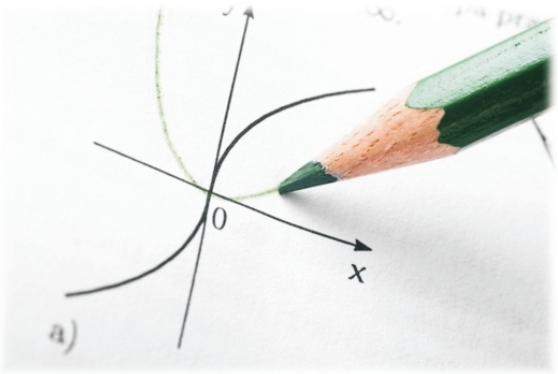
Explore the Roles of Engineers

ENGINEERS can be responsible for a range of tasks. They typically use math, physics, and scientific data to analyze the design and construction of just about everything. Their work is very precise and accurate, requiring attention to details and instructions. Engineers require good organizational and communication skills. They have had a significant influence on the built environment. Their work may involve designing building structures; developing chemicals; designing electrical, computer, and mechanical systems; and designing our infrastructure.



Objectives:

1. Describe the roles of engineers.
2. Summarize the historical influences of engineers.
3. Identify career opportunities related to the field of engineering.

Key Terms:

aerospace engineers
chemical engineers
civil engineers
computer engineers
electrical engineers
engineering technicians
industrial engineers
marine engineers
material engineers
mechanical engineers
nuclear engineers
petroleum engineers
structural engineers

Understanding the Roles of Engineers

Being an engineer requires having a range of knowledge across a variety of fields, depending on the specific disciplines involved. Engineers, in some manner, are involved in all of the buildings, machines, communication, and production systems that create our environment.

FIGURE 1. Engineers use a range of software. It can be used for designing and drawing as well as for data and statistical analysis.

KNOWLEDGE

Knowledge of a range of information is required for an engineer. This includes specific design techniques, tools, and principles involved in the production of precision technical plans, construction documents (blueprints), drawings, and models. Appropriate knowledge is also required of the materials or medium the engineer uses. For instance, an electrical engineer needs to know all about how electricity works, and a chemical engineer needs to know chemistry and how different elements react with each other.

Knowledge of arithmetic, algebra, geometry, calculus, and statistics as well as how they are applied can be critical, depending on the type of engineering. The ability to use and construct the English language is also necessary. Without correct spelling, grammar, and composition, text can give inaccurate information. Awareness of production processes and techniques, the refinement process, and methods of controlling quality and cost are useful for engineers. They also need to have a good grasp on how to use physical laws and principles, which are used for predicting and understanding how things work.

SKILLS

Being able to manage your time is essential for engineering. Some tasks may take weeks or months to complete. As a result, communication is critical. You must pay close attention to directions, listen, and understand points being made. You should restate what you heard to verify that you understood. Reading comprehension, mathematics, judgment and decision making, writing, critical thinking, and complex problem solving are other necessary skills. In addition, your ideas and concerns are important, and you must be able to express them verbally.

ABILITIES

Some engineering design documents may be long and in depth, so good reading comprehension is necessary to fully understand what is written. There are numerous ways to approach problems that can arise, so being able to make decisions based on standards and developed criteria is important. Therefore, engineers need the ability to think critically and to make judgment calls using logic and reasoning. Deductive and inductive reasoning skills can allow an engineer to find more efficient answers and to choose the most appropriate action. Being able to see the small details and how the whole works together is necessary. Creativity or coming up with clever and unusual ways to solve problems is also useful. However, all of these abilities will be useless without the ability to speak clearly, write coherently, read (and comprehend), and listen actively.

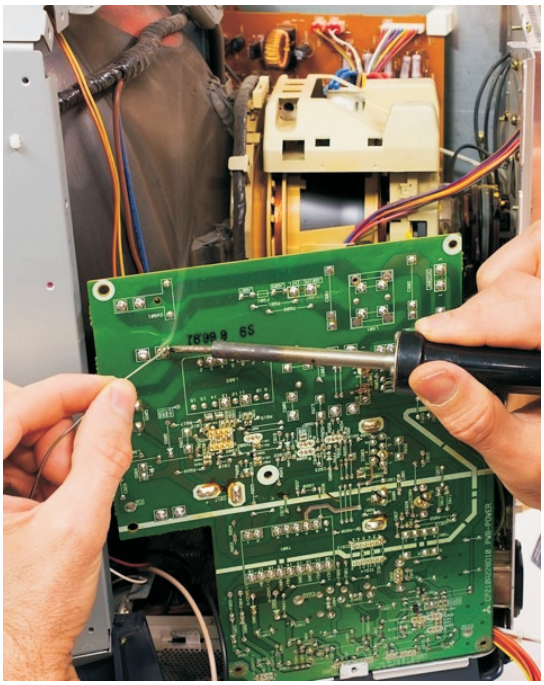


FIGURE 2. Engineering can require a range of skills, from organizing large-scale projects and technical drawings to overseeing very small-scale projects on electronic equipment.

