Sloan Career Cornerstone Center

Engineering Overview

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The Field

Engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is the link between scientific discoveries and the commercial applications that meet societal and consumer needs.

Many engineers develop new products. During the process, they consider several factors. For example, in developing an industrial robot, engineers specify the functional requirements precisely; design and test the robot's components; integrate the components to produce the final design; and evaluate the design's overall effectiveness, cost, reliability, and safety. This process applies to the development of many different products, such as chemicals, computers, power plants, helicopters, and toys.

In addition to their involvement in design and development, many engineers work in testing, production, or maintenance. These engineers supervise production in factories, determine the causes of a component's failure, and test manufactured products to maintain quality. They also estimate the time and cost required to complete projects. Supervisory engineers are responsible for major components or entire projects.

Engineers use computers extensively to produce and analyze designs; to simulate and test how a machine, structure, or system operates; to generate specifications for parts; to monitor the quality of products; and to control the efficiency of processes. Nanotechnology, which involves the creation of high-performance materials and components by integrating atoms and molecules, also is introducing entirely new principles to the design process.

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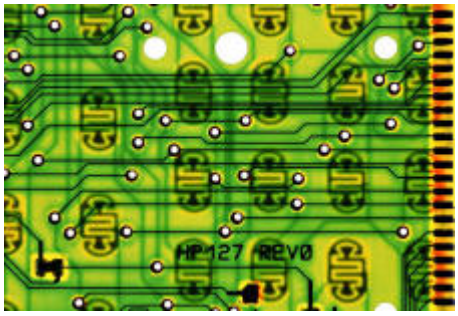
Engineering Disciplines



Most engineers specialize. More than 25 major specialties are recognized by professional societies, and the major branches have numerous subdivisions. In the United States, degrees in the different fields of engineering are accredited to ensure that the programs provide students with a top notch engineering education. Engineers also may specialize in one industry, such as motor vehicles, or in one field of technology, such as turbines or semiconductor materials.
Engineers in each branch have a base of knowledge and training that can be applied in many fields. Electronics engineers, for example, work in the medical, computer, communications, and missile guidance fields. Because there are many separate problems to solve in a large engineering project, engineers in one field often work closely with specialists in other scientific, engineering, and business occupations.

The Sloan Career Cornerstone Center offers in-depth information on a continually expanding list of both engineering and engineering technology degree fields, including:

Aerospace Engineering
Agricultural Engineering
Architectural Engineering
Bioengineering
Ceramic Engineering
Chemical Engineering
Civil Engineering
Computer Engineering
Construction Engineering
Electrical and Electronics Engineering
Engineering (General), Engineering Physics, or Engineering Science
Engineering Management
Engineering Mechanics
Environmental Engineering
Forest/Paper Engineering
Geological Engineering
Industrial Engineering
Manufacturing Engineering
Materials Science and Engineering
Mechanical Engineering
Metallurgical Engineering
Microelectronic Engineering
Mining Engineering
Naval Architecture and Marine Engineering
Nuclear Engineering
Ocean Engineering
Petroleum Engineering
Software Engineering
Surveying and Geomatics
Systems Engineering
and even a few more…

Preparation

Engineers typically enter the occupation with a bachelor's degree in an engineering specialty, but some basic research positions may require a graduate degree. Engineers offering their services directly to the public must be licensed. Continuing education to keep current with rapidly changing technology is important for engineers.

A bachelor's degree in engineering is required for almost all entry-level engineering jobs. College graduates with a degree in a natural science or mathematics occasionally may qualify

for some engineering jobs, especially in specialties in high demand. Most engineering degrees are granted in electrical, electronics, mechanical, or civil engineering. However, engineers trained in one branch may work in related branches. For example, many aerospace engineers have training in mechanical engineering. This flexibility allows employers to meet staffing needs in new technologies and specialties in which engineers may be in short supply. It also allows engineers to shift to fields with better employment prospects or to those that more closely match their interests. Click here to view profiles of several engineering undergraduate students.

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In addition to the standard engineering degree, many colleges offer 2- or 4-year degree programs in engineering technology. These programs, which usually include various hands-on laboratory classes that focus on current issues, prepare students for practical design and production work, rather than for jobs that require more theoretical and scientific knowledge. Graduates of 4-year technology programs may get jobs similar to those obtained by graduates with a bachelor's degree in engineering. Engineering technology graduates, however, are not qualified to register as professional engineers under the same terms as graduates with degrees in engineering. Some employers regard technology program graduates as having skills between those of a technician and an engineer.

