Technologists and Technicians, Except Health

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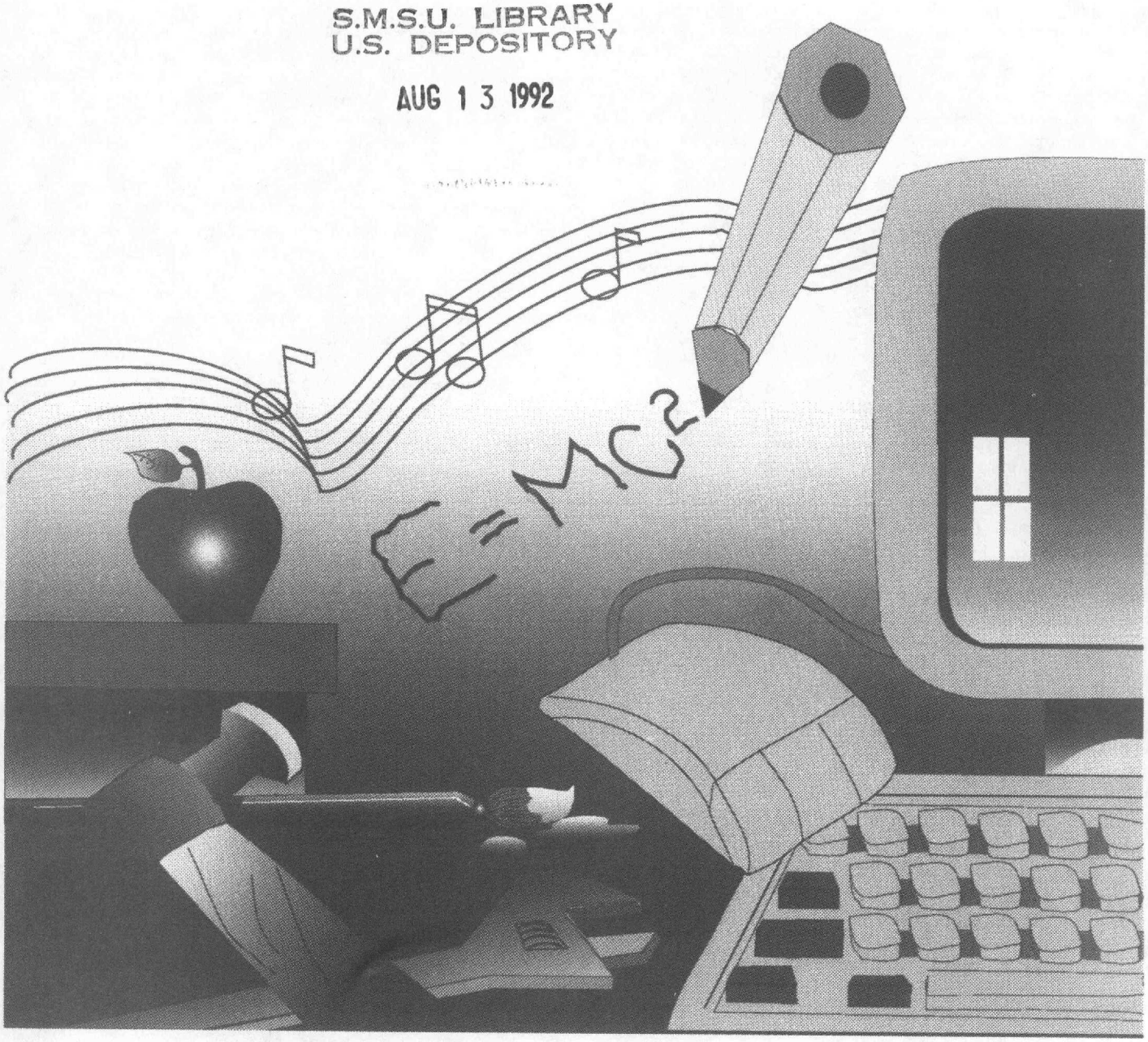


Aircraft Pilots

(D.O.T. 196 except .163 and 621.261-018)

Nature of the Work

Pilots are highly trained people who fly airplanes and helicopters to carry out a wide variety of tasks. Most pilots transport passengers, cargo, and mail, while others dust crops, spread seed for reforestation, test aircraft, and take photographs. Helicopter pilots are involved in firefighting, police work, offshore exploration for natural resources, evacuation and rescue efforts, logging operations, construction work, and weather station operations; some also transport passengers.

Except on small aircraft, two pilots usually make up the cockpit crew. Generally, the most experienced pilot (called captain) is in command and supervises all other crew members. The copilot assists in communicating with air traffic controllers, monitoring the instruments, and flying the aircraft. Most large aircraft have a third pilot in the cockpit—the flight engineer—who assists the other pilots by monitoring and operating many of the instruments and systems, making minor inflight repairs, and watching for other aircraft. New technology can perform many flight tasks, however, and virtually all new aircraft now fly with only two pilots. New aircraft have computerized controls, requiring pilots to make more extensive use of video controls.

Before departure, pilots plan their flights carefully. They confer with flight dispatchers and aviation weather forecasters to find out about weather conditions enroute and at their destination. Based on this information, they choose a route, altitude, and speed that should provide the fastest, safest, and smoothest flight. When flying under instrument flight rules (procedures governing the operation of the aircraft when there is poor visibility), the pilot in command must file an instrument flight plan with air traffic control so that the flight can be coordinated with other air traffic.

Before taking off, pilots thoroughly check their planes to make sure that the engines, controls, instruments, and other systems are functioning properly. They also make sure that baggage or cargo has been loaded correctly.

Takeoff and landing are the most difficult and dangerous parts of the flight and require close coordination between the pilot and copilot. For example, as the plane accelerates for takeoff, the pilot concentrates on the runway while the copilot scans the instrument panel. To calculate the speed they must attain to become airborne, pilots consider the altitude of the airport, outside temperature, weight of the plane, and the speed and direction of the wind. The moment the plane reaches takeoff speed, the copilot informs the pilot, who then pulls back on the controls to raise the nose of the plane.

Unless the weather is bad, the actual flight is relatively easy. Pilots steer the plane along their planned route and are monitored by the air traffic control stations they pass along the way. They continuously scan the instrument panel to check their fuel supply, the condition of their engines, and the air-conditioning, hydraulic, and other systems. Pilots may request a change in altitude or route if circumstances dictate. For example, if the ride is rougher than expected, they may ask air traffic control if pilots flying at other altitudes have reported better conditions. If so, they may request a change. This procedure also may be used to find a stronger tailwind or a weaker headwind to save fuel and increase speed. In addition, pilots monitor warning devices designed to help detect sudden shifts in wind conditions that can cause crashes.

If visibility is poor, pilots must rely completely on their instruments. Using the altimeter readings, they know how high above ground they are and can fly safely over mountains and other obstacles. Special navigation radios give pilots precise information which, with the help of special maps, tells them their exact position. Other very sophisticated equipment provides directions to a point just above the end of a runway and enables pilots to land completely "blind."

Once on the ground, pilots must complete records on their flight for their company and the Federal Aviation Administration (FAA).

Airline pilots have the services of large support staffs and consequently perform few nonflying duties. Pilots employed by businesses that use their own aircraft, however, usually are the businesses' only experts on flying and, consequently, have many other duties. They may load the plane, handle all passenger luggage to insure a balanced load, and supervise refueling. Other nonflying responsibilities include keeping records, scheduling flights, arranging for major maintenance, and performing minor maintenance and repair work on their planes.

Some pilots are instructors. They teach their students the principles of flight in ground-school classes and demonstrate how to operate aircraft in dual-controlled planes.

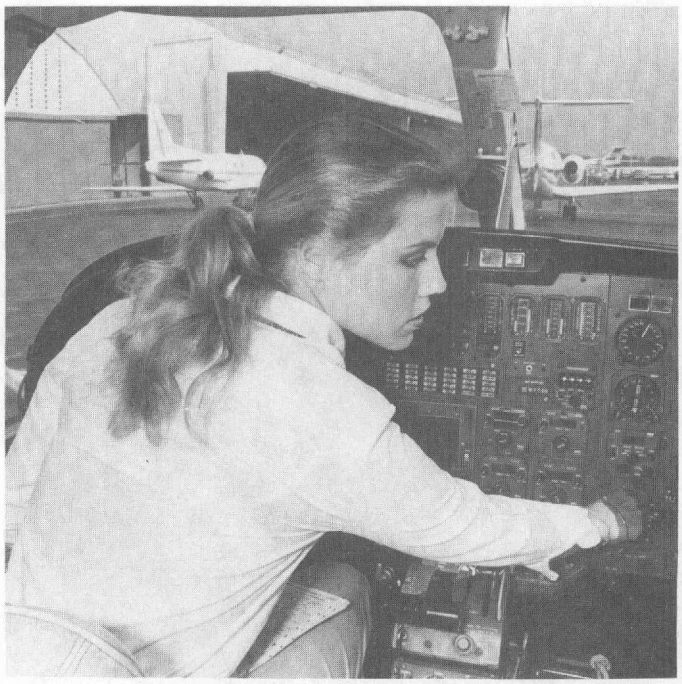
A few specially trained pilots employed by the airlines are "examiners" or "check pilots." They periodically fly with each airline pilot and copilot to make sure that they are proficient.

Working Conditions

By law, airline pilots cannot fly more than 100 hours a month or more than 1,000 hours a year. Most airline pilots fly an average of 75 hours a month and work an additional 120 hours a month performing nonflying duties. The majority of flights involve layovers away from home. When pilots are away from home, the airlines provide hotel accommodations, transportation between the hotel and airport, and an allowance for expenses. Airlines operate flights at all hours of the day and night, so work schedules often are irregular. Based on seniority, pilots generally have a choice of flights.

Pilots employed outside the airlines often have irregular schedules as well; they may fly 30 hours one month and 90 hours the next. Since these pilots frequently have many nonflying responsibilities, they have much less free time than airline pilots. Except for business pilots, most pilots employed outside the airlines do not remain away from home overnight. They may work odd hours, however. Instructors, for example, often give lessons at night or on weekends.

Airline pilots, especially those on international routes, often suffer jet lag—disorientation and fatigue caused by many hours of flying through different time zones. The work of test pilots, who check the flight performance of new and experimental planes, may be dangerous. Pilots who are crop dusters may be exposed to toxic chemicals and seldom have the benefit of a regular landing strip. Helicopter



Earnings of aircraft pilots are among the highest in the Nation.

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Washington, D.C. 20402

pilots involved in firefighting or police work are particularly subject to personal injury.

Although flying does not involve much physical effort, the mental stress of being responsible for a safe flight, no matter what the weather, can be tiring. Particularly during takeoff and landing, pilots must be alert and quick to react if something goes wrong.

Employment

Civilian pilots held about 90,000 jobs in 1990. Three-fifths worked for the airlines. Many others worked as flight instructors at local airports or for large businesses that use their own airplanes or helicopters to fly company cargo and executives. Some pilots flew small planes for air taxi companies, usually to or from lightly traveled airports not served by the airlines. Others worked for a variety of businesses performing tasks such as crop dusting, inspecting pipelines, or conducting sightseeing trips. Federal, State, and local governments also employed pilots. Several thousand pilots were self-employed.

Training, Other Qualifications, and Advancement

All pilots who are paid to transport passengers or cargo must have a commercial pilot's license with an instrument rating issued by the FAA. Helicopter pilots must hold a commercial pilot's certificate with a helicopter rating. To qualify for these licenses, applicants must be at least 18 years old and have at least 250 hours of flight experience. They also must pass a strict physical examination to make sure that they are in good health and have 20/20 vision with or without glasses, good hearing, and no physical handicaps that could impair their performance. Applicants must pass a written test that includes questions on the principles of safe flight, navigation techniques, and FAA regulations. They also must demonstrate their flying ability to FAA examiners.

To fly in bad weather, pilots must be rated by the FAA to fly by instruments. Pilots may qualify for this rating by having a total of 105 hours of flight experience, including 40 hours of experience in flying by instruments; passing a written examination on procedures and FAA regulations covering instrument flying; and demonstrating their ability to fly by instruments.

Airline pilots must fulfill additional requirements. They must pass FAA written and flight examinations to earn a flight engineer's license. Captains must have an airline transport pilot's license. Applicants for this license must be at least 23 years old and have a minimum of 1,500 hours of flying experience, including night and instrument flying.

