Metalworking, Plastic-working, and Woodworking Occupations

Reprinted from the
Occupational Outlook Handbook, 1994-95 Edition

U.S. Department of Labor
Bureau of Labor Statistics

Bulletin 2450-18

ISBN 0-16-043065-8
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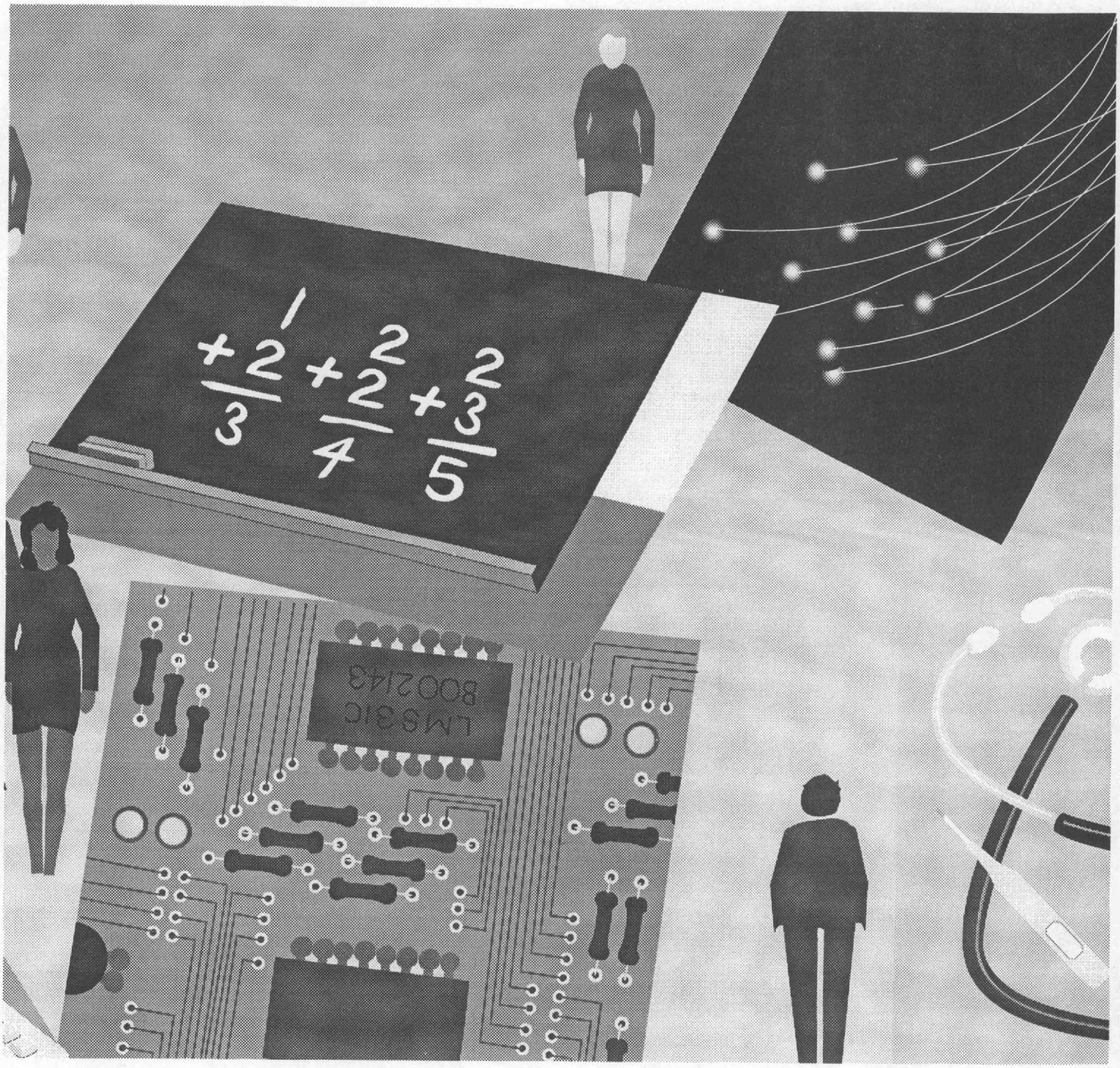


Boilermakers

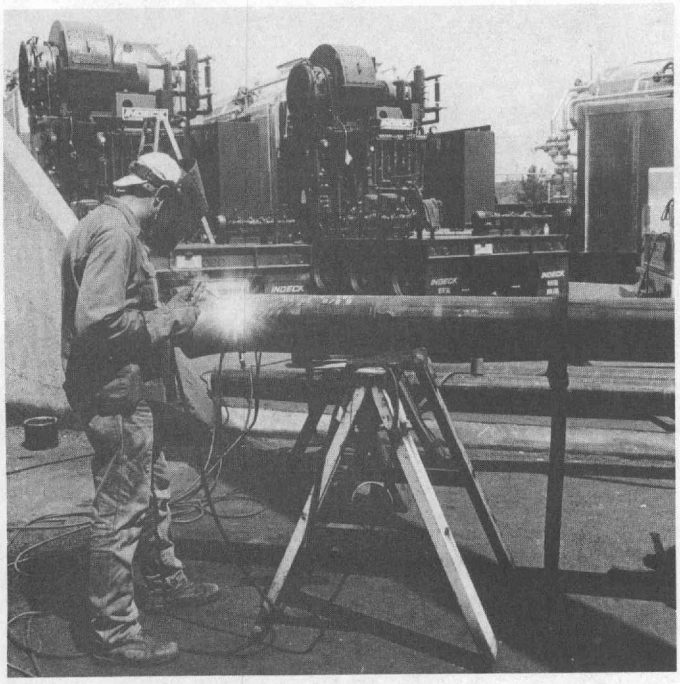
(D.O.T. 805.261 .361, and .381)

Nature of the Work

Boilermakers and boilermaker mechanics construct, assemble, and repair boilers, vats, and other large vessels that hold liquids and gases. Boilers supply steam to drive huge turbines in electric power plants and to provide heat or power in buildings, factories, and ships. Tanks and vats are used to process and store chemicals, oil, beer, and hundreds of other products.

Following blueprints, boilermakers locate and mark reference points on the boiler foundation for installing boilers and other vessels, using straightedges, squares, transits, and tape measures. They attach rigging and signal crane operators to lift heavy frame and plate sections and other parts into place. They align sections, using plumb bobs, levels, wedges, and turnbuckles; use hammers, files, grinders, and cutting torches to remove irregular edges so they fit properly; and bolt or weld them together. Boilermakers align and attach water tubes, stacks, valves, gauges, and other parts and test complete vessels for leaks or other defects. Usually they assemble large vessels temporarily in a fabrication shop to insure a proper fit and again on their permanent site.

Because boilers last for a long time—35 years or longer—much of the work boilermakers do is to maintain them and update components such as burners and boiler tubes to make them as efficient as possible. Boilermaker mechanics maintain and repair boilers and similar vessels. They clean or direct others to clean boilers and inspect tubes, fittings, valves, controls, and auxiliary machinery. They repair or replace defective parts, using hand and power tools, gas torches, and welding equipment, and may operate metalworking machinery to repair or make parts. They also dismantle leaky boilers, patch weak spots with metal stock, replace defective sections, or strengthen joints.



Boilermakers often retrofit old boilers with up to date equipment.

Working Conditions

Boilermakers often use potentially dangerous equipment such as acetylene torches and power grinders, handle heavy parts, and work on ladders or on top of large vessels. Work may be done in cramped quarters inside boilers, vats, or tanks that often are damp and poorly ventilated. To reduce the chance of injuries, they may wear hardhats, harnesses, respirators, protective clothing, and safety glasses and shoes. Boilermakers usually work a 40-hour week but occasionally work overtime to meet construction or production deadlines.

Employment

Boilermakers held about 26,000 jobs in 1992. About 44 percent worked in manufacturing, primarily in boiler manufacturing shops, iron and steel plants, petroleum refineries, chemical plants, and shipyards. Over one-third worked in the construction industry, assembling and erecting boilers and other vessels. Some also work for boiler repair firms, railroads, and in Navy shipyards and Federal power facilities.

Training, Other Qualifications, and Advancement

Most training authorities recommend a formal apprenticeship to learn this trade. Many people become boilermakers by working as helpers to experienced boilermakers, but generally lack the wide range of skills acquired through apprenticeship. Apprenticeship programs usually consist of 4 years of on-the-job training, supplemented by about 48 hours of classroom instruction each year in subjects such as set-up and assembly rigging, welding of all types, blueprint reading, and layout. Experienced boilermakers often attend apprenticeship classes to keep their knowledge current.

When hiring helpers, employers prefer high school or vocational school graduates. Courses in shop, mathematics, blueprint reading, welding, and machine metalworking are useful. Mechanical aptitude and the manual dexterity needed to handle tools also are important.

Some boilermakers advance to supervisory positions; because of their broader training, apprentices generally have an advantage in promotion.

Job Outlook

Persons who wish to become boilermakers may face some competition, due to the limited number of apprenticeships available and the relatively good wages a journey boilermaker earns. In addition, employment of boilermakers is expected to decline through the year 2005. However, some openings will arise from the need to replace experienced workers who leave the occupation.

Growth should be limited by several factors: The trend toward repairing and retrofitting rather than replacing existing boilers; the use of smaller boilers, which require less on-site assembly; automation of production technologies; and an increase in the use of imported boilers.

Most of the industries that purchase boilers are sensitive to economic conditions. Therefore, during economic downturns, construction boilermakers may be laid off. However, because boilers are maintained and repaired even during economic downturns, boilermaker mechanics generally have more stable employment.

Earnings

According to the limited data available, boilermakers who usually worked full time had median earnings of about $553 per week in 1992.

According to the International Brotherhood of Boilermakers, journey boilermakers earned $20.80 per hour in 1992. Apprentices started at 60 percent of journey wages, or about $12.50 hourly, with wages increasing gradually to the journey wage as progress is made in the apprenticeship.

For sale by the U.S. Government Printing Office
Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328
ISBN 0-16-043065-8

Most boilermakers belong to labor unions. The principal union is the International Brotherhood of Boilermakers. Others are members of the International Association of Machinists, United Automobile Workers, and the United Steelworkers of America.

Related Occupations
Workers in a number of other occupations assemble, install, or repair metal equipment or machines. These include assemblers, blacksmiths, instrument makers, ironworkers, machinists, millwrights, patternmakers, plumbers, sheet-metal workers, tool and die makers, and welders.

Sources of Additional Information
For further information regarding boilermaking apprenticeships or other training opportunities, contact local offices of the unions previously mentioned, local construction companies and boiler manufacturers, or the local office of the State employment service.

Carpenters

(D.O.T. 806.281-058; 860.281-010 through .684-014; 863.684-010; 869.361-018, .381-010, -034, .684-018, -034, -042, and -058; and 962.281-010)

Nature of the Work
Carpenters are involved in many different kinds of construction activity. They cut, fit, and assemble wood and other materials in the construction of buildings, highways and bridges, docks, industrial plants, boats, and many other structures. The duties of carpenters vary by type of employer. A carpenter employed by a special trade contractor, for example, may specialize in one or two activities such as setting forms for concrete construction or erecting scaffolding, while a carpenter employed by a general building contractor may perform many tasks, such as framing walls and partitions, putting in doors and windows, hanging kitchen cabinets, and installing paneling and tile ceilings. Although each carpentry task is somewhat different, most tasks involve the following steps.

Working from blueprints or instructions from supervisors, carpenters first do the layout—measuring, marking, and arranging materials. Local building codes often dictate where certain materials can be used, and carpenters have to know these requirements. Carpenters cut and shape wood, plastic, ceiling tile, fiberglass, and drywall, with hand and power tools, such as chisels, planes, saws, drills, and sanders. Carpenters then join the materials with nails, screws, staples, or adhesives. In the final step, they check the accuracy of their work with levels, rules, plumb bobs, and framing squares and make any necessary adjustments. When working with prefabricated components, such as stairs or wall panels, the carpenter's task is somewhat simpler because it does not require as much layout work or the cutting and assembly of as many pieces. These components are designed for easy and fast installation and can generally be installed in a single operation.

Carpenters employed outside the construction industry do a variety of installation and maintenance work. They may replace panes of glass, ceiling tiles, and doors, as well as repair desks, cabinets, and other furniture. Depending on the employer, carpenters may install partitions, doors, and windows; change locks; and repair broken furniture. In manufacturing firms, carpenters may assist in moving or installing machinery. (For more information on workers who install this machinery, see the statements on industrial machinery repairers and millwrights elsewhere in the *Handbook*.)

