



Computer hardware engineers work with circuit boards, computer chips, keyboards, modems, and scanners.

equipment exclusively. (See the statement on electrical and electronics engineers elsewhere in the *Handbook*.) In addition to design and development, computer hardware engineers may supervise the manufacturing and installation of computers and computer-related equipment. The rapid advances in computer technology are largely a result of the research, development, and design efforts of computer hardware engineers. To keep up with technology change, these engineers must continually update their knowledge.

Employment

The number of computer hardware engineers is relatively small compared with the number of other computer-related workers who work with software or computer applications. Computer hardware engineers held about 60,000 jobs in 2000. About 25 percent were employed in computer and data processing services. About 1 out of 10 worked in computer and office equipment manufacturing, but many also are employed in communications industries and engineering consulting firms.

Job Outlook

Computer hardware engineers are expected to have favorable job opportunities. Employment of computer hardware engineers is projected to increase faster than the average for all occupations through 2010, reflecting rapid employment growth in the computer and office equipment industry, which employs the greatest number of computer engineers. Consulting opportunities for computer hardware engineers should grow as businesses need help managing, upgrading, and customizing increasingly complex systems. Growth in embedded systems, a technology that uses computers to control other devices such as appliances or cell phones, also will increase the demand for computer hardware engineers. In addition to job openings arising from employment growth, other vacancies will result from the need to replace workers who move into managerial positions, transfer to other occupations, or leave the labor force.

Earnings

Median annual earnings of computer hardware engineers were \$67,300 in 2000. The middle 50 percent earned between \$52,960 and \$86,280. The lowest 10 percent earned less than \$42,620, and the highest 10 percent earned more than \$107,360. Median annual earnings in the industries employing the largest numbers of computer hardware engineers in 2000 were:

Computer and office equipment	\$75,730
Computer and data processing services	69,490
Electronic components and accessories	67,800
Telephone communication	59,160

Starting salaries for computer engineers with a bachelor's degree can be significantly higher than salaries of bachelor's degree graduates in many other fields. According to the National Association of Colleges and Employers, starting salary offers in 2001 for bachelor's degree candidates in computer engineering averaged \$53,924 a year; master's degree candidates averaged \$58,026; and Ph.D. candidates averaged \$70,140.

Sources of Additional Information

For further information about computer hardware engineers, contact:
 ▶ IEEE Computer Society, 1730 Massachusetts Ave. NW., Washington, DC 20036-1992. Internet: <http://www.computer.org>

(See introduction to the section on engineers for information on working conditions, training requirements, and other sources of additional information.)

Electrical and Electronics Engineers

(O*NET 17-2071.00, 17-2072.00)

Nature of the Work

From geographical information systems that can continuously provide the location of a vehicle to giant electric power generators, electrical and electronics engineers are responsible for a wide range of technologies. Electrical and electronics engineers design, develop, test, and supervise the manufacture of electrical and electronic equipment. Some of this equipment includes power generating, controlling, and transmission devices used by electric utilities; and electric motors, machinery controls, lighting, and wiring in buildings, automobiles, aircraft, radar and navigation systems, and broadcast and communications systems. Many electrical and electronics engineers also work in areas closely related to computers. However, engineers whose work is related exclusively to computer hardware are considered computer hardware engineers, an occupation covered elsewhere in the *Handbook*.

Electrical and electronics engineers specialize in different areas such as power generation, transmission, and distribution; communications; and electrical equipment manufacturing, or a subdivision of these areas—industrial robot control systems or aviation



An electrical engineer working for a consulting firm looks for defective circuits.

electronics, for example. Electrical and electronics engineers design new products, write performance requirements, and develop maintenance schedules. They also test equipment, solve operating problems, and estimate the time and cost of engineering projects.

Employment

Electrical and electronics engineers held about 288,000 jobs in 2000, making their occupation the largest branch of engineering. Most jobs were in engineering and business consulting firms, government agencies, and manufacturers of electrical and electronic and computer and office equipment, industrial machinery, and professional and scientific instruments. Transportation, communications, and utilities firms as well as personnel supply services and computer and data processing services firms accounted for most of the remaining jobs.