TASKS

In general, engineers design and analyze things and communicate ideas. They use technical drawings and numeric or written data that ranges across many industries. The technical drawings have become vital tools in modern development. Engineers represent their ideas through graphics, calculations, and written specifications. In general, they are required to research and analyze data for design proposals, production specifications, structural systems, technical manuals, and operating procedures. Engineers also resolve existing problems in various systems; evaluate feasibility and cost; and examine maintenance requirements for a range of applications.

Investigating, Diagnosing, and Repairing

Their work may include the oversight of installations, operations, and maintenance or the repair of machines and equipment to ensure they function according to specifications. Engineers may investigate equipment failures, diagnose the problem, and give recommendations that will improve function and operation. This work requires research, designing, and evaluation. Engineers also are responsible for the design of mechanical equipment. They describe how to install, operate, and maintain these systems through their knowledge of a range of scientific processes and physics.

Developing Standards and Guidelines

Through their research, testing, and analyzing of design performance, equipment operations, and required components, they develop standards and guidelines for a range of professions. The standards are used to modify existing products, machines, or constructions and to create new ones by writing engineering design and performance specifications.

Working with Drafters

Engineers work with drafters to develop graphics or drawings that can range from structural designs to electrical layouts and requirements. They primarily use CADD software and equipment, which may be basic drafting software or advanced software that analyzes data.

ENGINEERING TECHNOLOGY ACUMEN

Different types of software are used in engineering technology. Analytical or scientific software is used for statistical analysis and data organization. Environmental development software and industrial control software—including computer numerical control (CNC) software—is used to create an interface between humans and machines. Object or component-oriented development software is used to design and develop programs by organizing related functions into modules.

Historical Influences

All of the great structures of the world were designed and engineered. More than 2,000 years ago, Egyptian engineers and designers created the Great Pyramids of Giza. As early as 500 B.C., Greek engineers developed ways to use wood and stone to create and organize cities and places (e.g., the Parthenon). During the Roman Empire, engineers created roads that allowed people to travel and exchange ideas and goods. They also designed the structural arch that allowed for the creation of the Coliseum in Rome. Engineers have been involved in many of our technological revolutions from the Renaissance to the Industrial Revolution to the Digital Revolution.

RENAISSANCE

During the Renaissance, engineers helped create tools that allowed us to travel great distances over land and water. They also made it possible to view the celestial system in more detail. In addition, the advancement of the microscope made it possible to analyze how things are made. All of these helped in developing the laws of physics.

INDUSTRIAL REVOLUTION

During the Industrial Revolution, engineering innovation allowed us to produce machines and equipment that could refine materials and mass produce objects. During this time, engineers advanced our understanding of how structures work. They constructed bridges and built the Eiffel Tower.

DIGITAL REVOLUTION

The digital revolution relied on engineers developing material and electronic technology that led to the development of modern computers. This has given designers, architects, and engineers the ability to refine and communicate their ideas even more precisely. CADD has completely revolutionized the engineering profession. All of the modern electronic devices you use, from your TV to your cell phone, are made possible by the work of engineers.

FIGURE 3. The construction of the Eiffel Tower was made possible by drafters, designers, and engineers.

Career Possibilities

Engineers can work in a variety of settings and may have a specific niche. For most engineering positions, a bachelor's degree is the minimum education requirement. Some fields or positions will require a master's degree or a doctorate. For current information pertaining to educational requirements, salaries, job growth, and more, use the Occupational Outlook Handbook, which is available online for free.

FURTHER EXPLORATION...

ONLINE CONNECTION: Occupational Outlook Handbook

Understanding different aspects of a career is important when making a selection. Many sources can give you a range of information about engineering careers. Check out the information from the U.S. Department of Labor.

Visit the following Web site to see a range of statistical data on engineers:

http://www.bls.gov/oco/ocos027.htm

AEROSPACE ENGINEERS

Aerospace engineers are people who develop and design technology used for testing and building aircraft, rockets, and spacecraft. The median wage is $42.12 hourly or $87,610 annually.

FIGURE 4. Chemical processing plants can be complex and require the work of many engineers to ensure proper functioning.

CHEMICAL ENGINEERS

Chemical engineers are people who develop processes for creating and manufacturing chemicals and related products. They are involved in designing the plants and equipment for chemical production. They must have knowledge of physics, chemistry, and (in some cases) biology. The median wage is $37.91 hourly or $78,860 annually.

FIGURE 5. Chemical engineers can be involved in the creation of new solutions that help clean your clothes to the creation of more compact laptops.

CIVIL ENGINEERS

Civil engineers are people involved in the design of our infrastructure. They plan and oversee the development of a full range of structures and facilities (e.g., power plants, pipelines, water and sewage systems, waste disposal systems, water ways, dams, irrigation projects, roads, bridges, airports, and railroads). The median wage is $32.98 hourly or $68,600 annually.