Working Conditions
As in other building trades, carpentry work is sometimes strenuous. Prolonged standing, climbing, bending, and kneeling often are necessary. Carpenters risk injury from slips or falls, from working with sharp or rough materials, and from the use of sharp tools and power equipment. Many carpenters work outdoors.

Carpenters must be very careful when operating power equipment.

Some carpenters change employers each time they finish a construction job. Others alternate between working for a contractor and working as contractors themselves on small jobs.

Employment
Carpenters—the largest group of building trades workers—held about 990,000 jobs in 1992. Three of every 4 worked for contractors who build, remodel, or repair buildings and other structures. Most of the remainder worked for manufacturing firms, government agencies, wholesale and retail establishments, and schools. About 4 of every 10 were self-employed.

Carpenters are employed throughout the country in almost every community.

Training, Other Qualifications, and Advancement
Carpenters learn their trade through on-the-job training and through formal training programs. Some pick up skills informally by working under the supervision of experienced workers. Many acquire skills through vocational education. Others participate in employer training programs or apprenticeships.

Most employers recommend an apprenticeship as the best way to learn carpentry. Because the number of apprenticeship programs is limited, however, only a small proportion of carpenters learn their trade through these programs. Apprenticeship programs are administered by local chapters of the Associated Builders and Contractors and by local chapters of the Associated General Contractors, Inc., as well as by local joint union-management committees of the United Brotherhood of Carpenters and Joiners of America and the Associated General Contractors, Inc. or the National Association of Home Builders. These programs combine on-the-job training with related classroom instruction. Apprenticeship applicants generally must be at least 17 years old and meet local requirements. For example, some union locals test an applicant's aptitude for carpentry. The length of the program, usually about 3 to 4 years, varies with the apprentice's skill.

On the job, apprentices learn elementary structural design and become familiar with common carpentry jobs such as layout, form building, rough framing, and outside and inside finishing. They also learn to use the tools, machines, equipment, and materials of the trade. Apprentices receive classroom instruction in safety, first aid,

blueprint reading and freehand sketching, basic mathematics, and different carpentry techniques. Both in the classroom and on the job, they learn the relationship between carpentry and the other building trades.

Informal on-the-job training usually is less thorough than an apprenticeship. The degree of training and supervision often depends on the size of the employing firm. A small contractor who specializes in homebuilding may only provide training in rough framing. In contrast, a large general contractor may provide training in several carpentry skills.

A high school education is desirable, including courses in carpentry, shop, mechanical drawing, and general mathematics. Manual dexterity, eye-hand coordination, good physical condition, and a good sense of balance are important. The ability to solve arithmetic problems quickly and accurately also is helpful. Employers and apprenticeship committees generally view favorably training and work experience obtained in the Armed Services.

Carpenters may advance to carpentry supervisors or general construction supervisors. Carpenters usually have greater opportunities than most other construction workers to become general construction supervisors because they are exposed to the entire construction process. Some carpenters become independent contractors.

Job Outlook

Job opportunities for carpenters are expected to be plentiful through the year 2005, due primarily to extensive replacement needs. Well over 100,000 jobs will become available each year as carpenters transfer to other occupations or leave the labor force. The total number of job openings for carpenters each year usually is greater than for other craft occupations because the occupation is large and turnover is high. Since there are no strict training requirements for entry, many people with limited skills take jobs as carpenters but eventually leave the occupation because they find they dislike the work or cannot find steady employment.

Increased demand for carpenters will create additional job openings. Employment is expected to increase about as fast as the average for all occupations through the year 2005. Construction activity should increase in response to demand for new housing and commercial and industrial plants and the need to renovate and modernize existing structures. The demand for carpenters will be offset somewhat by expected productivity gains resulting from the increasing use of prefabricated components that can be installed much more quickly than by traditional construction methods. In addition, light, cordless pneumatic and combustion tools such as nailers and drills as well as sanders with electronic speed controls reduce fatigue and make workers more efficient.

Although employment of carpenters is expected to grow over the long run, people entering the occupation should expect to experience periods of unemployment. This results from the short-term nature of many construction projects and the cyclical nature of the construction industry. Building activity depends on many factors—interest rates, availability of mortgage funds, government spending, and business investment—that vary with the state of the economy. During economic downturns, the number of job openings for carpenters is reduced. The introduction of new and improved tools, equipment, techniques, and materials has vastly increased carpenters' versatility. Therefore, carpenters with all-round skills will have better opportunities than those who can only do relatively simple, routine tasks.

Job opportunities for carpenters also vary by geographic area. Construction activity parallels the movement of people and businesses and reflects differences in local economic conditions. Therefore, the number of job opportunities and apprenticeship opportunities in a given year may vary widely from area to area.

Earnings

Median weekly earnings of carpenters who were not self- employed were $425 in 1992. The middle 50 percent earned between $320 and $585 per week. Weekly earnings for the top 10 percent of all carpenters were more than $770; the lowest 10 percent earned less than $255.

Earnings may be reduced on occasion because carpenters lose work time in bad weather and when jobs are unavailable. A large proportion of carpenters are members of the United Brotherhood of Carpenters and Joiners of America.

Related Occupations

Carpenters are skilled construction workers. Workers in other skilled construction occupations include bricklayers, concrete masons, electricians, pipefitters, plasterers, plumbers, stonemasons, and terrazzo workers.

Sources of Additional Information

For information about carpentry apprenticeships or other work opportunities in this trade, contact local carpentry contractors, a local of the union mentioned above, a local joint union-contractor apprenticeship committee, or the nearest office of the State employment service or State apprenticeship agency.

For general information about this trade, contact:

☞ Associated Builders and Contractors, 729 15th St. NW., Washington, DC 20005.

☞ Associated General Contractors of America, Inc., 1957 E St. NW., Washington, DC 20006.

☞ Home Builders Institute, Educational Arm of the National Association of Home Builders, 1090 Vermont Ave. NW., Washington, DC 20005.

☞ United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, DC 20001.

Jewelers

(D.O.T. 199.281-010; 700.281-010, -014, -022, and .381-030, -042, and -046)

Nature of the Work

For thousands of years, people have worn and admired jewelry made from precious metals and stones, such as gold and diamonds. Jewelers use such materials to make, repair, and adjust rings, necklaces, bracelets, earrings, and other jewelry using a variety of tools and materials. They use drills, pliers, jeweler's soldering torches, saws, jeweler's lathes, and a variety of other handtools to mold and shape metal and to set gemstones. Jewelers also may use chemicals and polishing compounds, such as flux for soldering and tripoli and rouge for finishing.

Jewelers may specialize in one or more areas of the jewelry field—buying, design, gem cutting, repair, sales, or appraisal. In small retail or repair shops, jewelers may be involved in all aspects of the work. Regardless of the type of establishment or work setting, however, jewelers' work requires a high degree of skill and attention to detail. Those working in retail stores and repair shops generally spend much of their time repairing or adjusting jewelry. Typical work includes enlarging or reducing rings, resetting stones, and replacing broken clasps and mountings. Some jewelers also 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 are then soldered together, and the jeweler may mount a diamond or other gem or may engrave a design into the metal.

Other jewelers in retail stores are primarily involved in sales; many of them are certified gemologists, who appraise the quality and value of diamonds, other gemstones, and gem materials. Jewelers who own or manage stores or shops hire and train employees; order, market, and sell merchandise; and perform other managerial duties.

In manufacturing, jewelers usually specialize in a single operation. Some jewelers may make models or tools for the jewelry that is to be produced. Others do finishing work, such as setting stones or engraving. A growing number of jewelers use lasers for cutting and improving the quality of stones.

Technology has not yet greatly affected the jewelry industry. However, some manufacturing firms use CAD/CAM (computer-aided design and manufacturing) to facilitate product design and automate mold and model making. Use of such systems should increase in the future as they become more affordable for smaller companies. In retail stores, computers are used mainly for inventory control; some jewelers use computers to design and create customized pieces according to their customers' wishes. With the aid of computers, customers can choose from basic styles, and mix and match cuts, shanks, sizes, and stones to create their own pieces.

Working Conditions

Jewelers usually do most of their work seated in comfortable surroundings, and the trade involves few physical hazards. While the work is not physically strenuous, there is a lot of work with detail and intricate designs which may be tiring to some. Caution must be taken because the chemicals, sawing and drilling tools, and torches a jeweler uses can cause serious injury. In addition, doing delicate work while trying to satisfy demands for speed and quality from customers and employers can cause stress, and bending over a workbench for long periods can be uncomfortable. In the future, the use of computers may ease some of these conditions since applications like CAD/CAM greatly increase the speed and accuracy of the design and manufacturing process.

Because many of the materials with which they work are very valuable, those working in retail stores must observe strict security procedures. These may include locked doors that are only opened by a buzzer, barred windows, burglar alarms, and the presence of armed guards. This additional responsibility may create stress.

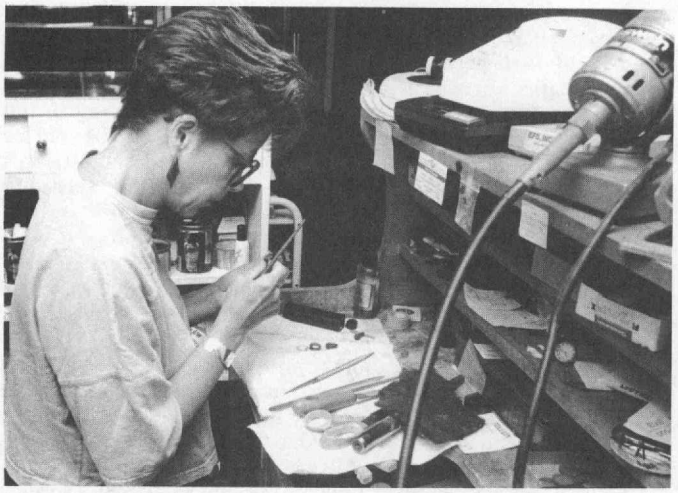
In repair shops, jewelers generally work alone with little supervision. In retail stores, on the other hand, they may talk with customers about repairs, perform custom design work, and even do some sales work.

In some plants manufacturing precious jewelry, the workweek is 35 hours. During slack periods, however, jewelers may have shortened workweeks or be laid off. Most jewelers in stores and repair shops work 40 to 48 hours a week, including evenings and Saturday. During peak sales seasons, such as Christmas, they often work longer hours, but are compensated for overtime.

Employment

Jewelers held about 30,000 jobs in 1992. About 4 out of 10 jewelers were self-employed; many operated their own store or repair shop, and some specialized in designing and creating custom jewelry.

Roughly half of all salaried jewelers worked in retail establishments, while almost one-third were employed in manufacturing plants. Although jewelry stores and repair shops can be found in every city and many small towns, most job opportunities are in larger metropolitan areas. Many jewelers employed in manufacturing work in New York, California, or Rhode Island where production is concentrated.



Jewelers need a steady hand for precision work.

Training, Other Qualifications, and Advancement

Jewelers' skills usually are learned in technical schools, through correspondence courses, or informally on the job. Some aspiring jewelers begin working as clerks in department stores and transfer to jobs in jewelry shops or manufacturing firms after gaining experience. Colleges and art schools also offer programs which can lead to a bachelor's or master's degree of fine arts in jewelry design. Formal training in the basic skills of the trade enhances one's employment and advancement opportunities. Many employers prefer well-rounded jewelers with design, repair, and sales skills.

For those interested in working in a jewelry store or repair shop, technical schools or courses offered by local colleges are the best sources of training. In these programs, which vary in length from 6 months to 3 years, 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 like blueprint reading, math, and shop theory. Most employers feel that graduates need an additional 3 or more years of supervised on-the-job training to refine their repair skills and to 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 sample making, wax carving, or gemology. Many employers pay all or part of the cost of this additional training.

Technical school programs lasting about 6 months and correspondence courses lasting several years also offer training in appraising and programs leading to a gemologist diploma. These advanced programs cover a wide range of topics including evaluating diamonds and colored stones, identifying gems, and designing jewelry.

In jewelry manufacturing plants, workers traditionally have developed their skills through informal on-the-job training programs. This training may last 3 to 4 years, depending on the difficulty of the specialty. Training usually focuses on casting, stonesetting, modelmaking, or engraving. In recent years, a growing number of technical schools and colleges have begun to offer training designed for jewelers working in manufacturing. Like employers in retail trade, those in manufacturing prefer graduates of these programs because they are familiar with the production process and the in-house training can be shortened significantly.