Graduate training is essential for engineering faculty positions and many research and development programs, but is not required for the majority of entry-level engineering jobs. Many engineers obtain graduate degrees in engineering or business administration to learn new technology and broaden their education. Many high-level executives in government and industry began their careers as engineers.

University Selection

About 1850 programs at colleges and universities offer bachelor's degrees in engineering that are accredited by ABET, Inc. and there are about another 750 accredited programs in engineering technology. The Sloan Career Cornerstone Center provides lists of accredited programs within specific engineering disciplines.

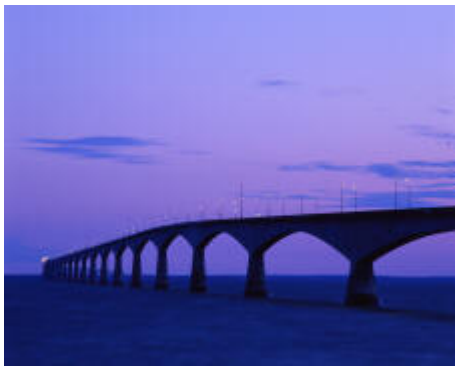
Accreditation

ABET accreditation is based on an examination of an engineering program's student achievement, program improvement, faculty, curricular content, facilities, and institutional commitment. Although most institutions offer programs in the major branches of engineering, only a few offer programs in the smaller specialties. Also, programs of the same title may vary in content. For example, some programs emphasize industrial practices, preparing students for a job in industry, whereas others are more theoretical and are designed to prepare students for graduate work. Therefore, students should investigate curricula and check accreditations carefully before selecting a college.

Admissions Requirements

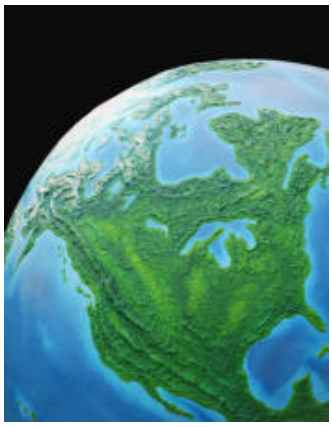
Admissions requirements for undergraduate engineering schools include a solid background in

mathematics (algebra, geometry, trigonometry, and calculus) and science (biology, chemistry, and physics), and courses in English, social studies, humanities, and computer and information technology. Bachelor's degree programs in engineering typically are designed to last 4 years, but many students find that it takes between 4 and 5 years to complete their studies. In a typical 4-year college curriculum, the first 2 years are spent studying mathematics, basic sciences, introductory engineering, humanities, and social sciences. In the last 2 years, most courses are in engineering, usually with a concentration in one branch. For example, the last 2 years of an aerospace program might include courses in fluid mechanics, heat transfer, applied aerodynamics, analytical mechanics, flight vehicle design, trajectory dynamics, and aerospace propulsion systems. Some programs offer a general engineering curriculum; students then specialize in graduate school or on the job.



Some engineering schools and 2-year colleges have agreements whereby the 2-year college provides the initial engineering education, and the engineering school automatically admits students for their last 2 years. In addition, a few engineering schools have arrangements whereby a student spends 3 years in a liberal arts college studying pre-engineering subjects and 2 years in an engineering school studying core subjects, and then receives a bachelor's degree from each school. Some colleges and universities offer 5-year master's degree programs. Some 5-year or even 6-year cooperative plans combine classroom study and practical work, permitting students to gain valuable experience and to finance part of their education.

Day in the Life



Many engineers work a standard 40-hour week. At times, deadlines or design standards may bring extra pressure to a job, sometimes requiring engineers to work longer hours. Most engineers work in office buildings, laboratories, or industrial plants. Others may spend time outdoors at construction sites and oil and gas exploration and production sites, where they monitor or direct operations or solve onsite problems. Some engineers travel extensively to plants or worksites.

Teams and Coworkers

Engineers should be creative, inquisitive, analytical, and detail-oriented. They should be able to work as part of a team and to communicate well, both orally and in writing. Communication abilities are important because engineers often interact with specialists in a wide range of fields outside engineering. Beginning engineering graduates usually work under the supervision of experienced engineers and, in large companies, also may receive formal classroom or seminar-type training. As new engineers gain knowledge and experience, they are assigned more difficult projects with greater independence to develop designs, solve problems, and make decisions. Engineers may advance to become technical specialists or to supervise a staff or team of engineers and technicians. Some may eventually become engineering managers or enter other managerial or sales jobs.

