Metalworking, Plastic-working, and Woodworking Occupations

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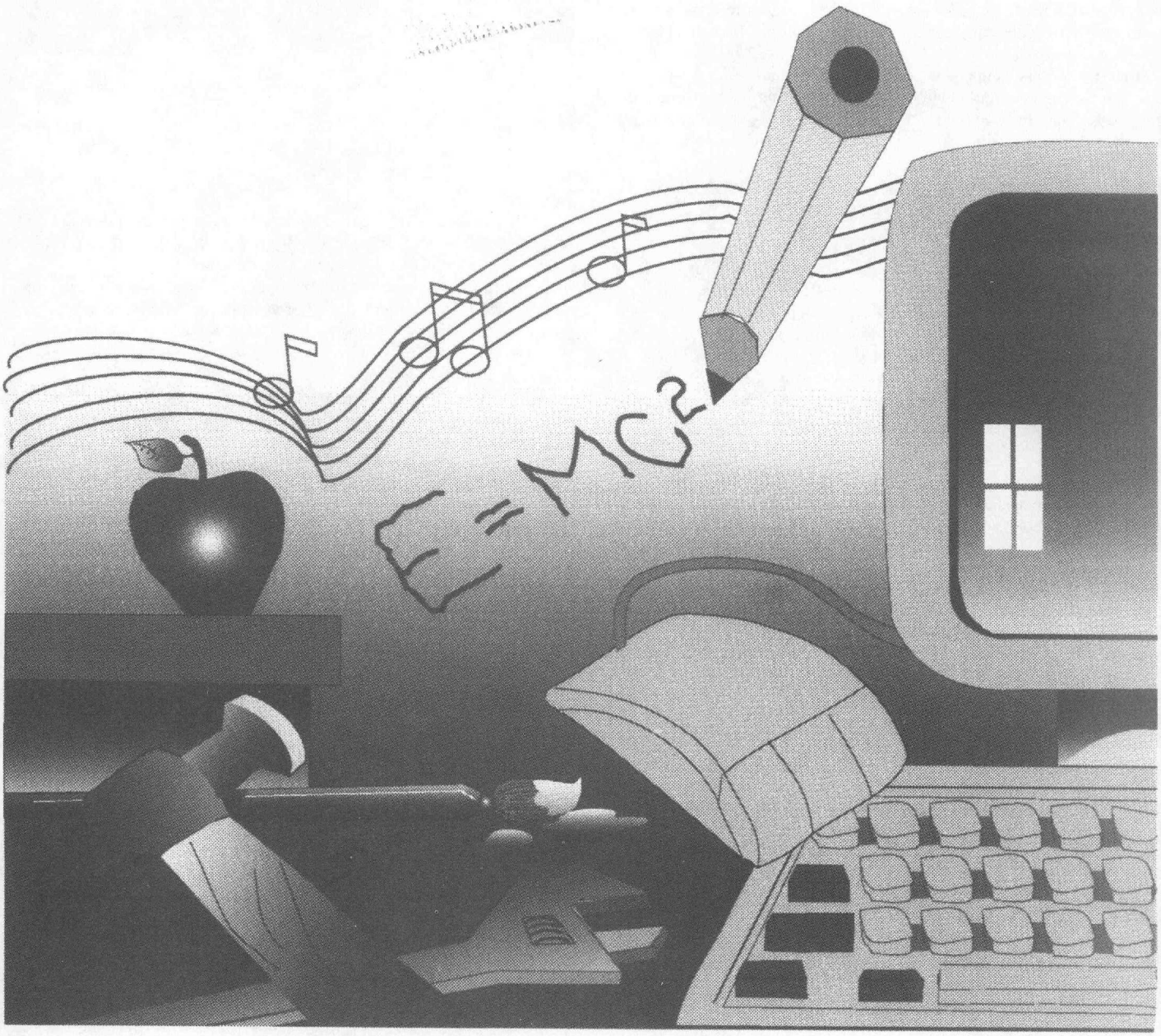


Boilermakers

(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.

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.

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, to meet construction or production deadlines, occasionally work overtime.

Employment

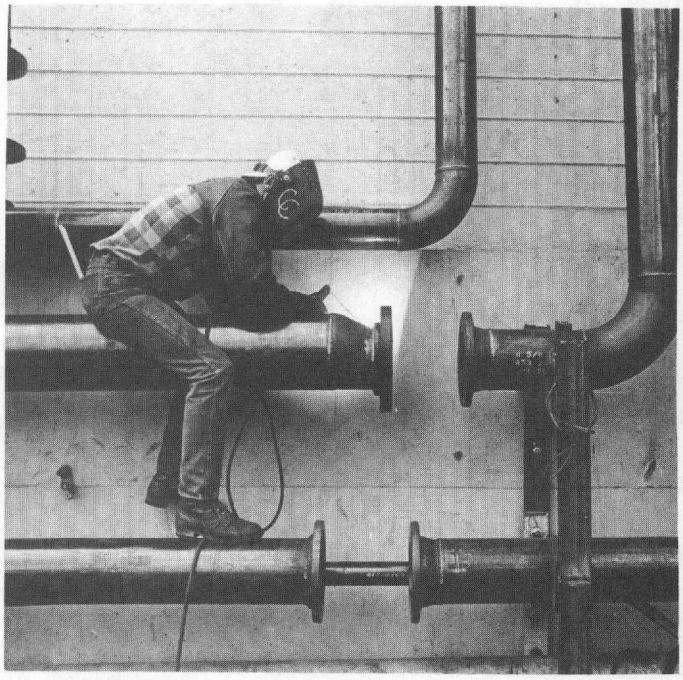
Boilermakers held about 22,000 jobs in 1990. Over one-half worked in the construction industry, assembling and erecting boilers and other vessels. About 1 out of 4 worked in manufacturing, primarily in boiler manufacturing shops, iron and steel plants, petroleum refineries, chemical plants, and shipyards. 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 are administered by joint union-management committees and usually consist of 4 years of on-the-job training, supplemented by about 48 hours of classroom instruction each year in subjects such as blueprint reading, shop mathematics, and welding. 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.



Boilermakers must be skilled metal workers and blueprint readers to ensure an exact fit.

Job Outlook

Little change in employment of boilermakers is expected through the year 2005. However, openings will arise from the need to replace experienced workers who leave the occupation.

Slow growth in the construction of new electric power plants and factories which use boilers and other vessels, the trend to repair rather than replace existing boilers—which takes fewer workers—and the use of smaller boilers—which require less on-site assembly—all should limit growth.

Most of the industries that purchase boilers are sensitive to economic conditions. Therefore, during economic downturns, construction boilermakers may be unemployed. 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 averaged about $550 per week in 1990.

Most boilermakers belong to labor unions. The principal union is the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers, and Helpers. Others are members of the International Association of Machinists and Aerospace Workers; United Automobile, Aerospace, and Agricultural Implement Workers of America; 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.

For sale by Superintendant of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Carpenters

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

Carpenters use levels to check the accuracy of their work.

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, 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 setting forms for concrete construction or in erecting scaffolding, while one who is 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. The final step is to 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 are involved in 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.

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 1,077,000 jobs in 1990. Almost eight of every ten 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 1 out of 3 was 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, Inc., and local chapters of the Associated General Contractors, as well as by local joint union-management committees of the United Brotherhood of Carpenters and Joiners of America and the Associated General Contractors 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 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.

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

Employment of carpenters 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.

Employment growth may not be as fast as in the past because of 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.

In addition to the jobs resulting from increased demand for carpenters, many openings will occur 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.

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 $412 in 1990. The middle 50 percent earned between $304 and $571 per week. Weekly earnings for the top 10 percent of all carpenters were more than $739; the lowest 10 percent earned less than $238.

Earnings may be reduced on occasion because carpenters lose work time in bad weather and when jobs are unavailable. Maintenance carpenters, who generally have more steady employment, averaged $15.01 an hour in 1990, according to a survey of selected metropolitan areas.