All licenses are valid as long as a pilot can pass the periodic physical examinations and tests of flying skills required by Government and company regulations.

Flying can be learned in military or civilian flying schools. Either kind of training satisfies the flight experience requirements for licensing. The FAA has certified about 600 civilian flying schools, including some colleges and universities that offer degree credit for pilot training. Military pilots gain substantial experience on jet aircraft and helicopters, which airlines and many businesses prefer. Having lost many pilots to the airlines in recent years, the Armed Forces are offering financial incentives to curb the high rate of attrition. More pilots are expected to stay in military flying, forcing the airlines to hire a higher proportion of general aviation pilots. As a result, most recent entrants to this occupation have received their flight instruction at FAA-certified schools.

Pilots hired by airlines must be high school graduates; however, most airlines require 2 years of college and prefer to hire college graduates. In fact, most entrants to this occupation have a college degree. Because pilots must be able to make quick decisions and accurate judgments under pressure, airline companies reject applicants who do not pass required psychological and aptitude tests. However, due to the shortage of pilots in recent years, many carriers have loosened educational qualifications and even vision requirements. Many airlines are hiring pilots with corrected vision rather than unaided 20/20 vision. The major airlines have raised the maximum age for employment, in some cases to more than 50 years.

New airline pilots usually start as flight engineers. Although airlines favor applicants who already have a flight engineer's license, they may train those who have only the commercial license. All new pilots receive several weeks of intensive training in simulators and classrooms before being assigned to a flight.

Companies other than airlines generally do not require as much flying experience. However, a commercial pilot's license is required, and companies prefer applicants who have experience in the type of plane they will be flying. New employees generally start as copilots. Test pilots often are required to have an engineering degree.

Most helicopter pilots are trained in the military. Military pilots only have to pass the FAA "military competency" examination in order to be licensed as a commercial helicopter pilot. Because of insurance requirements, most commercial companies require that helicopter pilots have 1,500 hours of flying time. If a pilot does not accumulate that time flying in the military, it is difficult to get a job in the commercial sector.

Advancement for all pilots generally is limited to other flying jobs. Many pilots start as flight instructors, building up their flying hours while they earn money teaching. As they become more experienced, these pilots occasionally fly charter planes and perhaps get jobs with small air transportation firms, such as air taxi companies. Some advance to business flying jobs. A small number get flight engineer jobs with the airlines.

In the airlines, advancement usually depends on seniority provisions of union contracts. After 2 to 7 years, flight engineers advance according to seniority to copilot and, after 5 to 15 years, to captain. Seniority also determines which pilots get the more desirable routes. In a nonairline job, a copilot may advance to pilot and, in large companies, to chief pilot in charge of aircraft scheduling, maintenance, and flight procedures.

Job Outlook

Due to an expected shortage of pilots, the job outlook for pilots should be favorable in the long run. Employment growth coupled with an expected wave of retirements will provide many job openings for pilots.

Many pilots who were hired in the late 1960's during the last major boom in the air transportation industry will be subject to mandatory retirement soon. In addition, the military, which in the past provided the majority of pilots, has increased its benefits and financial incentives in an effort to retain pilots. Thus, the military is expected to be a diminishing source of supply in the future. As a result, the developing shortage of pilots is expected to continue well into the future. College graduates who have experience flying jet aircraft and who have a commercial pilot's license and a flight engineer's license are expected to have the best opportunities for jobs with the major airlines.

Employment of pilots is expected to increase faster than the average for all occupations through the year 2005. While computerized flight engineering systems may reduce the demand for flight engineers, the expected growth in airline passenger and cargo traffic will create a need for more airliners, pilots, and flight instructors. Employment of business pilots is expected to grow more slowly than in the past as more businesses opt to fly with regional and smaller airlines serving their area rather than buy and operate their own aircraft.

Aircraft pilots understandably have a strong attachment to their occupation since it requires a substantial investment in specialized training and offers very high earnings. Generally, a relatively small proportion of pilots leave the occupation each year. However, because of the large number of retirements expected through the year 2005, replacement needs will be the primary source of job openings.

Employment of pilots is sensitive to cyclical swings in the economy. During recessions, when a decline in the demand for air travel forces airlines to curtail the number of flights, airlines may temporarily furlough some pilots. Commercial and corporate flying, flight instruction, and testing of new aircraft also decline during recessions, adversely affecting pilots employed in those areas.

Earnings

Earnings of airline pilots are among the highest in the Nation. According to the Future Aviation Professionals of America, the 1990

average salary for airline pilots was about $80,000 a year; for flight engineers, $40,000; for copilots, $65,000; and for captains, $107,000. Some senior captains on the largest aircraft earned as much as $165,000. Earnings depend on factors such as the type, size, and maximum speed of the plane, and the number of hours and miles flown. Extra pay may be given for night and international flights.

Generally, pilots working outside the airlines earn lower salaries. Average salaries for chief pilots ranged from about $43,000 to $74,000 a year in late 1989, according to a survey conducted by the National Business Aircraft Association; for captains/pilots, $45,000 to $60,000; and for copilots, $29,000 to $38,000. Usually, pilots who fly jet aircraft earn higher salaries than nonjet pilots.

Airline pilots generally are eligible for life and health insurance plans financed by the airlines. They also receive retirement benefits and, if they fail the FAA physical examination, disability payments. Some airlines provide allowances to pilots for purchasing and cleaning their uniforms. As an additional benefit, pilots and their immediate families usually are entitled to free or reduced fare transportation on their own and other airlines.

Most airline pilots are members of the Airline Pilots Association, International. Those employed by one major airline are members of the Allied Pilots Association. Some flight engineers are members of the Flight Engineers' International Association.

Related Occupations

Although they are not in the cockpit, air traffic controllers and dispatchers also play an important role in making sure flights are safe and on schedule, and participate in many of the decisions pilots must make.

Sources of Additional Information

Information about job opportunities in a particular airline and the qualifications required may be obtained by writing to the personnel manager of the airline. For addresses of airline companies and information about job opportunities and salaries, contact:

☛ Future Aviation Professionals of America, 4291 J. Memorial Dr., Atlanta, GA 30032. (This organization may be called toll free at 800-JET-JOBS.)

For information on airline pilots, contact:

☛ Airline Pilots Association, 1625 Massachusetts Ave. NW., Washington, DC 20036.

☛ Air Transport Association of America, 1709 New York Ave. NW., Washington, DC 20006.

For a copy of *List of Certificated Pilot Schools*, write to:

☛ Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

For information about job opportunities in companies other than airlines, consult the classified section of aviation trade magazines and apply to companies that operate aircraft at local airports.

Air Traffic Controllers

(D.O.T. 193.162 except -022, .167-010)

Nature of the Work

Air traffic controllers are the guardians of the airways. They keep track of planes flying within their assigned area and make certain that they are a safe distance apart. Their immediate concern is safety, but controllers also must direct planes efficiently to minimize delays. Some regulate airport traffic; others regulate flights between airports.

Although airport tower or terminal controllers watch over all planes traveling through the airport's airspace, their main responsibility is to organize the flow of aircraft in and out of the airport. Relying on radar and/or visual observation, they closely monitor each plane to maintain a safe distance between all aircraft and to guide pilots between the hangar or ramp and the end of the airport's airspace. In addition, controllers keep pilots informed about weather conditions that are associated with wind shear—a sudden change in the velocity or direction of wind that can cause the pilot to lose control of the aircraft.

During arrival or departure, each plane is handled by several controllers. As a plane approaches an airport, the pilot radios ahead to inform the terminal of its presence. The controller in the radar room just beneath the control tower has a copy of the plane's flight plan and already has observed the plane on radar. If the way is clear, the controller directs the pilot to a runway; if the airport is busy, the plane is fitted into a traffic pattern with other aircraft waiting to land. As the plane nears the runway, the pilot is asked to contact the tower. There, another controller, who also is watching the plane on radar, monitors the aircraft the last mile or so to the runway, delaying any departures that would interfere with the plane's landing. Once the plane has landed, a ground controller in the tower directs it along the taxiways to its assigned gate. The ground controller usually works entirely by sight, but may use radar if visibility is very poor.

A similar procedure is used for departures. The ground controller directs the plane to the proper runway. The local controller then informs the pilot about conditions at the airport, such as the weather, speed and direction of wind, and visibility. The local controller also issues runway clearance for the pilot to take off. Once in the air, the plane is guided out of the airport's airspace by the departure controller.

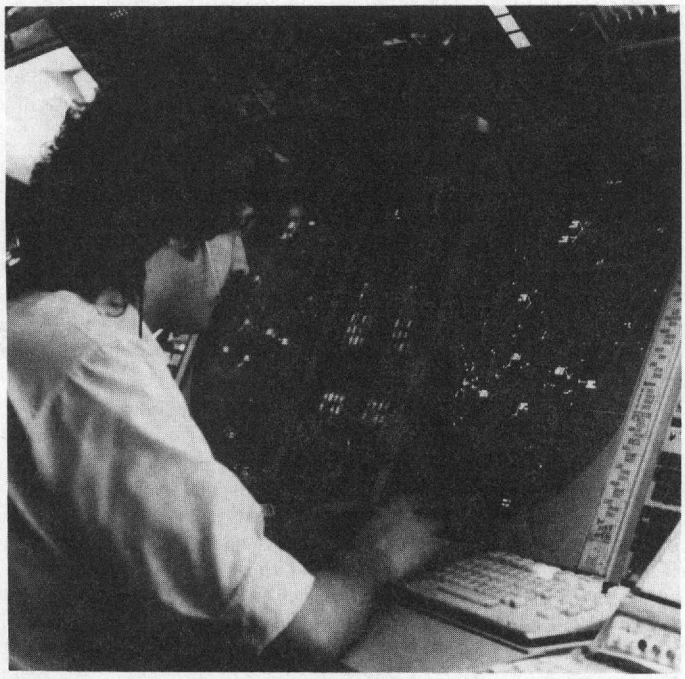
After each plane departs, airport tower controllers notify enroute controllers who will next take charge. There are 24 enroute control centers located around the country, each employing 300 to 700 controllers, with more than 150 on duty during peak hours at the busier facilities. Airplanes generally fly along designated routes; each center is assigned a certain airspace containing many different routes. Enroute controllers work in teams of up to three members, depending on how heavy traffic is; each team is responsible for a section of the center's airspace. A team, for example, might be responsible for all planes that are between 30 to 100 miles north of an airport and flying at an altitude between 6,000 and 18,000 feet.

To prepare for planes about to enter the team's airspace, the radar associate controller organizes flight plans coming from printing machines. If two planes are scheduled to enter the team's airspace at a similar time, location, and altitude, this controller may arrange with the preceding control unit for one plane to change its flight plans. The previous unit may have been another team at the same or an adjacent center, or a departure controller at a neighboring terminal. As a plane approaches a team's airspace, the radar controller accepts responsibility for the plane from the previous controlling unit. The controller also delegates responsibility for the plane to the next controlling unit when the plane leaves the team's airspace.

The radar controller, who is the senior team member, observes the planes in the team's airspace on radar and communicates with the pilots when necessary. Radar controllers warn pilots about nearby planes, bad weather conditions, and other possible hazards. Two planes on a collision course will be directed around each other. If a pilot wants to change altitude in search of better flying conditions, the controller will check to determine that no other planes will be along the proposed path. As the flight progresses, the team responsible for the aircraft notifies the next team in charge. Through team coordination, the plane arrives safely at its destination.

Both airport tower and enroute controllers usually control several planes at one time and often have to make quick decisions about completely different activities. For example, a controller might direct a plane on its landing approach and at the same time provide pilots entering the airport's airspace with information about conditions at the airport. While instructing these pilots, the controller also would observe other planes in the vicinity, such as those in a holding pattern waiting for permission to land, to ensure that they remain well separated.

In addition to airport towers and enroute centers, air traffic controllers also work in flight service stations operated at over 100 locations. These controllers provide pilots with information on the station's particular area, including terrain, preflight and inflight weather information, suggested routes, and other information important to the safety of a flight. Flight service station controllers assist pilots in emergency situations and participate in searches for missing or overdue aircraft.



Controllers are usually responsible for several planes at one time.

Working Conditions

Controllers work a basic 40-hour week; however, they may work additional hours for which they receive overtime pay or equal time off. Because most control towers and centers operate 24 hours a day, 7 days a week, controllers rotate night and weekend shifts.

