

The work of health and safety engineers is similar to that of industrial engineers in that they are concerned with the entire production process. They promote worksite or product safety and health by applying knowledge of industrial processes, as well as mechanical, chemical, and psychological principles. They must be able to anticipate and evaluate hazardous conditions as well as develop hazard control methods. They also must be familiar with the application of health and safety regulations.

Employment

Industrial engineers, including health and safety, held about 198,000 jobs in 2000. More than 65 percent of these jobs were in manufacturing industries. Because their skills can be used in almost any type of organization, industrial engineers are more widely distributed among manufacturing industries than are other engineers.

Their skills can be readily applied outside manufacturing as well. Some work in engineering and management services, utilities, and business services; others work for government agencies or as independent consultants.

Job Outlook

Despite industrial growth and more complex business operations, overall employment of industrial engineers, including health and safety, is expected to grow more slowly than the average for all occupations through 2010, reflecting greater use of automation in factories and offices. Employment of industrial engineers is expected to grow more slowly than average while health and safety engineers are expected to grow about as fast as average.

Because the main function of industrial and health and safety engineers is to make a higher quality product as efficiently and as safely as possible, their services should be in demand in the manufacturing sector as firms seek to reduce costs and increase productivity. There also is an increased demand for industrial engineers within the financial services sector, as more emphasis is put on information technology. Also, the growing concern for health and safety within work environments should increase the need for health and safety engineers.

Earnings

Median annual earnings of industrial engineers were \$58,580 in 2000. The middle 50 percent earned between \$47,530 and \$71,050. The lowest 10 percent earned less than \$38,140, and the highest 10 percent earned more than \$86,370. Median annual earnings in the manufacturing industries employing the largest numbers of industrial engineers in 2000 were:

Motor vehicles and equipment	\$63,010
Electronic components and accessories	62,560
Computer and office equipment	62,260
Computer and data processing services	60,510
Aircraft and parts	58,290

Median annual earnings of health and safety engineers were \$54,630 in 2000. The middle 50 percent earned between \$44,230 and \$67,500. The lowest 10 percent earned less than \$34,710, and the highest 10 percent earned more than \$82,320. In 2000, the median annual earnings of health and safety engineers in railroads were \$56,970.

According to a 2001 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in industrial engineering received starting offers averaging about \$48,320 a year; master's degree candidates averaged \$56,265 a year; and Ph.D. candidates were initially offered \$59,800.

Sources of Additional Information

For further information about industrial engineers, contact:

► Institute of Industrial Engineers, Inc., 25 Technology Park/Atlanta, Norcross, GA 30092. Internet: <http://www.iienet.org>

General information about safety engineers is available from:

► American Society of Safety Engineers, 1800 E Oakton St., Des Plaines, IL 60018-21. Internet: <http://www.asse.org>

Information about certification of safety professionals, including safety engineers, is available from:

► Board of Certified Safety Professionals, 208 Burwash Ave., Savoy, Illinois 61874-957. Internet: <http://www.bccsp.org>

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

Materials Engineers

(O*NET 17-2131.00)

Nature of the Work

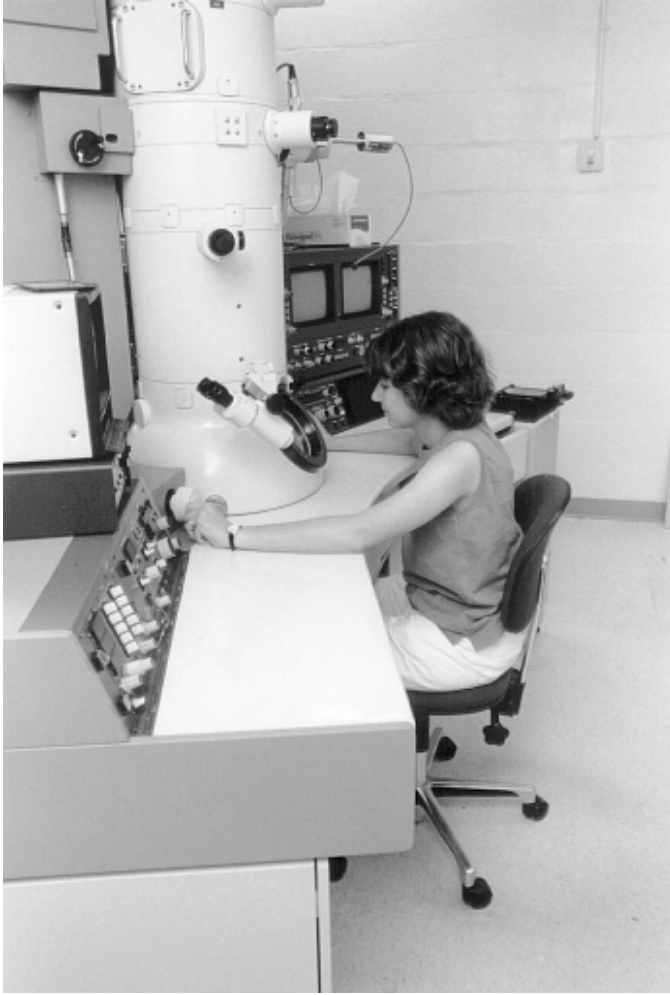
Materials engineers are involved in the extraction, development, processing, and testing of the materials used to create a diversity of products, from computer chips and television screens to golf clubs and snow skis. They work with metals, ceramics, plastics, semiconductors, and combinations of materials called composites to create new materials that meet certain mechanical, electrical, and chemical requirements. They also are involved in selecting materials for new applications.