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, Inc., 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, 15th and M Sts. NW., Washington, DC 20005.
- United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, DC 20001.

Jewelers

(D.O.T. 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, which typify the jewelry industry, 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 stone or may engrave a design into the metal.

Other jewelers in retail stores are primarily involved in sales; many of them are qualified gemologists, who appraise the quality and value of diamonds, other gemstones, and gem materials. Others 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 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. In retail stores, computers are used mainly for inventory control. However, 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.

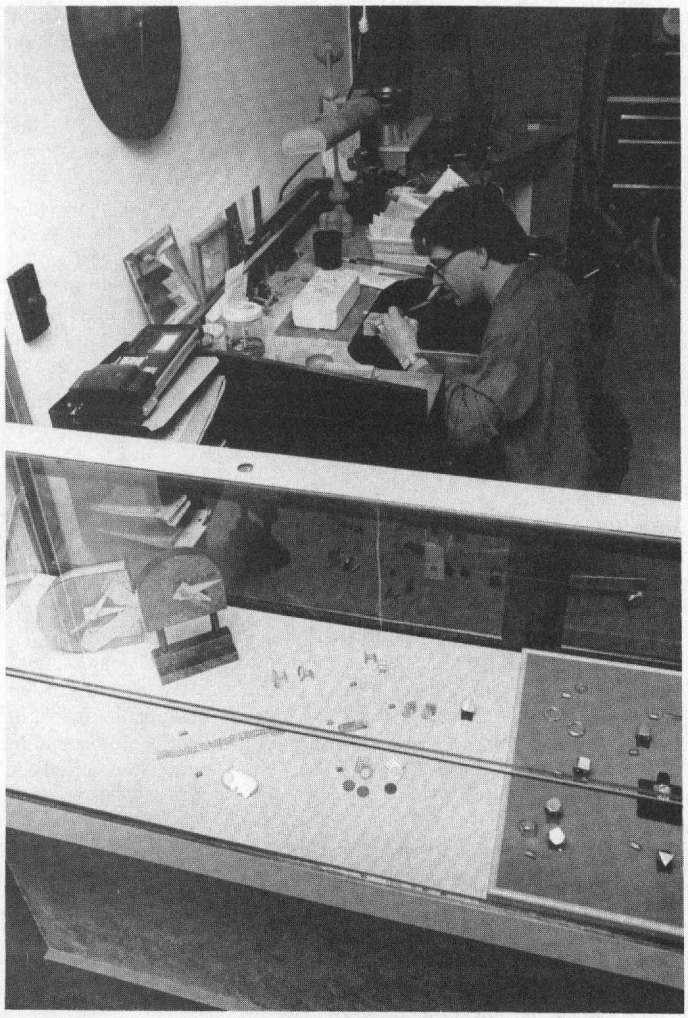
Working Conditions

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.

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 armed guards. The additional responsibility also may create stress.

In repair shops, jewelers generally work alone with little supervision. However, in retail stores, 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 short-



Over two-fifths of all jewelers are self-employed.

ened 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 40,000 jobs in 1990. Over two-fifths of all 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 approximately 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. Those employed in manufacturing are likely to work in New York, California, or Rhode Island, States where production is concentrated.

Training, Other Qualifications, and Advancement

Jewelers' skills usually are learned in technical schools, through correspondence courses, or informally on the job. 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.

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 gemology and appraising. These 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 or college programs, a high school diploma or its equivalent usually 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 eye-hand 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, fueled by increases in the number of affluent individuals, working women, double-income families, and fashion-conscious men.

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 because maintaining and repairing jewelry is an ongoing process, even during economic slowdowns. It is often less expensive to update or remount an existing piece than to purchase a new item.

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. Jewelers may also face competition from nontraditional stores such as department stores and catalog showrooms, since these stores often hire clerks rather than jewelers to service customers. Regardless of the industry,

job openings also will result from the need to replace experienced jewelers who transfer to other occupations, retire, or leave the labor force for other reasons.

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 $30,000 in 1990, while jewelry repair workers earned a median salary of $25,000.

For those in manufacturing, earnings of experienced, unionized jewelry workers averaged $10.00 an hour in 1991, 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 up to the minimum union wage for their job.

Most jewelers enjoy a variety of fringe benefits. For example, many jewelers receive annual vacations, health insurance, and reimbursement from their employers for work-related courses. In addition, some companies allow their employees to buy jewelry at cost or at substantially reduced prices.

Related Occupations

Other skilled workers in jewelry manufacturing or repair include polishers, lappers, gemcutters, gemologists, hand engravers, model makers, and watch repairers. Dental laboratory technicians also use casting, modelmaking, and buffing techniques.

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

(D.O.T. 600.280-010, -014, -018, -022, -026, -030, -034, -038, -042, .360-010; 638.281-026; and 714.281-018)

Nature of the Work

Machinists are skilled workers who produce precision metal parts that are made in numbers too small to produce with automated machinery. These parts are essential for the production and maintenance of industrial machinery, aircraft, automobiles, and many other manufactured goods. Although machinists can produce large quantities of one part, they 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.

Machinists often work independently. First, they 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, set the controls, and make the cuts. During the machining process, they must constantly monitor the feed and speed of the machine. Because the machining of metal products generates a significant amount of heat, machinists must ensure that the workpiece is being properly lubricated and cooled.

Traditionally, machinists have had direct control of their machines. However, the introduction of numerically controlled machines has greatly changed the nature of the work for many machinists. These machines have the capability to produce parts with a level of precision beyond that of traditional machining techniques. Machinists who work with numerically-controlled equipment are sometimes referred to as NC machinists. Numerical-control machine-tool operators also work with NC machinery. (For additional information on numerical-control machine-tool operators, see the statement elsewhere in the *Handbook*.)

When the machining operations are completed, machinists use precision instruments, such as micrometers, to make sure their work meets specifications. Then they finish and assemble the pieces.

In addition to creating new products, some machinists do maintenance work—repairing or making new parts for existing machinery. These workers use many of the same skills as other machinists. In order to repair a broken part, the maintenance machinist may have to refer to the original blueprints and perform many of the same machining operations that were needed to create the part.

Working Conditions

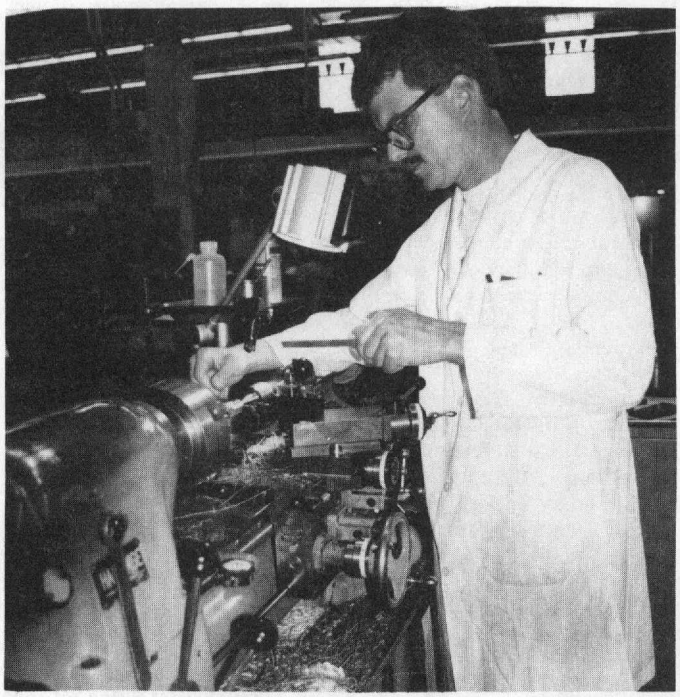
Most machine shops are well lighted and well ventilated. Working around high-speed machine tools, however, presents certain dangers, and workers must follow safety precautions. Machinists must wear protective equipment such as safety glasses to shield against bits of flying metal and earplugs to protect against the noise from machinery. 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. As companies invest in more expensive machinery, evening and weekend shifts are becoming more common. Overtime is common during peak production periods.