Earnings

Earnings for engineers vary significantly by specialty, industry, and education. Variation in median earnings and in the earnings distributions for engineers in a number of specialties is especially significant. In the Federal Government, mean annual salaries for engineers ranged from $81,085 in agricultural engineering to $126,788 in ceramic engineering in March 2009.

Specialty	Lowest 10%	Lowest 25%	Median	Highest 25%	Highest 10%
Aerospace engineers	$58,130	$72,390	$92,520	$114,530	$134,570
Agricultural engineers	43,150	55,430	68,730	86,400	108,470
Biomedical engineers	47,640	59,420	77,400	98,830	121,970
Chemical engineers	53,730	67,420	84,680	105,000	130,240
Civil engineers	48,140	58,960	74,600	94,470	115,630
Computer hardware engineers	59,170	76,250	97,400	122,750	148,590
Electrical engineers	52,990	64,910	82,160	102,520	125,810
Electronics engineers, except computer	55,330	68,400	86,370	106,870	129,920
Environmental engineers	45,310	56,980	74,020	94,280	115,430
Health and safety engineers, except mining safety engineers and inspectors	43,540	56,190	72,490	90,740	106,220
Industrial engineers	47,720	59,120	73,820	91,020	107,270
Marine engineers and naval architects	43,070	57,060	74,140	94,840	118,630
Materials engineers	51,420	63,830	81,820	102,040	124,470
Mechanical engineers	47,900	59,230	74,920	94,400	114,740
Mining and geological engineers, including mining safety engineers	45,020	57,970	75,960	96,030	122,750
Nuclear engineers	68,300	82,540	97,080	115,170	136,880
Petroleum engineers	57,820	80,040	108,020	148,700	>166,400
Engineers, all other	49,270	67,360	88,570	110,310	132,070

Starting Salaries

As a group, engineers earn some of the highest average starting salaries among those holding bachelor's degrees. Average starting salary offers for graduates of bachelor’s degree programs in engineering, according to a July 2009 survey by the National Association of Colleges and Employers, were as follows:

Petroleum	**$83,121**
Chemical	**64,902**
Mining and Mineral	**64,404**
Computer	**61,738**
Nuclear	**61,610**
Electrical/electronics and communications	**60,125**
Mechanical	**58,766**
Industrial/manufacturing	**58,358**
Materials	**57,349**
Aerospace/aeronautical/astronautical	**56,311**
Agricultural	**54,352**
Bioengineering and biomedical	**54,158**
Civil	**52,048**

Employment

Engineers hold 1.6 million jobs in the United States. About 36 percent of engineering jobs were found in manufacturing industries, and another 30 percent were in the professional, scientific, and technical services industries, primarily in architectural, engineering, and related services. Many engineers also worked in the construction, telecommunications, and wholesale trade industries. Federal, State, and local governments employed about 12 percent of engineers in 2008. About 6 percent were in the Federal Government, mainly in the U.S. Departments of Defense, Transportation, Agriculture, Interior, and Energy, and in the National Aeronautics and Space Administration. Many engineers in State and local government agencies worked in highway and public works departments. In 2008, about 3 percent of engineers were self-employed, many as consultants.

Engineers are employed in every state, in small and large cities and in rural areas. Some branches of engineering are concentrated in particular industries and geographic areas; for example, petroleum engineering jobs tend to be located in States with sizable petroleum deposits, such as Texas, Louisiana, Oklahoma, Alaska, and California. Other branches, such as civil engineering, are widely dispersed, and engineers in these fields often move from place to place to work on different projects.

Engineers are employed in every major industry. The industries employing the most engineers in each specialty are given in the table below, along with the percent of occupational employment in the industry.

Specialty	Industry	Percent
Aerospace engineers	Aerospace product and parts manufacturing	49
Agricultural engineers	Food manufacturing	25
	Architectural, engineering, and related services	15
Biomedical engineers	Medical equipment and supplies manufacturing	20
	Scientific research and development services	20
Chemical engineers	Chemical manufacturing	29
	Architectural, engineering, and related services	15
Civil engineers	Architectural, engineering, and related services	49
Computer hardware engineers	Computer and electronic product manufacturing	41
	Computer systems design and related services	19
Electrical engineers	Architectural, engineering, and related services	21
Electronics engineers, except computer	Computer and electronic product manufacturing	26
	Telecommunications	15
Environmental engineers	Architectural, engineering, and related services	29
	State and local government	21
Health and safety engineers, except mining safety engineers and inspectors	State and local government	10
Industrial engineers	Transportation equipment manufacturing	18
	Machinery manufacturing	8
Marine engineers and naval architects	Architectural, engineering, and related services	29
Materials engineers	Primary metal manufacturing	11
	Semiconductor and other electronic component manufacturing	9
Mechanical engineers	Architectural, engineering, and related services	22
	Transportation equipment manufacturing	14
Mining and geological engineers, including mining safety engineers	Mining	58
Nuclear engineers	Research and development in the physical, engineering, and life sciences	30
	Electric power generation, transmission and distribution	27
Petroleum engineers	Oil and gas extraction	43