During busy times, controllers must work rapidly and efficiently. This requires total concentration to keep track of several planes at the same time and make certain all pilots receive correct instructions. The mental stress of being responsible for the safety of several aircraft and their passengers can be exhausting.

Employment

Air traffic controllers held over 32,000 Federal Government jobs in 1990, at airports—in towers and flight service stations—and in enroute traffic control centers. The overwhelming majority worked for the FAA; a small number of civilian controllers worked for the Department of Defense. In addition to controllers employed by the Federal Government, some worked for private air traffic control companies providing service to non-FAA towers.

Training, Other Qualifications, and Advancement

Air traffic controller trainees are selected through the competitive Federal Civil Service system. Applicants must pass a written test that measures their ability to learn the controller's duties. Applicants with experience as a pilot, navigator, or military controller can improve their rating by scoring well on the occupational knowledge portion of the examination. Abstract reasoning and three-dimensional spatial visualization are among the aptitudes measured by the examination. In addition, applicants generally must have 3 years of general work experience or 4 years of college, or a combination of both. Applicants also must pass physical and psychological examinations, as well as drug screening tests. For airport tower and enroute center positions, applicants must be less than 31 years old. Those 31 years old and over are eligible for positions at flight service stations.

Potential controllers must be articulate, since directions to pilots must be given quickly and clearly. A good memory also is important because controllers constantly receive information which they must immediately grasp, interpret, and remember. Decisiveness is also required since controllers often have to make quick decisions.

Successful applicants receive a combination of on-the-job and formal training to learn the fundamentals of the airway system, FAA regulations, controller equipment, and aircraft performance characteristics. They receive 11 to 13 weeks of intensive screening and training at the FAA Academy in Oklahoma City. Over the next several years, this training will include instruction in the operation of the new, more automated air traffic control system—including the automated Microwave Landing System that will enable pilots to receive instructions over automated data links—that is being installed in control sites across the country.

It then takes several years of progressively more responsible work experience, interspersed with considerable classroom instruction and independent study, to become a fully qualified controller.

At airports, new controllers begin by supplying pilots with basic flight data and airport information. They then advance to ground controller, then local controller, departure controller, and finally, arrival controller. At an enroute traffic control center, new controllers first deliver printed flight plans to teams, gradually advancing to radar associate controller and then radar controller. Failure to become certified in any position at a facility within a specified time may result in dismissal. Controllers who fail to complete either the academy or the on-the-job portion of the training are dismissed. Controllers must pass a physical examination each year and a job performance examination twice each year. Controllers also are subject to drug screening as a condition of continuing employment.

Controllers can transfer to jobs at different locations or advance to supervisory positions, including management or staff jobs in air traffic control and top administrative jobs in the FAA.

Job Outlook

Employment of air traffic controllers is expected to grow slower than the average for all occupations through the year 2005. Employment growth is not expected to keep pace with growth in the number of aircraft flying because of the expected introduction of laborsaving air traffic control equipment that should make controllers more productive. Most job openings will arise from the need to replace controllers who transfer to other occupations or stop working.

Competition for air traffic controller jobs is expected to remain keen because the occupation's relatively high pay and liberal retirement program attract many more qualified applicants than the number of job openings.

Air traffic controllers who continue to meet the proficiency and medical requirements enjoy more job security than most workers. The demand for air travel and the workloads of air traffic controllers decline during recessions, but controllers seldom are laid off.

Earnings

Air traffic controllers who started with the FAA in 1991 earned about $21,000 (grade 7) a year. Controllers at the grade 9 level and above earn 5 percent more than other Federal workers in an equivalent grade. A controller's pay is determined by both the worker's job responsibilities and the complexity of the particular facility. Earnings are higher at facilities where traffic patterns are more complex. In 1990, controllers averaged about $47,200 a year.

Depending on length of service, they receive 13 to 26 days of paid vacation and 13 days of paid sick leave each year, life insurance, and health benefits. In addition, controllers can retire at an earlier age and with fewer years of service than other Federal employees.

Related Occupations

Other occupations which involve the direction and control of traffic in air transportation are airline-radio operator and airplane dispatcher.

Sources of Additional Information

A pamphlet providing general information about controllers and instructions for submitting an application is available from any U.S. Office of Personnel Management Job Information Center. Look under U.S. Government, Office of Personnel Management, in your telephone book to obtain a local Job Information Center telephone number, and call for a copy of the Air Traffic Controller Announcement. If there is no listing in your telephone book, dial the toll-free number 800-555-1212 and request the number of the Office of Personnel Management Job Information Center for your location.

Broadcast Technicians

(D.O.T. 193.167-014, 262-018, and -038; 194.062-010, .262-010, -014, -018,.282-010, .362-010, -014, -018, and .382-014)

Nature of the Work

Broadcast technicians install, test, repair, set up, and operate the electronic equipment used to record and transmit radio and television programs. They work with television cameras, microphones, tape recorders, light and sound effects, transmitters, antennas, and other equipment.

In the control room of a radio or television broadcasting studio, these technicians operate equipment that regulates the signal strength, clarity, and range of sounds and colors in the material being recorded or broadcast. They also operate control panels to select the source of the material being broadcast. Technicians may switch from one camera or studio to another, from film to live programming, or from network to local programs. By means of hand signals and, in television, by use of telephone headsets, they give technical directions to personnel in the studio.

Broadcast technicians in small stations perform a variety of duties. In large stations and at the networks, on the other hand, technicians are more specialized, although job assignments may change from day to day. The terms "operator," "engineer," and "technician" often are used interchangeably to describe these jobs. *Transmitter operators* monitor and log outgoing signals and operate transmitters. *Maintenance technicians* set up, adjust, service, and repair electronic broadcasting equipment. *Audio control engineers* regulate sound pickup, transmission, and switching, and *video control engineers* regulate the quality, brightness, and contrast of television pictures. *Recording engineers* operate and maintain video and sound recording equipment. Technicians operate equipment designed to produce special effects, such as the illusions of a bolt of lightning or a police siren. *Field technicians* set up and operate broadcasting equipment outside the studio.

Television news coverage requires so much electronic equipment, and the technology is changing so fast, that many stations assign technicians exclusively to news. *Chief engineers*, *transmission engineers*, and *broadcast field supervisors* supervise the technicians who operate and maintain broadcasting equipment.

Working Conditions

Broadcast technicians generally work indoors in pleasant surroundings. However, those who broadcast from natural disaster areas or crime scenes may work under less favorable conditions. Technicians doing maintenance may climb poles or antenna towers, while those setting up equipment do heavy lifting.

Technicians in large stations and the networks usually work a 40-hour week, but may occasionally work overtime under great pressure to meet broadcast deadlines. Technicians in small stations routinely work more than 40 hours a week. Evening, weekend, and holiday work is usual because most stations are on the air 18 to 24 hours a day, 7 days a week.

Employment

Broadcast technicians held about 33,000 jobs in 1990. About 9 out of 10 broadcast technicians were in radio and television broadcasting. About 8 percent worked for cable and other pay TV services. Television stations employ, on the average, many more technicians than radio stations. Some are employed in other industries, producing employee communications, sales, and training programs. Technician jobs in television are located in virtually all cities, while jobs in radio are also found in most smaller towns. The highest paying and most specialized jobs are concentrated in New York City, Los Angeles, Chicago, and Washington, D.C.—the originating centers for most of the network programs.

Training, Other Qualifications, and Advancement

The best way to prepare for a broadcast technician job—particularly for those who hope to advance to supervisory positions or to jobs in large stations and at the networks—is to obtain technical school, community college, or college training in broadcast technology or in engineering or electronics.

Anyone who operates and maintains broadcast transmitters in radio and television stations must have a restricted radiotelephone operator permit, according to Federal law. No examination is required to get one. The Federal Communications Commission no longer requires persons working with microwave to have a general radiotelephone operator license; however, some States may require a license.

Beginners learn skills on the job from experienced technicians and supervisors. They generally begin their careers in small stations and, if qualified, move on to larger ones. Large stations generally only hire technicians with experience. Many employers pay tuition and expenses for courses or seminars to help technicians keep abreast of developments in the field.

Certification by the Society of Broadcasting Engineers is a mark of competence and experience. The certificate is issued to experienced technicians who pass an examination.

Prospective technicians should take high school courses in math, physics, and electronics. Building electronic equipment from hobby kits and operating a "ham" or amateur radio are good experience, as is work in college radio and television stations.

Broadcast technicians must have an aptitude for working with electrical and mechanical systems and equipment and manual dexterity—the ability to perform tasks requiring precise, coordinated hand movements.

Experienced technicians may become supervisory technicians or chief engineers. A college degree in engineering is generally needed to become chief engineer at a large TV station.

Job Outlook

Employment of broadcast technicians is expected to show little or no change through the year 2005 because of laborsaving technical advances such as computer-controlled programming and remote control of transmitters. This has shifted the emphasis from operations to maintenance work, which frequently is performed by commercial and industrial electronic equipment repairers employed by broadcasting equipment manufacturers. (See the statement on this occupation elsewhere in the *Handbook*.)

People seeking beginning jobs as broadcast technicians are expected to face strong competition in major metropolitan areas, where the number of qualified jobseekers greatly exceeds the number of openings. There, stations seek highly experienced personnel. Prospects for entry level positions generally are good in small cities and towns for people with appropriate training. Most job openings will result from the need to replace experienced technicians who leave the occupation.

Earnings

Television stations usually pay higher salaries than radio stations; commercial broadcasting usually pays more than educational broadcasting; and stations in large markets pay more than those in small ones.

Technicians may switch from one camera or studio to another.

According to a survey conducted by the National Association of Broadcasters and the Broadcast Cable Financial Management Association, average earnings for technicians at radio stations were $22,000 a year in 1990; salaries ranged from $11,000 in the smallest markets to $33,000 in the largest markets. For chief technicians, average earnings were $26,000 and the range was $12,000 to $48,000. In television, average earnings for operator technician were $21,000 a year, and salaries ranged from $16,000 in the smallest markets to $32,000 in the largest markets; for technical director, average earnings were $23,000 and the range was $18,000 to $37,000; for maintenance technician, the average was $27,000 and the range was $22,000 to $37,000; and for chief engineer, the average was $44,000 and the salaries ranged from $36,000 in the smallest markets to $64,000 in the largest markets.

Related Occupations

Broadcast technicians need the electronics training and hand coordination necessary to operate technical equipment, and they generally complete specialized postsecondary programs. Others with similar jobs and training include drafters, engineering and science technicians, surveyors, air traffic controllers, radiologic technologists, respiratory therapy workers, EKG technicians, EEG technicians, and medical laboratory technicians.

Sources of Additional Information

For information about licensing, write to:

☛ Federal Communications Commission, 1919 M St. NW., Washington, DC 20554.

For information on careers for broadcast technicians, write to:

☛ National Association of Broadcasters Employment Clearinghouse, 1771 N St. NW., Washington, DC 20036.

For a list of schools that offer programs or courses in broadcasting, contact:

☛ Broadcast Education Association, National Association of Broadcasters, 1771 N St. NW., Washington, DC 20036.

For information on certification, contact:

☛ Society of Broadcast Engineers, 7002 Graham Rd., Suite 216, Indianapolis, IN 46220.

Computer Programmers

(D.O.T. 020.162-014, .167-018, -022, .187-010, and .262-010)

Nature of the Work

Computers increasingly affect our daily lives. They control the temperature and air quality in office buildings, connect telephone conference calls, and make the complex mathematical computations that allow scientists and engineers to put up, position, and communicate with weather tracking satellites. Computer programmers write, update, and maintain the detailed instructions (called programs or software) that list in a logical order the steps that these and other computers must execute.

In many large organizations, programmers follow descriptions prepared by systems analysts who have carefully studied the task that the computer system is going to perform. These descriptions list the input required, the steps the computer must follow to process data, and the desired arrangement of the output. (A more detailed description of the work of systems analysts is presented elsewhere in the *Handbook.*) Some organizations, particularly smaller ones, do not employ systems analysts. Instead, workers called programmer-analysts are responsible for both systems analysis and programming. Programmers in software development companies often work without the contribution of systems analysts. Instead, they may work directly with experts from various fields to create new software packages for specific applications like graphics, computer-aided design, animation, or educational instruction.