There are numerous new developments within materials engineering that make it possible to manipulate and use materials in various ways. For example, materials engineers have developed the ability to create and then study materials at an atomic level using advanced processes, electrons, neutrons, or x-rays and to replicate the characteristics of materials and their components with computers.

Materials engineers specializing in metals can be considered *metallurgical engineers*, while those specializing in ceramics can be considered *ceramic engineers*. Most metallurgical engineers work in one of the three main branches of metallurgy—extractive or chemical, physical, and process. Extractive metallurgists are concerned with removing metals from ores and refining and alloying them to obtain useful metal. Physical metallurgists study the nature, structure, and physical properties of metals and their alloys, and relate them to the methods of processing them into final products. Process metallurgists develop and improve metalworking processes such as casting, forging, rolling, and drawing. Ceramic engineers develop ceramic materials and the processes for making ceramic materials into useful products. Ceramics include all non-metallic, inorganic materials that generally require high temperatures in their processing. Ceramic engineers work on products as diverse as glassware, automobile and aircraft engine components, fiber-optic communication lines, tile, and electric insulators.

Employment

Materials engineers held about 33,000 jobs in 2000. Because materials are building blocks for other goods, materials engineers are widely distributed among manufacturing industries. In fact, 84 percent of materials engineers worked in manufacturing industries, primarily metal production and processing, electronic and other electrical equipment, transportation equipment, and industrial machinery and equipment. They also worked in services industries such as engineering and management and research and testing services. Most remaining materials engineers worked for Federal and State governments.



Materials engineers work with metals, ceramics, plastics, semiconductors, and composites to create new materials.

Job Outlook

Employment of materials engineers is expected to grow more slowly than the average for all occupations through 2010. More materials engineers will be needed to develop new materials for electronics and plastics products. However, many of the manufacturing industries in which materials engineers are concentrated—such as primary metals and stone, clay, and glass products—are expected to experience declines in employment, reducing employment opportunities for materials engineers. As firms contract out to meet their materials engineering needs, however, employment growth is expected in many services industries, including research and testing, personnel supply, health, and engineering and architectural services. In addition to growth, job openings will result from the need to replace materials engineers who transfer to other occupations or leave the labor force.

Earnings

Median annual earnings of materials engineers were \$59,100 in 2000. The middle 50 percent earned between \$47,320 and \$72,900. The lowest 10 percent earned less than \$37,680, and the highest 10 percent earned more than \$87,630.

According to a 2001 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in materials engineering received starting offers averaging \$49,936 a year.

Sources of Additional Information

For further information about materials engineers, contact:

- ▶ Minerals, Metals, & Materials Society, 184 Thorn Hill Rd., Warrendale, PA 15086. Internet: <http://www.tms.org>
- ▶ ASM International Foundation, Materials Park, OH 44073-0002. Internet: <http://www.asm-intl.org>

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Mechanical Engineers

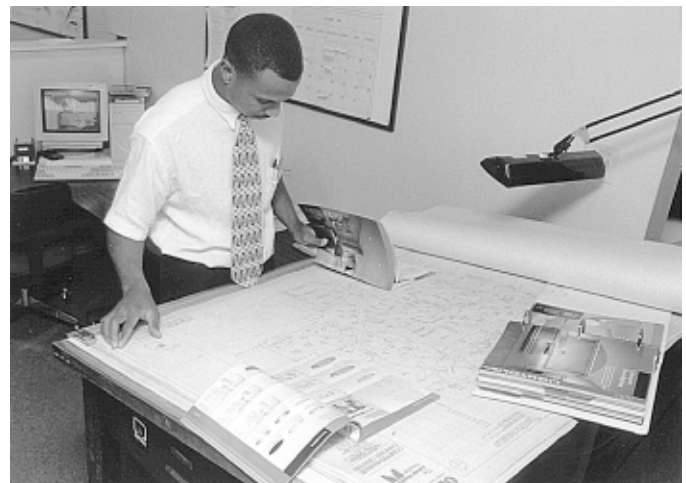
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Nature of the Work

Mechanical engineers research, develop, design, manufacture, and test tools, engines, machines, and other mechanical devices. They work on power-producing machines such as electric generators, internal combustion engines, and steam and gas turbines. They also develop power-using machines such as refrigeration and air-conditioning equipment, machine tools, material handling systems, elevators and escalators, industrial production equipment, and robots used in manufacturing. Mechanical engineers also design tools needed by other engineers for their work. The field of nanotechnology, which involves the creation of high-performance materials and components by integrating atoms and molecules, is introducing entirely new principles to the design process.

Computers assist mechanical engineers by accurately and efficiently performing computations and by aiding the design process by permitting the modeling and simulation of new designs. Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) are used for design data processing and for developing alternative designs.

Mechanical engineers work in many industries, and their work varies by industry and function. Some specialties include applied mechanics; computer-aided design and manufacturing; energy systems; pressure vessels and piping; and heating, refrigeration, and air-conditioning systems. Mechanical engineering is one of the broadest engineering disciplines. Mechanical engineers may work in production operations in manufacturing or agriculture, maintenance, or technical sales; many are administrators or managers.



A mechanical engineer works on designs for a hospital building.