To enter most technical school or college programs, a high school diploma or its equivalent is required. Courses in art, math, mechanical drawing, and chemistry are useful. Since computer-aided design is increasingly used in the jewelry field, it is recommended that students—especially those interested in design and manufacturing—obtain training in CAD.

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 and personable. In addition, employers require someone of good character because jewelers work with very valuable materials.

Advancement opportunities are limited and greatly dependent 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 salaried managers; some open their own businesses.

For those interested in starting their own business, a substantial financial investment is needed to 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 is expected to increase about as fast as the average for all occupations through the year 2005. Job opportunities for jewelers depend largely on jewelry sales and on demand for jewelry repair services. Demand for jewelry is affected by the amount of disposable income people have. Jewelry sales are expected to remain strong, and are currently being fueled by increases in the number of affluent individuals, working women, double-income families, and increasingly fashion-conscious men.

Jewelers have a relatively strong attachment to their occupations—reflecting the large proportion of self- employed workers. Nevertheless, job openings will largely result from the need to replace jewelers who transfer to other occupations, retire, or leave the labor force for other reasons.

Opportunities should be good for graduates from jeweler training programs. The job outlook will be best in jewelry stores and repair shops as jewelry sales rise. Demand for repair workers is strong since maintaining and repairing jewelry is an ongoing process, even during economic slowdowns. In fact, demand for jewelry repair often increases during recessions as people will repair or restore existing pieces rather than purchase new ones.

Those interested in pursuing a career in jewelry manufacturing will face keen competition. Many jewelry manufacturers have curtailed their operations because of increased jewelry imports. However, exports are steadily increasing as manufacturers become more competitive in foreign markets. Jewelers may also face competition from nontraditional stores such as department stores and catalog showrooms, because these stores often hire clerks rather than jewelers to service customers.

Earnings

Depending on the employer, jewelers may receive commissions on what they sell or bonuses for outstanding work. According to the *Jewelers' Circular-Keystone* annual salary survey, jewelers in retail stores earned a median salary of approximately $28,000 in 1991, while jewelry repair workers earned a median salary of $22,000.

For those in manufacturing, earnings of experienced, unionized jewelry workers averaged $10.00 an hour in 1992, according to the limited information available. Beginners in jewelry factories generally start at considerably less than experienced workers; as they become more proficient, they receive periodic raises.

Most jewelers enjoy a variety of fringe benefits including reimbursement from their employers for work- related courses and discounts on jewelry purchases.

Related Occupations

Other skilled workers who do similar jobs include polishers, dental laboratory technicians, gemcutters, hand engravers, and watch makers and repairers.

Sources of Additional Information

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

☞ Jewelers of America, 1185 Avenue of the Americas, New York, NY 10036.

☞ Manufacturing Jewelers and Silversmiths of America, 100 India St., Providence, RI 02903.

☞ Gemological Institute of America, 1660 Stewart St., Santa Monica, CA 90404.

Machinists and Tool Programmers

(D.O.T. 007.167-018; 600.260, -022, .280-022, -026, -030, -034, -042, .281-010, .380-010; 609.262-010; and 714.281-018)

Nature of the Work

Machinists produce precision metal parts, usually using machine tools such as lathes, drill presses, and milling machines. Although machinists can and sometimes do produce large quantities of one part, machinists often produce small batches or one-of-a-kind items. They set up and operate a wide variety of machine tools and know the working properties of metals such as steel, cast iron, aluminum, and brass. Using their skill with machine tools and their knowledge of metals, machinists plan and carry out the operations needed to make machined products that meet precise specifications.

Increasingly, the machine tools used to produce metal parts are numerically controlled (NC)—that is, they contain an electronic controller that directs the machine's operations. Most NC machines today are computer numerically controlled (CNC), which means that the controllers are computers. The controller "reads" a program—a coded list of the steps necessary to perform a specific machining job—and runs the machine tool's mechanisms through the steps. The quality of the products these machines produce depends largely on the programs, which may be produced by machinists or by workers who specialize in programming machine tools known as tool programmers. Although tool programmers and machinists are often considered separate occupations, because many of their duties are very similar or identical, both are covered in this statement.

Machinists first review blueprints or written specifications for a job. 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, plan the sequence of cutting and finishing operations, and mark the metal stock to show where these cuts should be made.

After this layout work is completed, they perform the necessary machining operations. Machinists position the metal stock on the machine tool—drill presses, lathes, milling machines, or others—set the controls, and make the cuts. Today, new machinery allows various functions to be performed with one setup, which reduces the need for additional, labor-intensive setups, saving time and money. During the machining process, they must constantly monitor the feed and speed of the machine. Machinists must also ensure that the workpiece is being properly lubricated and cooled because the machining of metal products generates a significant amount of heat.

Traditionally, machinists have had direct control of their machines. However, the introduction of numerically controlled machines, and in particular, computer numerically controlled machines, has greatly changed the nature of the work for machinists. NC machines not only are more productive, they enable parts to be produced with a level of precision beyond that possible with traditional machining techniques. Furthermore, because precise movements are recorded in the program, they allow this high level of precision to be consistently repeated. This uniformity is key to fulfilling customers' needs for quality products.

Tool programmers begin as machinists do—by analyzing blueprints, computing the size and position of the cuts, determining the sequence of machine operations, selecting tools, and calculating the machine speed and feed rates. They then write the program in the language of the machine's controller and store it. Skilled machinists also do programming. As computer software becomes more user friendly, machinists are expected to perform this function increasingly.

Machinists may work alone or with tool programmers to check new programs to ensure that machinery will function properly and the output will meet specifications. Because a problem with the program could damage the costly machinery and cutting tools, computer simulations may be used instead of a trial run to check the program. If errors are found, the program must be changed and retested until the problem is resolved. Programs can then be used for other jobs with similar specifications by making small adjustments to the existing program. This reduces the time and effort needed to start production of a part.

A growing number of firms have computer-aided design (CAD) systems that are used to write programs. When a part is designed using a CAD system, data about its dimensions are calculated; the CAD system can then use these data to develop the controller's program.

As machinery has become more complex, close tolerances or high precision of machined parts has also increased in importance. In some cases, for example, a part may have to meet specifications equal to one-twentieth of a strand of hair. As a result measuring devices have also increased in sophistication. Optical, acoustical, and laser measuring devices commonly ensure that work meets specifications.

Although machinists and tool programmers perform many similar duties, jobs can vary greatly. Some machinists, often called production machinists, may produce large quantities of one part, especially parts needing unusually complex operations, great precision, or when unusually sophisticated, expensive machinery is used. Usually, however, large numbers of parts requiring more routine operations are produced by metalworking machine operators (see the statement on metalworking and plastics-working machine operators elsewhere in the *Handbook*). Other machinists do maintenance work—repairing or making new parts for existing machinery. For example, 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

Most machine shops are well lighted and ventilated. Nevertheless, working around high-speed machine tools presents certain dangers, and workers must follow safety precautions. Machinists must wear protective equipment such as safety glasses to shield against bits of flying metal and earplugs to protect against machinery noise. They must also exercise caution when cleaning and disposing of coolants and lubricants because many of these materials can be hazardous. The job requires stamina because machinists stand most of the day and may lift moderately heavy workpieces.

Some tool programmers work in offices that are near, but separate from, the shop floor. These work areas are usually clean, well lighted, and free of machine noise.

Most machinists and tool programmers work a 40-hour week. Evening and weekend shifts are becoming more common as companies invest in more expensive machinery. Overtime is common during peak production periods.

Employment

Machinists and tool programmers held about 359,000 jobs in 1992. Most machinists worked in small machining shops or in manufacturing firms that produce durable goods such as metalworking and industrial machinery, aircraft, or motor vehicles. Maintenance machinists work in most industries that use production machinery. Although machinists and tool programmers work in all parts of the country, jobs are most plentiful in areas where manufacturing is concentrated.

Training, Other Qualifications, and Advancement

A high school or vocational school education, including mathematics, blueprint reading, metalworking, and drafting, is desirable for becoming a machinist or tool programmer. A basic knowledge of computers and electronics is helpful because of the increased use of computer-controlled machine tools. Experience with machine tools also is helpful. In fact, many of the people who enter the occupation have previously worked as machine tool operators or setters.

Machinist training varies from formal apprenticeship programs to informal on-the-job training. However, most employers consider a formal apprenticeship program the best way to learn the machinist trade. Apprentice 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, blueprint reading, mechanical drawing, and shop practices. In addition, as machine shops have increased their use of computer-controlled equipment, training in the operation and programming of numerically controlled machine tools has become essential. Community colleges and technical institutes increasingly offer classroom training in connection with company or association training programs.

Qualifications for tool programmers vary widely depending upon the complexity of the job. Basic requirements parallel those of machinists. Employers often prefer skilled machinists, tool and die makers, or those with technical school training. For some specialized types of programming, such as with complex parts for the aerospace or shipbuilding industries, employers may prefer individuals with a degree in engineering.

For those entering tool programming directly, a basic knowledge of computers and electronics is helpful because of the increased use of computer-controlled machine tools. Experience with machine tools also is helpful. Classroom training includes an introduction to numerical control and the basics of programming and then advances to more complex topics such as computer-aided design. Then, trainees start writing simple programs under the direction of an experienced programmer. Although machinery manufacturers are trying to standardize programming languages, currently there are numerous languages in use. Because of this, tool programmers must be able to learn and adapt to new programming languages.

Established workers may also take courses to update their skills and to learn the latest technology and equipment. Some employers offer tuition reimbursement for job-related courses. In addition, when new machinery is introduced, workers receive training in its operation—usually from a representative of the equipment manufacturer.

Persons interested in becoming a machinist or tool programmer should be mechanically inclined. They also should be able to work independently and do highly accurate work that requires concentration as well as physical effort.

Job Outlook

Employment of machinists and tool programmers is expected to decline slightly through the year 2005. Nevertheless, many job openings will arise each year from the need to replace experienced machinists and programmers who transfer to other occupations or retire. In recent years, employers have reported difficulties in attracting workers to machining and tool programming occupations. Therefore, good employment opportunities should exist for candidates with the necessary mechanical and mathematical aptitudes.

The number of openings for machinists is expected to be far greater than the number of openings for tool programmers because there are many more machinists than tool programmers. In addition, machinists are increasingly taking on the functions of tool programming as the programming of machine tools becomes easier due to simplified programming languages and procedures.

As the economy expands, so will the demand for goods that use machined metal parts. But, demand for these workers will be constrained by improvements in metalworking technology. For example, the use of computer-controlled machine tools reduces the time required for machining operations and increases productivity. Furthermore, when demand for machined goods falls, machinists and tool programmers involved in production may be laid off or be forced to work fewer hours. Apprenticeship opportunities may also decline.

Employment of machinists involved in plant maintenance is often more stable because proper maintenance and repair of costly equipment remain vital concerns even when production levels fall.

Earnings

Earnings of machinists compare favorably with those of other skilled workers. In 1992, median weekly earnings for machinists were about $492. Most earned between $376 and $623. Ten percent of all machinists had median weekly earnings of less than $275; the 10 percent with the highest earnings made more than $750 a week. In addition to their hourly wage, most workers receive health and life insurance, a pension plan, paid vacations, and sick leave.

Related Occupations

Occupations most closely related to that of machinist and tool programmer are, of course, the other machining occupations. These include tool and die maker, tool and die designer, tool planner, and instrument maker. Workers in other occupations that require precision and skill in working with metal include blacksmiths, gunsmiths, locksmiths, metal patternmakers, and welders.

Tool programmers apply their knowledge of machining operations, metals, blueprints, and machine programming to write programs that run machine tools. Computer programmers also write detailed instructions for a machine—in this case a computer.

Sources of Additional Information

For general information about this occupation, contact:

☞ The Association for Manufacturing Technology, 7901 Westpark Dr., McLean, VA 22102.

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

☞ The Tooling and Manufacturing Association, 1177 South Dee Rd., Park Ridge, IL 60068.

☞ Precision Metalforming Association, 27027 Chardon Rd., Richmond Heights, OH 44143.

Metalworking and Plastics-Working Machine Operators

(List of D.O.T. codes available on request from the Chief, Division of Occupational Outlook, Bureau of Labor Statistics, Washington, DC 20212.)

Nature of the Work

Consider the parts of a toaster—the metal or plastic housing or the lever that lowers the toast, for example. These parts, and many other metal and plastic products, are produced by metal and plastics-working machine operators. In fact, manual and numerical control machine tool operators in the metalworking and plastics industries play a major part in producing most of the consumer products on which we rely daily.