Regardless of setting, programmers write specific programs by breaking down each step into a logical series of instructions the computer can follow. They then code these instructions in a programming language, such as COBOL—traditionally used for business applications—FORTRAN—the standard for scientific programming—or one of the more advanced artificial intelligence languages.

While programmers may write completely new programs, most programming work involves the updating and modification of code for existing programs. When making changes to a section of code, called a routine, they need to make other users aware of the task that the routine is to perform. They do this by inserting comments in the coded instructions so others can understand the program. Programmers using computer-aided software engineering (CASE) can concentrate on writing the unique parts of the program because the computer automates some of the more basic processes. This also yields more reliable and consistent programs and increases programmers' productivity by eliminating some of the routine steps.

When the program is ready to be tested, programmers run the program to be sure the instructions are correct and will produce the desired information. They prepare sample data that test every part of the program and, after trial runs, review the results to see if any errors were made. If errors did occur, the program must be changed and rechecked until it produces the correct results. This is called "debugging" the program.

Finally, programmers prepare an instruction sheet for the computer operator who will run the program. (The work of computer operators is described in the statement on computer and peripheral equipment operators elsewhere in the *Handbook.*) They may also assist in writing a user's manual for the program.

Programs vary with the type of information to be accessed or generated. For example, the data involved in updating school records are different from those required to simulate a flight on a pilot trainee's monitor. Although simple programs can be written in a few hours, programs that use complex mathematical formulas or many data files may require more than a year of work. In some cases, several programmers may work together as a team under a senior programmer's supervision.

Programmers often are grouped into two broad types: Applications programmers and systems programmers. Applications programmers usually are oriented toward business, engineering, or science. They write software to handle specific jobs, such as a program used in an inventory control system or one to guide a missile after it has been fired. They also may work alone to revise existing packaged software. Systems programmers, on the other hand, maintain the software that controls the operation of an entire computer system. These workers make changes in the sets of instructions that determine how the central processing unit of the system handles the various jobs it has been given and communicates with peripheral equipment, such as terminals, printers, and disk drives. Because of their knowledge of the entire computer system, systems programmers often help applications programmers determine the source of problems that may occur with their programs.

Working Conditions

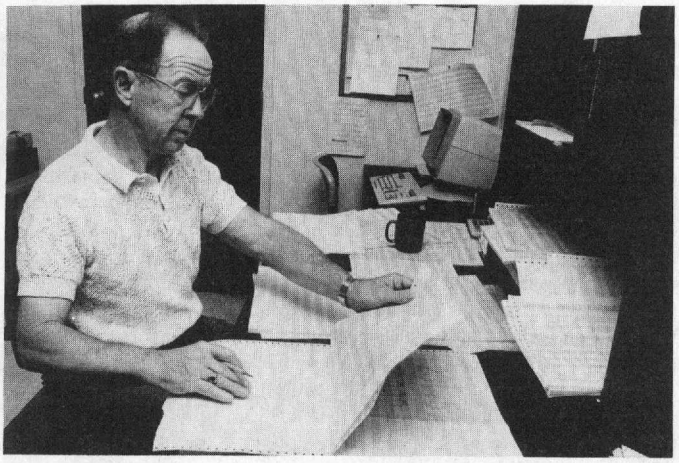
Programmers work in offices in comfortable surroundings. They usually work about 40 hours a week, but their hours are not always from 9 to 5. Programmers may report early or work late to use the computer when it is available; occasionally, they work longer hours in order to meet deadlines or fix critical problems that occur during off hours.

Employment

Computer programmers held about 565,000 jobs in 1990. Most were employed by data processing service organizations, including firms that write and sell software; firms providing other business services; manufacturers of office, computing, and accounting machines; banks; and educational institutions.

Applications programmers work for all types of firms that use computer systems. Systems programmers, on the other hand, usually work for organizations with large computer centers and for firms that manufacture computers or develop software.

A small but growing number of programmers are employed on a temporary basis. A financial services firm, for example, may need the services of several extra programmers to write and "debug" the software necessary to get a new data base management system running. Once the software is functioning, however, their services are no



Increasing use of packaged software and programming tools like CASE and object-oriented programming are making computer programmers more productive.

longer needed. Rather than hiring these programmers as permanent employees and then laying them off after the job is done, employers increasingly are contracting with temporary help agencies, consulting firms, or directly with programmers themselves. Such temporary jobs usually last several months but some last a year or longer.

Training, Other Qualifications, and Advancement

There are no universal training requirements for programmers because computer applications are so widespread and varied that employers' needs also vary greatly. Computer programming is taught at public and private vocational schools, community and junior colleges, and universities. High schools in many parts of the country also offer introductory courses in data processing. Many programmers are college graduates; others have taken special courses in computer programming to supplement their experience in fields such as accounting, inventory control, or other business areas.

Increasingly, the level of education and quality of training that employers seek have been rising due to the growth in the number of qualified applicants and the increasing complexity of some programming tasks. Bachelor's degrees are now commonly required; in the absence of a degree, substantial specialized experience may be needed.

Employers using computers for scientific or engineering applications prefer college graduates who have degrees in computer or information science, mathematics, engineering, or the physical sciences. Graduate degrees are required for some jobs.

Employers who use computers for business applications prefer to hire people who have had college courses in programming and business. Also, experience in accounting, management, and other business skills generally is preferred by employers. Some employers promote workers such as computer operators who have taken courses in programming to programmer jobs because of their particular work experience.

An indication of experience and professional competence at the senior programmer level is the Certificate in Computer Programming. This designation is conferred by the Institute for Certification of Computer Professionals upon candidates who have passed a core examination plus exams in two specialty areas. College graduates with little or no experience may be tested for certification as an Associate Computer Professional.

When hiring programmers, employers look for people who can think logically and who are capable of exacting analytical work. The job calls for patience, persistence, and the ability to work with extreme accuracy even under pressure. Ingenuity and imagination are also particularly important when programmers test their work for potential failures. Increasingly, interpersonal skills are valued because of the use of programmer teams and user suppport centers. The ability to work with abstract concepts and do technical analysis is especially important for systems programmers because they work with the software that controls the computer's operation.

Beginning programmers may spend their first weeks on the job attending training classes. After this initial instruction, they may work alone on simple assignments, or on a team with more experienced programmers. Either way, they generally must spend at least several months working under close supervision. Because of rapidly changing technology, programmers must continuously update their training by taking courses sponsored by their employer or software vendors.

For skilled workers, the prospects for advancement are good. In large organizations, they may be promoted to lead programmer and be given supervisory responsibilities. Some applications programmers become systems programmers after they gain experience and take courses in systems software. With general business experience, both applications programmers and systems programmers may become systems analysts or be promoted to a managerial position. Other programmers with specialized knowledge and experience with a language or operating system may work in research and development in artificial intelligence or CASE, for example.

Job Outlook

Employment of programmers is expected to grow much faster than the average for all occupations through the year 2005 as computer usage expands. The demand for programmers will increase as businesses, government, schools, and scientific organizations seek new applications for computers and improvements to the software already in use. The ever-increasing demand for information, further automation of offices and factories, advances in health and medicine, and continuing scientific research will drive the growth of programmer employment.

One important area of progress will be data communications. Networking computers so they can communicate with each other is necessary to achieve the greater efficiency that organizations require to remain competitive. Expert systems and other artificial intelligence principles and languages will increasingly be used in the years ahead, becoming productivity-enhancing tools available to programmers. Programmers will be creating and maintaining expert systems and embedding these technologies in more and more products.

Employment, however, is not expected to grow as rapidly as in the past as improved software and programming techniques, including CASE, simplify or eliminate some programming tasks. Data base management systems allow users to write simple programs to access data. The greater use of packaged software like word processing and spreadsheet packages also may moderate the growth in demand for applications programmers. These programmers will tailor these packages to fit users' specific requirements instead of writing original programs.

Although the proportion of programmers leaving the occupation each year is smaller than in most occupations, most of the job openings for programmers will result from replacement needs. Most of the programmers who leave the occupation transfer to other occupations, such as manager or systems analyst. Opportunities will exist throughout the economy, but jobs for both systems and applications programmers should be particularly plentiful in data processing service firms, software houses, and computer consulting businesses.

Because the number and quality of applicants have increased, employers have become more selective. Competition has increased for entry level positions, affecting even applicants with a bachelor's degree. Graduates of 2-year programs in data processing and people with less than a 2-year degree or its equivalent in work experience are facing especially strong competition for programming jobs. Prospects should be good for college graduates who are familiar with a variety of programming languages, particularly newer languages that apply to computer networking, data base management, and artificial intelligence.

Many employers prefer to hire applicants with previous experience in the field. Therefore, people who want to become programmers can enhance their chances by combining work experience with the appropriate formal training. Students have various options: Holding a summer or part-time job in a data processing department, participating in a college work-study program, or undertaking an internship. Students can greatly improve their employment prospects by also taking cours-

es such as accounting, management, engineering, or science—allied fields in which applications programmers are in demand.

Earnings

Median earnings of programmers who worked full time in 1990 were about $34,000 a year. The middle 50 percent earned between $25,700 and $42,300 annually. The lowest 10 percent earned less than $19,000, and the highest 10 percent more than $52,100.

Programmers working in the West and Northeast earned somewhat more than those working in the South and Midwest. On average, systems programmers earn more than applications programmers.

In the Federal Government, the entrance salary for programmers with a college degree or qualifying experience was about $17,000 a year in 1991; for those with a superior academic record, $21,000.

Related Occupations

Programmers must pay great attention to detail as they write and "debug" programs. Other professional workers who must be detail-oriented include statisticians, engineers, financial analysts, accountants, auditors, actuaries, and operations research analysts.

Sources of Additional Information

State employment service offices can provide information about job openings for computer programmers.

Further information about certification as a computer professional is available from:

☛ Institute for the Certification of Computer Professionals, 2200 East Devon Ave., Suite 268, Des Plaines, IL 60018.

Drafters

(D.O.T. 001.261; 002.261; 003.131, .261 except -010, 281; 005.281; 007.161-010, -014, and -018, .261, and .281; 010.281 except -022; 014.281; 017 except .261-010; and 726.364-014)

Nature of the Work

Drafters prepare technical drawings used by production workers to build spacecraft, industrial machinery and other manufactured products, office buildings, houses, bridges, and other structures. Their drawings show the technical details of the products and structures from all sides, with exact dimensions, the specific materials to be used, procedures to be followed, and other information needed to carry out the job. Drafters prepare and fill in technical details, using drawings, rough sketches, specifications, and calculations made by engineers, surveyors, architects, and scientists. For example, working from rough sketches, drafters use knowledge of standardized building techniques to draw the details of a structure, or employ knowledge of engineering theory to arrange the parts of a machine and determine the number and kind of fasteners needed. For this, they may use technical handbooks, tables, and calculators.

There are two methods by which drawings are prepared. In the traditional method, drafters sit at drawing boards and use compasses, dividers, protractors, triangles, and other drafting devices to prepare the drawing manually. Today, drafters also use computer-aided drafting (CAD) systems. They use computer work stations to create the drawing on a video screen. They may put the drawing on paper or just store it electronically. These systems permit drafters to easily prepare many variations of a design.

When CAD systems were first introduced, some thought a new occupation—CAD operator—would result. It is now apparent that a person who produces a technical drawing using CAD is still a drafter, and needs all the knowledge of traditional drafters as well as CAD skills.

Despite CAD's advantages, much drafting is still done manually, partly because of the cost of CAD systems, but also because of problems in shifting office procedures to the use and storage of CAD-generated drawings. However, the cost of CAD systems is dropping rapidly, and by the year 2005 it is likely that almost all drafters will use CAD systems regularly, although manual drafting probably will still be used in certain applications.

Many drafters specialize. *Architectural drafters* draw architectural and structural features of buildings and other structures. They may specialize by the type of structure, such as schools or office buildings, or by material, such as reinforced concrete or stone.

Aeronautical drafters prepare engineering drawings used for the manufacture of aircraft and missiles.

Electrical drafters draw wiring and layout diagrams used by workers who erect, install, and repair electrical equipment and wiring in powerplants, electrical distribution systems, and buildings.

Electronic drafters draw wiring diagrams, circuit board diagrams, schematics, and layout drawings used in the manufacture, installation, and repair of electronic equipment.

Civil drafters prepare drawings and topographical and relief maps used in civil engineering projects such as highways, bridges, flood control projects, and water and sewage systems.

