

laid off. However, a growing number of drafters should continue to be employed on a temporary or contract basis, as more companies turn to the personnel-supply services industry to meet their changing needs.

### Earnings

Earnings for drafters vary by specialty and level of responsibility. Median hourly earnings of architectural and civil drafters were \$16.93 in 2000. The middle 50 percent earned between \$13.79 and \$20.86. The lowest 10 percent earned less than \$11.18, and the highest 10 percent earned more than \$26.13. Median hourly earnings of architectural and civil drafters in engineering and architectural services in 2000 were \$16.75.

Median hourly earnings of electrical and electronics drafters were \$18.37 in 2000. The middle 50 percent earned between \$14.19 and \$23.76. The lowest 10 percent earned less than \$11.30, and the highest 10 percent earned more than \$29.46. In engineering and architectural services, the average hourly earnings for electrical and electronics drafters were \$17.30.

Median hourly earnings of mechanical drafters were \$18.19 in 2000. The middle 50 percent earned between \$14.43 and \$23.20. The lowest 10 percent earned less than \$11.70, and the highest 10 percent earned more than \$28.69. The average hourly earnings for mechanical drafters in engineering and architectural services were \$16.98.

### Related Occupations

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

### Sources of Additional Information

Information on schools offering programs in drafting and related fields is available from:

► Accrediting Commission of Career Schools and Colleges of Technology, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201.

Internet: <http://www.accset.org>

Information about certification is available from:

► American Design Drafting Association, P.O. Box 11937, Columbia, SC 29211. Internet: <http://www.adda.org>

## Engineering Technicians

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### Significant Points

- Electrical and electronic engineering technicians make up about 45 percent of all engineering technicians.
- Because the type and quality of training programs vary considerably, prospective students should carefully investigate training programs before enrolling.
- Opportunities will be best for individuals with an associate degree or extensive job training in engineering technology.

### Nature of the Work

Engineering technicians use the principles and theories of science, engineering, and mathematics to solve technical problems in research

and development, manufacturing, sales, construction, inspection, and maintenance. Their work is more limited in scope and more practically oriented than that of scientists and engineers. Many engineering technicians assist engineers and scientists, especially in research and development. Others work in quality control—inspecting products and processes, conducting tests, or collecting data. In manufacturing, they may assist in product design, development, or production. Although many workers who repair or maintain various types of electrical, electronic, or mechanical equipment often are called technicians, these workers are covered in the *Handbook* section on installation, maintenance, and repair occupations.

Engineering technicians who work in research and development build or set up equipment, prepare and conduct experiments, collect data, calculate or record the results, and help engineers or scientists in other ways, such as making prototype versions of newly designed equipment. They also assist in design work, often using computer-aided design equipment.

Most engineering technicians specialize in certain areas, learning skills and working in the same disciplines as engineers. Occupational titles, therefore, tend to follow the same structure as those of engineers.

*Aerospace engineering and operations technicians* install, construct, maintain, and test systems used to test, launch, or track aircraft and space vehicles. They may calibrate test equipment and determine the cause of equipment malfunctions. Using computer and communications systems, aerospace engineering and operations technicians often record and interpret test data.

*Chemical engineering technicians* usually are employed in industries producing pharmaceuticals, chemicals, and petroleum products, among others. They work in laboratories as well as processing plants. They help develop new chemical products and processes, test processing equipment and instrumentation, gather data, and monitor quality.

*Civil engineering technicians* help civil engineers plan and build highways, buildings, bridges, dams, wastewater treatment systems, and other structures, and perform related surveys and studies. Some estimate construction costs and specify materials to be used, and some may even prepare drawings or perform land-surveying duties. Others may set up and monitor instruments used to study traffic conditions. (Separate statements on cost estimators; drafters; and surveyors, cartographers, photogrammetrists, and surveying technicians can be found elsewhere in the *Handbook*.)

*Electrical and electronics engineering technicians* help design, develop, test, and manufacture electrical and electronic equipment such as communication equipment, radar, industrial and medical measuring or control devices, navigational equipment, and computers. They may work in product evaluation and testing, using measuring and diagnostic devices to adjust, test, and repair equipment. (Workers who only repair electrical and electronic equipment are discussed in the statement on electrical and electronics installers and repairers found elsewhere in the *Handbook*. Many of these repairers often are referred to as electronics technicians.)

