects will be good for qualified individuals because the number of applicants in this field is normally low.

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. Liquid waste travels through customers' sewer pipes to liquid waste treatment plants, where it is either treated and 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, chemical compounds, and microorganisms from the water. They also control pumps, valves, and other equipment that moves the water or liquid waste 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 operate chemical-feeding devices, take samples of the water or liquid waste, perform chemical and biological laboratory analyses, and adjust the amounts of chemicals, such as chlorine, in the water. They use a variety of instruments to sample and measure water quality and common hand and power tools to make repairs. Operators also make minor repairs to valves, pumps, and other equipment.

Water and liquid waste 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. When equipment malfunctions, operators also may use computers to determine the cause of the malfunction and seek its solution.

Occasionally, operators must work during emergencies. A heavy rainstorm, for example, may cause large amounts of liquid waste 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 plant. In smaller plants, one operator may control all of the machinery, perform tests, keep records, handle complaints, and perform repairs and maintenance. A few operators may handle both a water treatment and a liquid waste treatment plant. In larger plants with many employees, operators may be more specialized and monitor only one process. The staff also may include chemists, engineers, laboratory technicians, mechanics, helpers, supervisors, and a superintendent.

Water pollution standards have become increasingly stringent since the adoption of two major Federal environmental statutes: the Clean Water Act of 1972, which implemented a national system of regulation on the discharge of pollutants; and the Safe Drinking Water Act of 1974, which established standards for drinking water. Industrial facilities sending 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 drinking water standards. 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 to knowing and understanding the Federal regulations, operators must be aware of any guidelines imposed by the State or locality in which the plant operates.

Working Conditions

Water and liquid waste 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 de-

Operators take samples of water or liquid waste, perform laboratory analyses, and adjust the amounts of chemicals in the water.

manding and often is performed in unclean locations. Operators must pay close attention to safety procedures, due to the presence of hazardous conditions, such as slippery walkways, dangerous gases, and malfunctioning equipment. Plants operate 24 hours a day, 7 days a week; therefore, operators work one of three 8-hour shifts, including weekends and holidays, on a rotational basis. Operators may be required to work overtime.

Employment

Water and liquid waste treatment plant and system operators held about 99,000 jobs in 2002. About 3 in 4 operators worked for local governments. Others worked primarily for private water, sewage, and other systems utilities, and for private waste treatment and disposal companies. Private firms are increasingly providing operation and management services to local governments on a contract basis.

Water and liquid waste 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.

Training, Other Qualifications, and Advancement

A high school diploma usually is required for an individual to become a water or liquid waste treatment plant operator. Operators need mechanical aptitude and should be competent in basic mathematics, chemistry, and biology. They must have the ability to apply data to formulas prescribing treatment requirements, flow levels, and concentration levels. Some basic familiarity with computers also is necessary because of the trend toward computer-controlled equipment and more sophisticated instrumentation. Certain positions—particularly in larger cities and towns—are covered by civil service regulations. Applicants for these positions may be required to pass a written examination testing their mathematics skills, mechanical aptitude, and general intelligence.

The completion of an associate degree or a 1-year certificate program in water quality and liquid waste treatment technology increases an applicant's chances for employment and promotion because plants are becoming more complex. Offered throughout the country, these programs provide a good general knowledge of water and liquid waste treatment processes, as well as basic preparation for becoming an operator.

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 liquid waste 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.

The Safe Drinking Water Act Amendments of 1996, enforced by the U.S. Environmental Protection Agency, specify national minimum standards for certification and recertification of operators of community and nontransient, noncommunity water systems. As a result, operators must pass an examination to certify that they are capable of overseeing liquid waste treatment plant operations. There are different levels of certification, depending on the operator's experience and training. Higher certification levels qualify the operator for a wider variety of treatment processes. Certification requirements vary by State and by size of treatment plants. Although relocation may mean having to become certified in a new jurisdiction, many States accept other States' certifications.