Mechanical drafters draw detailed working diagrams of machinery and mechanical devices, including dimensions, fastening methods, and other engineering information.

Working Conditions

Drafters usually work in well-lighted and well-ventilated rooms. They often sit at drawing boards or computer terminals for long periods of time. Doing detailed work may cause eyestrain and back discomfort.

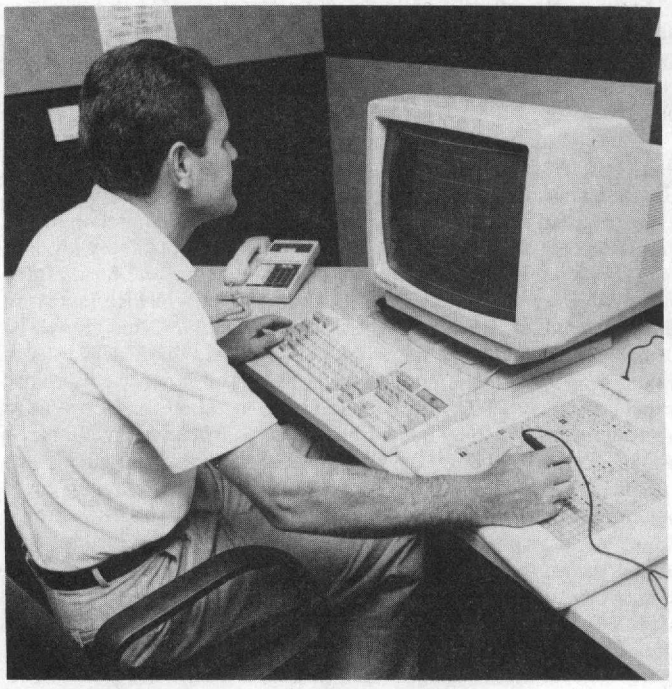
Employment

Drafters held about 326,000 jobs in 1990. About one-third of all drafters worked in engineering and architectural services, firms that design construction projects or do other engineering work on a contract basis for organizations in other parts of the economy; about one-third worked in durable goods manufacturing industries, such as machinery, electrical equipment, and fabricated metals; and the remainder were mostly employed in the construction, transportation, communications, and utilities industries.

About 14,000 drafters worked in government in 1990, primarily at the State and local level. Most drafters in the Federal Government worked for the Department of Defense.

Training, Other Qualifications, and Advancement

Employers prefer applicants for drafting positions who have post-high school training in technical institutes, junior and community colleges, or extension divisions of universities. Employers are most interested in applicants who have well-developed drafting and



Drafting is often done with computer-aided systems.

mechanical drawing skills, a solid background in computer-aided design techniques, and courses in mathematics, science, and engineering technology.

Many types of publicly and privately operated schools provide drafting training. The kind and quality of programs can vary considerably. Therefore, prospective students should be careful in selecting a program. They should contact prospective employers regarding their preferences and ask schools to provide information about the kinds of jobs obtained by graduates, instructional facilities and equipment, and faculty qualifications.

Technical institutes offer intensive technical training but less theory and general education than junior and community colleges. Many offer 2-year associate degree programs, which are similar to or part of the programs offered by community colleges or State university systems. Other technical institutes are run by private, often for-profit, organizations, sometimes called proprietary schools; their programs vary considerably in length and types of courses offered. Some are 2-year associate degree programs.

Junior and community colleges offer curriculums similar to those in technical institutes but may include more theory and liberal arts. Often there may be little or no difference between technical institute and community college programs. However, courses taken at junior or community colleges are more likely to be accepted for credit at 4-year colleges than those at technical institutes. After completing the 2-year program, some graduates qualify for jobs as drafters while others continue their education in a related field at 4-year colleges.

Four-year colleges usually do not offer drafting training, but college courses in engineering, architecture, and mathematics are useful for obtaining a job as a drafter.

Area vocational-technical schools are postsecondary public institutions that serve local students and emphasize training needed by local employers. Most require a high school diploma or its equivalent for admission.

Other training may be obtained in the Armed Forces in technical areas which can be applied in civilian drafting jobs. Some additional training may be needed, depending on the military skills acquired and the kind of job, but often this is gained on the job. Some correspondence schools also offer training for drafters.

Those planning careers in drafting should be able to draw freehand three-dimensional objects and do detailed work accurately and neatly. Artistic ability is helpful in some specialized fields, as is knowledge of manufacturing and construction methods. In addition, prospective drafters should be able to work closely with engineers, surveyors, architects, and other workers.

Entry level drafters usually do routine work under close supervision. After gaining experience, they do more difficult work with less supervision and may advance to senior drafter, designer, or supervisor. With appropriate college courses, they may become engineers or architects.

Job Outlook

Employment of drafters is expected to grow more slowly than the average for all occupations through the year 2005. Industrial growth and the increasingly complex design problems associated with new products and processes will greatly increase the demand for drafting services. However, greater use of CAD equipment—which increases drafters' productivity—is expected to offset some of this growth in demand. Although some in the field had expected that CAD systems would decrease drafters' employment, this has not occurred in most situations where CAD systems have been installed. In fact, it now appears that productivity gains from CAD have been relatively modest. One reason is that CAD systems make it easier to produce more variations of a design. As in other areas, the ease of obtaining computer-generated information stimulates a demand for more information. Also, drawing the initial design on a CAD system is almost as time consuming as when it is done manually. Although growth in employment will create many job openings, most job openings are expected to arise as drafters transfer to other occupations or leave the labor force.

Drafters are highly concentrated in industries that are sensitive to cyclical swings in the economy, such as engineering and architectural services and durable goods manufacturing. During recessions, when fewer buildings are designed, drafters may be laid off.

Earnings

Median annual earnings of drafters who worked year round, full time were about $25,900 in 1990; the middle 50 percent earned between $19,300 and $33,500 annually; 10 percent earned more than $41,600; 10 percent earned less than $15,400.

Experienced drafters in manufacturing, transportation, and utilities averaged between $18,600 and $31,500 a year in 1990. Senior drafters averaged about $36,200 a year in 1990.

Related Occupations

Other workers who prepare or analyze detailed drawings and make precise calculations and measurements include architects, landscape architects, engineers, engineering technicians, science technicians, photogrammetrists, and surveyors.

Sources of Additional Information

General information on career opportunities in drafting is available from:

☛ American Design Drafting Association, 5522 Norbeck Road, Suite 391, Rockville, MD 20853.

Information on schools offering programs in drafting and other areas is available from:

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

Engineering Technicians

(D.O.T. 002.280, .281; 003.161, .261, .362; 005.261; 006.261; 007.161-026 and -030, .167-010 and -022, .181; 008.261; 010.261-010 and -026; 011.261-010 and -014, .281, .361; 012.261-014, .267; 013.161; 017.261-010; 019.161-014, .261-022 and -026, .267, .281, .381; 194.381, .382-010; 199.261-014; 726.261; .281-010; 761.281-014; 828.261-018; and 962.382)

Nature of the Work

Engineering technicians use the principles and theories of science, engineering, and mathematics to solve problems in research and development, manufacturing, sales, construction, and customer service. Their jobs are more limited in scope and more practically oriented than those of scientists and engineers. Many engineering technicians assist engineers and scientists, especially in research and development. Others work in production or inspection jobs.

Engineering technicians who work in research and development build or set up equipment, prepare and conduct experiments, calculate or record the results, and assist engineers in other ways. Some make prototype versions of newly designed equipment. They also assist in routine design work, often using computer-aided design equipment.

Engineering technicians who work in manufacturing follow the general directions of engineers. They may prepare specifications for materials, devise and run tests to ensure product quality, or study ways to improve manufacturing efficiency. They may also supervise production workers to make sure they follow prescribed procedures.

Engineering technicians also work as field representatives of manufacturers, wholesalers, or retailers. They help customers install, test, operate, and maintain complex technical equipment, and may write repair or operating manuals.

Civil engineering technicians help civil engineers plan and build highways, buildings, bridges, dams, wastewater treatment systems, and other structures and do related surveys and studies. Some inspect water and wastewater treatment systems to ensure that pollution control requirements are met. Others estimate construction costs and specify materials to be used. (See statement on cost estimators elsewhere in the *Handbook*.)

Electronics engineering technicians help develop, manufacture, and service electronic equipment such as radios, radar, sonar, television, industrial and medical measuring or control devices, navigational equipment, and computers, often using measuring and diagnostic devices to test, adjust, and repair equipment. Workers who only repair

electrical and electronic equipment are discussed in several other statements elsewhere in the *Handbook*. Many of these repairers are often called electronics technicians.

Industrial engineering technicians study the efficient use of personnel, materials, and machines in factories, stores, repair shops, and offices. They prepare layouts of machinery and equipment, plan the flow of work, make statistical studies, and analyze production costs.

Mechanical engineering technicians help engineers design and develop machinery and other equipment by making sketches and rough layouts. They also record data, make computations, analyze results, and write reports. When planning production, mechanical engineering technicians prepare layouts and drawings of the assembly process and of parts to be manufactured. They estimate labor costs, equipment life, and plant space. Some test and inspect machines and equipment in manufacturing departments or work with engineers to eliminate production problems.

Working Conditions

Most engineering technicians work regular hours in laboratories, offices, electronics shops, industrial plants, or construction sites. Service representatives usually spend much of their time working in customers' establishments. Some may be exposed to electrical shock and other hazards from equipment.

Employment

Engineering technicians held about 755,000 jobs in 1990. About two-fifths worked in manufacturing, mainly in the electrical and electronic machinery and equipment, transportation equipment, and industrial machinery industries. Over one-fifth worked in service industries, mostly in engineering or business services companies who do engineering work on contract for government, manufacturing, or other organizations.

In 1990, the Federal Government employed about 65,000 engineering technicians. About three-fifths worked for the Department of Defense; others worked for the Departments of Transportation, Agriculture, and Interior, the Tennessee Valley Authority, and the National Aeronautics and Space Administration. State governments employed about 37,000 and local governments about 26,000.

Training, Other Qualifications, and Advancement

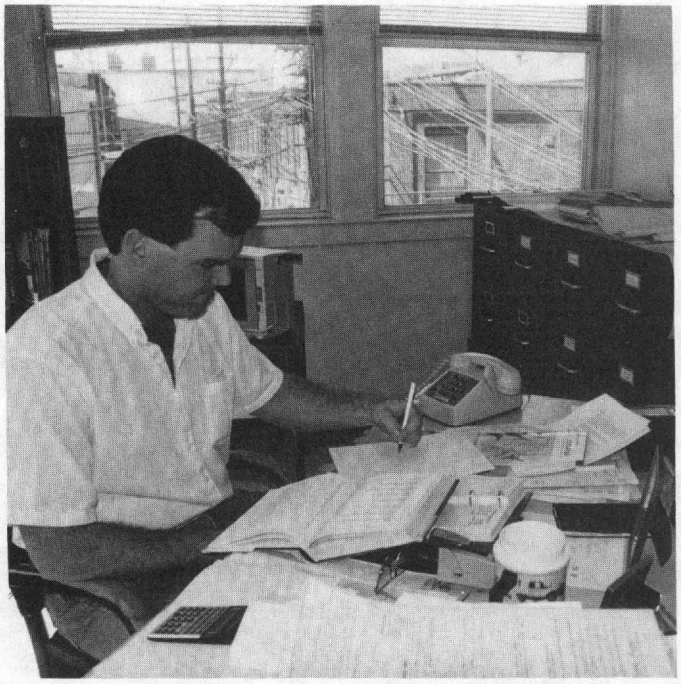
Although it is possible to qualify for some engineering technician jobs with no formal training, most employers prefer to hire someone who will require less on-the-job training and supervision. Training is available at technical institutes, junior and community colleges, extension divisions of colleges and universities, public and private vocational-technical schools, and through some technical training programs in the Armed Forces. Persons with college courses in science, engineering, and mathematics may also qualify for some positions but may need additional specialized training and experience.

In some cases, training can be obtained on the job or through apprenticeship programs or correspondence schools.

Many types of publicly and privately operated schools provide technical training. The kind and quality of programs vary considerably. Therefore, prospective students should be careful in selecting a program. They should contact prospective employers regarding their preferences and ask schools to provide information about the kinds of jobs obtained by graduates, instructional facilities and equipment, and faculty qualifications.