Employment

Machinists held about 386,000 jobs in 1990. 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 were employed in most industries that use production machinery. Although machinists work in all parts of the country, jobs are most plentiful in areas where manufacturing is concentrated.

Training, Other Qualifications, and Advancement

Machinist training varies from formal apprenticeship programs to informal on-the-job training. However, most employers consider a



Machinists produce precision metal parts.

formal apprenticeship program the best way to learn the machinist trade. Typical machinist apprentice programs consist of shop training and related classroom instruction. In shop training, apprentices learn chipping, filing, handtapping, dowel fitting, riveting, and the operation of various machine tools. In addition, as machine shops have increased their use of computer-controlled equipment, training in operation and programming of numerically controlled machine tools has become essential. Classroom instruction includes math, blueprint reading, mechanical drawing, and shop practices. Classroom training is increasingly being offered at community colleges in connection with company training programs. Established machinists 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, machinists receive training in its operation—usually from a representative of the equipment manufacturer.

Less formal on-the-job training is also offered by many companies. However, nonapprentice training varies by establishment. Some employers offer on-the-job training that may or may not include classroom instruction.

Persons interested in becoming a machinist should have manual dexterity and be mechanically inclined in order to use the tools and machines required to build complex parts. They also should be able to work independently and do highly accurate work that requires concentration as well as physical effort.

A high school or vocational school education, including mathematics, blueprint reading, metalworking, and drafting, is desirable. 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.

Job Outlook

Employment of machinists is expected to increase more slowly than the average for all occupations through the year 2005. As the economy expands, so will the demand for goods that use machined metal parts. However, the demand for machinists will be constrained by improvements in metalworking technology. For example, the use of computer-controlled machine tools reduces the time required for machining operations, thereby increasing machinists' productivity. In addition, the increased use of plastics, ceramics, and composites is expected to further reduce demand for precision metal products and, thus, for machinists. Nevertheless, many openings will arise each year from the need to replace experienced machinists who transfer to other occupations or retire.

In recent years, employers have reported difficulties in attracting enough candidates with the necessary mechanical and mathematical aptitudes. Employment opportunities for qualified applicants should continue to be good.

Employment of machinists fluctuates with economic conditions. When demand for machined goods falls, machinists involved in production may be laid off or be forced to work fewer hours. Apprenticeship opportunities 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 1990, median weekly earnings for machinists were about $486. Most earned between $367 and $613. Ten percent of all machinists had median weekly earnings of less than $283, while the 10 percent with the highest earnings made more than $747 a week.

Related Occupations

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

Sources of Additional Information

For general information about this occupation, contact:

- The National Machine Tool Builders Association, 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.

Metalworking and Plastics-Working Machine Operators

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

Nature of the Work

Metalworking and plastics-working machine operators run the machines that produce thousands of metal and plastic parts that are used in almost all consumer products. For example, think of the parts of a toaster—the metal or plastic housing and the plastic switch or lever to lower the toast. These and many other metal and plastic parts are products on which most of us rely daily.

Metalworking and plastics-working machine operators can be separated into two groups: Those who set up machines for operation and those who tend the machines while they operate. Before production can begin, each machine must be readied. Setup operators prepare the machines prior to production and make adjustments to the machines during production. Because they must know how the machines operate, these workers have more training and are usually more highly skilled than those who operate or tend the machinery. Operators and tenders monitor the machinery during operation. They may load or unload the machine or make minor adjustments to the controls.

Setup operators and tenders are usually identified by the kind of machine they run, such as screw machine operator, plastics-molding machine setup operator, or lathe tender. Although some may specialize in one or two types of machines, most workers are trained to set up or operate a variety of machines. Job duties usually vary by the type of firm as well as the type of machine. Although metal and plastics working machine operators have many similar duties, production of metal and plastics goods have distinct differences.

Metalworking machine operators set up and tend machines which form all types of metal parts used in many manufactured products. Traditionally, setup operators plan and set up the correct 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 proper 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.

Computer controlled machinery has affected the nature of work of many setup operators. Computer controlled machines simplify setups by using formerly tested computer programs for new workpieces. For example, 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. The machine is then set in the same or a similar manner for that of the original workpiece.

Although there are many different types of metalworking machine tools that require specific knowledge and skills, operators perform many similar tasks. Most operators tend machines, performing simple, repetitive operations that can be learned quickly. Typically, these workers place metal stock in a machine on which the speeds and sequence of operation have already been set. Operators may watch one or more machines and make minor adjustments according to their instructions. Computer controlled equipment allows operators to monitor an even larger number of machines at one time. For example, some workers might tend grinding machines that remove excess material from the surface of machined products while others might oversee machines that extrude metal through a die to form wire.

Regardless of the type of machine they operate, machine tenders usually depend on skilled setup workers for major adjustments when the machines are not operating 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.

Plastic products are produced by various methods of which injection molding is the most common. The injection molding process 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 by this method. Extruding machine operators tend machines which force the plastic compound through a die that contains an opening of the desired shape of the final project, producing long parts such as pipes or window frames. Blow molding machine operators, on the other hand, tend machines which 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 soda bottles are produced by this method.

During these processes, plastics-working machine operators check the feed of the materials, temperature and pressure of the machine, and rate at which the product hardens. Depending on the type of equipment in use, they may 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. Molds and dies are quite costly, and operators must exercise proper care to avoid damaging them.

In computer-controlled systems, plastics working machine operators have very little interaction with the machinery or materials. Rather, these workers monitor computers that control the loading, forming, and unloading processes. For most operators, however, the job duties are a combination of manual and monitoring tasks.

Working Conditions

Many metalworking and plastics-working machine operators work in areas that are clean, well lighted, and well ventilated. Regardless of setting, all of these workers operate powerful, high-speed machines which 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 equipment such as protective clothing varies by work setting and the machines with which they work. 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 metalworking and plastics-working machine operators work a 40-hour week, but overtime is common during periods of increased production. Production workers in industries where metal and plastics workers are concentrated average 4 or 5 hours of overtime per week. Because most metalworking and plastics working shops operate more than one shift, many 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.

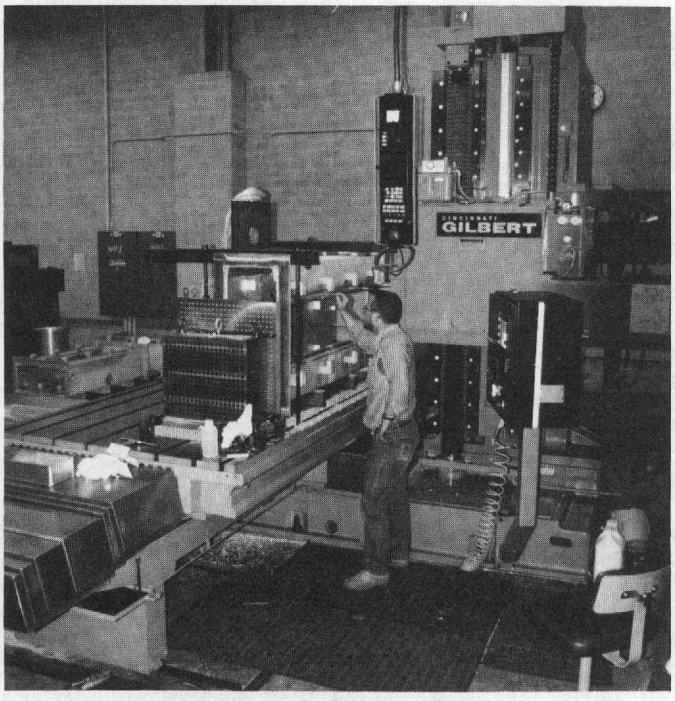
Employment

Metalworking and plastics-working machine operators held about 1,473,000 jobs in 1990. Over 70 percent of these workers are found in five industries. Table 1 shows the employment distribution of metal and plastics working machine operators by detailed occupation.