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 operation. Operators and tenders, on the other hand, primarily monitor the machinery during operation, sometimes loading or unloading the machine or making minor adjustments to the controls. Many workers do both—set up and operate the equipment. Because the set-up 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 the machinery.

Setters, operators, tenders, and set-up operators are usually identified by the type of machine with which they work. Some examples of specific titles are screw machine operator, plastics-molding machine setup operator, and lathe tender. Although some workers specialize in one or two types of machinery, many are trained to set up or operate a variety of machines. Job duties usually vary based on the size of the firm as well as on the type of machine being operated.

Metalworking machine setters and operators set up and tend machines that cut and form all types of metal parts. Traditionally, setup workers plan and set up the sequence of operations according to blueprints, layouts, or other instructions. They adjust 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 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.

Plastics working machine operators set up and tend machines that transform plastic compounds—chemical based products that can be produced in powder, pellet, or syrup form—into a wide variety of consumer goods such as toys, tubing, and auto parts. These products are produced by various methods, of which injection molding is the most common. The injection molding machine heats 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 using this method. To produce long parts such as pipes or window frames, on the other hand, an extruding machine is usually employed. These machines force a plastic compound through a die that contains an opening of the desired shape of the final product. Yet another type of plastics working technique is blow molding. Blow-molding machines force hot air into a mold which contains a plastic tube. As the air moves into the mold, the plastic tube is inflated to the shape of the mold and a plastic container is formed. The familiar 2-liter soft drink bottles are produced using this method.

Regardless of the process used, plastics-working machine operators check the materials feed, the temperature and pressure of the machine, and the rate at which the product hardens. Depending on the type of equipment in use, they may also load material into the machine, make minor adjustments to the machinery, or unload and inspect the finished products. Plastics-working machine operators also remove clogged material from molds or dies. Because molds and dies are quite costly, operators must exercise proper care to avoid damaging them.

Metal and plastics-working machine operators are increasingly being called upon to work with numerically controlled (NC) equipment. These machine tools have two major components: An electronic controller and a machine tool. Almost all NC machines today are computer numerically controlled (CNC), which means that the controllers are computers. The controller directs the mechanisms of the machine tool through the positioning and machining described in the program or instructions for the job. A program could contain, for example, commands that cause the controller to move a drill bit to certain spots on a workpiece and drill a hole at each spot.

Each type of CNC machine tool, such as a milling machine, a lathe, or a punch press, performs a specific task. A part may be worked on by several machines before it is finished. CNC machines are often used in computer-integrated manufacturing (CIM) systems. In these systems, automated material handling equipment moves workpieces through a series of work stations where machining processes are computer numerically controlled. In some cases, the workpiece is stationary and the tools change automatically. Although the machining is done automatically, numerically controlled machine tools must be set up and used properly in order to obtain the maximum benefit from their use. These tasks are the responsibility of numerical-control machine-tool operators or, in some instances, machinists. (See the statement on machinists and tool programmers elsewhere in the *Handbook*.)

Like the duties of manual metal and plastics machine operators, the duties of numerical-control machine-tool operators vary. In some shops, operators tend just one machine. More likely, however, they might tend a number of machines or do some programming. As

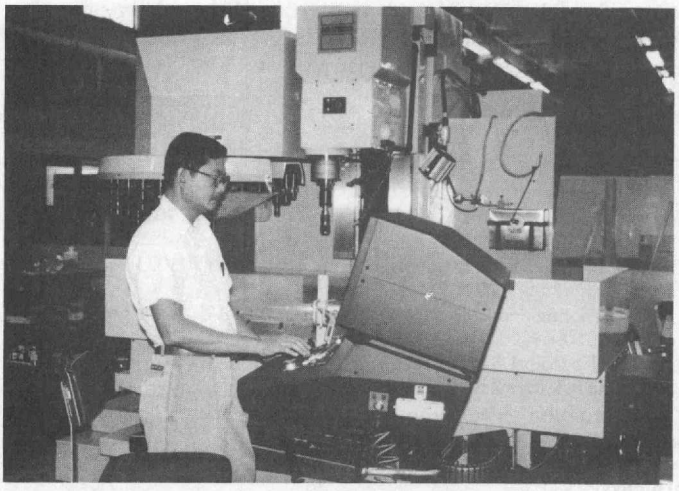
a result, the skill requirements of these workers vary from job to job. Although there are many variations in operators' duties, they generally involve many of the tasks described below.

Working from given instructions, operators load programs that are usually stored on floppy disks into the controller. They also securely position the workpiece, attach the necessary tools, and check the coolants and lubricants. Many numerically controlled machines are equipped with automatic tool changers, so operators may also load several tools in the proper sequence. In addition, heat generated by machining could damage the cutting tools and the part being machined, so operators must ensure that the proper coolants and lubricants are being used. This entire process may require a few minutes or several hours, depending on the size of the workpiece and the complexity of the job.

A new program must be "debugged," or adjusted, to obtain the desired results. If the tool moves to the wrong position or makes a cut that is too deep, for example, the program must be changed so that the job is done properly. Sometimes an NC operator will debug programs, but more often a machinist or tool programmer will perform this function. (See the statement on machinists and tool programmers elsewhere in the *Handbook*.) A new generation of machine tool technology called direct numerical control allows operators to make changes to the program and enter new specifications via menu-driven mini computers on the shop floor.

Because numerically controlled machine tools are very expensive, an important duty of operators is to monitor the machinery to prevent situations that could result in costly damage to the cutting tools or other parts. The extent to which the operator performs this function depends on the type of job as well as the type of equipment being used. Some numerically controlled machine tools automatically monitor and adjust machining operations. When the job has been properly set up and the program has been checked, the operator may only need to monitor the machine as it operates. These operators often set up and monitor more than one machine. Other jobs require frequent loading and unloading, tool changing, or programming. Operators may check the finished part using micrometers, gauges, or other precision inspection equipment to ensure that it meets specifications. Increasingly, however, this function is being performed by numerically controlled machine tools that are able to inspect products as they are being produced.

CNC machines are changing the nature of the work that machine setters and operators perform. For example, computer-controlled machines simplify setups by using formerly tested computer programs for new workpieces. If a workpiece is similar to one previously produced, small adjustments can be made to the old program instead of developing a new program from scratch. Also, operators of this equipment have less physical interaction with the machinery or materials. They primarily act as "troubleshooters," monitoring machines on which the loading, forming, and unloading processes are often controlled by computers.



Automated machinery has increased the productivity of many machine operators.

Working Conditions

Most metalworking and plastics-working machine operators work in areas that are clean, well lit, and well ventilated. Regardless of setting, all of 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 noise from the machines. Other required equipment varies by work setting and by machine. For example, workers in the plastics industry who work near materials that emit dangerous fumes or dust must wear face masks or self- contained breathing apparatuses.

Most metal and plastics working machine operators work a 40-hour week, but overtime is common during periods of increased production. The industries in which metal and plastics workers are concentrated average 3 or 4 hours of overtime per week. Because many metalworking and plastics working shops operate more than one shift daily, some operators work nights and weekends.

The work requires stamina because operators are on their feet much of the day and may do moderately heavy lifting. Approximately 35-40 percent of these workers are union members; the metalworking industries have a higher rate of unionization than the plastics industry.

Employment

Metalworking and plastics-working machine operators held about 1,378,000 jobs in 1992. Of these, 1,305,000 were manual machine operators, and 73,000 were NC machine operators. Eight out of every 10 of these workers are found in five industries: Fabricated metal products, industrial machinery and equipment, miscellaneous plastic products, transportation equipment, and primary metals. Table 1 shows the distribution of employment of metal and plastics-working machine operators by detailed occupation.

Table 1. Distribution of Metal and plastics-working machine operators by detailed occupation, 1992

Occupation	*Percent*
Machine tool cutting and forming machine setters and operators	49
Molding machine setters and operators	14
Sheetmetal workers and duct installers	8
Combination machine tool setters and operators	7
Numerical control machine operators	5
Plating machine setters and operators	4
Metal fabricators, structural metal products	3
Heaters and heat treating machine setters and operators	2

SOURCE: Bureau of Labor Statistics

Training, Other Qualifications, and Advancement

Most metal and plastics-working machine operators learn their skills on the job. Trainees begin by observing and assisting experienced workers, often in formal training programs. Under supervision they may supply material, start and stop the machine, or remove finished products from the machine. As part of their training they advance to more difficult tasks like adjusting feed speeds, changing cutting tools, or inspecting a finished product for defects. Eventually they become responsibile for their own machine or machines.

The complexity of 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 several years to become a skilled operator or to advance to the more highly skilled job of setup operator.

Although setup operators perform many of the same tasks as skilled machine operators, they also need to have a thorough knowledge of the machinery and of the products being produced. Setup operators often study blueprints, plan the sequence of work, make the first production run, and determine which adjustments need to be made. Strong analytical abilities are particularly important to perform this job. Some companies have formal training programs

for setup operators that combine classroom instruction with on-the-job training.

CNC machine tool operators undergo similar training. Working under a supervisor or an experienced operator, trainees learn to set up and run one or more kinds of numerically controlled machine tools. Trainees usually learn the basics of their jobs within a few months. However, the length of the training period varies with the number and complexity of the machine tools the operator will run and with the individual's ability. If the employer expects operators to write programs, trainees may attend programming courses offered by machine tool manufacturers or technical schools. These courses usually last a couple of weeks.

Although no special education is required for most operating jobs, 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. This is especially true for numerical control machine operators, who may need to be retrained often in order to learn to operate new equipment. 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 are also pluses. Those interested in becoming a metal or plastics-working machine operator can improve their employment opportunities by completing high school courses in shop, mathematics, and blueprint reading and by gaining a working knowledge of the properties of metals and plastics.

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 positions of machinist or tool and die maker. Manual machine operators can move on to CNC equipment when it is introduced into their establishments. Some setup workers and CNC operators may advance to supervisory positions. CNC operators who have substantial training in numerical control programming may advance to the higher paying job of tool programmer. (See statements on machinists and tool programmers, and tool and die makers found elsewhere in the *Handbook*.)

Job Outlook

Overall employment of metal and plastics-working machine operators is expected to decline through the year 2005. This decline is likely to affect metalworking machine operators more than those working with plastics machines. In addition, setters and more highly skilled operators are more likely to be retained by firms than are semi-skilled operators and tenders. In spite of the overall employment decline, however, a large number of jobs will become available each year as current operators and setters transfer to other occupations or leave the labor force.

A major factor driving the employment decline is the increasing productivity resulting from computer-controlled equipment. In order to remain competitive, many firms are adopting this technology to improve quality and lower production costs. Computer-controlled equipment allows operators to simultaneously tend a greater number of machines and often makes setup easier, thereby reducing the amount of time setup workers spend on each machine. For these reasons, employment of CNC machine operators is expected to increase in the future despite the decline in machine operators as a whole. Lower-skilled positions like manual machine tool operators and tenders are more likely to be eliminated by increasing automation than those of setters and set up operators, whose higher skills are more in demand and whose job functions are less easily automated.

The demand for metal and plastics machine operators largely mirrors the demand for the parts they produce. In recent years, plastic products have been substituted for metal goods in many consumer and manufacturing products. Although the rate of substitution may slow in the future, this process is likely to continue and should result in a relatively stronger demand for machine operators in plastics than in metalworking. Both industries, however, face stiff foreign competition that is limiting the demand for domestically-produced parts. One way that larger U.S. producers have responded to this competition is by moving production operations to other countries in order to reduce labor costs. These moves are likely to continue and will further reduce employment opportunities for metal and plastics-working machine tool operators in the United States.

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 this changing environment. In addition, new shopfloor arrangements will reward workers with good basic mathematics and reading skills, good communication skills, flexibility, and the ability and willingness to learn new tasks. Those interested in working with CNC machine tools will most likely need to have a high school education and should be familiar with several types of machines and operating systems.

Earnings

Median weekly earnings for most metal and plastics- working machine operators were $413 in 1992. The middle 50 percent earned between $300 and $536. The top 10 percent earned over $697 and the bottom 10 percent earned less than $236. Plastic molding machine operators earned somewhat less, about $359 a week. Numerical-control machine-tool operators earned between $450 and $500 a week in 1992, according to the limited data available.

Earnings of production workers vary considerably by industry, however. Average weekly wages for production workers in industries where employment of metal and plastics-working machine operators is concentrated are shown in the following tabulation.