COMPUTER ENGINEERS

Computer engineers are people who develop computer technology through design, development, and research. They create and test computers and related equipment for all types of users. The median wage is $42.54 hourly or $88,470 annually.

ELECTRICAL ENGINEERS

Electrical engineers are people who design components and systems that rely on electricity. This requires research and development by exploring electronics and material proper-

ties for conduction. Electrical engineers can apply their skills across a wide range of professions, including electronic controls in cars and planes, telecommunications, and acoustical and instrument controls. The median wage is $38.91 hourly or $81,050 annually.

ENGINEERING TECHNICIANS

Engineering technicians are people who address issues (e.g., the industrial layout of manufacturing and production). They typically work with an engineering staff utilizing computer interface software (e.g., CADD and CNC systems) to aid engineers in the design and possible fabrication or creation processes. This field typically requires vocational-technical school training, related on-the-job experience, and sometimes an associate's degree. The median wage is $22.51 hourly or $46,610 annually.

INDUSTRIAL ENGINEERS

Industrial engineers are people who focus on the integrated systems used for managing the production of industrial processes. They develop, design, and test possible solutions. These include quality and inventory control; cost analysis and production coordination; logistics and material flow; and human work factors. The median wage is $32.99 hourly or $69,620 annually.

FIGURE 6. Industrial engineers are involved with the design of products (e.g., these car parts) and how the parts can be produced.

MARINE ENGINEERS

Marine engineers are people who research and design ship machinery and equipment (e.g., power supply systems and propulsion machines). The median wage is $35.09 hourly or $72,990 annually.

MATERIAL ENGINEERS

Material engineers are people who study and research materials for manufacturing and products as well as the machinery used to refine and create the products. They investigate and design materials that meet performance specifications. Material engineers also create new uses and variations of known materials. The median wage is $37.91 hourly or $78,860 annually.

MECHANICAL ENGINEERS

Mechanical engineers are people who can be involved with anything that has movable parts (e.g., tools, engines, and machines). They also study and research the movement of liquids and air. The median wage is $33.58 hourly or $69,850 annually.

NUCLEAR ENGINEERS

Nuclear engineers are people concerned with the utilization of nuclear energy and its waste. They develop strategies and conduct research on how we release and control nuclear energy. To solve problems and present solutions, they apply the principles and theories of nuclear science. The median wage is $43.38 hourly or $90,220 annually.

PETROLEUM ENGINEERS

Petroleum engineers are people who develop ways to extract, refine, and distribute oil and gas. They design methods to improve production and the tools used in the oil industry. These engineers offer technical services and advice for drilling and for efficient economical progress. The median wage is $47.30 hourly or $98,380 annually.

STRUCTURAL ENGINEERS

FIGURE 7. Some structures can be complex and require a team of engineers to calculate all the forces and to design the proper structure.

Structural engineers are people who primarily use mathematical calculations to design structural items, including the size and location. They analyze the forces in columns and beams to resist gravity and lateral (e.g., wind or seismic) loads. They create structural systems with columns and beams out of wood, steel, and concrete. Their knowledge and skills ensure that buildings, bridges, and other built forms perform safely. In many cases, they work with architects and other engineers to creatively solve problems and to create innovative solutions. The median wage is $42.12 hourly or $87,610 annually.

Summary:

Being an engineer requires having knowledge across a variety of fields. In general, engineers design and analyze things and communicate ideas. They use technical drawings and numeric or written data. Engineers represent their ideas through graphics, calculations, and written specifications.

Knowledge of arithmetic, algebra, geometry, calculus, and statistics as well as how they are applied can be critical. Being able to manage time is essential. Many alternate ways to approach problems may exist, so being able to make decisions based on standards and developed criteria is important.

All of the great structures of the world were designed and engineered. The range and types of engineering are broad. Some responsibilities are creating materials and new chemicals; designing airplanes, ships, and buildings; and building electronic equipment that runs our computers. Typically, most engineering jobs require at least a bachelor's degree.

Checking Your Knowledge:

1. Give two examples of how engineers represent their ideas.
2. Engineers require knowledge across a range of studies. List three of these areas.
3. Name three different fields in engineering.
4. What is the job of a civil engineer?
5. What type of degree or training does an engineering technician need?

Expanding Your Knowledge:

Use some of the provided Web sites and others to research an area of engineering that is of interest to you. Create a PowerPoint presentation to share with the class. You may want to interview someone in the field and incorporate the information into your presentation.

Web Links:

A Sightseer's Guide to Engineering
http://www.engineeringsights.org/

Discover Engineering
http://www.discoverengineering.org/

Types of Engineering and Schools
http://www.top-engineering-schools.com/types-of-engineering.html

Introduction to Types of Engineering
http://www.nativeaccess.com/types/index.html