Technical institutes offer intensive technical training but less theory and general education than junior and community colleges. Many offer 2-year associate degree programs, and are similar to or are part of a community college or are part of State university systems. Other technical institutes are run by private, often for-profit, organizations, sometimes called proprietary schools; their programs vary considerably in length and types of courses offered. Some are 2-year associate degree programs.

Junior and community colleges offer curriculums similar to those in technical institutes but may include more theory and liberal arts. Often there may be little or no difference between technical institute and community college programs. However, courses taken at junior or community colleges are more likely to be accepted for credit at 4-year colleges than those at technical institutes. After completing the 2-year program, some graduates get jobs as engineering technicians while others continue their education at 4-year colleges.



Engineering technicians use knowledge of scientific and engineering principles to solve problems.

Four-year colleges usually do not offer engineering technician training, but college courses in science, engineering, and mathematics are useful for obtaining a job as an engineering technician.

Area vocational-technical schools include postsecondary public institutions that serve local students and emphasize training needed by local employers. Most require a high school diploma or its equivalent for admission.

Other training in technical areas may be obtained in the Armed Forces. Many military technical training programs are highly regarded by employers. Some additional training may be needed, depending on the military skills acquired and the kind of job, but often this is gained on the job. Some correspondence schools also offer training for engineering technicians.

Prospective engineering technicians should take as many high school science and math courses as possible. Engineering technicians need an aptitude for mathematics and science. For design work, creativity also is desirable. They should be able to work well with others since they are often part of a team of engineers and other technicians. Those in sales and service should be able to work independently and deal effectively with customers.

Engineering technicians usually begin by doing routine work under the close supervision of an experienced technician, engineer, or scientist. As they gain experience, they are given more difficult assignments with only general supervision. Some engineering technicians eventually become supervisors, and a few, engineers.

Job Outlook

Well-qualified engineering technicians should experience good employment opportunities through the year 2005. Employment is expected to increase faster than the average for all occupations due to expected continued rapid growth in the output of technical products. Competitive pressures and advancing technology will force companies to improve and update manufacturing facilities and product designs more rapidly than in the past. However, like engineers, employment of engineering technicians is influenced by local and national economic conditions. The employment outlook also varies with the area of specialization and industry. Some types of engineering technicians, such as civil engineering and aeronautical engineering technicians, experience greater cyclical fluctuations than others.

Technicians whose jobs are defense related may be laid off in times of defense cutbacks.

Despite the projected faster-than-average growth, most job openings will be to replace technicians who transfer to other occupations or leave the labor force.

Earnings

In 1991, engineering technicians in private industry earned an average annual salary of $20,400 at the most junior level. Engineering technicians with more experience and the ability to work with little supervision averaged $28,300, and those in supervisory or senior level positions averaged $38,800.

In the Federal Government, engineering technicians could start at $13,515, $15,171, or $16,973 in 1991, depending on their education and experience. In 1991, the average salary for engineering technicians in supervisory, nonsupervisory, and management positions in the Federal Government was $33,688; for electronics technicians, $38,516; and for industrial engineering technicians, $34,008.

Related Occupations

Engineering technicians apply scientific and engineering principles usually acquired in postsecondary programs below the baccalaureate level. Occupations of a similar nature include science technicians, drafters, surveyors, broadcast technicians, and health technologists and technicians.

Sources of Additional Information

A number of engineering technology-related organizations provide information on engineering technician and technology careers. JETS-Guidance, at 1420 King St., Suite 405, Alexandria, VA 22314, serves as a central distribution point for information from most of these organizations. To receive information, write JETS-Guidance for an order form and enclose a stamped, self-addressed business-size envelope.

For information on engineering technicians specializing in electronics, contact:

☛ International Society of Certified Electronics Technicians, 2708 W. Berry, Fort Worth, TX 76109.

Library Technicians

(D.O.T. 100.367-018)

Nature of the Work

Library technicians help librarians acquire, prepare, and organize material, and help users find materials and information. Technicians in small libraries handle a wide range of duties; those in large libraries usually specialize.

Depending on the employer, library technicians may have other titles, such as library technical assistants. Technicians assist in the use of public catalogs, direct library users to standard references, organize and maintain periodicals, handle interlibrary loan requests, perform routine cataloging and coding of library materials, verify information on order requests, retrieve information from computer data bases, and supervise other support staff, such as circulation desk workers. Some library technicians operate and maintain audiovisual equipment such as projectors, tape recorders, and videocassette recorders, and assist library users with microfilm or microfiche readers. Technicians may also design posters, bulletin boards, or displays.

Those in school libraries teach students to use the school library/media center and encourage them to do so. They also help teachers get instructional materials and help students with special assignments. Some work in special libraries maintained by government agencies, corporations, law firms, advertising agencies, museums, professional societies, medical centers, and research laboratories, where they conduct literature searches, compile bibliographies, and prepare abstracts, usually on subjects of particular interest to the organization.

Working Conditions

Technicians who work with users answer questions and provide assistance. Technicians who prepare library materials sit at desks or computer terminals for long periods and may develop headaches or eyestrain from working with video display terminals. Some duties like calculating circulation statistics can be repetitive and boring. Others, such as computer searches using local and regional library networks and cooperatives, can be interesting and challenging.

Library technicians in school libraries work regular school hours. Those in public libraries and college and university (academic) libraries may work weekends and evenings. Library technicians in special libraries usually work normal business hours.

Employment

Library technicians held about 65,000 jobs in 1990. Most worked in school, academic, or public libraries. Some worked in hospitals and religious organizations. The Federal Government, primarily the Department of Defense and the Library of Congress, and State and local governments also employed library technicians.

Training, Other Qualifications, and Advancement

Training requirements for library technicians vary widely, ranging from a high school diploma to postsecondary training as a library technician. Employers may hire individuals with work experience or other training, or may train inexperienced workers on the job. Given the widespread use of automation in libraries, computer skills are needed for many jobs.

Some 2-year colleges offer an associate of arts degree in library technology. Programs include both liberal arts and library-related study. Students learn about library organization and operation and how to order, process, catalog, locate, and circulate library materials and work with library automation.

Job Outlook

Employment of library technicians is expected to grow more slowly than the average for all occupations through the year 2005. However, many library technicians will be needed annually to replace those who transfer to other fields or leave the labor force.

Employment of other library workers—librarians and library clerks—grew little during the 1980's, and future employment growth should be similar. Employment of library technicians is expected to follow the growth pattern of other library workers. Budgetary con-

Some library technicians have a high school diploma, while others have a 2-year associate of arts degree.

straints will likely contribute to the slow growth in employment of library technicians in school, public, and college and university libraries. However, rapid growth in the number of professional and managerial workers who use special libraries should result in relatively fast employment growth of library technicians in special libraries.

Earnings

Salaries for library technicians vary widely, depending on the type of library and geographic location. Salaries of library technicians in the Federal Government averaged $21,700 in 1991.

Related Occupations

Library technicians perform organizational and administrative duties. Workers in other occupations with similar duties include library clerks, information clerks, record clerks, medical record technicians, and title searchers. Library technicians also assist librarians. Other workers who assist professional workers include museum technicians, teacher aides, legal assistants, and engineering and science technicians.

Sources of Additional Information

Information about a career as a library technician and a directory of schools offering training programs in this field can be obtained from:

☛ Council on Library/Media Technicians, Cuyahoga Community College, 2900 Community College Ave., Cleveland, OH 44115.

For information on training programs for library/media technical assistants, write to:

☛ American Library Association, Office for Library Personnel Resources, 50 East Huron St., Chicago, IL 60611.

Information on schools receiving Federal financial assistance for library training is available from:

☛ Office of Educational Research and Improvement, Library Programs, Library Development Staff, U.S. Department of Education, 555 New Jersey Ave. NW., Washington, DC 20208-5571.

Those interested in a position as a library technician in the Federal service should write to:

☛ Office of Personnel Management, 1900 E St. NW., Washington DC 20415.

Information concerning requirements and application procedures for positions in the Library of Congress may be obtained directly from:

☛ Personnel Office, Library of Congress, 101 Independence Ave. SE., Washington, DC 20540.

Paralegals

(D.O.T. 119.267-022 and -026)

Nature of the Work

Not all legal work requires a law degree. Lawyers are often assisted in their work by paralegals—also called "legal assistants"—who perform many of the same tasks as lawyers, except for those tasks considered to be the practice of law.

Paralegals work directly under the supervision of a lawyer. While the lawyer assumes responsibility for the paralegal's work, a paralegal is often allowed to perform all the functions of a lawyer other than accepting clients, setting legal fees, giving legal advice, or presenting a case in court.

Paralegals generally do background work for lawyers. To help prepare a case for trial, a paralegal investigates the facts of the case to make sure that all relevant information is uncovered. The paralegal may conduct research to identify the appropriate laws, judicial decisions, legal articles, and other material that will be used to determine whether or not the client has a good case. After analyzing all the information, the paralegal may prepare a written report that is used by the attorney to decide how the case should be handled. Should the attorney decide to file a lawsuit on behalf of the client, the paralegal may assist in the preparation of legal arguments, draft pleadings to be filed with the court, obtain affidavits, and assist the attorney during the trial. The paralegal also may keep files of all documents and correspondence important to the case.

Besides litigation, paralegals may also work in areas such as bankruptcy, corporate law, criminal law, employee benefits, patent and copyright law, and real estate. They help draft documents such as contracts, mortgages, separation agreements, and trust instruments. They may help prepare tax returns and plan estates. Some paralegals coordinate the activities of the law office employees and keep the financial records for the office.

Paralegals who work for corporations help attorneys with such matters as employee contracts, shareholder agreements, stock option plans, and employee benefit plans. They may help prepare and file annual financial reports, maintain corporate minute books and resolutions, and help secure loans for the corporation. Paralegals may also review government regulations to make sure that the corporation operates within the law.

The duties of paralegals who work in government vary depending on the type of agency that employs them. Generally, paralegals in government analyze legal material for internal use, maintain reference files, conduct research for attorneys, collect and analyze evidence for agency hearings, and prepare informative or explanatory material on the law, agency regulations, and agency policy for general use by the agency and the public.

Paralegals employed in community legal service projects help the poor, the aged, and other persons in need of legal aid. They file forms, conduct research, and prepare documents. When authorized by law, they may represent clients at administrative hearings.

Some paralegals, usually those in small and medium-sized law firms, have varied duties. One day the paralegal may do research on judicial decisions on improper police arrests and the next day may help prepare a mortgage contract. This requires a general knowledge of many areas of the law.

Some paralegals work for large, departmentalized law firms, government agencies, and corporations and specialize in one area of the law. Some specialties are real estate, estate planning, family law, labor law, litigation, and corporate law. Even within specialties, functions often are broken down further so that a paralegal deals with one narrow area of the specialty. For example, paralegals who specialize in labor law may deal exclusively with employee benefits.

A growing number of paralegals are using computers in their work. Computer software packages are increasingly used to search legal literature stored in the computer and identify legal texts relevant to a specific subject. In litigation that involves many supporting documents, paralegals may use computers to organize and index the material. Paralegals may also use computer software packages to perform tax computations and explore the consequences of possible tax strategies for clients.

Working Conditions

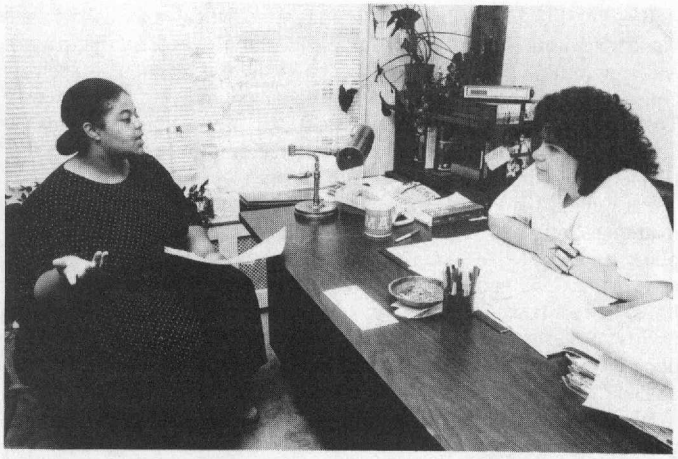
Paralegals do most of their work at desks in offices and law libraries. Occasionally, they travel to gather information and perform other duties.

Paralegals employed by corporations and government work a standard 40-hour week. Although most paralegals work year round, some are temporarily employed during busy times of the year then released when work diminishes. Paralegals who work for law firms sometimes work very long hours when they are under pressure to meet deadlines. Some law firms reward such loyalty with bonuses and additional time off.