Transportation equipment	$633
Primary metals industries	590
Industrial machinery and equipment	525
Fabricated metal products	475
Rubber and misc. plastics products	433

Most machine operators receive standard benefits such as pension plans, vacation and sick leave, and retirement plans.

Related Occupations

Workers in occupations closely related to metalworking and plastics-working machine occupations include machinists, tool and die makers, extruding and forming machine operators producing synthetic fibers, woodworking machine operators, and metal patternmakers. Numerical-control machine-tool operators may program CNC machines or alter existing programs, which are functions closely related to those performed by NC machine tool programmers.

Sources of Additional Information

For general information about the metalworking trades, contact:

☞ The Association for Manufacturing Technology, 7901 Westpark Dr., McLean, VA 22102.

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

☞ The Tooling and Manufacturing Association, 1177 South Dee Rd., Park Ridge, IL 60068.

☞ The National Screw Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141.

Information on educational programs in plastics technology and polymer sciences is available from:

☞ The Society of the Plastics Industry, Inc., 1275 K St. NW., Washington, DC 20005.

☞ The Plastics Education Foundation of The Society of Plastics Engineers, Inc., 14 Fairfield Dr., Brookfield, CT 06804-0403.

Sheetmetal Workers

(D.O.T. 804.281-010 and -014)

Nature of the Work

Sheetmetal workers make, install, and maintain air-conditioning, heating, ventilation, and pollution control duct systems; roofs; siding; rain gutters and downspouts; skylights; restaurant equipment; outdoor signs; and many other building parts and products made from metal sheets. They may also work with fiberglass and plastic materials. Although some workers specialize in fabrication, installation, or maintenance, most do all three jobs. (This statement does not include workers employed in the mass production of sheetmetal products.)

Sheetmetal workers usually fabricate their products at a shop away from the construction site. They first study plans and specifications to determine the kind and quantity of materials they will need. They then measure, cut, bend, shape, and fasten pieces of sheet metal to make duct work, counter tops, and other custom products. In an increasing number of shops, sheetmetal workers use computerized metalworking equipment. This enables them to experiment with different layouts and to select the one that results in the least waste of material. They cut or form the parts with computer-controlled saws, lasers, shears, and presses.

In shops without computerized equipment and for products that cannot be made on such equipment, sheetmetal workers use hand calculators to make the required calculations and use tapes, rulers, and other measuring devices for layout work. They then cut or stamp the parts on machine tools.

Before assembling the pieces, sheetmetal workers check each part for accuracy and, if necessary, finish it by using hand, rotary, or squaring shears and hacksaws. After the parts have been inspected, workers fasten the seams and joints together with welds, bolts, cement, rivets, solder, specially formed sheetmetal drive clips, or other connecting devices. They then take the parts to the construction site where they further assemble the pieces as they install them. These workers install ducts, pipes, and tubes by joining them end to end and hanging them with metal hangers secured to a ceiling or a wall. They also use shears, hammers, punches, and drills to make parts at the worksite or to alter parts made in the shop.

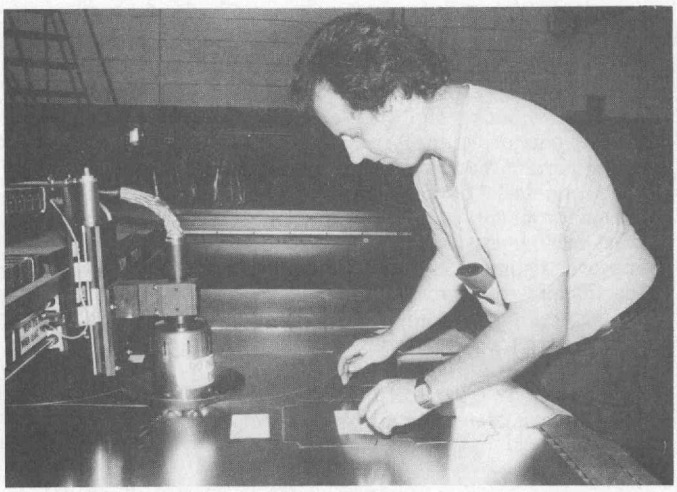
Some jobs are done completely at the job site. When installing a metal roof, for example, sheetmetal workers measure and cut the roofing panels that are needed to complete the job. They secure the first panel in place and interlock and fasten the grooved edge of the next panel into the grooved edge of the first. Then they nail or weld the free edge of the panel to the structure. This two-step process is repeated for each additional panel. Finally, they fasten machine-made molding at joints, along corners, and around windows and doors for a neat, finished effect.

In addition to installation, some sheetmetal workers specialize in testing, balancing, adjusting, and servicing existing air-conditioning and ventilation systems to make sure they are functioning properly and to improve their energy efficiency. Sheetmetal workers may also perform safe removal of asbestos and toxic materials.

Working Conditions

Sheetmetal workers usually work a 40-hour week. Those who fabricate sheetmetal products work in shops that are well lighted and well ventilated. They stand for long periods and may have to lift heavy materials and finished pieces. Sheetmetal workers must follow safety practices because working around high-speed machines can be dangerous. They may be subject to cuts from sharp metal, burns from soldering and welding, and falls from ladders and scaffolds. They generally wear safety glasses and must not wear jewelry or loose-fitting clothing that could easily get caught in a machine.

Those doing installation work do considerable bending, lifting, standing, climbing, and squatting, sometimes in close quarters or in awkward positions. Although installing duct systems and kitchen equipment is done indoors, the installation of siding, roofs, and gutters involves much outdoor work, requiring sheetmetal workers to work in all kinds of weather.



In many shops, sheet-metal workers use computerized equipment to cut parts.

Employment

Sheetmetal workers held about 91,000 wage and salary jobs in the construction industry in 1992. Seven of every 10 worked for plumbing, heating, and air-conditioning contractors; 1 of every 5 worked for roofing and sheetmetal contractors; and the rest worked for other special trade contractors and for general contractors engaged in residential and commercial building. Unlike many other construction trades, very few sheetmetal workers are self- employed.

Jobs for sheetmetal workers are distributed throughout the country in about the same proportion as the total population.

Training, Other Qualifications, and Advancement

Sheetmetal contractors consider apprenticeship the best way to learn this trade. The apprenticeship program consists of 4 or 5 years of on-the-job training and a minimum of 144 hours per year of classroom instruction. Apprenticeship programs provide comprehensive instruction in both sheetmetal fabrication and installation. They are administered by local joint committees composed of the Sheet Metal Workers' International Association and local chapters of the Sheet Metal and Air-Conditioning Contractors National Association, or by local chapters of the Associated Builders and Contractors.

On the job, apprentices learn the basics of pattern layout and how to cut, bend, fabricate, and install sheet metal. They begin with basic ductwork and gradually advance to more difficult jobs, such as making more complex ducts, fittings, and decorative pieces. They also use materials such as fiberglass, plastics, and other non-metallic materials.

In the classroom, apprentices learn drafting, plan and specification reading, trigonometry and geometry applicable to layout work, the use of computerized equipment, welding, and the principles of heating, air-conditioning, and ventilating systems. Safety is stressed throughout the program. In addition, apprentices learn the relationship between sheetmetal work and other construction work.

A relatively small number of persons pick up the trade informally, usually by working as helpers to experienced sheetmetal workers. Most begin by carrying metal and cleaning up debris in a metal shop while they learn about materials and tools and their uses. Later, they learn to operate machines that bend or cut metal. In time, helpers go out on the job site to learn installation. Those who acquire their skills this way often take vocational school courses in mathematics or sheetmetal fabrication to supplement their work experience. Helpers usually must pass an exam to be promoted to the journey level.

Applicants for jobs as apprentices or helpers should be in good physical condition and have mechanical and mathematical aptitude.

Good eye-hand coordination, spatial and form perception, and manual dexterity are also important. Local apprenticeship committees require a high school education or its equivalent. Courses in Algebra, trigonometry, geometry, mechanical drawing, and shop provide a helpful background for learning the trade, as does work experience obtained in the Armed Services.

It is important that experienced sheetmetal workers keep abreast of new technolgical developments such as the growing use of computerized layout and laser cutting machines. Workers often take additional training provided by the union or by their employer in order to improve existing skills or to acquire new ones.

Sheetmetal workers may advance to supervisory jobs. Some take additional training in welding and do more specialized work. Others go into the contracting business for themselves. Because a sheetmetal contractor must have a shop with equipment to fabricate products, this type of contracting business is more expensive to start than other types of construction contracting.

Job Outlook

Employment of sheetmetal workers in construction is expected to increase faster than the average for all occupations through the year 2005. Demand for sheetmetal installation should increase as more industrial, commercial, and residential structures are built. Growing demand for more energy-efficient air-conditioning, heating, and ventilation systems in the growing stock of older buildings, as well as other types of renovation and maintenance work, also should boost employment. In addition, the greater use of decorative sheetmetal products and increased architectural restoration are expected to add to the demand for sheetmetal workers. Despite this growth in demand, most job openings will arise as experienced workers retire or leave the occupation for other reasons.

Job prospects are expected to be excellent for skilled sheetmetal workers over the long run, although workers may experience periods of unemployment when construction projects end and when economic conditions reduce the amount of construction activity. Because local economic conditions can vary so widely, there can be shortages of experienced workers in some areas and an oversupply in other parts of the country. Nevertheless, employment of sheetmetal workers is less sensitive to declines in new construction than employment of some other construction workers, such as carpenters. Maintenance of existing equipment—which is less affected by economic fluctuations than new construction—makes up a large part of the work done by sheetmetal workers. Installation of new air-conditioning and heating systems in existing buildings also continues during construction slumps as individuals and businesses seek more energy-efficient equipment to cut utility bills. Because a large proportion of sheetmetal installation and maintenance is done indoors, these workers usually lose less work time due to bad weather than other construction workers.

Apprenticeship opportunities also should be plentiful as unions and employers strive to meet the rising demand for skilled workers. However, the availability of training slots fluctuates with economic conditions, so the number of openings may vary from year to year and by geographic area.

Earnings

According to the Engineering News Record, average hourly earnings—including benefits—for union sheetmetal workers were $27.62 in 1992. Wages ranged from a low of $18.06 in Birmingham, Alabama, to a high of $42.47 in New York City. Apprentices generally start at about 40 percent of the rate paid to experienced workers. Throughout the course of the apprenticeship program, they receive periodic increases as they acquire the skills of the trade.

In addition, union workers in some areas receive supplemental wages from the union when they are on layoff or shortened workweeks. A large proportion of sheetmetal workers are members of the Sheet Metal Workers' International Association.

Related Occupations

To fabricate and install sheetmetal products, sheetmetal workers combine metalworking skills and knowledge of construction materials and techniques. Other occupations in which workers lay out and fabricate metal products include layout workers, machinists, metal fabricators, metal patternmakers, shipfitters, and tool and die makers. Construction occupations requiring similar skills and knowledge include heating, air-conditioning, and refrigeration technicians and glaziers.

Sources of Additional Information

For more information about apprenticeships or other work opportunities, contact local sheetmetal contractors or heating, refrigeration, and air-conditioning contractors; a local of the Sheet Metal Workers Union; a local of the Sheetmetal and Air Conditioning Contractors Association; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or apprenticeship agency.

For general information about sheetmetal workers, contact:

☞ The Sheet Metal National Training Fund, 601 N. Fairfax St., Suite 240, Alexandria, VA 22314.

☞ Associated Builders and Contractors, 1300 N. 17th St. NW., Rossyln, VA 22209.

☞ The Sheetmetal and Air Conditioning Contractors Association, 4201 Lafayette Center Dr., Chantilly, VA 22021.

☞ The Sheet Metal Workers International Association, 1750 New York Ave. NW., Washington, DC 20006.

Structural and Reinforcing Ironworkers

(D.O.T. 801.361-014, -018, -022, .381-010, .684-026; and 809.381-022, and -026)

Nature of the Work

Materials made from iron, steel, aluminum, and bronze are used extensively in the construction of highways, bridges, office buildings, power transmission towers, and other large buildings. These structures have frames made of steel columns, beams, and girders. In addition, reinforced concrete—concrete containing steel bars or wire fabric—is an important material in buildings, bridges, and other structures. The steel gives the concrete additional strength. Metal stairways, catwalks, floor gratings, ladders, and window frames, as well as lampposts, railings, fences, and decorative ironwork are used to make these structures more functional and attractive. Structural and reinforcing ironworkers fabricate, assemble, and install these products. These workers also repair, renovate, and maintain older buildings and structures such as steel mills, utility plants, automobile factories, highways, and bridges.