Table 1. Distribution of metal and plastics-working machine operators by detailed occupation, 1990

Occupation	*Percent*
Total	100
Machine tool cutting and forming machine setters and operators	52
Sheet-metal workers	16
Plastics molding and casting machine operators	10
All other metal and plastics-working machine operators and tenders	7
Combination machine tool setters and operators	6
Electrolytic plating and coating machine setters and operators, metal and plastic	3
Heaters and heat treating and related machine operators and tenders	2
Metal molding machine setters and operators	2
Metal fabricators, structural metal products	1

SOURCE: *Bureau of Labor Statistics*



Automated machinery has replaced many machine operators.

Metalworking machine operators held about 1,330,000 jobs in 1990. Most worked in factories that produce fabricated metal products, nonelectrical machinery, primary metal products, and transportation equipment. These industries tend to be found in the midwestern, northeastern, and far western sections of the country, where such manufacturing activity is centered.

Plastics molding and casting machine operators held about 143,000 jobs in 1990. Unlike metal working machine operators, the vast majority of plastics working machine operators were employed by plastics processing firms which often tend to be small companies located throughout the country.

Training, Other Qualifications, and Advancement

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, and remove finished products from the machine. As they gain experience, they advance to more difficult tasks and obtain responsibility for their own machine or machines. For example, they may learn to adjust feed speeds and cutting tools. In addition, they often inspect the finished product for obvious defects.

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 becoming a skilled operator or advancing to the more highly skilled job of setup operator often requires several years.

Although setup operators perform many of the same tasks as skilled machine operators, they have a better 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. They need good analytical abilities to perform this job. Some companies have formal training programs for setup operators that combine classroom instruction with on-the-job training.

Although no special education is required for most jobs, employers prefer to hire those with good basic skills and many require employees to have a high school education and to read, write, and speak English. Because machinery is becoming more complex, employers increasingly look for persons with good communications skills as well as mechanical aptitude; experience working with machinery is a plus. Those interested in becoming a metal or plastics working machine operator can improve their opportunities by completing high school courses in shop, mathematics, and blueprint reading. For those interested in becoming a machine setup operator, a high school diploma is often required. In addition, a working knowledge of the properties of metals and plastics is useful.

Those interested in this field should have good coordination, manual dexterity, and the ability to work under supervision. Physical stamina also is important because much time is spent standing.

Advancement opportunities in these occupations are limited. Advancement usually takes the form of higher pay. Operators can advance to setup operator. Some workers advance to supervisory jobs or transfer to trainee jobs for skilled occupations such as machinist or mold maker. (See statements on machinists, tool and die makers, and numerically controlled machine tool operators found elsewhere in the *Handbook*.)

Job Outlook

Employment of metalworking and plastics-working machine operators as a whole is expected to decline through the year 2005. However, many job openings will be created as these workers transfer to other occupations or leave the labor force. Employment of metalworking machine operators is expected to decline through the year 2005, while employment of plastics-working machine operators is expected to increase as fast as the average for all occupations.

The demand for metal and plastics parts is expected to increase as the economy expands. However, foreign competition and improvements in manufacturing technology will prevent employment from keeping pace with this demand. Many of the industries that employ metalworking and plastics-working machine operators face increasing foreign competition. In addition, many U.S. firms have moved production operations to other countries in order to reduce costs. Such moves have lowered employment opportunities in these occupations.

In order to remain competitive, many firms are adopting technologies that significantly increase productivity, further reducing the demand for operators. The most significant technology affecting these workers is computer-controlled equipment. This equipment allows operators to tend a greater number of machines at one time and often makes setups easier, reducing the amount of time setup workers spend on each machine.

Another factor that is expected to reduce demand for metalworking machine operators while increasing the demand for plastics machine operators is the increased substitution of plastics for metal, glass, and paper products. The demand for plastics is expected to continue to increase as new plastics applications are developed and consumption of existing plastics products increases.

The outlook also varies by specific job function. Machine operators and tenders will be more adversely affected by increased levels of automation than machine setup operators because the functions of setup operators are not easily automated.

Workers with a thorough background in machine operations, mathematics, blueprint reading, and a good working knowledge of the properties of metals and plastics will be best able to adjust to the changing job requirements that will result from technological advances. Those skilled in the setup of metalworking and plastics-working machines should fare better than those whose responsibilities solely include tending and operating machinery. In addition, those able to setup or tend several different types of machines will have the best employment prospects.

Earnings

Median weekly earnings for metal and plastics working machine operators were $403 in 1990. The middle 50 percent earned between $296 and $519. The top 10 percent earned over $622 and the bottom 10 percent earned less than $226. Metal and plastics processing machine operators' weekly earnings were slightly lower, with median weekly earnings of about $352 and the middle 50 percent earning between $258 and $484 in 1990.

However, earnings of production workers vary considerable by industry. 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	$592
Plastics materials and resins	580
Primary metals industries	551
Machinery, except electrical	494
Fabricated metal products	447

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

Related Occupations

Workers in occupations closely related to metalworking and plastics-working machine occupations include numerical-control machine-tool operators, machinists, tool and die makers, extruding and forming machine operators producing synthetic fibers, woodworking machine operators, and metal patternmakers.

Sources of Additional Information

For general information about the metalworking trades, contact:

- The National Machine Tool Builders, 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.

Numerical-Control Machine-Tool Operators

(D.O.T. 604.362; 605.360, .380; 606.362, .382-014; 609.662; and 617.280)

Nature of the Work

People generally associate manufacturing with mass production. However, the manufacture of industrial equipment, aircraft, and many other products involves machining—cutting or forming metal or plastic workpieces into parts for final products—that is done in small batches. For decades, batch production was done by precision machinists using machine tools such as milling machines and lathes. Today, numerically controlled machine tools—machine tools that can be programmed to make parts of different dimensions automatically—bring the benefits of automation to batch production.

Numerically controlled (NC) machine tools have two major components: An electronic controller and a machine tool. Most NC machines today are computer numerically controlled (CNC), which means that the controllers are minicomputers. 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, for example, could contain 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 machine tool, such as a milling machine, a lathe, or a punch press, performs a specific task, and one part may be worked on by several machines before it is finished. Most of these machines can be numerically controlled. 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 elsewhere in the *Handbook*.)

Numerically controlled 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 performed by NC machines. In some cases, the workpiece is stationary and the tools change automatically.

The duties of numerical-control machine-tool operators vary. In some shops, operators merely tend one machine. In others, they might program and tend machines, operate more than one machine at a time, or operate more than one type of machine. 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 written instructions or directions from supervisors, operators must load the program—usually stored on a floppy disk—into the controller, position the workpiece, attach the necessary tools, and check the coolants and lubricants.

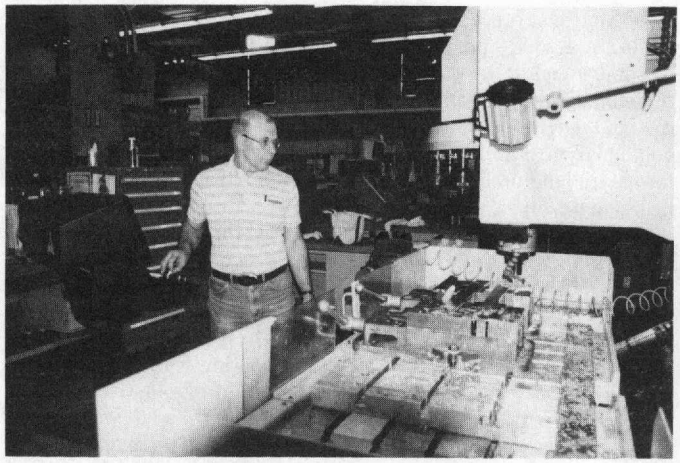
Operators must secure the piece to the worktable correctly, so the piece does not move while it is machined and the subsequent machining is done correctly. Many numerically controlled machines are equipped with automatic tool changers, so operators must also load several tools in the proper sequence. In addition, because the heat generated by machining could damage the cutting tools and the part being machined, operators must ensure that the proper coolants and lubricants are being used. Loading the tools and positioning and securing the workpiece may take from a few minutes to several hours, depending on the size of the workpiece and the complexity of the job. However, advances in automation have greatly reduced this setup time.

