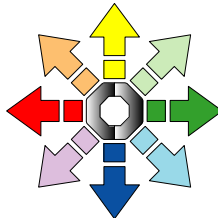


IN-DEPTH CAREER REPORT

for

Engineers: All Specialties

APRIL 4, 2009



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I. Occupational Outlook:

ENGINEERS

Significant Points

- Overall job opportunities in engineering are expected to be good, but will vary by specialty.
- A bachelor's degree is required for most entry-level jobs.
- Starting salaries are significantly higher than those of college graduates in other fields.
- Continuing education is critical for engineers wishing to enhance their value to employers as technology evolves.

Nature of the Work

Engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is the link between perceived social needs and commercial applications.

Engineers consider many factors when developing a new product. For example, in developing an industrial robot, engineers precisely specify the functional requirements; 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, gas turbines, helicopters, and toys.

In addition to design and development, many engineers work in testing, production, or maintenance. These engineers supervise production in factories, determine the causes of component failure, and test manufactured products to maintain quality. They also estimate the time and cost to complete projects. Some move into engineering management or into sales. In sales, an engineering background enables them to discuss technical aspects and assist in product planning, installation, and use. 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; and to generate specifications for parts. Many engineers also use computers to monitor product quality and control process efficiency. The field of 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.

Most engineers specialize. This section provides details on the 17 engineering specialties covered in the Federal Government's Standard Occupational Classification system and on engineering in general. Numerous specialties are recognized by professional societies, and the major branches of engineering have numerous subdivisions. Some examples include structural and transportation engineering, which are subdivisions of civil engineering; and ceramic, metallurgical, and polymer engineering, which are subdivisions of materials engineering. Engineers also may specialize in one industry, such as motor vehicles, or in one type of technology, such as turbines or semiconductor materials.

- **Aerospace engineers** design, develop, and test aircraft, spacecraft, and missiles and supervise the manufacture of these products. Those who work with aircraft are called *aeronautical engineers*, and those working specifically with spacecraft are *astronautical engineers*. Aerospace engineers develop new technologies for use in aviation, defense systems, and space exploration, often specializing in areas such as structural design, guidance, navigation and control, instrumentation and communication, or production methods. They also may specialize in a particular type of aerospace product, such as commercial aircraft, military fighter jets, helicopters, spacecraft, or missiles and rockets, and may become experts in aerodynamics, thermodynamics, celestial mechanics, propulsion, acoustics, or guidance and control systems.
- **Agricultural engineers** apply knowledge of engineering technology and science to agriculture and the efficient use of biological resources. They design agricultural machinery and equipment and agricultural structures. Some specialize in areas such as power systems and machinery design; structures and environment engineering; and food and bioprocess engineering. They develop ways to conserve soil and water and to improve the processing of agricultural products. Agricultural engineers often work in research and development, production, sales, or management.
- **Biomedical engineers** develop devices and procedures that solve medical and health-related problems by combining their knowledge of biology and medicine with engineering principles and practices. Many do research, along with life scientists, chemists, and medical scientists, to develop and evaluate systems and products such as artificial organs, prostheses (artificial devices that replace missing body parts), instrumentation, medical information systems, and health management and care delivery systems. Biomedical engineers may also design devices used in various medical procedures, imaging systems such as magnetic resonance imaging (MRI), and devices for automating insulin injections or controlling body functions. Most engineers in this specialty need a sound background in another engineering specialty, such as mechanical or electronics engineering, in addition to specialized biomedical training. Some specialties within biomedical engineering include biomaterials, biomechanics, medical imaging, rehabilitation engineering, and orthopedic engineering.
- **Chemical engineers** apply the principles of chemistry to solve problems involving the production or use of chemicals and biochemicals. They design equipment and processes for large-scale chemical manufacturing, plan and test methods of manufacturing products and treating byproducts, and supervise production. Chemical engineers also work in a variety of manufacturing industries other than chemical manufacturing, such as those producing energy, electronics, food, clothing, and paper. They also work in healthcare, biotechnology, and business services. Chemical engineers apply principles of chemistry, physics, mathematics, and mechanical and electrical engineering. Some may specialize in a particular chemical

process, such as oxidation or polymerization. Others specialize in a particular field, such as materials science, or in the development of specific products. They must be aware of all aspects of chemicals manufacturing and how the manufacturing process affects the environment and the safety of workers and consumers.

- **Civil engineers** design and supervise the construction of roads, buildings, airports, tunnels, dams, bridges, and water supply and sewage systems. They must consider many factors in the design process, from the construction costs and expected lifetime of a project to government regulations and potential environmental hazards such as earthquakes. Civil engineering, considered one of the oldest engineering disciplines, encompasses many specialties. The major specialties are structural, water resources, construction, environmental, transportation, and geotechnical engineering. Many civil engineers hold supervisory or administrative positions, from supervisor of a construction site to city engineer. Others may work in design, construction, research, and teaching.
- **Computer hardware engineers** research, design, develop, test, and oversee the installation of computer hardware and supervise its manufacture and installation. Hardware refers to computer chips, circuit boards, computer systems, and related equipment such as keyboards, modems, and printers. The work of computer hardware engineers is very similar to that of electronics engineers, but, unlike electronics engineers, computer hardware engineers work exclusively with 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.
- **Electrical engineers** design, develop, test, and supervise the manufacture of electrical equipment. Some of this equipment includes electric motors; machinery controls, lighting, and wiring in buildings; automobiles; aircraft; radar and navigation systems; and power-generating, -controlling, and transmission devices used by electric utilities. Although the terms “electrical” and “electronics” engineering often are used interchangeably in academia and industry, electrical engineers have traditionally focused on the generation and supply of power, whereas electronics engineers have worked on applications of electricity to control systems or signal processing. Electrical engineers specialize in areas such as power systems engineering or electrical equipment manufacturing.
- **Electronics engineers, except computer**, are responsible for a wide range of technologies, from portable music players to the global positioning system (GPS), which can continuously provide the location of a vehicle. Electronics engineers design, develop, test, and supervise the manufacture of electronic equipment such as broadcast and communications systems. Many 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. Electronics engineers specialize in areas such as communications, signal processing, and control systems or have a specialty within one of these areas—industrial robot control systems or aviation electronics, for example.
- **Environmental engineers** develop solutions to environmental problems using the principles of biology and chemistry. They are involved in water and air pollution control, recycling, waste disposal, and public health issues. Environmental engineers conduct hazardous-waste management studies in which they evaluate the significance of the hazard, advise on treatment and containment, and develop regulations to prevent mishaps. They design municipal water supply and industrial wastewater treatment systems. They conduct research on the environmental impact of proposed construction projects, analyze scientific

data, 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 may also be involved in the protection of wildlife. Many environmental engineers work as consultants, helping their clients to comply with regulations and to clean up hazardous sites.