Paralegals handle many routine assignments, particularly when they are inexperienced. Some find that these assignments offer little challenge and become frustrated with their duties. However, paralegals usually assume more responsible and varied tasks as they gain experience. Furthermore, as new laws and judicial interpretations emerge, paralegals are exposed to many new legal problems that make their work more interesting and challenging.

Employment

Paralegals held about 90,000 jobs in 1990. Private law firms employed the vast majority; most of the remainder worked for various levels of government. Paralegals are found in nearly every Federal Government agency; the Departments of Justice, Treasury, Interior, and Health and Human Services, and the General Services Adminis-



Paralegals do legal research and investigate facts to help lawyers prepare cases for trial.

tration are the largest employers. State and local governments and publicly funded legal service projects employ paralegals as well. Banks, real estate development companies, and insurance companies also employ small numbers of paralegals.

Training, Other Qualifications, and Advancement

There are several ways to enter the paralegal profession. Employers generally require formal paralegal training; several types of training programs are acceptable. However, some employers prefer to train their paralegals on the job, promoting experienced legal secretaries or hiring persons with college education but no legal experience. Other entrants have experience in a technical field that is useful to law firms, such as a background in tax preparation for tax and estate practice or nursing or health administration for personal injury practice.

Over 600 formal paralegal training programs are offered by 4-year colleges and universities, law schools, community and junior colleges, business schools, and proprietary schools. In 1991, over 150 programs had been approved by the American Bar Association (ABA). Although this approval is neither required nor sought by many programs, graduation from an ABA-approved program can enhance one's employment opportunities. The requirements for admission to formal training programs vary widely. Some require some college courses or a bachelor's degree. Others accept high school graduates or persons with legal experience. A few schools require standardized tests and personal interviews.

Most paralegal programs are completed in 2 years, although some take as long as 4 years and award a bachelor's degree upon completion. Other programs take only a few months to complete, but require a bachelor's degree for admission. Programs typically include a combination of general courses on subjects such as the law and legal research techniques, and courses that cover specialized areas of the law, such as real estate, estate planning and probate, litigation, family law, contracts, and criminal law. Many employers prefer applicants with training in a specialized area of the law. Programs also increasingly include courses that introduce students to the legal applications of computers. Many paralegal training programs include an internship in which students gain practical experience by working for several months in a law office, corporate legal department, or government agency. Experience gained in internships is an asset when seeking a job after graduation. Depending on the program, graduates may receive a certificate, an associate degree, or, in some cases, a bachelor's degree.

The quality of paralegal training programs varies; the better programs generally emphasize job placement. Prospective students should examine the experiences of recent graduates of programs in which they are considering enrolling.

Paralegals need not be certified, but the National Association of Legal Assistants has established standards for voluntary certification which require various combinations of education and experience. Paralegals who meet these standards are eligible to take a 2-day examination given each year at several regional testing centers by the Certifying Board of Legal Assistants of the National Association of Legal Assistants. Persons who pass this examination may use the designation Certified Legal Assistant (CLA). This designation is a sign of competence in the field and may enhance employment and advancement opportunities.

Paralegals must be able to handle legal problems logically and effectively communicate, both orally and in writing, their findings and opinions to their supervising attorney. They must understand legal terminology and have good research and investigative skills. Familiarity with the operation and applications of computers in legal research and litigation support is increasingly important. Paralegals must always stay abreast of new developments in the law that affect their area of practice.

Because paralegals often deal with the public, they must be courteous and uphold the high ethical standards of the legal profession. A few States have established ethical guidelines that paralegals in the State must follow.

Experienced paralegals usually are given progressively more responsible duties and less supervision. In large law firms, corporate legal departments, and government agencies, experienced paralegals may supervise other paralegals and clerical staff and delegate work assigned by the attorneys. Advancement opportunities include promotion to managerial and other law-related positions within the firm or corporate legal department. However, some paralegals find it easier to move to another law firm when seeking increased responsibility or advancement.

Job Outlook

The number of job openings for paralegals is expected to increase significantly through the year 2005, but so will the number of persons pursuing this career. Thus, keen competition for jobs should continue as the growing number of graduates from paralegal training programs keeps pace with employment growth. Still, job prospects are generally expected to be good for graduates of highly regarded formal programs.

Employment of paralegals has grown tremendously since the emergence of this occupation in the late 1960's. Employment is expected to continue to grow much faster than the average for all occupations through the year 2005. The emphasis on hiring paralegals should continue in both legal and law-related fields so that the cost, availability, and efficiency of legal services can be improved. Besides jobs arising from growth in demand for paralegals, numerous job openings are expected to arise as persons leave the occupation for various reasons.

Private law firms will continue to be the largest employers of paralegals as a growing population sustains the need for legal services. The growth of prepaid legal plans also should contribute to the demand for the services of law firms. A growing array of other organizations, such as corporate legal departments, insurance companies, real estate and title insurance firms, and banks will also hire paralegals. Job opportunities are expected to expand throughout the private sector as more companies become aware that paralegals are able to do many legal tasks for lower salaries than lawyers.

Job opportunities for paralegals will expand even in the public sector. Community legal service programs—which provide assistance to the poor, the aged, minorities, and middle-income families—operate on limited budgets and will employ more paralegals to keep expenses down and serve the most people. Federal, State, and local government agencies, consumer organizations, and the courts also should continue to hire paralegals in increasing numbers.

To a limited extent, paralegal jobs are affected by the business cycle. During recessions, the demand for some discretionary legal services, such as planning estates, drafting wills, and handling real estate transactions, declines. Corporations are less inclined to initiate litigation when falling sales and profits lead to fiscal belt tightening. As a result, full time paralegals employed in offices adversely affected by a recession may be laid off or have their work hours reduced. On the other hand, during recessions, corporations and individuals are more likely to face other legal problems, such as bankruptcies,

foreclosures, and divorces, that require legal solutions. Furthermore, the continuous emergence of new laws and judicial interpretations of existing laws creates new business for lawyers and paralegals without regard to the business cycle.

Earnings

Earnings of paralegals vary greatly. Salaries depend on the education, training, and experience the paralegal brings to the job, the type and size of employer, and the geographic location of the job. Generally, paralegals who work for large law firms or in large metropolitan areas earn more than those who work for smaller firms or in less populated regions.

Paralegals had an average annual salary of about $24,900 in 1991, according to a utilization and compensation survey by the National Association of Legal Assistants; the middle 50 percent earned between $20,000 and $29,000 a year. Starting salaries of paralegals averaged $20,900, while paralegals with from 3 to 5 years of experience averaged $24,200 a year. Salaries of paralegals with over 10 years of experience averaged $28,500 annually, according to the same survey. In addition to a salary, many paralegals received an annual bonus, which averaged $1,100 in 1991. Employers of the majority of paralegals provided life and health insurance benefits and contributed to a retirement plan on their behalf.

Paralegal Specialists hired by the Federal Government in 1991 started at about $17,000 or $21,000 a year, depending on their training and experience. The average annual salary of paralegals who worked for the Federal Government in 1990 was about $32,164.

Related Occupations

Several other occupations also call for a specialized understanding of the law and the legal system but do not require the extensive training of a lawyer. Some of these are abstractors, claim examiners, compliance and enforcement inspectors, occupational safety and health workers, patent agents, police officers, and title examiners.

Sources of Additional Information

General information on a career as a paralegal and a list of paralegal training programs approved by the American Bar Association may be purchased for a $5 fee from:

☛ Standing Committee on Legal Assistants, American Bar Association, 750 North Lake Shore Dr., Chicago, IL 60611.

For information on certification of paralegals, schools that offer training programs in a specific State, and standards and guidelines for paralegals, contact:

☛ National Association of Legal Assistants, Inc., 1601 South Main St., Suite 300, Tulsa, OK 74119.

Information on a career as a paralegal, schools that offer training programs, and local paralegal associations can be obtained from:

☛ National Federation of Paralegal Associations, Suite 201, 104 Wilmot Rd., Deerfield, IL 60015-5195.

☛ National Paralegal Association, P.O. Box 406, Solebury, PA 18963.

Information on paralegal training programs may be obtained from:

☛ American Association for Paralegal Education, P.O. Box 40244, Overland Park, KS 66204.

General information about a career as a legal assistant manager is available from:

☛ Legal Assistant Management Association, P.O. Box 40129, Overland Park, KS 66204.

Science Technicians

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

Nature of the Work

Science technicians use the principles and theories of science and mathematics to solve problems in research and development and to investigate, invent, and help improve products. Their jobs are more practically oriented than those of scientists.

In recent years, laboratory instrumentation and procedures have become more complex, changing the nature of the work of science technicians in research and development. The increasing use of robotics to perform many routine tasks formerly done by technicians has freed technicians to operate other, more sophisticated laboratory equipment. Science technicians make extensive use of computers, computer-interfaced equipment, robotics, and high-technology industrial applications such as biological engineering.

Technicians set up, operate, and maintain laboratory instruments, monitor experiments, calculate and record results, and often develop conclusions. Those who work in production test products for proper proportions of ingredients or for strength and durability.

Agricultural technicians work with agricultural scientists in food and fiber research, production, and processing. Some conduct tests and experiments to improve the yield and quality of crops or to increase the resistance of plants and animals to disease, insects, or other hazards. Other agricultural technicians do animal breeding and nutrition work.

Biological technicians work with biologists, studying living organisms. Many help conduct medical research, helping to find a cure for cancer or AIDS, for example, or they may help conduct pharmaceutical research. Biological technicians also analyze organic substances such as blood, food, and drugs; some examine evidence in criminal investigations. Biological technicians working in biotechnology labs use the knowledge and techniques gained from basic research by scientists, including gene splicing and recombinant DNA, and apply these techniques in product development.

Chemical technicians work with chemists and chemical engineers, developing and using chemicals and related products and equipment. Most do research and development, testing, or other laboratory work. For example, they might test packaging for design, materials, and environmental acceptability; assemble and operate new equipment to develop new products; improve product quality; or develop new production techniques. Some chemical technicians collect and analyze samples of air and water to monitor pollution levels. Those who focus on basic research might produce compounds through complex organic synthesis.

Nuclear technicians operate nuclear test and research equipment, monitor radiation, and assist nuclear engineers and physicists in research. Some also operate remote control equipment to manipulate radioactive materials or materials to be exposed to radioactivity.

Petroleum technicians measure and record physical and geologic conditions in oil or gas wells using instruments lowered into wells or by analysis of the mud from wells. In oil and gas exploration, they

Science technicians often work independently, setting up and monitoring laboratory experiments.

collect and examine geological data or test geological samples to determine petroleum and mineral content. Some petroleum technicians, called scouts, collect information about oil and gas well drilling operations, geological and geophysical prospecting, and land or lease contracts.

Other science technicians collect weather information or assist oceanographers.

Working Conditions

Science technicians work under a wide variety of conditions. Many work indoors, usually in laboratories, and have regular hours. Some occasionally work irregular hours to monitor experiments that can't be completed during regular working hours. Others, such as agricultural and petroleum technicians, perform much of their work outdoors, sometimes in remote locations, and some may be exposed to hazardous conditions. Chemical technicians sometimes work with toxic chemicals, nuclear technicians may be exposed to radiation, and biological technicians sometimes work with disease-causing organisms or radioactive agents. However, there is little risk if proper safety procedures are followed.

Employment

Science technicians held about 246,000 jobs in 1990. Almost 40 percent worked in manufacturing, especially in the chemical, petroleum refining, and food processing industries. Almost 20 percent worked in colleges and universities and another 11 percent worked in research and testing services.

In 1990, the Federal Government employed about 20,000 science technicians, mostly in the Departments of Defense, Agriculture, Interior, and Commerce.

Training, Other Qualifications, and Advancement

There are several ways to qualify for a job as a science technician. Most employers prefer applicants who have at least 2 years of specialized training. Many junior and community colleges offer associate degrees in a specific technology or a more general education in science and mathematics. A number of 2-year associate degree programs are designed to provide easy transfer to a 4-year college or university if desired. Technical institutes generally offer technician training but provide less theory and general education than junior or community colleges. The length of programs at technical institutes varies, although 2-year associate degree programs are common. Some of these schools offer cooperative-education programs, allowing students the opportunity to work at a local company while attending classes in alternate terms. Many science technicians have a bachelor's degree in science or mathematics, or have had science and math courses in 4-year colleges. Some people with bachelor's degrees in a physical or life science become science technicians because they can't find or don't want a job as a scientist or because employers couldn't find properly trained technicians with less education. In some cases, they may be able to move into jobs as scientists, managers, or technical sales workers.