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 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 tool programmers, numerical control, elsewhere in the *Handbook*.)

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 machinery and lost production. 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, changing of tools, programming, or constant attention to ensure that the machining is proceeding properly. Regardless of the type of run, operators check the finished part using micrometers, gauges, or other precision inspection equipment to ensure that it meets specifications.

Working Conditions

Numerical-control machine-tool operators work in machine shops where they are on their feet most of the day and may have to lift moderately heavy workpieces. However, as machining becomes more automated, there is less physical work. Machine shops usually are well lighted and ventilated, and the machines on which they work have guards and shields that minimize the operators' exposure to moving parts. Because of flying bits of metal and noise from the machinery, however, safety glasses and earplugs must be worn. Operators also must exercise caution around the coolants and lubricants used during the machining process because some of these liquids may be hazardous.



Numerical-control machine-tool operators work with a variety of machines.

Although numerical-control machine-tool operators generally work 40 hours a week, overtime is common during periods of high manufacturing activity.

Employment

Numerical-control machine-tool operators held about 70,000 jobs in 1990. Most worked in industries that manufacture durable goods, such as aircraft, electrical and metalworking machinery, and fabricated metal products. Although jobs are found throughout the country, employment is concentrated in metropolitan areas in the northeastern and midwestern parts of the country, where durable goods manufacturing is centered.

Training, Other Qualifications, and Advancement

Just as the responsibilities of NC machines operators vary greatly, so do the requirements for entering the occupation. Traditional machinists may become operators as NC equipment is introduced into their establishment. Other machine operators or shop helpers may also advance to become NC operators. Most employers prefer high school graduates. Courses in shop math, plane geometry, and blueprint reading may improve an employee's chances of getting selected for an operator job.

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 job 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 1 to 2 weeks.

Because programming languages may vary by machine, operators usually receive additional training when new equipment is introduced. Most often this training is conducted at the plant by a representative of the machinery manufacturer.

Numerical-control machine-tool operators may advance to supervisory jobs. Operators who have substantial training in numerical-control programming may move to the higher paying job of tool programmer.

Job Outlook

Employment of numerical-control machine-tool operators is expected to increase about as fast as the average for all occupations through the

year 2005. Although the use of numerically controlled machine tools is expected to expand, the greater productivity of operators will moderate employment. Advances in technology, such as the use of adaptive controls, will make operators more productive. Improvements in the controllers and in the software used for programming them also are likely to increase productivity and limit the rate of employment growth somewhat. In addition, in some cases employers will prefer that machinists operate these tools. However, many job openings are expected to arise from the need to replace operators who retire or transfer to other occupations.

Another factor limiting employment growth of these operators will be economic conditions in the industries in which they work. Demand for these workers depends on the production of manufactured products. When manufacturing activity falls, employment of numerical-control machine-tool operators declines.

Earnings

In 1990, numerical-control machine-tool operators earned about $15.85 an hour, according to the limited data available. This is higher than the average hourly earnings for all production workers in manufacturing but slightly lower than the hourly rates of skilled machining workers such as machinists and tool and die makers.

Because many numerical-control machine-tool operators work for medium-size and large firms, they usually receive a wide variety of benefits—including health and life insurance, a pension plan, and vacation and sick leave.

Related Occupations

Numerical-control machine-tool operators use their skill and knowledge of machines and processes to set up and operate one or more types of automatically controlled machine tools. Other occupations in which workers use machines to cut or form metal and plastic include machinists, bending machine operators, drill press operators, grinder operators, milling machine operators, and shear operators.

Sources of Additional Information

For general information about this occupation, contact:

- The National Machine Tool Builders Association, 7901 Westpark Dr., McLean, VA 22103.
- 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.

Sheet-Metal Workers

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

Nature of the Work

Sheet-metal 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 sheet-metal products.)

Sheet-metal workers usually fabricate their products at a shop away from the construction site. They first study blueprints 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, sheet-metal 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, shears, and presses. In some shops, workers cut parts with computer-controlled lasers.

In shops without computerized equipment and for products that cannot be made on such equipment, sheet-metal 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, sheet-metal 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 sheet-metal 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 finished 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 roof, for example, sheet-metal 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 sheet-metal 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. Sheet-metal workers may also perform safe removal of asbestos and toxic materials.

Working Conditions

Sheet-metal workers usually work a 40-hour week. Those who fabricate sheet-metal 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. Sheet-metal 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 often 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 sheet-metal workers to work in all kinds of weather.

Employment

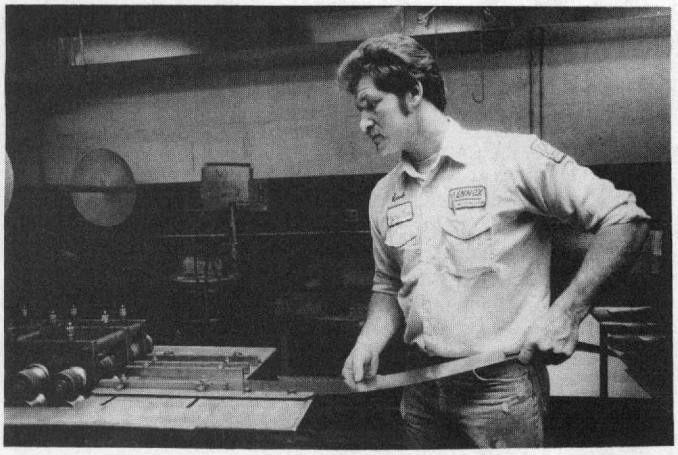
Sheet-metal workers held about 98,000 wage and salary jobs in the construction industry in 1990. Three of every 4 worked for plumbing, heating, and air-conditioning contractors; 1 of every 5 worked for roofing and sheet-metal contractors; and the rest worked for other special trade contractors and for general contractors engaged in residential and commercial building. Unlike many other construction trades, very few sheet-metal workers are self-employed.

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

Training, Other Qualifications, and Advancement

Sheet-metal 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 sheet-metal fabrication and installation. They are administered by joint committees of locals 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



Most sheet-metal workers are employed by plumbing, heating, and air-conditioning contractors.

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 acoustical tile, which sometimes are substituted for metal.

In the classroom, apprentices learn drafting, blueprint 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 sheet-metal work and other construction work.

A relatively small number of persons pick up the trade informally, usually by working as helpers to experienced sheet-metal 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 sheet-metal fabrication to supplement their work experience. Helpers usually must pass an exam to be promoted to the journeyman 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 trigonometry, geometry, mechanical drawing, and shop provide a helpful background for learning the trade.

Experienced sheet-metal workers often take additional training to improve existing skills or to acquire new ones. This training is often provided by the union or by their employer.

Sheet-metal 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 sheet-metal 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 sheet-metal workers in construction is expected to increase about as fast as the average for all occupations through the year 2005. Demand for sheet-metal 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 sheet-metal products and increased architectural restoration are expected to add to the demand for sheet-metal workers. Despite this growth in demand, most job openings will arise as experienced workers retire or leave the occupation for other reasons.

Job prospects should be favorable 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 sheet-metal 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 sheet-metal 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 sheet-metal 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 fringe benefits—for union sheet-metal workers were $26.06 in 1990. Wages ranged from a low of $16.60 in New Orleans to a high of $39.61 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 sheet-metal workers are members of the Sheet Metal Workers' International Association.

Related Occupations

To fabricate and install sheet-metal products, sheet-metal 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 technicianss and glaziers.