- **Health and safety engineers, except mining safety engineers and inspectors**, promote worksite or product safety by applying knowledge of industrial processes and mechanical, chemical, and human performance principles. Using this specialized knowledge, they identify and measure potential hazards to people or property, such as the risk of fires or the dangers involved in the handling of toxic chemicals. Health and safety engineers develop procedures and designs to reduce the risk of injury or damage. Some work in manufacturing industries to ensure the designs of new products do not create unnecessary hazards. They must be able to anticipate, recognize, and evaluate hazardous conditions, as well as develop hazard control methods.
- **Industrial engineers** determine the most effective ways to use the basic factors of production—people, machines, materials, information, and energy—to make a product or to provide a service. They are mostly concerned with increasing productivity through the management of people, methods of business organization, and technology. To solve organizational, production, and related problems efficiently, industrial engineers carefully study the product requirements, use mathematical methods to meet those requirements, and design manufacturing and information systems. They develop management control systems to aid in financial planning and cost analysis, and design production planning and control systems to coordinate activities and ensure product quality. They also design or improve systems for the physical distribution of goods and services, as well as determine the most efficient plant locations. Industrial engineers develop wage and salary administration systems and job evaluation programs. Many industrial engineers move into management positions because the work is closely related to the work of managers.
- **Marine engineers and naval architects** are involved in the design, construction, and maintenance of ships, boats, and related equipment. They design and supervise the construction of everything from aircraft carriers to submarines, and from sailboats to tankers. Naval architects work on the basic design of ships, including hull form and stability. Marine engineers work on the propulsion, steering, and other systems of ships. Marine engineers and naval architects apply knowledge from a range of fields to the entire design and production process of all water vehicles. Workers who operate or supervise the operation of marine machinery on ships and other vessels also may be called marine engineers or, more frequently, ship engineers.
- **Materials engineers** are involved in the development, processing, and testing of the materials used to create a range of products, from computer chips and television screens to golf clubs and snow skis. They work with metals, ceramics, plastics, semiconductors, and composites to create new materials that meet certain mechanical, electrical, and chemical requirements. They also are involved in selecting materials for new applications. Materials engineers have developed the ability to create and then study materials at an atomic level, using advanced processes to replicate the characteristics of materials and their components with computers. Most materials engineers specialize in a particular material. For example, metallurgical engineers specialize in metals such as steel, and ceramic engineers develop

ceramic materials and the processes for making ceramic materials into useful products such as glassware or fiber optic communication lines.

- **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, as well as 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 that other engineers need for their work. 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.
- **Mining and geological engineers, including mining safety engineers**, find, extract, and prepare coal, metals, and minerals for use by manufacturing industries and utilities. They design open-pit and underground mines, supervise the construction of mine shafts and tunnels in underground operations, and devise methods for transporting minerals to processing plants. Mining engineers are responsible for the safe, economical, and environmentally sound operation of mines. Some mining engineers work with geologists and metallurgical engineers to locate and appraise new ore deposits. Others develop new mining equipment or direct mineral- processing operations that separate minerals from the dirt, rock, and other materials with which they are mixed. Mining engineers frequently specialize in the mining of one mineral or metal, such as coal or gold. With increased emphasis on protecting the environment, many mining engineers work to solve problems related to land reclamation and water and air pollution. Mining safety engineers use their knowledge of mine design and practices to ensure the safety of workers and to comply with State and Federal safety regulations. They inspect walls and roof surfaces, monitor air quality, and examine mining equipment for compliance with safety practices.
- **Nuclear engineers** research and develop the processes, instruments, and systems used to derive benefits from nuclear energy and radiation. They design, develop, monitor, and operate nuclear plants to generate power. They may work on the nuclear fuel cycle—the production, handling, and use of nuclear fuel and the safe disposal of waste produced by the generation of nuclear energy—or on the development of fusion energy. Some specialize in the development of nuclear power sources for spacecraft; others find industrial and medical uses for radioactive materials, as in equipment used to diagnose and treat medical problems.
- **Petroleum engineers** search the world for reservoirs containing oil or natural gas. Once these resources are discovered, petroleum engineers work with geologists and other specialists to understand the geologic formation and properties of the rock containing the reservoir, determine the drilling methods to be used, and monitor drilling and production operations. They design equipment and processes to achieve the maximum profitable recovery of oil and gas. Because only a small proportion of oil and gas in a reservoir flows out under natural forces, petroleum engineers develop and use various enhanced recovery methods. These include injecting water, chemicals, gases, or steam into an oil reservoir to force out more of the oil and doing computer-controlled drilling or fracturing to connect a larger area of a reservoir to a single well. Because even the best techniques in use today recover only a portion of the oil and gas in a reservoir, petroleum engineers research and develop technology and methods to increase recovery and lower the cost of drilling and production operations.

Working Conditions

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.

Many engineers work a standard 40-hour week. At times, deadlines or design standards may bring extra pressure to a job, requiring engineers to work longer hours.

Training, Other Qualifications, and Advancement

A bachelor's degree in engineering is required for almost all entry-level engineering jobs. College graduates with a degree in a physical 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.

Most engineering programs involve a concentration of study in an engineering specialty, along with courses in both mathematics and the physical and life sciences. General courses not directly related to engineering, such as those in the social sciences or humanities, are often a required component of programs. Many programs also include courses in general engineering. A design course, sometimes accompanied by a computer or laboratory class or both, is part of the curriculum of most programs.