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 liquid waste treatment, and some employers pay part of the tuition for related college courses in science or engineering.

As operators are promoted, they become responsible for more complex treatment processes. Some operators are promoted to plant supervisor or superintendent; others advance by transferring to a larger facility. Postsecondary training in water and liquid waste treatment, coupled with increasingly responsible experience as an operator, may be sufficient to qualify a worker for becoming 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 a 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.

Job Outlook

Employment of water and liquid waste treatment plant and system operators is expected to grow about as fast as the average for all occupations through the year 2012. Job prospects will be good for qualified individuals because the number of applicants in this field is normally low, due primarily to the unclean and physically demanding nature of the work.

The increasing population and growth of the economy are expected to boost demand for essential water and liquid waste treatment services. As new plants are constructed to meet this demand, employment of water and liquid waste treatment plant and system operators will increase. In addition, many job openings will occur as experienced operators leave the labor force or transfer to other occupations.

Local governments are the largest employers of water and liquid waste treatment plant and system operators. However, Federal certification requirements have increased utilities' reliance on private firms specializing in the operation and management of water and liquid waste treatment facilities. As a result, employment in privately owned facilities will grow faster than the average.

Earnings

Median annual earnings of water and liquid waste treatment plant and system operators were $33,390 in 2002. The middle 50 percent earned between $25,790 and $42,490. The lowest 10 percent earned less than $20,220, and the highest 10 percent earned more than $52,110. Median annual earnings of water and liquid waste treatment plant and systems operators in 2002 were $33,210 in local government and $32,190 in water, sewage, and other systems.

In addition to their annual salaries, water and liquid waste 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**

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

Welding, Soldering, and Brazing Workers

(0*NET 51-4121.01, 51-4121.02, 51-4121.03, 51-4121.04, 51-4121.05, 51-4122.01, 51-4122.02, 51-4122.03, 51.4122.04)

Significant Points

- Job prospects should be excellent.
- Training ranges 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.

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.

Welders use many types of welding equipment set up in a variety of positions, such as flat, vertical, horizontal, and overhead. They may perform manual welding, in which the work is entirely controlled by the welder, or semiautomatic welding, in which the welder uses machinery, such as a wire feeder, to perform welding tasks.

Arc welding is the most common type of 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 workpiece being welded. The second clip is connected to a thin welding rod. When the rod touches the workpiece, a powerful electrical circuit is created. The massive heat created by the electrical current causes both the workpiece and the steel core of the rod to melt together, cooling quickly to form a solid bond. During welding, the flux that surrounds the rod's core vaporizes, forming an inert gas that serves to protect the weld from atmospheric elements that might weaken it. Welding speed is important. Variations in speed can change the amount of flux applied, weakening the weld, or weakening the surrounding metal by increasing heat exposure.

Two common but advanced types of welding are Gas Tungsten Arc (TIG) and Gas Metal Arc (MIG) welding. TIG welding often is used with stainless steel or aluminum. While TIG uses welding rods, MIG uses a spool of continuously fed wire, which allows the welder to join longer stretches of metal without stopping to replace the rod. In TIG welding, 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 workpiece. In MIG welding, the welder holds the wire feeder, which functions like the alligator clip in arc welding. Instead of using gas flux surrounding the rod, TIG and MIG protect the initial weld from the environment by blowing inert gas onto the weld.

Like arc welding, soldering and brazing use molten metal to join two pieces of metal. However, the metal added during the process has a melting point lower than that of the workpiece, so only the added metal is melted, not the workpiece. 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 workpiece, these processes normally do not create the distortions or weaknesses in the workpiece 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.