Before construction can begin, ironworkers must erect the steel frames and assemble the cranes and derricks that move structural steel, reinforcing bars, buckets of concrete, lumber, and other materials and equipment around the construction site. This equipment arrives at the construction site in sections. There it is lifted into position by a mobile crane. Ironworkers then connect the sections and set up the cables that do the hoisting.

Once this job has been completed, ironworkers begin to connect steel columns, beams, and girders according to blueprints and instructions from supervisors and superintendents. Structural steel, reinforcing rods, and ornamental iron generally are delivered to the construction site ready for erection—cut to the proper size with holes drilled for bolts and numbered for assembly. This work is done by ironworkers in fabricating shops located away from the construction site. There they lay out the raw steel received from a steel mill and cut, bend, drill, bolt, and weld each piece according to the specifications for that particular job. Ironworkers at the construction site unload and stack the fabricated steel so it can be hoisted easily when needed.

To hoist the steel, ironworkers attach cables from the crane or derrick. One worker directs the hoist operator with hand signals. Another worker holds a rope (tag line) attached to the steel to prevent it from swinging. The steel is hoisted into place in the framework, where several workers using spud wrenches position it with connecting bars and jacks. Workers use driftpins or the handle of a spud wrench—a long wrench with a pointed handle—to align the

holes in the steel with the holes in the framework. Then they bolt the piece in place temporarily, check vertical and horizontal alignment with plumb bobs, laser equipment, transits, or levels and then bolt or weld it permanently in place.

Reinforcing ironworkers set the bars in the forms that hold concrete, following blueprints that show the location, size, and number of reinforcing bars. They fasten the bars together by tying wire around them with pliers. When reinforcing floors, workers place blocks under the reinforcing bars to hold them off the deck. Although these materials usually arrive ready to use, ironworkers may occasionally have to cut the bars with metal shears or acetylene torches, bend them by hand or machine, or weld them with arc-welding equipment. Some concrete is reinforced with welded wire fabric. Workers cut and fit the fabric and, while a concrete crew places the concrete, ironworkers use hooked rods to position it properly in the concrete.

Ornamental ironwork and related pieces are installed after the exterior of the building has been completed. As the pieces are hoisted into position, ironworkers bring them into position, make sure they fit correctly, and bolt, braze, or weld them for a secure fit. They also erect metal tanks used to store petroleum, water, or other fluids and assemble prefabricated metal buildings according to plans or specifications.

Working Conditions

Structural and reinforcing ironworkers usually work outside in all kinds of weather. However, those who work at great heights do not work when it is wet, icy, or extremely windy. Because the danger of injuries due to falls is so great, ironworkers use safety devices such as safety belts, scaffolding, and nets to reduce the risk.

Employment

Structural and reinforcing ironworkers held about 66,000 jobs in 1992. Almost all of these workers were employed in the construction industry. Nearly 6 of every 10 worked for structural steel erection contractors; most of the remainder worked for a variety of contractors specializing in the construction of homes, factories, commercial buildings, churches, schools, bridges and tunnels, and water, sewer, communications, and power lines. Very few are self-employed.

Ironworkers are employed in all parts of the country, but most work in metropolitan areas, where most commercial and industrial construction takes place.

Training, Other Qualifications, and Advancement

Most employers recommend apprenticeship as the best way to learn this trade. Apprenticeship programs are usually administered by joint union-management committees made up of representatives of local unions of the International Association of Bridge, Structural and Ornamental Ironworkers and local chapters of contractors' associations. The apprenticeship consists of 3 years of on-the-job training and a minimum of 144 hours a year of classroom instruction.

Reinforcing workers work together to tie-wire reinforcing bars.

In the classroom, apprentices study blueprint reading, mathematics for layout work, the basics of structural erecting, rigging, reinforcing, welding and burning, ornamental erection and assembling, and the care and safe use of tools and materials. On the job, apprentices work in all aspects of the trade, such as unloading and storing materials at the job site, rigging materials for movement by crane or derrick, connecting structural steel, and welding.

Some ironworkers learn informally on the job. These workers generally do not receive classroom training, although some large contractors have extensive training programs. On-the-job trainees usually begin by assisting experienced ironworkers by doing simple jobs like carrying various materials. With experience, they perform more difficult tasks like cutting and fitting different parts. Learning through work experience alone may not provide training as complete as an apprenticeship program, however, and usuaally takes longer.

Ironworkers generally must be at least 18 years old. A high school diploma may be preferred by employers and may be required by some local apprenticeship committees. Courses in general mathematics, mechanical drawing, and shop are helpful.

Because materials used in ironworking are heavy and bulky, ironworkers must be in good physical condition. They also need good agility, balance, eyesight, and spatial perception in order to work at great heights on narrow beams and girders. Ironworkers should not be afraid of heights or suffer from dizziness.

Some experienced workers become supervisors. Others may go into the contracting business for themselves.

Job Outlook

Employment of structural and reinforcing ironworkers is expected to increase about as fast as the average for all occupations through the year 2005. Growth in industrial and commercial construction as well as the rehabilitation and maintenance of an increasing number of older buildings, factories, power plants, and highways and bridges is expected to increase employment demand. In addition, more ironworkers will be needed to build incinerators and other structures to contain hazardous materials as part of ongoing toxic waste cleanup. Despite this rising demand for structural and reinforcing ironworkers, most openings will result from the need to replace experienced ironworkers who transfer to other occupations or leave the labor force.

The number of job openings fluctuates from year to year as economic conditions and the level of construction activity change. During economic downturns, ironworkers can experience high rates of unemployment. Similarly, job opportunities for ironworkers may vary widely by geographic area.

Job openings for ironworkers usually are more abundant during the spring and summer months, when the level of construction activity increases.

Earnings

According to the *Engineering News Record*, prevailing union wage rates—including benefits—for ironworkers averaged about $27 an hour in 1992. Their wages ranged from a low of about $18 in New Orleans, to a high of between $38-49 in New York City.

Apprentices generally start at about 40 percent of the rate paid to experienced workers. Throughout the course of the apprenticeship program, they receive periodic increases as they acquire the skills of the trade.

Earnings for ironworkers may be reduced on occasion because work can be limited by bad weather and the short-term nature of construction jobs.

Many workers in this trade are members of the International Association of Bridge, Structural and Ornamental Ironworkers.

Related Occupations
Structural and reinforcing ironworkers play an essential role in erecting buildings, bridges, highways, powerlines, and other structures. Others who also work on these construction jobs are operating engineers, concrete masons, and welders.

Sources of Additional Information
For more information on apprenticeships or other work opportunities, contact local general contractors; a local of the Ironworkers union; a local joint ironworkers' union-management apprenticeship committee; a local or State chapter of the Associated Builders and Contractors, or the nearest office of the State employment service or apprenticeship agency.

For general information about ironworkers, contact:
☞ Associated General Contractors of American, Inc., 1300 North 17th St., Rossyln, VA 22209-3883
☞ International Association of Bridge, Structural and Ornamental Iron Workers, 1750 New York Ave. NW., Washington, DC 20006.
☞ National Erectors Association, 1501 Lee Hwy., Suite 202, Arlington, VA 22209.
☞ National Association of Reinforcing Steel Contractors, P.O. Box 280, Fairfax, VA 22030.

Tool and Die Makers

(D.O.T. 601.260-010, -014, .280 except -038, -054; .281-010, -014, and -026, .380, .381 except -018, -038; and 739.381-018 and -022)

Nature of the Work
Tool and die makers are highly skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines that produce a variety of products—from clothing and furniture to heavy equipment and parts for aircraft.

Toolmakers craft precision tools which 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. Diemakers 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. In addition, tool and die makers may repair worn or damaged tools, dies, gauges, jigs, and fixtures, and design tools and dies.

Tool and die makers must have a much broader knowledge of machining operations, mathematics, and blueprint reading than most other machining workers. They use many types of machine tools and precision measuring instruments and must be familiar with the machining properties, such as hardness and heat tolerance, of a wide variety of common metals and alloys.

Working from blueprints or instructions, tool and die makers plan the sequence of operations necessary to manufacture the tool or die. They measure and mark the pieces of metal that will be cut to form parts of the final product. They then cut, bore, or drill the part as required. They also check the accuracy of what they have done to ensure that the final product will meet specifications. Then they assemble the parts and perform finishing jobs such as filing, grinding, and smoothing surfaces.

Modern technology is helping to change tool and die makers' jobs. Firms commonly use computer aided design (CAD) to develop products. Specifications from the computer program can then be used to develop designs electronically for the required tools and dies. The designs can then be sent to computer numerically controlled (CNC) machines to produce the die. Programs can also be electronically stored and adapted for future use. This saves time and increases productivity of the workers.

In shops that use numerically controlled (NC) machine tools, tool and die makers' duties may be slightly different. For example, although they still manually check and assemble the tool or die, each of its components may be produced on an NC machine. In addition, they often assist in the planning and writing of NC programs.

Tool and die makers work with little direct supervision. Although they must produce extremely precise parts, they also must work quickly and economically. Taking too much time or wasting materials can reduce their employer's profit.

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. Machines have guards and shields that minimize the exposure of workers to moving parts. Tool and die makers, however, must follow safety rules and wear protective equipment. For example, they must wear safety glasses in order to shield against bits of flying metal and earplugs to protect against noise. They may be exposed to hazardous materials such as lubricants or cleaners. In addition, they spend much of the day on their feet and may do moderately heavy lifting.

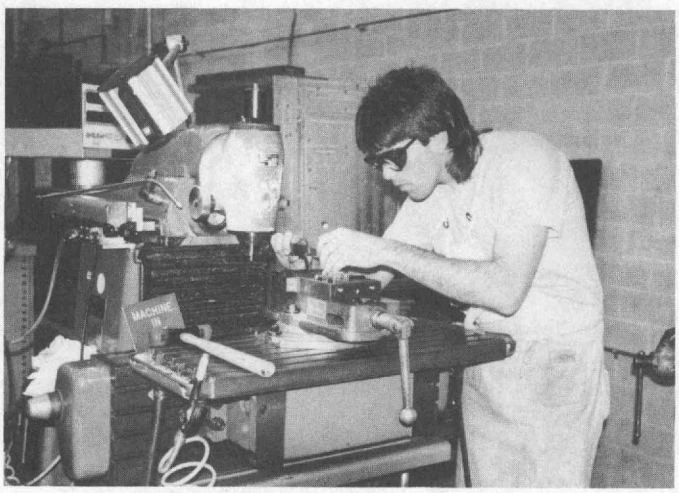
Companies employing tool and die makers traditionally operate one shift per day. However, as the cost of new machinery and technology has increased, many employers now have more than one shift. Overtime and Saturday work are common, especially during peak production periods.

Employment
About 138,000 persons were employed as tool and die makers in 1992. Most worked in industries that manufacture metalworking machinery and equipment, motor vehicles, aircraft, and plastics products. Although they are found throughout the country, jobs are most plentiful in the Midwest and Northeast, where many of the metalworking industries are located.

Training, Other Qualifications, and Advancement
Tool and die makers learn their trade through formal apprenticeship programs or less formal on-the-job training. The best way to learn all aspects of tool and die making, according to most employers, is a formal apprenticeship program that combines classroom instruction and job experience.

Most employers prefer persons with a high school or vocational school education and, increasingly, those with an associate's degree. Courses in math, blueprint reading, metalworking, and drafting, as well as machine shop experience, are helpful.

During the 4 or 5 years of a tool and die apprenticeship, apprentices learn to operate milling machines, lathes, grinders, and other machine tools. They also learn to use handtools in fitting and assembling tools, gauges, and other mechanical and metal forming equipment, and they study metalworking processes such as heat treating and plating. Classroom training usually consists of mathematics, mechanical drawing, tool designing, tool programming, and blueprint reading.



Workers who become tool and die makers without completing formal apprenticeships generally acquire their skills through informal on-the-job programs. They often begin as machine operators and gradually take on more difficult assignments. Many machinists become tool and die makers. In fact, tool and die makers are often considered highly specialized machinists. (See the statement on machinists and tool programmers elsewhere in the *Handbook*.)

Because tools and dies must meet strict specifications—precision to one ten-thousandth of an inch is not uncommon—the work of tool and die makers requires a high degree of patience and attention to detail. Good eyesight is essential.

There are several ways for skilled workers to advance. Some move into supervisory and administrative positions in their firms; others become tool designers or tool programmers.