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 in the application of engineering principles, 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.

About 360 colleges and universities offer bachelor's degree programs in engineering that are accredited by the Accreditation Board for Engineering and Technology (ABET), Inc., and about 230 colleges offer accredited programs in engineering technology. ABET accreditation is based on an examination of an engineering program's student achievement, program improvement, faculty, curriculum, facilities, and institutional commitment to certain principles of quality and ethics. 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 curriculums and check accreditations carefully before selecting a college.

Admissions requirements for undergraduate engineering schools include a solid background in mathematics (algebra, geometry, trigonometry, and calculus) and science (biology, chemistry, and physics), with courses in English, social studies, and humanities. 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 specialty. Some programs offer a general engineering curriculum; students then specialize on the job or in graduate school.

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 that allow students who spend 3 years in a liberal arts college studying pre-engineering subjects and 2 years in an engineering school studying core subjects to receive 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.

All 50 States and the District of Columbia require licensure for engineers who offer their services directly to the public. Engineers who are licensed are called professional engineers (PE). This licensure generally requires a degree from an ABET-accredited engineering program, 4 years of relevant work experience, and successful completion of a State examination. Recent graduates can start the licensing process by taking the examination in two stages. The initial Fundamentals of Engineering (FE) examination can be taken upon graduation. Engineers who pass this examination commonly are called engineers in training (EIT) or engineer interns (EI). After acquiring suitable work experience, EITs can take the second examination, the Principles and Practice of Engineering exam. Several States have imposed mandatory continuing education requirements for relicensure. Most States recognize licensure from other States, provided that the manner in which the initial license was obtained meets or exceeds their own licensure requirements. Many civil, electrical, mechanical, and chemical engineers are licensed PEs. Independent of licensure, various certification programs are offered by professional organizations to demonstrate competency in specific fields of engineering.

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.

Employment

In 2004 engineers held 1.4 million jobs. The distribution of employment by engineering specialty is as follows:

Total, all engineers	1,449,000	100%
Civil	237,000	16.4
Mechanical	226,000	15.6
Industrial	177,000	12.2
Electrical	156,000	10.8
Electronics, except computer	143,000	9.9
Computer hardware	77,000	5.3
Aerospace	76,000	5.2
Environmental	49,000	3.4
Chemical	31,000	2.1
Health and safety, except mining safety	27,000	1.8
Materials	21,000	1.5
Nuclear	17,000	1.2
Petroleum	16,000	1.1
Biomedical	9,700	0.7
Marine engineers and naval architects	6,800	0.5
Mining and geological, including mining safety	5,200	0.4
Agricultural	3,400	0.2
All other engineers	172,000	11.8

About 555,000 engineering jobs were found in manufacturing industries, and another 378,000 wage and salary jobs were in the professional, scientific, and technical services sector, primarily in architectural, engineering, and related services and in scientific research and development

services. Many engineers also worked in the construction and transportation, telecommunications, and utilities industries.

Federal, State, and local governments employed about 194,000 engineers in 2004. About 91,000 of these 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. Most engineers in State and local government agencies worked in highway and public works departments. In 2004, about 41,000 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 areas with sizable petroleum deposits, such as Texas, Louisiana, Oklahoma, Alaska, and California. Others, 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.

Table 1. Percent concentration of engineering specialty employment in key industries, 2004

Specialty	Industry	Percent
Aerospace	Aerospace product and parts manufacturing	59.6
Agricultural	State and local government	22.6
Biomedical	Scientific research and development services	18.7
	Pharmaceutical and medicine manufacturing	15.6
Chemical	Chemical manufacturing	27.8
	Architectural, engineering, and related services	16.3
Civil	Architectural, engineering, and related services	46.0
Computer hardware	Computer and electronic product manufacturing	43.2
	Computer systems design and related services	15.0
Electrical	Architectural, engineering, and related services	19.6
	Navigational, measuring, electromedical, and control instruments manufacturing	10.8
Electronics, except computer	Telecommunications	17.5
	Federal government	14.4
Environmental	Architectural, engineering, and related services	28.9
	State and local government	19.6
Health and safety, except mining safety	State and local government	12.4
Industrial	Machinery manufacturing	7.8

Table 1. Percent concentration of engineering specialty employment in key industries, 2004

Specialty	Industry	Percent
	Motor vehicle parts manufacturing	7.1
Marine engineers and naval architects	Architectural, engineering, and related services	34.5
Materials	Computer and electronic product manufacturing	14.3
Mechanical	Architectural, engineering, and related services	18.1
	Machinery manufacturing	13.4
Mining and geological, including mining safety	Mining	49.9
Nuclear	Electric power generation, transmission and distribution	36.1
Petroleum	Oil and gas extraction	47.4

Job Outlook

Overall engineering employment is expected to grow about as fast as the average for all occupations over the 2004-14 period. Engineers have traditionally been concentrated in slow-growing manufacturing industries, in which they will continue to be needed to design, build, test, and improve manufactured products. However, increasing employment of engineers in faster growing service industries should generate most of the employment growth. Overall job opportunities in engineering are expected to be favorable because the number of engineering graduates should be in rough balance with the number of job openings over this period. However, job outlook varies by specialty, as discussed later in this section.

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 further increase productivity as investment in plant and equipment increases to 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 in other fields, however, technological advances are not expected to limit employment opportunities substantially, because they will permit the development of new products and processes.

There are many well-trained, often English-speaking engineers available around the world willing to work at much lower salaries than are U.S. engineers. The rise of the Internet has made it relatively easy for much 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, the need for onsite engineers to interact with other employees and with clients will remain.

Compared with most other workers, a smaller proportion of engineers leave their jobs each year. Nevertheless, many job openings will arise from replacement needs, reflecting the large size of this profession. Numerous job openings will be created by engineers who transfer to management, sales, or other professional occupations; additional openings will arise as engineers retire or leave the labor force 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, has had the same result.