Some companies offer formal or on-the-job training for science technicians. Technicians also may qualify for their jobs with some types of Armed Forces training.

Persons interested in careers as science technicians should take as many high school science and math courses as possible. Science courses taken beyond high school, in an associate's or bachelor's program, should be laboratory oriented, with an emphasis on "bench" skills. Communication skills are important, and technicians should be able to work well with others since technicians often are part of a team. Because computers and computer-interfaced equipment are increasingly used in research and development laboratories, computer skills are also valuable.

Technicians usually begin work as trainees in routine positions under the direct supervision of a scientist or experienced technician. Job candidates whose training or educational background encompasses extensive hands-on experience with a variety of laboratory equipment, including computers and related equipment, usually require a much shorter period of on-the-job training. As they gain experience, they take on more responsibility and carry out assignments under only general supervision. Some eventually become supervisors.

Job Outlook

Science technicians with good technical and communications skills should experience very good employment opportunities through the year 2005. Employment is expected to increase about as fast as the average for all occupations through the year 2005 due to an expected growth in scientific research and development and production of technical products. Because of the growth of biotechnology, employment of biological technicians is expected to grow faster than for most other science technicians. Job opportunities for chemical technicians are also expected to be very good. Employment of nuclear and petroleum technicians is expected to grow more slowly.

Despite the projected growth, most job openings will arise from the need to replace technicians who transfer to other occupations or leave the labor force.

Earnings

Median annual earnings of science technicians were about $24,700 in 1990; the middle 50 percent earned between $17,700 and $32,400. Ten percent earned less than $13,700, and 10 percent earned over $42,600.

In the Federal Government in 1991, science technicians could start at $13,515, $15,171, or $16,973, depending on their education and experience. The average salary for biological technicians employed by the Federal Government in 1991 was $22,863; for mathematical technicians, $26,211; for physical science technicians, $28,060; for geodetic technicians, $33,096; for hydrologic technicians, $26,928; and for meteorologic technicians, $33,279.

Related Occupations

Other technicians who apply scientific principles at a level usually taught in 2-year associate degree programs include engineering technicians, broadcast technicians, drafters, and health technologists and technicians. Some of the work of agricultural and biological technicians is related to that in agriculture and forestry occupations.

Sources of Additional Information

For information about a career as a chemical technician, contact:

☛ American Chemical Society, Education Division, Career Publications, 1155 16th St. NW., Washington, DC 20036.

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.

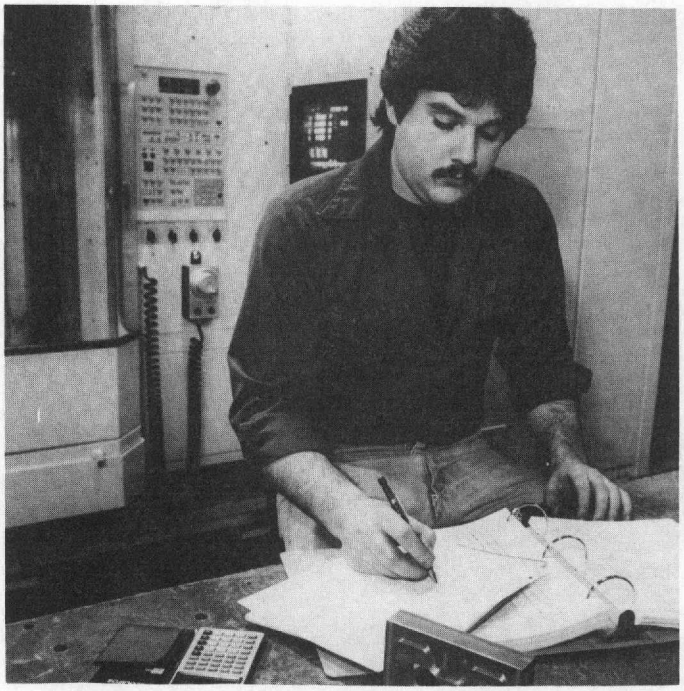
Training, Other Qualifications, and Advancement

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.

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.



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

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

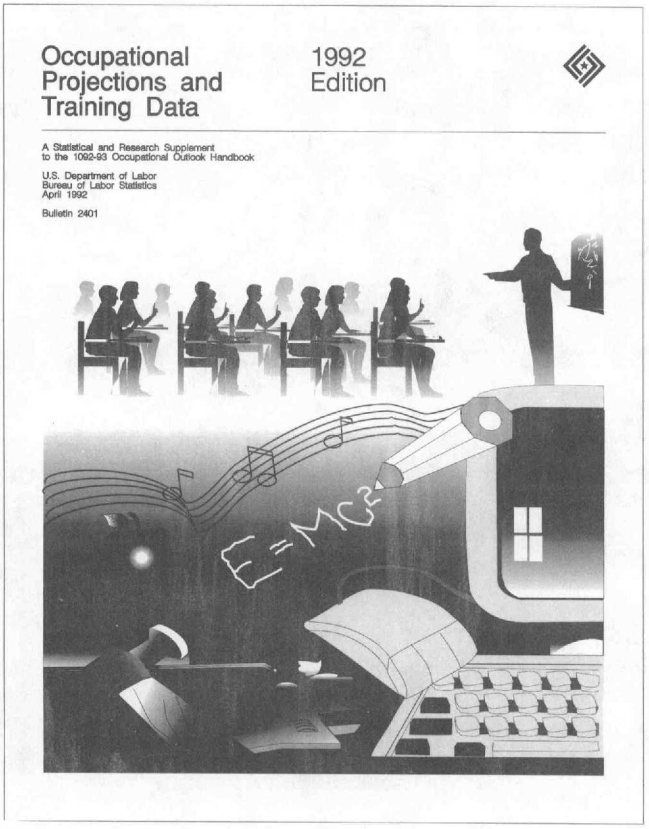
instructions for a machine—in this case a computer. Other highly skilled workers involved in metal machining work are tool and die designers, tool planners, tool and die makers, and machinists.

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.

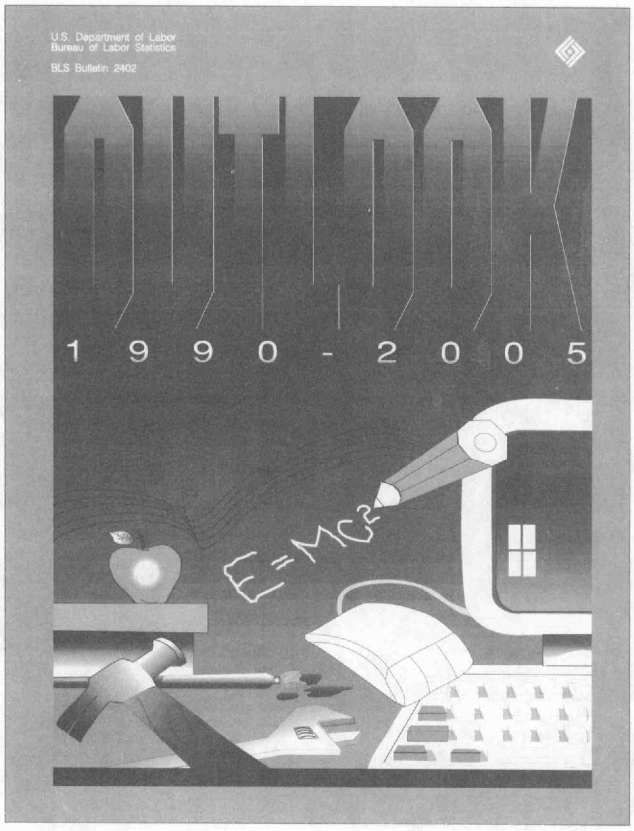
Related Publications



BLS Bulletin 2401

Occupational Projections and Training Data, 1992 Edition

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



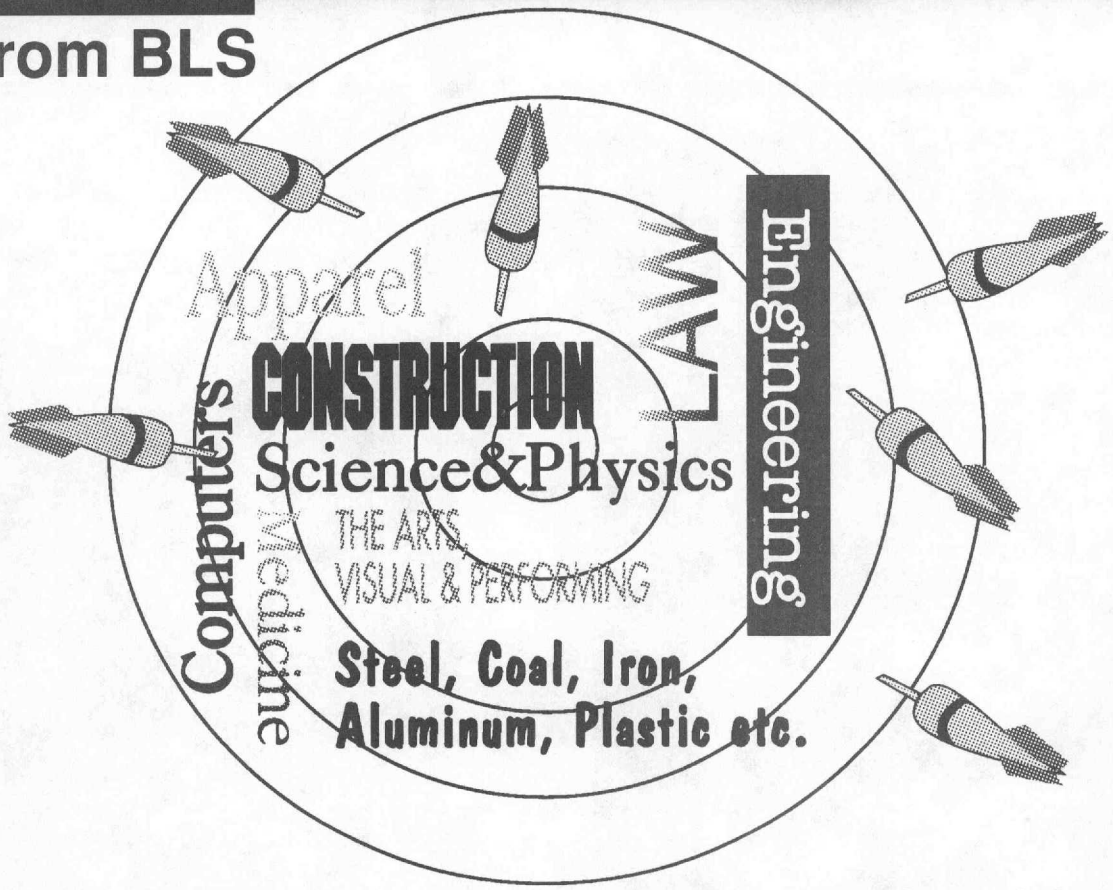
BLS Bulletin 2402

Outlook 1990-2005

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

Note:
At press time, prices for these publications were not available. For prices and ordering information, contact any of the Bureau of Labor Statistics Regional Offices listed on the inside of the front cover, or the Division of Occupational Outlook, Bureau of Labor Statistics, Washington, DC 20212.

New from BLS



Do you want to know more about work in industries?

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- Geographic areas having the most jobs
- Size of establishments
- Goods and services produced
- Kinds of workers employed—what types of work is done
- Common working conditions and hazards
- Jobs that can be entered from high school; from college
- Jobs that do not require specialized education or training
- Opportunities for acquiring skills
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Then, don't miss this new publication!

Career Guide to Industries

Career Guide to Industries, BLS Bulletin 2403, was produced by the same staff that prepares the *Occupational Outlook Handbook*—the Federal Goverment's premier career guidance publication. This new book is a must for guidance counselors, individuals planning their careers, job seekers, and others who want the latest word on career information from an industry perspective.

Note: At press time, the price for this publication was not available. Contact any of the Bureau of Labor Statistics Regional Offices listed on the inside front cover, or the Division of Occupational Outlook, Bureau of Labor Statistics, Washington, DC 20212.