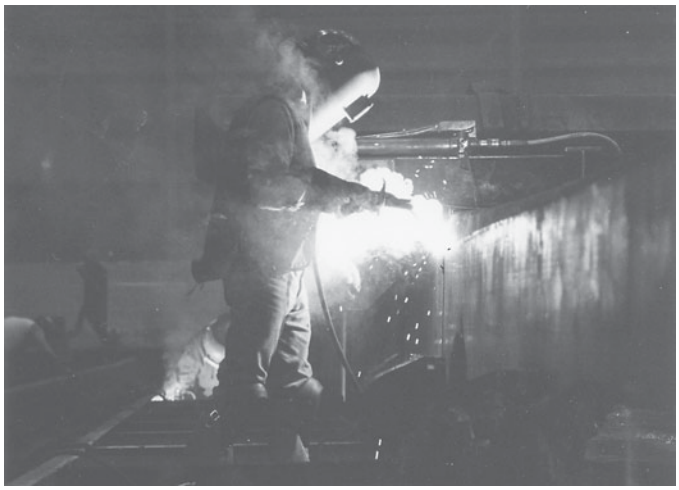
Skilled welding, soldering, and brazing workers generally plan work from drawings or specifications or use their knowledge of fluxes and base metals to analyze the parts to be joined. These workers then select and set up welding equipment, execute the planned welds, and examine welds to ensure that they meet standards or specifications. Highly skilled welders often are trained to work with a wide variety of materials in addition to steel, such as titanium, aluminum, or plastics. 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.

Automated welding is used in an increasing number of production processes. In these instances, a machine or robot performs the welding tasks while 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 (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.

Working Conditions

Welding, soldering, and brazing workers often are exposed to a number of hazards, including the intense light created by the arc, poisonous fumes, and very hot materials. 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, however,



Some welding, soldering, and brazing workers are employed in ship and boat building.

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 55 percent of welders, solderers, and brazers work a 40-hour week, overtime is common, and some welders work up to 70 hours per week. 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.

Employment

Welding, soldering, and brazing workers held about 452,000 jobs in 2002. Of these jobs, about 2 of every 3 were found in manufacturing. Jobs were concentrated in transportation equipment manufacturing (motor vehicle body and parts and ship and boat building), machinery manufacturing (agriculture, construction, and mining machinery), and architectural and structural metals manufacturing. Most jobs for welding, soldering, and brazing machine setters, operators, and tenders were found in the same manufacturing industries as skilled welding, soldering, and brazing workers.

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. Formal training is available in high schools, vocational schools, and postsecondary institutions, such as vocational-technical institutes, community colleges, and private welding schools. The Armed Forces operate welding schools as well. Some employers provide training. Courses in blueprint reading, shop mathematics, mechanical drawing, physics, chemistry, and metallurgy are helpful. Knowledge of computers is gaining importance, especially for welding, soldering, and brazing machine operators, who are becoming responsible for the programming of computer-controlled machines, including robots.

Some welders become certified, a process whereby the employer sends a worker to an institution, such as an independent testing lab or technical school, to weld a test specimen according to specific codes and standards required by the employer. Testing procedures are based on the standards and codes set by one of several industry associations with which the employer may be affiliated. If the welding inspector at the examining institution determines that the worker has performed according to the employer's guidelines, the inspector will then certify the welder being tested as able to work with a particular welding procedure.

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 need to be willing to receive training and perform tasks in other production jobs.

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.

Job Outlook

Job prospects should be excellent, as many potential entrants who could be welders may prefer to attend college or may prefer work that has more comfortable working conditions. Employment of welding, soldering, and brazing workers is expected to grow about as fast as the average for all occupations over the 2002-12 period. In addition, many openings will arise as workers retire or leave the occupation for other reasons.

The major factor affecting employment of welders is the health of the industries in which they work. Because almost every manufacturing industry uses welding at some stage of manufacturing or in the repair and maintenance of equipment, a strong economy will keep demand for welders high. A downturn affecting industries such as auto manufacturing, construction, or petroleum, however, would have a negative impact on the employment of welders in those areas, and could cause some layoffs. Levels of government funding for shipbuilding as well as for infrastructure repairs and improvements are expected to be another important determinant of the future number of welding jobs.