It is important for engineers, as it is for those working 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 advanced electronics or information technology, may find that technical knowledge can become outdated rapidly. By keeping current in their field, engineers are able to deliver the best solutions and greatest value to their employers. Engineers who have not kept current in their field may find themselves passed over for promotions or vulnerable to layoffs.

The following section discusses job outlook by engineering specialty.

- **Aerospace engineers** are expected to have slower-than-average growth in employment over the projection period. Although increases in the number and scope of military aerospace projects likely will generate new jobs, increased efficiency will limit the number of new jobs in the design and production of commercial aircraft. Even with slow growth, the employment outlook for aerospace engineers through 2014 appears favorable: the number of degrees granted in aerospace engineering declined for many years because of a perceived lack of opportunities in this field, and, although this trend is reversing, new graduates continue to be needed to replace aerospace engineers who retire or leave the occupation for other reasons.
- **Agricultural engineers** are expected to have employment growth about as fast as the average for all occupations through 2014. The growing interest in worldwide standardization of agricultural equipment should result in increased employment of agricultural engineers. Job opportunities also should result from the need to feed a growing population, develop more efficient agricultural production, and conserve resources.
- **Biomedical engineers** are expected to have employment growth that is much faster than the average for all occupations through 2014. The aging of the population and the focus on health issues will drive demand for better medical devices and equipment designed by biomedical engineers. Along with the demand for more sophisticated medical equipment and procedures, an increased concern for cost-effectiveness will boost demand for biomedical engineers, particularly in pharmaceutical manufacturing and related industries. However, because of the growing interest in this field, the number of degrees granted in biomedical engineering has increased greatly. Biomedical engineers, particularly those with only a

bachelor's degree, may face competition for jobs. Unlike the case for many other engineering specialties, a graduate degree is recommended or required for many entry-level jobs.

- **Chemical engineers** are expected to have employment growth about as fast as the average for all occupations through 2014. Although overall employment in the chemical manufacturing industry is expected to decline, chemical companies will continue to research and develop new chemicals and more efficient processes to increase output of existing chemicals. Among manufacturing industries, pharmaceuticals may provide the best opportunities for jobseekers. However, most employment growth for chemical engineers will be in service industries such as scientific research and development services, particularly in energy and the developing fields of biotechnology and nanotechnology.
- **Civil engineers** are expected to see average employment growth through 2014. Spurred by general population growth and an increased emphasis on infrastructure security, more civil engineers will be needed to design and construct safe and higher capacity transportation, water supply, and pollution control systems, as well as large buildings and building complexes. They also will be needed to repair or replace existing roads, bridges, and other public structures. Because construction and related industries—including those providing design services—employ many civil engineers, employment opportunities will vary by geographic area and may decrease during economic slowdowns, when construction often is curtailed.
- **Computer hardware engineers** are expected to have average employment growth through 2014. Although the use of information technology continues to expand rapidly, the manufacture of computer hardware is expected to be adversely affected by intense foreign competition. As computer and semiconductor manufacturing contract out more of their engineering needs, much of the growth in employment should occur in the computer systems design and related services industry. However, use of foreign computer hardware engineering services also will serve to limit job growth. Computer engineers should still have favorable employment opportunities, as the number of new entrants is expected to be in balance with demand.
- **Electrical engineers** should have favorable employment opportunities. The number of job openings resulting from employment growth and from 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 engineers is expected to increase about as fast as the average for all occupations through 2014. Although international competition and the use of engineering services performed in other countries may limit employment growth, strong demand for electrical devices such as giant electric power generators or wireless phone transmitters should boost growth. Prospects should be particularly good for electrical engineers working in engineering services firms providing technical expertise to other companies on specific projects.
- **Electronics engineers, except computer**, should have good job opportunities, and employment is expected to increase about as fast as the average for all occupations through 2014. Although rising demand for electronic goods—including advanced communications equipment, defense-related electronic equipment, medical electronics, and consumer products—should continue to increase employment, foreign competition in electronic products development and the use of engineering services performed in other countries will act to limit employment growth. Job growth is expected to be fastest in service-providing industries—particularly consulting firms that provide expertise in electronics engineering.

- **Environmental engineers** should have favorable job opportunities. Employment of environmental engineers is expected to increase much faster than the average for all occupations through 2014. More environmental engineers will be needed to comply with 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. Even though employment of environmental engineers should be less affected by economic conditions than that of most other types of engineers, a significant economic downturn could reduce the emphasis on environmental protection, reducing environmental engineers' job opportunities.
- **Health and safety engineers, except mining safety engineers and inspectors,** are projected to experience average employment growth through 2014. Because the main function of health and safety engineers is to make products and production processes as safe as possible, their services should be in demand as concern for health and safety within work environments increases. As new technologies for production or processing are developed, health and safety engineers will be needed to ensure their safety.
- **Industrial engineers** are expected to have employment growth about as fast as the average for all occupations through 2014. As firms seek to reduce costs and increase productivity, they increasingly will turn to industrial engineers to develop more efficient processes to reduce costs, delays, and waste. Because their work is similar to that done in management occupations, many industrial engineers leave the occupation to become managers. Many openings will be created by the need to replace industrial engineers who transfer to other occupations or leave the labor force.
- **Marine engineers and naval architects** likely will experience employment growth that is slower than the average for all occupations. Strong demand for naval vessels and for yachts and other small craft should more than offset the long-term decline in the domestic design and construction of large oceangoing vessels. There should be good prospects for marine engineers and naval architects because of growth in employment, the need to replace workers who retire or take other jobs, and the limited number of students pursuing careers in this occupation.
- **Materials engineers** are expected to have employment growth about as fast as the average for all occupations through 2014. Although many of the manufacturing industries in which materials engineers are concentrated are expected to experience declining employment, materials engineers still will be needed to develop new materials for electronics, biotechnology, and plastics products. Growth should be particularly strong for materials engineers working on nanomaterials and biomaterials. As manufacturing firms contract for their materials engineering needs, employment growth is expected in professional, scientific, and technical services industries.
- **Mechanical engineers** are projected to have an average rate of employment growth through 2014. Although total employment in manufacturing industries—in which employment of mechanical engineers is concentrated—is expected to decline, employment of mechanical engineers in manufacturing should increase as the demand for improved machinery and machine tools grows and as industrial machinery and processes become increasingly complex. Also, emerging technologies in biotechnology, materials science, and nanotechnology will create new job opportunities for mechanical engineers. Additional

opportunities for mechanical engineers will arise because the skills acquired through earning a degree in mechanical engineering often can be applied in other engineering specialties.