Job Outlook

Employment of tool and die makers is expected to decline through the year 2005. As the economy grows, the demand for motor vehicles, aircraft, machinery, and other products that use machined metal parts will increase. Rising demand for these goods will increase the need for tools and dies. Employment growth, however, will be limited by increased use of numerically controlled machine tools. The greater use of NC machine tools has reduced the number of operations done by hand, so high-quality precision parts can be made with fewer workers. In addition, because precision metal products are a primary component of manufacturing machinery, increased imports of finished goods, as well as precision metal products, lessen the demand for tool and die makers.

Despite the expected decline in employment, many openings each year will be created by tool and die makers who retire. A relatively large proportion of tool and die makers are at least 50 years of age. Currently, enrollments in tool and die maker training programs have not increased enough to satisfy the demand for these workers because employers in many locations are finding it difficult to attract enough qualified candidates. As older workers begin to leave the occupation in larger numbers, employers in certain parts of the country may face more pronounced shortages. Jobseekers with the appropriate skills and background should find excellent opportunities.

Earnings

Median weekly earnings for tool and die makers who worked full time were $642 in 1992. Most earned between $499 and $803 a week. Ten percent earned less than $409 a week, and the 10 percent with the highest weekly earnings made more than $911.

Related Occupations

The occupations most closely related to the work of tool and die makers are the other machining occupations. These include machinist, mold maker, instrument maker, metalworking machine operator, and tool programmer.

Other occupations that require precision and skill in working with metal include blacksmith, gunsmith, locksmith, metal patternmaker, and welder.

Sources of Additional Information

For general information about tool and die makers, contact:

☞ The Association for Manufacturing Technology, 7901 Westpark Dr., McLean, VA 22102.

☞ The National Tooling and Machining Association, 9300 Livingston Rd., Ft. Washington, MD 20744.

☞ The Tooling and Manufacturing Association, 1177 South Dee Rd., Park Ridge IL 60068.

☞ Precision Metalforming Association, 27027 Chardon Rd., Richmond Heights, OH 44143.

Welders, Cutters, and Welding Machine Operators

(D.O.T. 553.684-010; 613.667-010; 614.684-010; 709.684-086; 727.662, .684-022; 810; 811; 812; 813.684-010; 814; 815; 816 except .482 and .682; 819.281-010, -014, -022, .361, .381, .384, .684, and .685)

Nature of the Work

Welding is the most common way of permanently joining metal parts. Heat is applied to the pieces to be joined, melting and fusing them to form a permanent bond. Because of its strength, welding is used to construct and repair parts of ships, automobiles, spacecraft, and thousands of other manufactured products. Welding is used to join beams and steel reinforcing rods when constructing buildings, bridges, and other structures, and also in utilities such as nuclear power plants and refineries.

Welders use all types of welding equipment 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 semi-automatic welding, in which the welder uses machinery, such as a wire feeder, to perform welding tasks. They generally plan work from drawings or specifications or by analyzing damaged metal, using their knowledge of welding and metals. They select and set up welding equipment and may also examine welds to insure they meet standards or specifications. Some welders have more limited duties. They perform routine production work that has already been planned and laid out. These jobs do not require knowledge of all welding techniques.

In many production processes—where the work is repetitive and the items to be welded are relatively uniform—automated welding is used. In this process, a welding machine operator monitors the machine, which performs the welding tasks. Welding machine operators set up and operate welding machines as specified by layouts, work orders, or blueprints. Operators must constantly monitor the machine to ensure that it produces the desired weld.

The work of arc, plasma, and flame cutters is closely related to that of welders. However, instead of joining metals, cutters use the heat from burning gases or an electric arc to cut and trim metal objects to specific dimensions. Cutters also dismantle large objects,

Welders work on a variety of structures and other objects, including heavy machinery, bridges, and nuclear power plants.

such as ships, railroad cars, automobiles or aircraft. Some operate and monitor cutting machines similar to those used by welding machine operators.

Working Conditions

Welders and cutters frequently are exposed to potential hazards. They use protective clothing, safety shoes, goggles, helmets with protective lenses, and other devices to prevent burns and eye injuries and to protect them from falling objects. Automated welding machine operators are not exposed to as many hazards. A face shield or goggles generally provide adequate protection. Because some metals may give off toxic gases and fumes as they melt, Federal regulations require ventilation to meet strict guidelines, minimizing these hazards. Occasionally, some workers are in contact with rust, grease, and dirt on metal surfaces. Some welders are isolated for short intervals while they work in booths constructed to contain sparks and glare. In some settings, however, working conditions are much better and few hazards or discomforts are encountered.

Employment

Welders, cutters, and welding machine operators held about 403,000 jobs in 1992. About 9 out of 10 welders and cutters were employed in manufacturing, services, construction, or wholesale trade. The majority of those in manufacturing were employed in transportation equipment, industrial machinery and equipment, or fabricated metal products. All welding machine operators were employed in manufacturing industries, primarily machinery, motor vehicles, and fabricated metal products.

Training, Other Qualifications, and Advancement

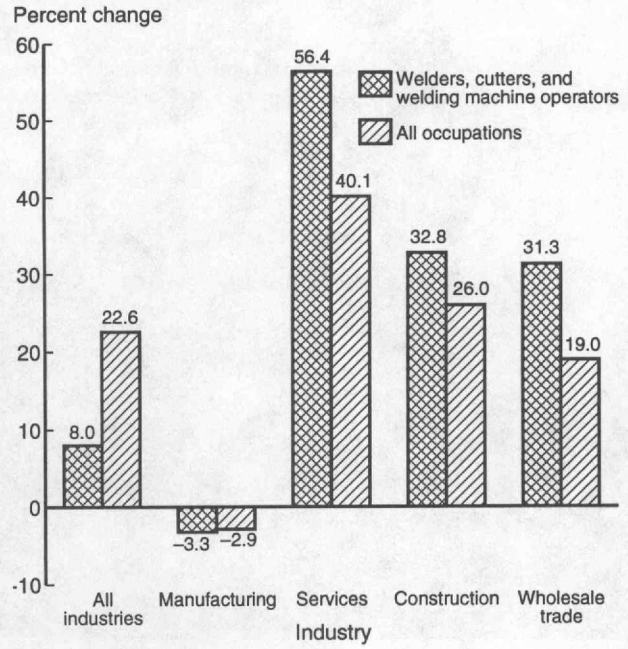
Training for welders can range from a few weeks of school or on-the-job training for low skilled positions to several years of combined school and on-the-job training for highly skilled jobs. Formal training is available in high schools, vocational schools, and post-secondary institutions such as vocational-technical institutes, community colleges, and private welding schools. The Armed Forces operate welding schools as well. Some employers provide training to help welders improve their skills. Courses in blueprint reading, shop mathematics, mechanical drawing, physics, chemistry, and metallurgy are helpful.

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 to specific codes and standards required by the employer. The testing procedures are usually based on the standards and codes set by one of several industry associations the employer may be affiliated with. If the welding inspector at the examining institution determines that the worker has performed according to the employer's guidelines, he or she then certifies that the welder being tested is able to work with a particular welding procedure.

Welders and cutters need manual dexterity, good eyesight, and good hand-eye coordination. They should be able to concentrate on detailed work for long periods and be able to bend, stoop, and work in awkward positions.

Welders can advance to more skilled jobs with additional training and experience. They may be promoted to welding technicians, supervisors, inspectors, or instructors. Some experienced welders open their own repair shops.

The growth of welders, cutters, and welding machine operators varies greatly by industry.



Source: Bureau of Labor Statistics

Job Outlook

Employment of welders, cutters, and welding machine operators is expected to increase more slowly than the average for all occupations through the year 2005. Many job openings will result from the need to replace experienced workers who transfer to other occupations or leave the labor force.

In certain industries—construction, wholesale trade, and repair services, for example—employment of welders and cutters will grow more rapidly. The level of construction is expected to expand, as is the number of metal products needing repair, increasing the need for welding and cutting. This work is generally less routine and more difficult to automate than other welding jobs. Greater use of welding automation in manufacturing where simple repetitive welds are done could cause manual welders to be replaced by welding machine operators. Despite the welding jobs eliminated by automated welding systems, manual welders, especially those with a wide variety of skills, will still be needed for the maintenance, repair, and other work in manufacturing that cannot be automated.

Welders, cutters, and welding machine operators in construction and manufacturing are vulnerable to periodic layoffs due to economic downturns.

Earnings

Median earnings for welders and welding machine operators were about $440 a week in 1992. The middle 50 percent earned between $342 and $562. The top 10 percent earned more than $715, and the lowest 10 percent earned less than $278.

Almost one-third of 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 and Pipe Fitting Industry of the United States and Canada; and the United Electrical, Radio, and Machine Workers of America.

Related Occupations

Welders and cutters are skilled metal workers. Other metal workers include blacksmiths, forge shop workers, all-round machinists, machine-tool operators, tool and die makers, millwrights, sheet-metal workers, boilermakers, and metal sculptors.

Welding machine operators run machines that weld metal parts. Others who run metalworking machines include lathe and turning, milling and planing, punching and stamping press, and rolling machine operators.

Sources of Additional Information

For information on training opportunities and jobs for welders, cutters, and welding machine operators, contact local employers, the

local office of the State employment service, or welding training centers.

Information on careers in welding is available from:
☞ American Welding Society, 550 NW. LeJeune Rd., Miami, FL 33126-5699.

Woodworking Occupations

(List of D.O.T. codes available on request from the Chief, Division of Occupational Outlook, Bureau of Labor Statistics, Washington, DC 20212.)

Nature of the Work

Wood is one of the oldest, most basic building materials. Even in our age of sophisticated composites and alloys, the demand for wood products continues unabated. Helping to meet this demand are production woodworkers and precision woodworkers. Production woodworkers can be found in primary industries, such as sawmills and plywood mills, as well as in secondary industries that manufacture furniture, kitchen cabinets, musical instruments, and other fabricated wood products. Precision woodworkers, on the other hand, usually work in small shops that make architectural woodwork, furniture, and many other specialty items.

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, they also make sporting goods items, including baseball bats, racquets, and oars, as well as musical instruments, toys, caskets, tool handles, and thousands of other wooden items.

Production workers usually set up, operate, and tend woodworking machines—such as power saws, planers, sanders, lathes, jointers, and routers—to cut and shape components from lumber, plywood, and other wood panel products. Working from blueprints, instructions from supervisors, or shop drawings that they produce, woodworkers determine the method of shaping and sequence of assembling parts. Before cutting, they must often measure and mark the materials to be cut. They verify dimensions to adhere to specifications and may trim parts to insure a tight fit, using handtools such as planes, chisels, wood files, or sandpaper.

Production woodworkers generally operate a specific woodworking machine; however, some wood machine operators are responsible for a variety of machines. Lower skilled operators may merely press a switch on a woodworking machine and monitor or tend the automatic operation, while more highly skilled operators set up their equipment, cut and shape wooden parts, and verify dimensions using a template, caliper, or rule. In sawmills, machine operators cut logs into planks, timbers, or boards. In veneer mills, they cut veneer sheets from logs for making plywood. While in furniture plants, they make furniture components such as table legs, drawers, rails, and spindles.

Many companies have installed computer-controlled machinery, which lends itself to precision, accuracy, and less waste. With computerized numerical controls, 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 strong mathematical skills.

Whether computer-controlled or manual equipment was used to machine the parts, the next step in the manufacturing process is the production of subassemblies using fasteners and adhesives. These pieces are then brought together to form a complete unit. The product is then finish sanded, stained, sealed, 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.

Precision or custom woodworkers, such as cabinetmakers, wood pattern and model makers, wood machinists, and furniture and wood finishers, work on a customized basis, often building one-of-a-kind items. For this reason, they normally need substantial training and an ability to work from detailed instructions and specifications. They often are required to exercise independent judgment when undertaking an assignment. Precision woodworkers generally perform a complete cycle of cutting, shaping, surface preparation, and assembling prepared parts of complex wood components into a finished wood product.

Working Conditions

Working conditions vary from industry to industry, and job to job. In primary industries, such as logging and sawmilling, working conditions are physically demanding due to the handling of heavy, bulky material. Workers in this area may also encounter excessive noise and dust and other air quality pollutants. However, these factors can be controlled by using earplugs and respirators. Rigid adherence to safety precautions minimizes risk of injury from contact with rough woodstock, and from the use of sharp tools and power equipment. The risk of injury is also lowered by the installation of computer-controlled equipment that reduces the physical labor and the hands-on contact with the machine.