Regardless of the state of the economy, the pressures to improve productivity and hold down labor costs are leading many companies to invest more in automation, especially computer-controlled and robotically-controlled welding machinery. This will reduce the demand for some low-skilled welders, solderers, and brazers because these simple, repetitive jobs are being automated. The growing use of automation, however, should increase demand for welding, soldering, and brazing machine setters, operators, and tenders. Welders working on construction projects or in equipment repair will not be affected by technology change to the same extent, because their jobs are not as easily automated.

Technology is helping to improve welding, creating more uses for welding in the workplace and expanding employment opportunities. For example, new ways are being developed to bond dissimilar materials and nonmetallic materials, such as plastics, composites, and new alloys. Also, laser beam and electron beam welding, new fluxes, and other new technologies and techniques are improving the results of welding, making it useful in a wider assortment of applications. Improvements in technology have also boosted welding productivity, making welding more competitive with other methods of joining materials.

Earnings

Median hourly earnings of welders, cutters, solderers, and brazers were $14.02 in 2002. The middle 50 percent earned between $11.41 and $17.34. The lowest 10 percent had earnings of less than $9.41, while the top 10 percent earned over $21.79. The range of earnings of welders reflects the wide range of skill levels. Median hourly earnings in the industries employing the largest numbers of welders, cutters, solderers, and brazers in 2002 were:

Motor vehicle parts manufacturing	$16.02
Agriculture, construction, and mining machinery manufacturing	13.74
Architectural and structural metals manufacturing	13.34
Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	13.06
Motor vehicle body and trailer manufacturing	12.83

Median hourly earnings of welding, soldering, and brazing machine setters, operators, and tenders were $13.90 in 2002. The middle 50 percent earned between $11.22 and $17.77. The lowest 10 percent had earnings of less than $9.36, while the top 10 percent earned over $24.60. Median hourly earnings in motor vehicle parts manufacturing, the industry employing the largest numbers of welding machine operators in 2002 were $18.29.

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 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.

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 and educational opportunities in welding is available from:

➤ American Welding Society, 550 N.W. Lejeune Rd., Miami, FL 33126-5699. Internet: **http://www.aws.org**

Woodworkers

(0*NET 51-7011.00, 51-7021.00, 51-7031.00, 51-7032.00, 51-7041.01, 51-7041.02, 51-7042.01, 51-7042.02, 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 2 or more years.
- Employment of woodworkers is expected to grow more slowly than average through the year 2012. Little or no growth is expected among woodworking machine setters, operators, and tenders.
- Job prospects will be best for workers with knowledge of computerized numerical control machine tool operation.

Nature of the Work

Despite the development of sophisticated plastics and other materials, the demand for wood products continues unabated. Helping to meet this demand are woodworkers. Woodworkers are found in industries that produce wood, such as sawmills and plywood mills; in industries that use wood to produce furniture, kitchen cabinets, musical instruments, and other fabricated wood products; or in small shops that make architectural woodwork, furniture, and many other specialty items.

All woodworkers are employed at some stage of the process through which logs of wood are transformed into finished products. Some of these workers produce the structural elements of buildings; others mill hardwood and softwood lumber; still others assemble finished wood products. They operate machines that cut, shape, assemble, and finish raw wood to make the doors, windows, cabinets, trusses, plywood, flooring, paneling, molding, and trim that are components of most homes. Others may fashion home accessories, such as beds, sofas, tables, dressers, and chairs. In addition to these household goods, woodworkers also make sporting goods, including baseball bats and oars, as well as musical instruments, toys, caskets, tool handles, and thousands of other wooden items.

Production woodworkers set up, operate, and tend woodworking machines such as power saws, planers, sanders, lathes, jointers, and routers that cut and shape components from lumber, plywood, and other wood products. In sawmills, *sawing machine operators and tenders* set up, operate, or tend wood sawing machines that cut logs into planks, timbers, or boards. In plants manufacturing wood products, 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. Lower skilled operators may merely press a switch on a woodworking machine and monitor the automatic operation, whereas more highly skilled operators set up equipment, cut and shape wooden parts, and verify dimensions using a template, caliper, or rule.