- **Mining and geological engineers, including mining safety engineers**, are expected to have good employment opportunities, despite a projected decline in employment. Many mining engineers currently employed are approaching retirement age, a factor that should create some job openings over the 2004-14 period. In addition, relatively few schools offer mining engineering programs, and the small number of yearly graduates is not expected to increase substantially. Favorable job opportunities also may be available worldwide as mining operations around the world recruit graduates of U.S. mining engineering programs. As a result, some graduates may travel frequently or even live abroad. Employment of mining and geological engineers, including mining safety engineers, is projected to decline through 2014, primarily because most of the industries in which mining engineers are concentrated—such as coal, metal, and copper mining—are expected to experience declines in employment.
- **Nuclear engineers** are expected to have good opportunities because the small number of nuclear engineering graduates is likely to be in rough balance with the number of job openings. Employment of nuclear engineers is expected to grow more slowly than the average for all occupations through 2014. Most openings will result from the need to replace nuclear engineers who transfer to other occupations or leave the labor force. Although no commercial nuclear powerplants have been built in the United States for many years, nuclear engineers will be needed to operate existing plants. In addition, nuclear engineers may be needed to research and develop future nuclear power sources. They also will be needed to work in defense-related areas, to develop nuclear medical technology, and to improve and enforce waste management and safety standards.
- **Petroleum engineers** are expected to have a decline in employment through 2014 because most of the potential petroleum-producing areas in the United States already have been explored. Even so, favorable opportunities are expected for petroleum engineers because the number of job openings is likely to exceed the relatively small number of graduates. All job openings should result from the need to replace petroleum engineers who transfer to other occupations or leave the labor force. Petroleum engineers work around the world and, in fact, the best employment opportunities may be in other countries. Many foreign employers seek U.S.-trained petroleum engineers, and many U.S. employers maintain overseas branches.

Earnings

Earnings for engineers vary significantly by specialty, industry, and education. Even so, as a group, engineers earn some of the highest average starting salaries among those holding bachelor's degrees. The following tabulation shows average starting salary offers for engineers, according to a 2005 survey by the National Association of Colleges and Employers.

Curriculum	Bachelor's	Master's	Ph.D.
Aerospace/aeronautical/astronautical	\$50,993	\$62,930	\$72,529
Agricultural	46,172	53,022	—
Bioengineering and biomedical	48,503	59,667	—

Chemical	53,813	57,260	79,591
Civil	43,679	48,050	59,625
Computer	52,464	60,354	69,625
Electrical/electronics and communications	51,888	64,416	80,206
Environmental/environmental health	47,384	—	—
Industrial/manufacturing	49,567	56,561	85,000
Materials	50,982	—	—
Mechanical	50,236	59,880	68,299
Mining & mineral	48,643	—	—
Nuclear	51,182	58,814	—
Petroleum	61,516	58,000	—

Variation in median earnings and in the earnings distributions for engineers in the various branches of engineering also is significant. For engineers in specialties covered in this statement, earnings distributions by percentile in May 2004 are shown in the following tabulation.

Specialty	10%	25%	50%	75%	90%
Aerospace	\$52,820	\$64,380	\$79,100	\$94,900	\$113,520
Agricultural	37,680	43,270	56,520	77,740	90,410
Biomedical	41,260	51,620	67,690	86,400	107,530
Chemical	49,030	60,920	76,770	94,740	115,180
Civil	42,610	51,430	64,230	79,920	94,660
Computer hardware	50,490	63,730	81,150	102,100	123,560
Electrical	47,310	57,540	71,610	88,400	108,070
Electronics, except computer	49,120	60,280	75,770	92,870	112,200
Environmental	40,620	50,740	66,480	83,690	100,050
Health and safety, except mining safety	39,930	49,900	63,730	79,500	92,870
Industrial	42,450	52,210	65,020	79,830	93,950
Marine engineers and naval architects	43,790	54,530	72,040	89,900	109,190
Materials	44,130	53,510	67,110	83,830	101,120
Mechanical	43,900	53,070	66,320	82,380	97,850
Mining and geological, including mining safety	39,700	50,500	64,690	83,050	103,790
Nuclear	61,790	73,340	84,880	100,220	118,870
Petroleum	48,260	65,350	88,500	113,180	140,800

In the Federal Government, mean annual salaries for engineers ranged from \$100,059 in ceramic engineering to \$70,086 in agricultural engineering in 2005.

Related Occupations

Engineers apply the principles of physical science and mathematics in their work. Other workers who use scientific and mathematical principles include architects, except landscape and naval; engineering and natural sciences managers; computer and information systems managers; computer programmers; Computer software engineers; mathematicians; drafters; engineering technicians; sales engineers; science technicians; and physical and life scientists, including agricultural and food scientists, biological scientists, conservation scientists and foresters, atmospheric scientists, chemists and materials scientists, environmental scientists and hydrologists, geoscientists, and physicists and astronomers.

Sources of Additional Information

Information about careers in engineering is available from:

- JETS, 1420 King St., Suite 405, Alexandria, VA 22314-2794. Internet: <http://www.jets.org>

Information on ABET-accredited engineering programs is available from:

- Accreditation Board for Engineering and Technology, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012. Internet: <http://www.abet.org>

Those interested in information on the Professional Engineer licensure should contact:

- National Society of Professional Engineers, 1420 King St., Alexandria, VA 22314-2794. Internet: <http://www.nspe.org>
- National Council of Examiners for Engineering and Surveying, P.O. Box 1686, Clemson, SC 29633-1686. Internet: <http://www.ncees.org>

Information on general engineering education and career resources is available from:

- American Society for Engineering Education, 1818 N St. NW., Suite 600, Washington, DC 20036-2479. Internet: <http://www.asee.org>

Information on obtaining positions as engineers with the Federal Government is available from the Office of Personnel Management through USAJOBS, the Federal Government's official employment information system. This resource for locating and applying for job opportunities can be accessed through the Internet at <http://www.usajobs.opm.gov> or through an interactive voice response telephone system at (703) 724-1850 or TDD (978) 461-8404. These numbers are not tollfree, and charges may result.