Electrical and electronic engineering technology is also applied to a wide variety of systems such as communications and process controls. *Electromechanical engineering technicians* combine fundamental principles of mechanical engineering technology with knowledge of electrical and electronic circuits to design, develop, test, and manufacture electrical and computer-controlled mechanical systems.

*Environmental engineering technicians* work closely with environmental engineers and scientists in developing methods and devices used in the prevention, control, or correction of environmental hazards. They inspect and maintain equipment affecting air pollution and recycling. Some inspect water and wastewater



*Some engineering technicians help engineers by setting up equipment and conducting experiments.*

treatment systems to ensure that pollution control requirements are met.

*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, develop, test, and manufacture industrial machinery, consumer products, and other equipment. They may assist in product tests—by setting up instrumentation for auto crash tests, for example. They may make sketches and rough layouts, 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 at least 40 hours a week in laboratories, offices, or manufacturing or industrial plants, or on construction sites. Some may be exposed to hazards from equipment, chemicals, or toxic materials.

### **Employment**

Engineering technicians held about 519,000 jobs in 2000. About 233,000 of these were electrical and electronics engineering technicians. About 35 percent of all engineering technicians worked in durable goods manufacturing, mainly in the electrical and electronic equipment, industrial machinery and equipment, instruments and related products, and transportation equipment industries. Another 26 percent worked in service industries, mostly in engineering or business services companies that do engineering work on contract for government, manufacturing firms, or other organizations.

In 2000, the Federal Government employed about 23,000 engineering technicians. The major employer was the Department of Defense, followed by the Departments of Transportation, Agriculture, and Interior, the Tennessee Valley Authority, and the National Aeronautics and Space Administration. State governments employed about 22,000, and local governments, about 21,000.

### **Training, Other Qualifications, and Advancement**

Although it may be possible to qualify for a few engineering technician jobs without formal training, most employers prefer to hire someone with at least a 2-year associate degree in engineering technology. Training is available at technical institutes, community colleges, extension divisions of colleges and universities, public and private vocational-technical schools, and the Armed Forces. Persons with college courses in science, engineering, and mathematics may qualify for some positions but may need additional specialized training and experience. Although employers usually do not require engineering technicians to be certified, such certification may provide jobseekers a competitive advantage.

Prospective engineering technicians should take as many high school science and math courses as possible to prepare for postsecondary programs in engineering technology. Most 2-year associate degree programs accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC/ABET) require, at a minimum, college algebra and trigonometry, and one or two basic science courses. Depending on the specialty, more math or science may be required.

The type of technical courses required also depends on the specialty. For example, prospective mechanical engineering technicians may take courses in fluid mechanics, thermodynamics, and mechanical design; electrical engineering technicians may take classes in electric circuits, microprocessors, and digital electronics; and those preparing to work in environmental engineering technology need courses in environmental regulations and safe handling of hazardous materials.

Because many engineering technicians may assist in design work, creativity is desirable. Good communication skills and the ability to work well with others also is important because these workers often are part of a team of engineers and other technicians.

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

Many publicly and privately operated schools provide technical training; the type 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. Graduates of ABET-accredited programs usually are recognized to have achieved an acceptable level of competence in the mathematics, science, and technical courses required for this occupation.

Technical institutes offer intensive technical training through application and practice, but less theory and general education than community colleges. Many offer 2-year associate degree programs, and are similar to or part of a community college or State university system. 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, although some are 2-year associate degree programs.

Community colleges offer curriculums that are similar to those in technical institutes, but that may include more theory and liberal arts. Often there may be little or no difference between technical institute and community college programs, as both offer associate degrees. After completing the 2-year program, some graduates get jobs as engineering technicians, while others continue their education at 4-year colleges. However, there is a difference between an associate degree in pre-engineering and one in engineering technology. Students who enroll in a 2-year pre-

engineering program may find it very difficult to find work as an engineering technician should they decide not to enter a 4-year engineering program, because pre-engineering programs usually focus less on hands-on applications and more on academic preparatory work. Conversely, graduates of 2-year engineering technology programs may not receive credit for many of the courses they have taken if they choose to transfer to a 4-year engineering program. Colleges with these 4-year programs 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. Many 4-year colleges offer bachelor's degrees in engineering technology, but graduates of these programs often are hired to work as technologists or applied engineers, not technicians.