The next step in the manufacturing process is the production of subassemblies using fasteners and adhesives. Next, the pieces are brought together 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 a helper.

Woodworkers have been greatly affected by the introduction of computer-controlled machinery. This technology has raised worker productivity by allowing one operator to simultaneously tend a greater number of machines. With computerized numerical controls (CNC), an operator can program a machine to perform a sequence of operations automatically, resulting in greater precision and reliability. The integration of computers with equipment has improved production speeds and capabilities, simplified setup and maintenance requirements, and increased the demand for workers with computer skills.

While this costly equipment has had a great impact on workers in the largest, most efficient firms, precision or custom woodworkers—who generally work in smaller firms—have continued to employ the same production techniques they have used for many years. Workers such as *cabinetmakers and bench carpenters; model makers and patternmakers;* and *furniture finishers* work on a customized basis, often building one-of-a-kind items. These highly skilled precision woodworkers usually perform a complete cycle of tasks—cutting, shaping, and preparing surfaces, and assembling prepared parts of complex wood components into a finished wood product. For this reason, these 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.

Working Conditions

Working conditions vary by industry and specific job duties. In logging and sawmills, for example, working conditions are physically demanding due to the handling of heavy, bulky material. Workers in these industries also may encounter excessive noise, dust, and other air pollutants. However, the use of earplugs and respirators may partially alleviate these problems. Also, rigid adherence to safety precautions minimizes risk of injury from contact with rough wood stock, sharp tools, and power equipment. The risk of injury also is lowered by the installation of computer-controlled equipment, which reduces the physical labor and hands-on contact with machinery.

All woodworkers are employed at some stage of the process through which logs of wood are transformed into finished products.

In furniture and kitchen cabinet manufacturing, employees who operate machinery often must wear ear and eye protection. They also must follow operating safety instructions and use safety shields or guards to prevent accidents. Those who work in the finishing area must be provided with an appropriate dust or vapor mask or a complete protective safety suit, or must work in a finishing environment that removes all vapors and dust particles from the atmosphere. Prolonged standing, lifting, and fitting of heavy objects are common characteristics of the job.

Employment

Woodworkers held about 374,000 jobs in 2002. Self-employed woodworkers, mostly cabinetmakers and furniture finishers, accounted for 10 percent of these jobs. Employment among detailed woodworking occupations was distributed as follows:

Cabinetmakers and bench carpenters	147,000
Woodworking machine setters, operators, and tenders, except sawing	95,000
Sawing machine setters, operators, and tenders, wood	56,000
Furniture finishers	39,000
Model makers, wood	4,400
Patternmakers, wood	4,200
All other woodworkers	29,000

About 3 out of 4 woodworkers were employed in manufacturing industries. Among these woodworkers, 41 percent were found in establishments fabricating household and office furniture and fixtures and 28 percent worked in wood product manufacturing, producing a variety of raw, intermediate, and finished wood stock. 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, production jobs are concentrated in the South and Northwest, close to the supply of wood, whereas furniture makers are more prevalent in the East. Custom shops can be found everywhere, but generally are concentrated in or near highly populated areas.

Training, Other Qualifications, and Advancement

Most woodworkers are trained on the job, picking up skills informally from experienced workers. Most woodworkers learn basic machine operations and job tasks in a few months, but becoming a skilled woodworker often requires 2 or more years.

Some woodworkers acquire skills through vocational education or by working as carpenters on construction jobs. Others may attend colleges or universities that offer training in areas including wood technology, furniture manufacturing, wood engineering, and production management. These programs prepare students for positions in production, supervision, engineering, and management.

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 at first 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.

Employers increasingly seek applicants with a high school diploma or the equivalent, because of the growing sophistication of machinery and the constant need for retraining. Persons seeking woodworking jobs can enhance their employment and advancement prospects by completing high school and receiving training in mathematics, science, and computer applications. Other important qualities for entrants in this occupation include mechanical ability, manual dexterity, and the ability to pay attention to detail.