For more detailed information on an engineering specialty, contact societies representing the individual branches of engineering. Each can provide information about careers in the particular branch.

Aerospace engineers

- Aerospace Industries Association, 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3901. Internet: <http://www.aia-aerospace.org>
- American Institute of Aeronautics and Astronautics, Inc., 1801 Alexander Bell Dr., Suite 500, Reston, VA 20191-4344. Internet: <http://www.aiaa.org>

Agricultural engineers

- American Society of Agricultural and Biological Engineers, 2950 Niles Rd., St. Joseph, MI 49085-9659. Internet: <http://www.asabe.org>

Biomedical engineers

- Biomedical Engineering Society, 8401 Corporate Dr., Suite 225, Landover, MD 20785-2224. Internet: <http://www.bmes.org>

Chemical engineers

- American Institute of Chemical Engineers, 3 Park Ave., New York, NY 10016-5991. Internet: <http://www.aiche.org>
- American Chemical Society, Department of Career Services, 1155 16th St. NW., Washington, DC 20036. Internet: <http://www.chemistry.org/portal/Chemistry>

Civil engineers

- American Society of Civil Engineers, 1801 Alexander Bell Dr., Reston, VA 20191-4400. Internet: <http://www.asce.org>

Computer hardware engineers

- IEEE Computer Society, 1730 Massachusetts Ave. NW., Washington, DC 20036-1992. Internet: <http://www.computer.org>

Electrical and electronics engineers

- Institute of Electrical and Electronics Engineers–USA, 1828 L St. NW., Suite 1202, Washington, DC 20036. Internet: <http://www.ieeeusa.org>

Environmental engineers

- American Academy of Environmental Engineers, 130 Holiday Court, Suite 100, Annapolis, MD 21401. Internet: <http://www.aaee.net>

Health and safety engineers

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

- Board of Certified Safety Professionals, 208 Burwash Ave., Savoy, IL 61874.
Internet: <http://www.bcsp.org>

Industrial engineers

- Institute of Industrial Engineers, 3577 Parkway Lane, Suite 200, Norcross, GA 30092. Internet: <http://www.iienet.org>

Materials engineers

- The Minerals, Metals, & Materials Society, 184 Thorn Hill Rd., Warrendale, PA 15086-7514. Internet: <http://www.tms.org>
- ASM International, 9639 Kinsman Rd., Materials Park, OH 44073-0002. Internet: <http://www.asminternational.org>

Mechanical engineers

- The American Society of Mechanical Engineers, 3 Park Ave., New York, NY 10016-5990. Internet: <http://www.asme.org>
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE., Atlanta, GA 30329. Internet: <http://www.ashrae.org>
- Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096-0001. Internet: <http://www.sae.org>

Marine engineers and naval architects

- Society of Naval Architects and Marine Engineers, 601 Pavonia Ave., Jersey City, NJ 07306. Internet: <http://www.sname.org>

Mining and geological engineers, including mining safety engineers

- The Society for Mining, Metallurgy, and Exploration, Inc., 8307 Shaffer Parkway, Littleton, CO 80127-4102. Internet: <http://www.smenet.org>

Nuclear engineers

- American Nuclear Society, 555 North Kensington Ave., LaGrange Park, IL 60526.
Internet: <http://www.ans.org>

Petroleum engineers












- Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083-3836.
Internet: <http://www.spe.org>









Source: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2006-07 Edition*, projections through 2014.

II. CAREER DETAILS:

ENGINEERS

Tasks

Importance	Category	Task
75 	Core	Read and interpret blueprints, technical drawings, schematics, and computer-generated reports.
71 	Core	Confer with engineers and other personnel to implement operating procedures, resolve system malfunctions, and provide technical information.
70 	Core	Research and analyze customer design proposals, specifications, manuals, and other data to evaluate the feasibility, cost, and maintenance requirements of designs or applications.
67 	Core	Specify system components or direct modification of products to ensure conformance with engineering design and performance specifications.
64 	Core	Research, design, evaluate, install, operate, and maintain mechanical products, equipment, systems and processes to meet requirements, applying knowledge of engineering principles.
60 	Core	Investigate equipment failures and difficulties to diagnose faulty operation, and to make recommendations to maintenance crew.
59 	Core	Assist drafters in developing the structural design of products using drafting tools or computer-assisted design (CAD) or drafting equipment and software.
58 	Core	Provide feedback to design engineers on customer problems and needs.
57 	Core	Oversee installation, operation, maintenance, and repair to ensure that machines and equipment are installed and functioning according to specifications.
57 	Core	Conduct research that tests and analyzes the feasibility, design, operation and performance of equipment, components and systems.
56 	Core	Recommend design modifications to eliminate machine or system malfunctions.

53		Core	Develop and test models of alternate designs and processing methods to assess feasibility, operating condition effects, possible new applications and necessity of modification.
74		Supplemental	Develop, coordinate, and monitor all aspects of production, including selection of manufacturing methods, fabrication, and operation of product designs.
63		Supplemental	Estimate costs and submit bids for engineering, construction, or extraction projects, and prepare contract documents.
59		Supplemental	Perform personnel functions such as supervision of production workers, technicians, technologists and other engineers, or design of evaluation programs.
58		Supplemental	Solicit new business and provide technical customer service.
56		Supplemental	Establish and coordinate the maintenance and safety procedures, service schedule, and supply of materials required to maintain machines and equipment in the prescribed condition.
52		Supplemental	Study industrial processes to determine where and how application of equipment can be made.
50		Supplemental	Write performance requirements for product development or engineering projects.