In secondary industries, such as furniture and kitchen cabinet manufacturing, working conditions also depend on the industry and the particular job. Those employees who operate machinery must wear ear and eye protection, and must always follow safety regulations concerning machine operation and the use of safety shields or guards. Those who work in the finishing area must either be provided with an appropriate dust or vapor mask, a complete protective safety suit, or they must be in a finishing environment that removes all vapors and particle matter from the atmosphere. Prolonged standing, lifting, and fitting heavy objects are also common characteristics of the job.

Employment

Workers in woodworking occupations held about 341,000 jobs in 1992. One of every 7, mostly cabinetmakers and furniture and wood finishers, was self-employed. Employment was distributed as follows:

Woodworkers, precision	220,000
Woodworking machine setters and operators	121,000
Head sawyers	59,000
Woodworking machine operators	62,000

Eight of every 10 salaried woodworkers worked in manufacturing industries. One in 4 was employed in establishments fabricating household and office furniture; 1 of every 5 was in establishments

Woodworking employment is highly sensitive to the condition of the overall economy.

making millwork, plywood, and structural wood members, used primarily in construction; and 1 in 8 worked in sawmills and planing mills manufacturing a variety of raw, intermediate, and finished woodstock. Woodworkers also were employed by wholesale and retail lumber dealers, furniture stores, reupholstery and furniture repair shops, and construction firms.

Woodworking jobs are found throughout the country. However, production jobs are concentrated in the South and Northwest, close to the supply of wood, while furniture makers are more prevalent in the East. Custom shops can be found everywhere, but are generally 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. Some acquire skills through vocational education or by working as carpenters on construction jobs. Others may attend colleges or universities that offer training in many areas including wood technology, furniture manufacturing, wood engineering, and production management. These programs prepare students for positions in production, supervision, engineering, or management.

Beginners usually observe and help experienced machine operators. They may supply material or remove fabricated products from the machine. Trainees do simple machine operating jobs and are at first closely supervised by experienced workers. As they gain experience, they perform more complex jobs with less supervision. Some may learn to read blueprints, set up machines, and plan the sequence of their work. Most woodworkers learn the basic machine operations or job tasks in a few months, but becoming a skilled woodworker often requires 2 years or more.

In the past, a high school education was seldom required. However, persons seeking woodworking jobs can enhance their employment and advancement prospects by completing high school. Training in mathematics, science, and computer applications will be beneficial in the future as woodworking technology becomes more sophisticated, and as more companies install computerized equipment. Employers often look for individuals with mechanical ability, manual dexterity, and the ability to pay attention to detail.

Advancement opportunities are often limited and depend upon availability, seniority, and a worker's skills and initiative. Experienced woodworkers may become inspectors or supervisors responsible for the work of a group of woodworkers. Production workers can advance into these positions by assuming additional responsibilities and by attending workshops, seminars, or college programs. Those who are highly skilled may set up their own woodworking shops.

Job Outlook

Employment in the woodworking occupations is expected to grow more slowly than the average for all occupations through the year 2005. As the Nation's population, personal income, and business expenditures grow, the demand for wood products will increase. In addition, the continuing need for repair and renovation of residential and commercial properties is expected to stimulate demand. Opportunities for woodworkers who specialize in such items as moldings, cabinets, stairs, and windows, should therefore be particularly good.

Several factors may limit the growth of woodworking occupations in coming years. Environmental measures designed to control various pollutants used in or generated by woodworking processes are likely to have a significant impact on employment, especially in secondary industries. Primary industries will be more affected by a shortage of timber as the harvesting of old growth forests on Federal lands becomes more restricted. Technological advances like computerized numerical control machinery and computer-aided design packages will prevent employment from rising as fast as the demand for wood products, particularly in the mills and manufacturing plants where many of the processes can be automated. In addition, some jobs will be lost in the United States as imports continue to grow and as U.S. firms move production to other countries. Finally, materials such as metal, plastic, and fiberglass will continue to be used as alternatives to wood in many products, primarily because they are cheaper, stronger, or easier to shape.

As a result of these trends, employment opportunities in the primary wood industries may be more limited than those in the secondary industries. Also, as firms automate production, the demand for well educated workers will increase. Employment in all of the woodworking occupations is highly sensitive to economic cycles, so the growth in these occupations will be primarily affected by the overall state of the economy. Although this growth will be modest, thousands of openings will arise each year because of the need to replace experienced workers who transfer to other occupations or leave the labor force.

Earnings

Median weekly earnings for salaried full-time precision woodworkers were about $385 in 1992. The middle 50 percent earned between $294 and $443. The lowest 10 percent earned less than $244, while the highest 10 percent earned over $630. Median weekly earnings for full-time woodworking machine operators were around $306 in 1992. The middle 50 percent earned between $237 and $392. The lowest 10 percent earned less than $185, while the highest 10 percent earned over $495. Earnings vary by industry, geographic region, skill, educational level, and by the complexity of the machinery operated. Woodworkers usually receive a basic benefit package including medical and dental benefits and a pension plan.

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

Related Occupations

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 precision metalworkers, metalworking and plastics-working machine operators, metal fabricators, molders and shapers, and leather workers.

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.

For general information about furniture woodworking occupations, contact:

☞ American Furniture Manufacturers Association, Manufacturing Services Division, P.O. Box HP-7, High Point, NC 27261.

☞ The Furniture Center, North Carolina State University, Furniture Extension, Campus Box 7906, Raleigh, NC 27695-7906.

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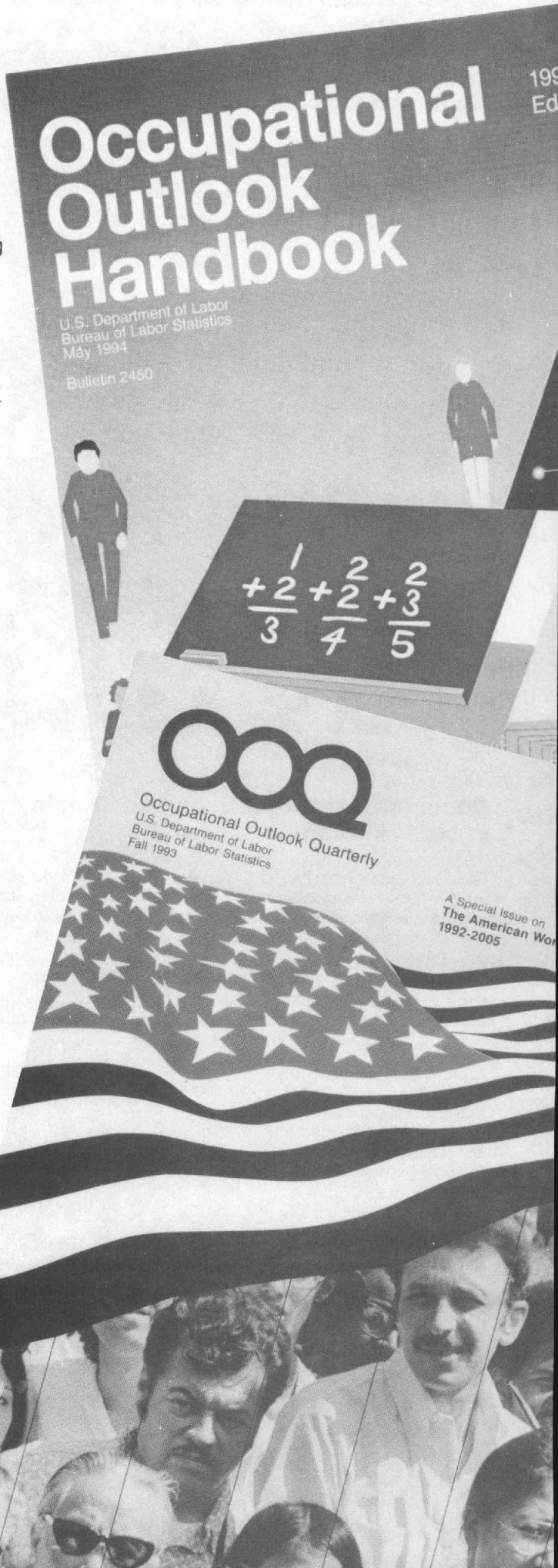

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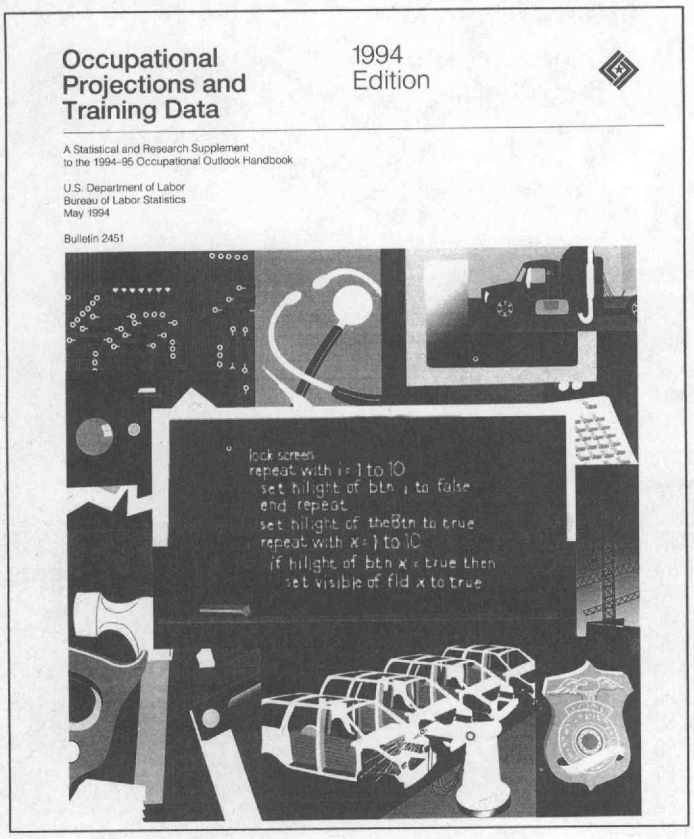

BLS Bulletin 2451

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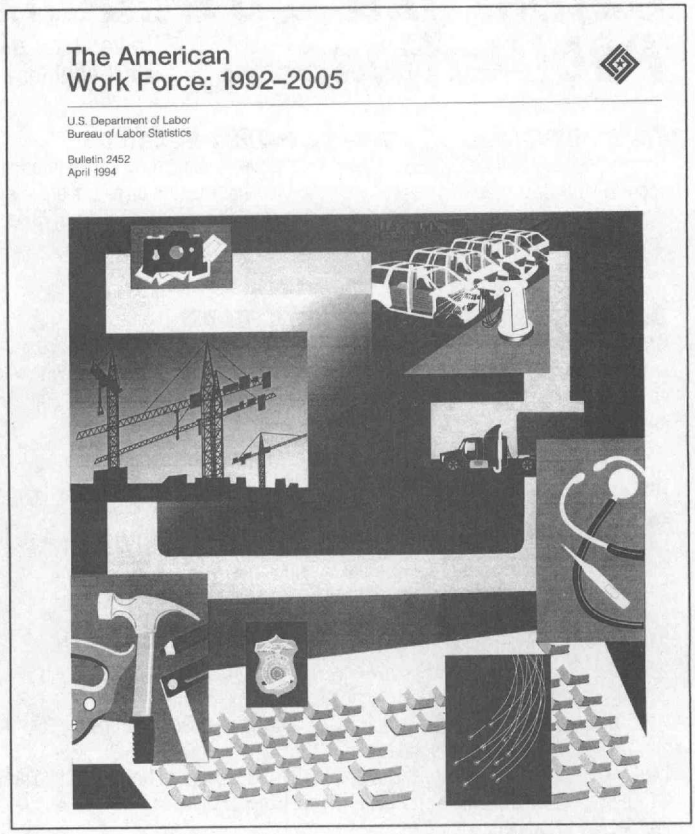
This supplement to the *Occupational Outlook Handbook* provides the statistical and technical data supporting the information presented in the *Handbook*. Education and training planners, career counselors, and jobseekers can find valuable information that ranks occupations by employment growth, earnings, susceptibility to unemployment, separation rates, and part-time work.



BLS Bulletin 2452

The American Work Force: 1992-2005

Every 2 years, the Bureau of Labor Statistics producers detailed projections of the U.S. economy and labor force. This bulletin presents the Bureau's latest analyses of economic and industrial growth, the labor force, and trends in occupational employment into the 21st century. An overview article focuses on important issues raised by these projections.

Note:
At press time, prices for these publications were not available. For prices and ordering information, contact any of the Bureau of Labor Statistics Regional Offices.

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