Career Path Forecast

According to the U.S. Department of Labor, Bureau of Labor Statistics, employment of engineers is expected to grow about as fast as the average for all occupations over the next decade, but growth will vary by specialty. Biomedical engineers should experience the fastest growth, while civil engineers should see the largest employment increase. Overall job opportunities in engineering are expected to be good. Overall engineering employment is expected to grow by 11 percent over the 2008-18 decade, about as fast as the average for all occupations.

Engineers traditionally have been concentrated in slower growing or declining manufacturing industries, in which they will continue to be needed to design, build, test, and improve manufactured products. However, increasing employment of engineers in engineering, research and development, and consulting services industries should generate most of the employment growth. The job outlook varies by engineering specialty, as discussed later. Competitive pressures and advancing technology will force companies to improve and update product designs and to optimize their manufacturing processes. Employers will rely on engineers to increase productivity and expand output of goods and services. New technologies continue to improve the design process, enabling engineers to produce and analyze various product designs much more rapidly than in the past. Unlike the situation in some other occupations, however, technological advances are not expected to substantially limit employment opportunities in engineering, because engineers are needed to provide the ideas that lead to improved products and more productive processes.

The continued globalization of engineering work will likely dampen domestic employment growth to some degree. There are many well-trained, often English-speaking, engineers available around the world who are willing to work at much lower salaries than U.S. engineers. The rise of the Internet has made it relatively easy for part of the engineering work previously done by engineers in this country to be done by engineers in other countries, a factor that will tend to hold down employment growth. Even so, there will always be a need for onsite engineers to interact with other employees and clients.

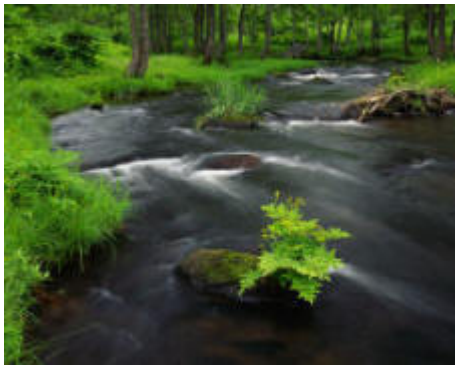
Overall job opportunities in engineering are expected to be good, and, indeed, prospects will be excellent in certain specialties. In addition to openings from job growth, many openings will be created by the need to replace current engineers who retire; transfer to management, sales, or other occupations; or leave engineering for other reasons.

Many engineers work on long-term research and development projects or in other activities that continue even during economic slowdowns. In industries such as electronics and aerospace, however, large cutbacks in defense expenditures and in government funding for research and development have resulted in significant layoffs of engineers in the past. The trend toward contracting for engineering work with engineering services firms, both domestic

and foreign, also has made engineers more vulnerable to layoffs during periods of lower demand.

It is important for engineers, as it is for workers in other technical and scientific occupations, to continue their education throughout their careers, because much of their value to their employer depends on their knowledge of the latest technology. Engineers in high-technology areas, such as biotechnology or information technology, may find that their technical knowledge will become outdated rapidly. By keeping current in their field, engineers will be able to deliver the best solutions and greatest value to their employers. Engineers who have not kept current in their field may find themselves at a disadvantage when seeking promotions or during layoffs.

Professional Organizations



Professional organizations and associations provide a wide range of resources for planning and navigating a career in engineering. These groups can play a key role in your development and keep you abreast of what is happening in your industry. Associations promote the interests of their members and provide a network of contacts that can help you find jobs and move your career forward. They can offer a variety of services including job referral services, continuing education courses, insurance, travel benefits, periodicals, and meeting and conference opportunities. Many professional societies also have student chapters. Student engineers are encouraged to join their local chapter and participate in programs and activities to help network with other students and professional engineers.

A broad list of professional associations is available at www.careercornerstone.org.