Tools & Technology

Tools used in this occupation:

Cold forming presses
 Coordinate measuring machines CMM
 Flowmeters
 Interferometers
 Machine mounts or vibration isolators
 Scanning probe microscopes
 Semiconductor process systems
 Strain gauges
 Voltage comparator integrated circuits

X ray radiography examination equipment

Technology used in this occupation:

Analytical or scientific software

Computer aided design CAD software

Computer aided manufacturing CAM software

Development environment software

Financial analysis software

Graphics or photo imaging software


Industrial control software

Materials requirements planning logistics and supply chain software




Object or component oriented development software

Project management software












Knowledge








Importance	Knowledge
88 	Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
77 	Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
74 	Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
72 	Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
72 	Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.
70 	Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique,

production methods, and coordination of people and resources.







- 55  **English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- 53  **Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- 50  **Physics** — Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub- atomic structures and processes.


















Skills

Importance	Skill
89 	Mathematics — Using mathematics to solve problems.
88 	Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
87 	Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
85 	Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
85 	Science — Using scientific rules and methods to solve problems.
82 	Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
80 	Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.
80 	Time Management — Managing one's own time and the time of others.
78 	Writing — Communicating effectively in writing as appropriate for the needs of the audience.
76 	Operations Analysis — Analyzing needs and product requirements to create a design.
76 	Speaking — Talking to others to convey information effectively.


- 74  **Coordination** — Adjusting actions in relation to others' actions.
- 73  **Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.
- 68  **Monitoring** — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
- 61  **Systems Analysis** — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
- 59  **Negotiation** — Bringing others together and trying to reconcile differences.
- 58  **Installation** — Installing equipment, machines, wiring, or programs to meet specifications.
- 57  **Equipment Selection** — Determining the kind of tools and equipment needed to do a job.

Abilities

Importance		Ability
78		Oral Comprehension — The ability to listen to and understand information and ideas presented through spoken words and sentences.
75		Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
75		Written Comprehension — The ability to read and understand information and ideas presented in writing.
72		Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.
72		Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
72		Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

- 72  **Near Vision** — The ability to see details at close range (within a few feet of the observer).
- 72  **Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.
- 62  **Flexibility of Closure** — The ability to identify or detect a known pattern (a figure, object, word, or sound) that is hidden in other distracting material.
- 62  **Speech Clarity** — The ability to speak clearly so others can understand you.
- 62  **Visualization** — The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.
- 60  **Mathematical Reasoning** — The ability to choose the right mathematical methods or formulas to solve a problem.
- 60  **Selective Attention** — The ability to concentrate on a task over a period of time without being distracted.
- 60  **Speech Recognition** — The ability to identify and understand the speech of another person.
- 60  **Written Expression** — The ability to communicate information and ideas in writing so others will understand.
- 56  **Category Flexibility** — The ability to generate or use different sets of rules for combining or grouping things in different ways.
- 56  **Fluency of Ideas** — The ability to come up with a number of ideas about a topic (the number of ideas is important, not their quality, correctness, or creativity).
- 56  **Number Facility** — The ability to add, subtract, multiply, or divide quickly and correctly.
- 53  **Perceptual Speed** — The ability to quickly and accurately compare similarities and differences among sets of letters, numbers, objects, pictures, or patterns. The things to be compared may be presented at the same time or one after the other. This ability also includes comparing a presented object with a remembered object.
- 50  **Far Vision** — The ability to see details at a distance.
- 50  **Finger Dexterity** — The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
- 50  **Memorization** — The ability to remember information such as words, numbers, pictures, and procedures.
- 50  **Originality** — The ability to come up with unusual or clever ideas

about a given topic or situation, or to develop creative ways to solve a problem.

50  **Speed of Closure** — The ability to quickly make sense of, combine, and organize information into meaningful patterns.





Work Activities

Importance	Work Activity
81 	Making Decisions and Solving Problems — Analyzing information and evaluating results to choose the best solution and solve problems.
78 	Interacting With Computers — Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.
76 	Getting Information — Observing, receiving, and otherwise obtaining information from all relevant sources.
72 	Communicating with Supervisors, Peers, or Subordinates — Providing information to supervisors, co-workers, and subordinates by telephone, in written form, e-mail, or in person.
68 	Evaluating Information to Determine Compliance with Standards — Using relevant information and individual judgment to determine whether events or processes comply with laws, regulations, or standards.
67 	Identifying Objects, Actions, and Events — Identifying information by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events.
67 	Organizing, Planning, and Prioritizing Work — Developing specific goals and plans to prioritize, organize, and accomplish your work.
67 	Processing Information — Compiling, coding, categorizing, calculating, tabulating, auditing, or verifying information or data.
62 	Analyzing Data or Information — Identifying the underlying principles, reasons, or facts of information by breaking down information or data into separate parts.
62 	Communicating with Persons Outside Organization — Communicating with people outside the organization, representing the organization to customers, the public, government, and other external sources. This information can be exchanged in person, in writing, or by telephone or e-mail.

- 58  **Interpreting the Meaning of Information for Others** — Translating or explaining what information means and how it can be used.
- 58  **Updating and Using Relevant Knowledge** — Keeping up-to-date technically and applying new knowledge to your job.
- 57  **Establishing and Maintaining Interpersonal Relationships** — Developing constructive and cooperative working relationships with others, and maintaining them over time.
- 56  **Documenting/Recording Information** — Entering, transcribing, recording, storing, or maintaining information in written or electronic/magnetic form.
- 56  **Monitor Processes, Materials, or Surroundings** — Monitoring and reviewing information from materials, events, or the environment, to detect or assess problems.
- 54  **Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment** — Providing documentation, detailed instructions, drawings, or specifications to tell others about how devices, parts, equipment, or structures are to be fabricated, constructed, assembled, modified, maintained, or used.
- 54  **Judging the Qualities of Things, Services, or People** — Assessing the value, importance, or quality of things or people.
- 52  **Thinking Creatively** — Developing, designing, or creating new applications, ideas, relationships, systems, or products, including artistic contributions.
- 50  **Resolving Conflicts and Negotiating with Others** — Handling complaints, settling disputes, and resolving grievances and conflicts, or otherwise negotiating with others.


