# Engineering

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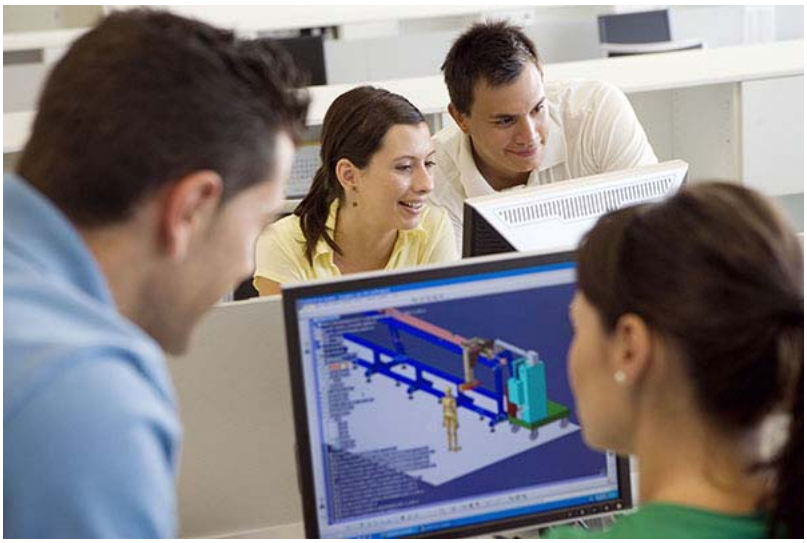
## Key Concepts

- Engineers participate in the design through maintenance of structures, machines, and products that make better use of energy resources and materials and improve living conditions at lower cost.
- Over time, engineering has branched out into many specialized fields, such as biomedical engineering, earthquake engineering, and genetic engineering, to name a few.
- As engineering has become more specialized, projects (such as in biotechnology) have become more complex and require specialists from many different fields working together.

**The application of science and mathematics for designing, developing, constructing, and maintaining structures, machines, and products as well as for protecting human health and the environment.** Engineering involves people, money, materials, machines, and energy. It is differentiated from science because it is primarily concerned with how to direct to useful and economical ends the natural phenomena that scientists discover and formulate into acceptable theories. Engineering therefore requires above all the creative imagination to innovate useful applications of natural phenomena (see **illustration**). It is always dissatisfied with present methods and equipment. It seeks newer, faster, cheaper, better means of using natural sources of energy and materials to improve living conditions.

## *Evolution of engineering*

Traditionally there were two engineering divisions or disciplines: military and civil. As knowledge of natural phenomena grew and the potential civil applications became more complex, the civil engineering discipline became more specialized. The practicing engineer began to restrict operations to narrower channels. For instance, civil engineering came to be concerned primarily with static structures, such as dams, bridges, and buildings, whereas mechanical engineering split off to concentrate on dynamic structures, such as machinery and engines. Similarly, mining engineering became concerned with the discovery of, and removal from, geological structures of metalliferous ore bodies, whereas metallurgical engineering involved extraction and refinement of the metals from the ores. From the practical applications of electricity and chemistry, electrical and chemical engineering arose.



**Engineers use computer-aided design (CAD) programs to develop new, technologically innovative products as well as to estimate the performance and cost of design prototypes and to calculate the optimal values for design parameters. (Credit: Pixtal/AGE Fotostock)**

This splintering process continued as narrower specialization became more prevalent. Civil engineers had more specialized training as structural engineers, dam engineers, water-power engineers, bridge engineers; mechanical engineers as machine-design engineers, industrial engineers, automotive engineers; electrical engineers as power and telecommunication engineers, whereas the power engineers divided into fossil-fuel and nuclear engineers; mining engineers as metallic-ore mining engineers and fossil-fuel (coal and petroleum) engineers.

As a result of this ever-increasing utilization of technology, people and their environments have been affected in various ways—some good, some bad. Environmental engineering, for example, has been expanded from treating the waste products of humans and technological processes to managing natural resources and mitigating environmental problems. In addition, because people and money are as much involved in engineering as materials, machines, and energy sources, the management engineer arose as another integrating factor.

## *Integrating influences*

While specialization was taking place, there were also integrating influences in the engineering field. The growing complexity of technology called for many specialists to cooperate in the design of industrial processes and even in the design of individual genes. Multidisciplinary activity then developed to coordinate complex projects. For example, bioengineering— engineering applications in biomedicine, biology, and other life sciences—projects, such as the design and development of artificial organs and prosthetic devices, requires expertise in electrical engineering, mechanical engineering, materials science, polymer chemistry, and biology, among others.

Typical engineers go through several phases of activity during their careers. Formal education must be broad and deep in the sciences and humanities underlying the particular field. As an engineer's degree of specialization increases, continued post-scholastic education is required. Normal promotion thus brings interdisciplinary activity as the engineer supervises various specialists. Finally, the engineer enters into the management function by interweaving workers, money, materials, machines, and energy sources into completed processes for the use of humankind.

## *Types of engineering*

In addition to the traditional engineering disciplines of civil, chemical, electrical, and mechanical engineering, there are various other engineering disciplines and subdisciplines.

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## Keywords

engineering; civil engineering; chemical engineering; electrical engineering; mechanical engineering; materials; energy; economics

## Additional Readings

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