Sources of Additional Information

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

For general information about sheet-metal workers, contact:

- National Training Fund for the Sheet Metal and Air Conditioning Industry, Edward F. Carlough Plaza, 601 N. Fairfax St., Suite 240, Alexandria, VA 22314.
- Associated Builders and Contractors, 729 15th St. NW., Washington, DC 20005.
- The Sheet-Metal and Air Conditioning Contractors' National Association, 4201 Lafayette Center Dr., Chantilly, VA 22021.

Structural and Reinforcing Ironworkers

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

Nature of the Work

Materials made from iron, steel, aluminum, and bronze are used extensively in the construction of highways, bridges, power transmission towers, and many 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 or metal chairs 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 92,000 jobs in 1990. Almost all of these workers were employed in the construction industry. About 5 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.

Reinforcing iron workers work together to wire-tie reinforcing bars.

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.

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 generally 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 agility, balance, good 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 to meet the demand for nonresidential buildings, power transmission towers, and highway, subway, and bridge construction, rehabilitation, and maintenance—types of construction that require extensive use of structural steel and reinforced concrete. However, most openings will result from the need to replace experienced ironworkers who transfer to other fields of work 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. 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

Median weekly earnings for ironworkers were about $569 in 1990. The middle 50 percent earned between $406 and $773 weekly. Apprentices usually start at 40 to 60 percent of the wages paid to experienced workers. 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 International Association of Bridge, Structural and Ornamental Ironworkers; 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 America, Inc., 1957 E St. NW., Washington, DC 20006.
- International Association of Bridge, Structural and Ornamental Iron Workers, 1750 New York Ave. NW., Washington, DC 20006.
- National Erectors Association, 1501 Lee Hwy., Arlington, VA 22209.
- National Association of Reinforcing Steel Contractors, 10382 Main St., Fairfax, VA 22030.

Tool and Die Makers

(D.O.T. 601.280 except -054, .281-010, -014, and -026, .380-010, .381 except -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. Because they work with all commonly used metals and alloys, these workers must be familiar with the machining properties, such as hardness and heat tolerance, of a wide variety of 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.

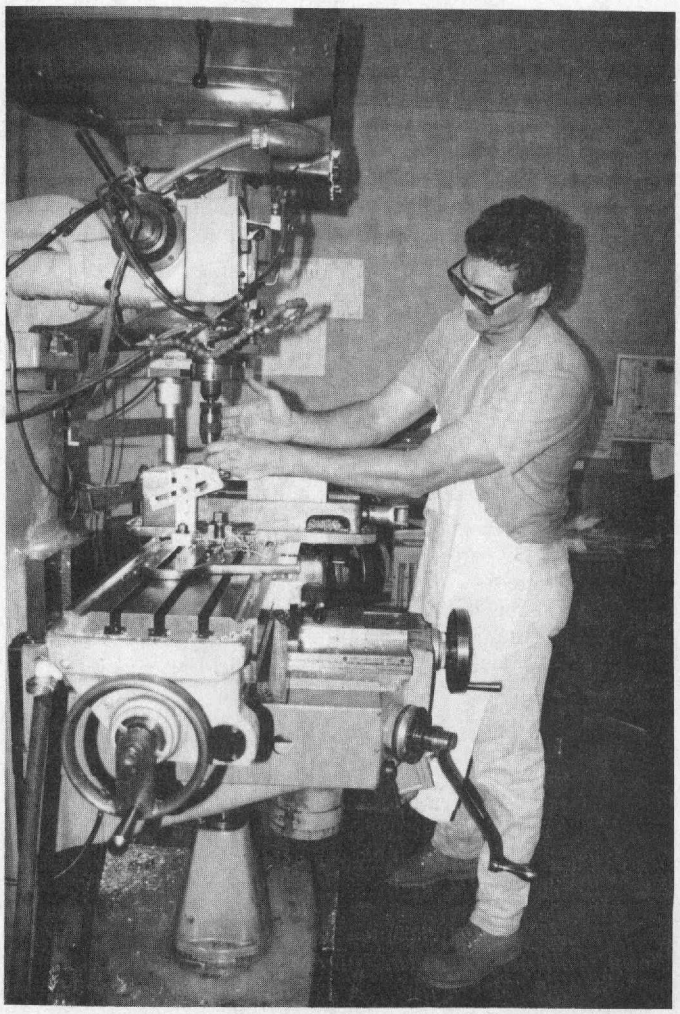
In shops that use numerically controlled (NC) machine tools, tool and die makers' duties may be slightly different. For example, although they still manually check and assemble the tool or die, each of its components may be produced on an NC machine. In addition, they often assist in the planning and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



Despite declining employment of tool and die makers, opportunities are excellent for those with the required skills.

Employment
About 141,000 persons were employed as tool and die makers in 1990. 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. However, most employers consider a formal apprenticeship program that combines classroom instruction and job experience the best way to learn all aspects of tool and die making.

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 equipment, and they study metalworking processes such as heat treating. 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 are gradually given more difficult assignments. In addition, many machinists become tool and die makers.

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 change little 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 and the workers who make them. 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.

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. Also, a relatively large proportion of tool and die makers are at least 50 years of age. As these older workers begin to leave the occupation, 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 $557 in 1990. Most earned between $439 and $690 a week. Ten percent earned less than $310 a week, while the 10 percent with the highest weekly earnings made more than $844.

In 1990, tool and die makers employed in metropolitan areas had average earnings of $16.68 an hour. In comparison, the average for all nonsupervisory workers in private industry, except farming, was $10.03.

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 National Machine Tool Builders Association, 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.

Tool Programmers, Numerical Control

(D.O.T 007.167-018 and 020.187-014)

Nature of the Work
Aircraft, industrial machinery, construction equipment, and many other durable goods require precision-machined metal parts. Most of these parts are made with machine tools—drill presses, lathes, milling machines, and others—an increasing number of which are numerically controlled (NC). NC machine tools 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 minicomputers. 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 coded instructions, known as programs, that are written by tool programmers.

Tool programmers must have a broad knowledge of machining operations, mathematics, and blueprint reading. They must know how various machine tools operate and the working properties of the metals and plastics used to make parts. 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 languages.

Programmers begin writing a program by analyzing the blueprints of the item to be made. They next compute the size and position of the cuts that must be made on the workpiece and determine the sequence of machine operations. They must also select the proper cutting tools needed to machine the workpiece into the desired shape and calculate the machine speed and feed rate needed for the type of material being machined. They also determine the quantities and types of coolants and lubricants that will be discharged during the machining process. They then write the program in the language of the machine's controller and store it, usually on a computer disk. Depending upon the size and complexity of the program, a programmer may work alone or as part of a team.

Most often, programmers use computers to write the program for the machine controller. The computer uses programs called post processors to translate the program into the language of the controller and store it. These stored programs are sometimes used for future jobs with similar specifications by making small adjustments to the program.

A growing number of firms have computer-aided design (CAD) systems that programmers can use to write the program for the controller. When a part is designed using a CAD system, data about its dimensions are calculated. In a CAD system with the proper software, the tool programmer can use these data to develop the controller's program.

Programmers also write instructions to help the machine operator set up and tend the machine. In addition, they may assist the operator in the initial setup and operation of the machine. Finally, programmers may watch a trial run of the machine to ensure that it is functioning properly and check the output to be sure all specifications are met. 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.

The length of time it takes to complete a program depends on its complexity. For simple programs, only one programmer may be needed. However, for more complex machining operations, a team of programmers may work for several months on the project.

Working Conditions

Many tool programmers work in offices that are near, but separate from, the shop floor. Work areas are usually clean, well lighted and ventilated, and free of machine noise. However, they often assist machinists or numerical-control machine-tool operators on the shop floor.

Most tool programmers work a 40-hour week; however, overtime is common during periods of increased manufacturing activity.