California, Texas, New York, and New Jersey—States with many large electronics firms—employ nearly one-third of all electrical and electronics engineers.

Job Outlook

Electrical and electronics engineering graduates should have favorable job opportunities. The number of job openings resulting from employment growth and the need to replace electrical engineers who transfer to other occupations or leave the labor force is expected to be in rough balance with the supply of graduates. Employment of electrical and electronics engineers is expected to grow about as fast as the average for all occupations through 2010.

Projected job growth stems largely from increased demand for electrical and electronic goods, including advanced communications equipment, defense-related electronic equipment, and consumer electronics products. The need for electronics manufacturers to invest heavily in research and development to remain competitive and gain a scientific edge will provide openings for graduates who have learned the latest technologies. Opportunities for electronics engineers in defense-related firms should improve as aircraft and weapons systems are upgraded with improved navigation, control, guidance, and targeting systems. However, job growth is expected to be fastest in services industries—particularly consulting firms that provide electronic engineering expertise.

Continuing education is important for electrical and electronics engineers. Engineers who fail to keep up with the rapid changes in technology risk becoming more susceptible to layoffs or, at a minimum, more likely to be passed over for advancement.

Earnings

Median annual earnings of electrical engineers were \$64,910 in 2000. The middle 50 percent earned between \$51,700 and \$80,600. The lowest 10 percent earned less than \$41,740, and the highest 10 percent earned more than \$94,490. Median annual earnings in the industries employing the largest numbers of electrical engineers in 2000 were:

Computer and office equipment	\$69,700
Measuring and controlling devices	67,570
Search and navigation equipment	67,330
Electronic components and accessories	65,830
Engineering and architectural services	65,040

Median annual earnings of electronics engineers, except computer, were \$64,830 in 2000. The middle 50 percent earned between \$52,430 and \$79,960. The lowest 10 percent earned less than \$43,070, and the highest 10 percent earned more than \$94,330. Median annual earnings in the industries employing the largest numbers of electronics engineers in 2000 were:

Federal Government	\$70,890
Search and navigation equipment	68,930
Electronic components and accessories	63,890
Electrical goods	62,860
Telephone communication	57,710

According to a 2001 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in electrical and electronics engineering received starting offers averaging \$51,910 a year; master's degree candidates averaged \$63,812; and Ph.D. candidates averaged \$79,241.

Sources of Additional Information

Information on electrical and electronics engineers is available from:
 ► Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08855-1331. Internet: <http://www.ieee.org>

(See introduction to the section on engineers for information on working conditions, training requirements, and other sources of additional information.)

Environmental Engineers

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Nature of the Work

Using the principles of biology and chemistry, environmental engineers develop methods to solve problems related to the environment. They are involved in water and air pollution control, recycling, waste disposal, and public health issues. Environmental engineers conduct hazardous-waste management studies, evaluate the significance of the hazard, offer analysis on treatment and containment, and develop regulations to prevent mishaps. They design municipal sewage and industrial wastewater systems. They analyze scientific data, research controversial projects, and perform quality control checks.

Environmental engineers are concerned with local and worldwide environmental issues. They study and attempt to minimize the effects of acid rain, global warming, automobile emissions, and ozone depletion. They also are involved in the protection of wildlife.

Many environmental engineers work as consultants, helping their clients comply with regulations and clean up hazardous sites, including brownfields, which are abandoned urban or industrial sites that may contain environmental hazards.

Employment

Environmental engineers held about 52,000 jobs in 2000. More than one-third worked in engineering and management services and about 16,000 were employed in Federal, State, and local government agencies. Most of the rest worked in various manufacturing industries.

Job Outlook

Employment of environmental engineers is expected to increase faster than the average for all occupations through 2010. More environmental engineers will be needed to meet environmental regulations and to develop methods of cleaning up existing hazards. A shift in emphasis toward preventing problems rather than controlling those that already exist, as well as increasing public health concerns, also will spur demand for environmental engineers. However, political factors determine the job outlook for environmental engineers more than that for other engineers. Looser environmental regulations would reduce job opportunities; stricter regulations would enhance opportunities.