Area vocational-technical schools, another source of technical training, 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. However, skills acquired in military programs are often narrowly focused, so they may not be useful in civilian industry, which often requires broader training. Therefore, some additional training may be needed, depending on the acquired skills and the kind of job.

The National Institute for Certification in Engineering Technologies (NICET) has established a voluntary certification program for engineering technicians. Certification is available at various levels, each level combining a written examination in 1 of more than 30 specialties with a certain amount of job-related experience, a supervisory evaluation, and a recommendation.

### Job Outlook

Opportunities will be best for individuals with an associate degree or extensive job training in engineering technology. As technology becomes more sophisticated, employers continue to look for technicians who are skilled in new technology and require a minimum of additional job training. An increase in the number of jobs affecting public health and safety should create job opportunities for certified engineering technicians.

Overall employment of engineering technicians is expected to increase about as fast as the average for all occupations through 2010. As production of technical products continues to grow, competitive pressures will force companies to improve and update manufacturing facilities and product designs more rapidly than in the past. However, the growing availability and use of advanced technologies, such as computer-aided design and drafting and computer simulation, will continue to increase productivity and limit job growth. In addition to growth, many job openings will stem from the need to replace technicians who retire or leave the labor force.

Like engineers, employment of engineering technicians is influenced by local and national economic conditions. As a result, the employment outlook varies with industry and specialization. Some types of engineering technicians, such as civil engineering and aerospace engineering and operations technicians, experience greater cyclical fluctuations in employment than do others. Increasing demand for more sophisticated electrical and electronic products, as well as the expansion of these products and systems into all areas of industry and manufacturing processes, will contribute to average growth in the largest specialty—electrical and electronics engineering technicians. At the same time, new specializations will contribute to growth among all other engineering technicians; fire protection engineering, water quality control, and environmental

technology are some of many new specialties for which demand is increasing.

### Earnings

Median annual earnings of electrical and electronics engineering technicians were \$40,020 in 2000. The middle 50 percent earned between \$31,570 and \$49,680. The lowest 10 percent earned less than \$25,210, and the highest 10 percent earned more than \$58,320. Median annual earnings in the industries employing the largest numbers of electrical and electronics engineering technicians in 2000 are shown below.

Federal Government .....	\$50,000
Telephone communication .....	45,640
Engineering and architectural services .....	40,690
Electrical goods .....	38,120
Electronic components and accessories .....	35,500

Median annual earnings of civil engineering technicians were \$35,990 in 2000. The middle 50 percent earned between \$27,810 and \$44,740. The lowest 10 percent earned less than \$21,830, and the highest 10 percent earned more than \$54,770. Median annual earnings in the industries employing the largest numbers of civil engineering technicians in 2000 are shown below.

Local government .....	\$39,080
Engineering and architectural services .....	36,670
State government .....	32,160

In 2000, the average annual salary for aerospace engineering and operations technicians in the aircraft and parts industry was \$53,340, and the average annual salary for environmental engineering technicians in engineering and architectural services was \$29,960. The average annual salary for industrial engineering technicians in computer and data processing services and electric components and accessories was \$73,320 and \$36,300, respectively. In engineering and architectural services, the average annual salary for mechanical engineering technicians was \$40,580.

### Related Occupations

Engineering technicians apply scientific and engineering principles usually acquired in postsecondary programs below the baccalaureate level. Similar occupations include science technicians; drafters; surveyors, cartographers, photogrammetrists, and surveying technicians; and broadcast and sound engineering technicians and radio operators.

### Sources of Additional Information

For \$3.50, a full package of guidance materials and information (product number SP-01) on a variety of engineering technician and technology careers is available from:

- ▶ Junior Engineering Technical Society (JETS), 1420 King St., Suite 405, Alexandria, VA 22314-2794. Free information is available on the JETS Internet site: <http://www.jets.org>

Information on ABET-accredited engineering technology programs is available from:

- ▶ Accreditation Board for Engineering and Technology, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202. Internet: <http://www.abet.org>

Information on certification of engineering technicians is available from:

- ▶ National Institute for Certification in Engineering Technologies (NICET), 1420 King St., Alexandria, VA 22314-2794. Internet: <http://www.nicet.org>