Employment

Numerical-control tool programmers held about 7,800 jobs in 1990. Almost all worked for manufacturing firms or small machine shops that produce durable goods such as aircraft parts, industrial machinery, or instruments.

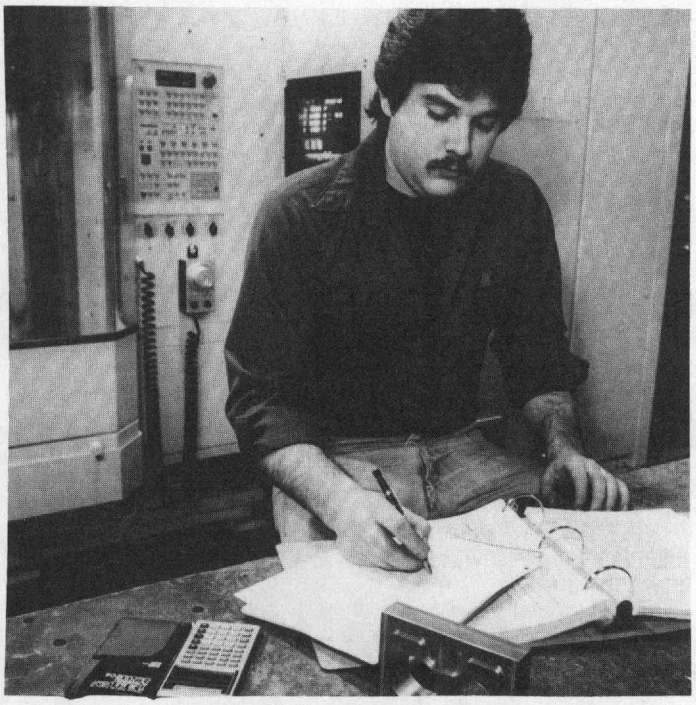
Although tool programmers work in all parts of the country, jobs are most plentiful in areas where manufacturing is concentrated.

Training, Other Qualifications, and Advancement

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

For those interested in pursuing a career as a tool programmer, high school courses in mathematics, blueprint reading, metalworking, data processing, physics, and drafting provide a valuable background.

Most programmers learn their skills through a combination of formal classroom training and on-the-job training. Those entering the occupation with a degree in engineering may have limited knowledge of machining practices, so they often spend time on the shop floor to acquire this knowledge.



Programming languages used by tool programmers are becoming more standardized, increasing their productivity.

Classroom training begins with an introduction to numerical control and the basics of programming and advances to more complex topics such as computer-aided design. Then, trainees start writing simple programs under the direction of an experienced programmer. Although they are writing these programs for the machining of metal parts, the program may initially be tested on wood or wax because an error could severely damage the machinery and cutting tools.

Because programming methods vary for different brands of numerically controlled machine tools, programmers must receive additional training when new machinery is introduced. This often is conducted at the plant by a representative of the machinery manufacturer. In addition, to stay abreast of developments in the field, programmers often continue to upgrade their programming skills through courses at community colleges. Although practice varies from shop to shop, many employers will pay for this training.

Tool programmers can advance to supervisory jobs or may transfer to skilled machining jobs such as tool designer.

Job Outlook

Employment of tool programmers is expected to increase more slowly than the average for all occupations through the year 2005. Although the use of numerically controlled machine tools is increasing, simplified programming languages and procedures will increase the productivity of programmers. In addition, machinists will increasingly perform programming functions, further reducing the demand for programmers. Therefore, most openings are expected to occur as programmers transfer to other fields of work or retire. Because this is a relatively small occupation, however, the total number of job openings will be much smaller than in other machining occupations such as metalworking and plastics-working machine operator, machinist, or tool and die maker.

Those interested in this occupation should keep in mind that employment is very sensitive to economic conditions. As manufacturing activity falls, so does demand for tool programmers. When this occurs, programmers may face layoffs or reduced workweeks.

Earnings

According to the limited data available, experienced programmers earned between $13.00 and $18.00 an hour 1990. In addition to their hourly wage, most tool programmers receive health and life insurance, a pension plan, paid vacations, and sick leave.

Related Occupations

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. Other highly skilled workers involved in metal machining work are tool and die designers, tool planners, tool and die makers, and machinists.

Sources of Additional Information

For more information about this occupation, contact:

- The National Machine Tool Builders Association, 7901 Westpark Dr., McLean, VA 22102.
- The National Tooling and Machining Association, 9300 Livingston Rd., Ft. Washington, MD 20744.
- The Tooling and Manufacturing Association (formerly The Tool and Die Institute), 1177 South Dee Rd., Park Ridge, IL 60068.

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; 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 con-

Training for welding jobs ranges from a few days to several years.

struct and repair parts of ships, automobiles, spacecraft, and thousands of other manufactured products. Welding is also used to join beams and steel reinforcing rods in buildings, bridges, and other structures.

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—automatic welding is used. In automatic welding, 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. Cutters use heat from burning gases or an electric arc to cut and trim rather than join metal. Some operate and monitor cutting machines.

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. Automatic welding machine operators are not exposed to as many hazards. A face shield or goggles generally provide adequate protection. Although lighting and ventilation usually are adequate, some metals give off toxic gases and fumes as they melt. Workers often 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.

Employment

Welders, cutters, and welding machine operators held about 427,000 jobs in 1990. Welders and cutters held about 3 out of 4 jobs, while welding machine operators held about 1 out of 4.

Nearly 7 out of 10 welders were in plants that manufacture boilers, construction equipment, motor vehicles, machinery, ships, appliances, and other metal products. Most others were in firms that construct bridges, large buildings, pipelines, and other structures or were in repair shops. All welding machine operators were in manufacturing industries, primarily machinery, motor vehicles, and fabricated metal products.

Training, Other Qualifications, and Advancement

Training for welders can range from a few days of school or on-the-job training for low skilled positions to several years of school and on-the-job training for highly skilled jobs. Formal training is available in high schools, vocational schools, and postsecondary institutions such as vocational-technical institutes and community colleges. 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.

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

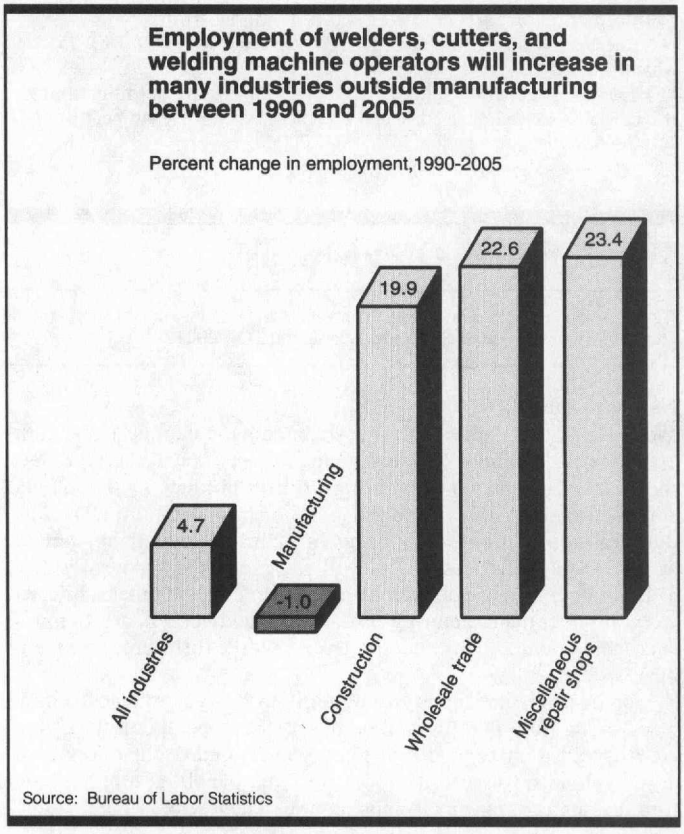
Welders who work on aircraft, boilers, buildings, bridges, pipelines, and other jobs where the strength of the weld is critical for safety must pass employer performance tests or standard tests to become certified.