Advancement opportunities often are limited and depend upon availability, 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 often can advance into these positions by assuming additional responsibilities and by attending workshops, seminars, or college programs. Those who are highly skilled may set up their own woodworking shops.

Job Outlook

Employment of woodworkers is expected to grow more slowly than average through the year 2012. Little or no growth is expected among woodworking machine setters, operators, and tenders. Employment of cabinetmakers and bench carpenters and furniture finishers is expected to grow more slowly than average and employment of model makers and patternmakers is expected to grow about as fast as the average for all occupations. Job openings also will arise each year because of the need to replace experienced woodworkers who transfer to other occupations or leave the labor force.

Demand for woodworkers will stem from increases in population, personal income, and business expenditures, in addition to the continuing need for repair and renovation of residential and commercial properties. Therefore, opportunities should be available for woodworkers who specialize in such items as moldings, cabinets, stairs, and windows. Due to increasingly automated manufacturing processes, job prospects will be best for highly skilled woodworkers with knowledge of computerized numerical control machine tool operation.

Several factors may limit the growth of woodworking occupations. Technological advances, such as robots and CNC machinery, will continue to increase productivity among woodworkers, preventing employment from rising as fast as the demand for wood products, particularly in the mills and manufacturing plants where many processes can be automated. In addition, more jobs in the United States will be lost as imports continue to grow and as U.S. firms move some production to other countries. Also, the demand for wood may be reduced somewhat, as materials such as metal, plastic, and fiberglass continue to be used in many products as alternatives to wood. Environmental measures designed to control various pollutants used in, or generated by, woodworking processes also may adversely impact employment.

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 hourly earnings of cabinetmakers and bench carpenters were $11.54 in 2002. The middle 50 percent earned between $9.26 and $14.66. The lowest 10 percent earned less than $7.70, and the highest 10 percent earned more than $18.11. Median hourly earnings in the industries employing the largest numbers of cabinetmakers and bench carpenters in 2002 are shown below:

Office furniture (including fixtures) manufacturing	$13.02
Household and institutional furniture and kitchen cabinet manufacturing	11.19
Other wood product manufacturing	11.14

Median hourly earnings of sawing machine setters, operators, and tenders, wood were $10.62 in 2002. The middle 50 percent earned between $8.70 and $13.11. The lowest 10 percent earned less than $7.36, and the highest 10 percent earned more than $15.94. Median hourly earnings in the industries employing the largest numbers of sawing machine setters, operators, and tenders, wood in 2002 are shown below:

Sawmills and wood preservation	$11.59
Veneer, plywood, and engineered wood product manufacturing	10.91
Household and institutional furniture and kitchen cabinet manufacturing	10.40
Other wood product manufacturing	10.06

Median hourly earnings of woodworking machine setters, operators, and tenders, except sawing were $10.59 in 2002. The middle 50 percent earned between $8.72 and $13.03. The lowest 10 percent earned less than $7.39, and the highest 10 percent earned more than $15.93. Median hourly earnings in the industries employing the largest numbers of woodworking machine setters, operators, and tenders, except sawing in 2002 are shown below:

Office furniture (including fixtures) manufacturing	$11.00
Sawmills and wood preservation	10.99
Veneer, plywood, and engineered wood product manufacturing	10.99
Household and institutional furniture and kitchen cabinet manufacturing	10.54
Other wood product manufacturing	10.26

In 2002, median hourly earnings were $10.92 for furniture finishers and $10.11 for all other woodworkers.

Some woodworkers, such as those in logging or sawmills who are engaged in processing primary wood and building materials, are members of the International Association of Machinists. Others belong to the United Brotherhood of Carpenters and Joiners of America.

Related Occupations

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, and tool and die makers.

Sources of Additional Information

For information about woodworking occupations, contact local furniture manufacturers, sawmills and planing mills, cabinetmaking or millwork firms, lumber dealers, a local of one of the unions mentioned above, or the nearest office of the State employment service.