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

Job Outlook

Little or no change in employment of welders, cutters, and welding machine operators is expected through the year 2005. Most 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. 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 robots in manufacturing should cause employment of manual welders to decline, and employment of welding machine operators to increase. Despite the welding jobs eliminated by robot welding systems, manual welders 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 $425 a week in 1990. The middle 50 percent earned between $300 and $550. The top 10 percent earned more than $700, and the lowest 10 percent earned less than $250.

Over 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., P.O. Box 351040, Miami, FL 33135.

For a list of certified schools that offer training in welding, contact:

☛ National Association of Trade and Technical Schools, Department BL, P.O. Box 2006, Annapolis Junction, MD 20701-2006.

Woodworking Occupations

(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. Woodworkers comprise a variety of occupations. Some woodworkers produce the structural elements of buildings; others produce hardwood and softwood lumber; still others produce finished wood products. Production woodworkers are found in primary industries such as sawmills and plywood mills, as well as in secondary industries such as furniture, kitchen cabinet, musical instrument, and other fabricated wood product manufacturing. Precision woodworkers are found in small shops making architectural woodwork, furniture, and many other specialty items.

Woodworkers are found throughout the process of transforming wood in log form into finished 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. They fashion home accessories such as beds, sofas, tables, dressers, and chairs. They also make sporting goods items, including baseball bats, racquets, skis, oars, and surfboards, as well as musical instruments, toys, caskets, tool handles, and thousands of other wooden items.

Working from blueprints, instructions from supervisors, or shop drawings often developed by themselves, woodworkers determine the method of shaping and sequence of assembling parts. To begin, they do a layout—measuring and marking the materials to be cut. Production workers 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. They verify dimensions to adhere to specifications and may trim parts to insure a tight fit, using handtools such as planes, chisels, or wood files and sandpaper.

After the machining process, assemblers produce subassemblies using fasteners and adhesives. Subassemblies are then brought together to form a complete unit. The product is then finish sanded, stained, sealed, and if necessary, finish coated with a material such as lacquer or varnish. Woodworkers may work in teams or be assisted by a helper.

Production woodworkers generally operate a specific woodworking machine; however, some wood machine operators may set up their equipment, cut and shape wooden parts, and verify dimensions using a template, calipers, or rule. Other operators may press a switch on a woodworking machine and monitor or tend the automatic operation.

Wood machine operators in sawmills cut logs into planks, timbers, or boards. In veneer mills, they cut veneer sheets from logs for making plywood. And in furniture plants, they make furniture components such as table legs, drawers, rails, and spindles.

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, such as a piece of furniture.

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 trained workers, particularly those with strong mathematical skills.

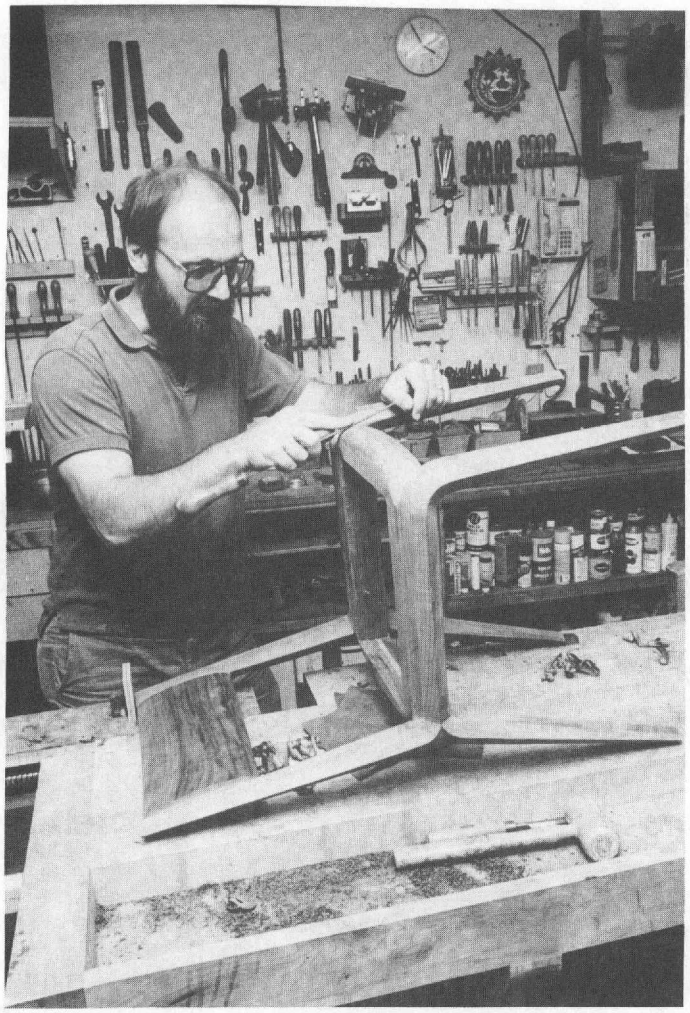
Working Conditions

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 to provide a safe work place. Rigid adherence to safety precautions minimizes risk of injury from contact with rough woodstock, and from the use of sharp tools and power equipment.

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, or with a complete protective safety suit, or be in a finishing environment which removes all vapors and particle matter from the atmosphere. Prolonged standing, lifting, and fitting heavy objects are also characteristic of the job.

Employment

Workers in woodworking occupations held about 349,000 jobs in 1990. Over 10 percent, mostly cabinetmakers and furniture and wood



Precision woodworkers build customized items.

finishers, were self-employed. Employment was distributed as follows:

Woodworkers, precision	213,000
Woodworking machine setters and operators	136,000
Head sawyers	72,000
Woodworking machine operators	64,000

About 85 percent of all salaried woodworkers worked in manufacturing industries. Approximately 21 percent were employed in establishments fabricating household and office furniture; 21 percent were in establishments making millwork, plywood, and structural wood members, used primarily in construction; and 11 percent 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, manufacturing 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 learn their jobs through on-the-job training, 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 which 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, remove fabricated products from the machine, and stack them. Trainees do simple machine operating jobs, supervised closely 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. However, many firms hire workers to perform specialized tasks on a machine. These jobs may offer little opportunity to develop all-round skills.

In the past, a high school education was seldom required. However, persons seeking woodworking jobs can enhance their employment and advancement opportunities 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 and seminars or college programs. Those with all-round skills 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. Demand for wood products is also stimulated by the rising demand for repair and renovation of residential and commercial property. Opportunities for woodworkers who specialize in such items as moldings, cabinets, stairs, and windows, should be particularly good.

Several factors may limit the growth of woodworking occupations. Materials such as metal, plastic, and fiberglass are used as alternatives to wood in many products, primarily because they are cheaper, stronger, or easier to shape. In addition, some jobs may be lost to imports. Job growth may also be dampened by increased environmental measures to control various pollutants used in or generated by woodworking processes, as well as old growth timber set aside for endangered species such as the spotted owl. The use of improved machinery, tools, and other technological advances—including computerized numerical control machinery and computer-aided design packages—will also 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.

Although employment 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.

Employment of woodworkers, like that of many other manufacturing workers, is sensitive to cyclical changes in the economy.

Earnings

Median weekly earnings for salaried full-time precision woodworkers were about $355 in 1990. The middle 50 percent earned between $270 and $520. The lowest 10 percent earned less than $200, while the highest 10 percent earned over $710. Median weekly earnings for full-time woodworking machine operators were around $295 in 1990. The middle 50 percent earned between $230 and $385. The lowest 10 percent earned less than $190, while the highest 10 percent earned over $470. Earnings vary by industry, geographic region, skill, and 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/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, and the United Brotherhood of Carpenters and Joiners of America, all AFL-CIO affiliates.

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 plastic-working machine operatives, 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.
- Institute for Woodworking Education, 1012 Tenth St., Manhattan Beach, CA 90266.