Work Context

Context	Work Context
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- 97  **Indoors, Environmentally Controlled** — How often does this job require working indoors in environmentally controlled conditions?
- 92  **Electronic Mail** — How often do you use electronic mail in this job?
- 92  **Face-to-Face Discussions** — How often do you have to have face-to-face discussions with individuals or teams in this job?
- 87  **Freedom to Make Decisions** — How much decision making freedom, without supervision, does the job offer?




- 86  **Telephone** — How often do you have telephone conversations in this job?
- 86  **Work With Work Group or Team** — How important is it to work with others in a group or team in this job?
- 85  **Importance of Being Exact or Accurate** — How important is being very exact or highly accurate in performing this job?
- 84  **Contact With Others** — How much does this job require the worker to be in contact with others (face-to-face, by telephone, or otherwise) in order to perform it?
- 84  **Duration of Typical Work Week** — Number of hours typically worked in one week.
- 79  **Letters and Memos** — How often does the job require written letters and memos?
- 77  **Impact of Decisions on Co-workers or Company Results** — How do the decisions an employee makes impact the results of co-workers, clients or the company?
- 77  **Structured versus Unstructured Work** — To what extent is this job structured for the worker, rather than allowing the worker to determine tasks, priorities, and goals?
- 75  **Frequency of Decision Making** — How frequently is the worker required to make decisions that affect other people, the financial resources, and/or the image and reputation of the organization?
- 72  **Time Pressure** — How often does this job require the worker to meet strict deadlines?
- 70  **Coordinate or Lead Others** — How important is it to coordinate or lead others in accomplishing work activities in this job?
- 66  **Spend Time Sitting** — How much does this job require sitting?
- 62  **Responsibility for Outcomes and Results** — How responsible is the worker for work outcomes and results of other workers?
- 57  **Deal With External Customers** — How important is it to work with external customers or the public in this job?
- 57  **Level of Competition** — To what extent does this job require the worker to compete or to be aware of competitive pressures?
- 56  **Consequence of Error** — How serious would the result usually be if the worker made a mistake that was not readily correctable?
- 52  **Wear Common Protective or Safety Equipment such as Safety Shoes, Glasses, Gloves, Hearing Protection, Hard Hats, or Life Jackets** — How much does this job require wearing common

protective or safety equipment such as safety shoes, glasses, gloves, hard hats or life jackets?






50  **Sounds, Noise Levels Are Distracting or Uncomfortable** — How often does this job require working exposed to sounds and noise levels that are distracting or uncomfortable?

Work Styles



Importance	Work Style
86 	Attention to Detail — Job requires being careful about detail and thorough in completing work tasks.
80 	Cooperation — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.
79 	Dependability — Job requires being reliable, responsible, and dependable, and fulfilling obligations.
75 	Leadership — Job requires a willingness to lead, take charge, and offer opinions and direction.
72 	Achievement/Effort — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.
70 	Adaptability/Flexibility — Job requires being open to change (positive or negative) and to considerable variety in the workplace.
70 	Analytical Thinking — Job requires analyzing information and using logic to address work-related issues and problems.
66 	Initiative — Job requires a willingness to take on responsibilities and challenges.
65 	Integrity — Job requires being honest and ethical.
63 	Innovation — Job requires creativity and alternative thinking to develop new ideas for and answers to work-related problems.
63 	Persistence — Job requires persistence in the face of obstacles.
62 	Independence — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.
60 	Self Control — Job requires maintaining composure, keeping emotions in check, controlling anger, and avoiding aggressive behavior, even in very difficult situations.

- 60  **Stress Tolerance** — Job requires accepting criticism and dealing calmly and effectively with high stress situations.
- 59  **Concern for Others** — Job requires being sensitive to others' needs and feelings and being understanding and helpful on the job.
- 56  **Social Orientation** — Job requires preferring to work with others rather than alone, and being personally connected with others on the job.

Work Values

Extent	Work Value
83 	Independence — Occupations that satisfy this work value allow employees to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.
81 	Achievement — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.
67 	Working Conditions — Occupations that satisfy this work value offer job security and good working conditions. Corresponding needs are Activity, Compensation, Independence, Security, Variety and Working Conditions.
66 	Recognition — Occupations that satisfy this work value offer advancement, potential for leadership, and are often considered prestigious. Corresponding needs are Advancement, Authority, Recognition and Social Status.
51 	Support — Occupations that satisfy this work value offer supportive management that stands behind employees. Corresponding needs are Company Policies, Supervision: Human Relations and Supervision: Technical.

Work Needs

Extent	Work Need
88 	Autonomy — Workers on this job plan their work with little supervision.
84 	Ability Utilization — Workers on this job make use of their individual

abilities.

- 81  **Creativity** — Workers on this job try out their own ideas.
- 81  **Responsibility** — Workers on this job make decisions on their own.
- 78  **Achievement** — Workers on this job get a feeling of accomplishment.
- 78  **Social Status** — Workers on this job are looked up to by others in their company and their community.
- 75  **Activity** — Workers on this job are busy all the time.
- 75  **Working Conditions** — Workers on this job have good working conditions.
- 72  **Security** — Workers on this job have steady employment.
- 69  **Authority** — Workers on this job give directions and instructions to others.
- 66  **Company Policies and Practices** — Workers on this job are treated fairly by the company.
- 66  **Compensation** — Workers on this job are paid well in comparison with other workers.
- 66  **Recognition** — Workers on this job receive recognition for the work they do.
- 66  **Variety** — Workers on this job have something different to do every day.
- 62  **Moral Values** — Workers on this job are never pressured to do things that go against their sense of right and wrong.
- 59  **Supervision, Human Relations** — Workers on this job have supervisors who back up their workers with management.
- 53  **Advancement** — Workers on this job have opportunities for advancement.
- 53  **Co-workers** — Workers on this job have co-workers who are easy to get along with.
- 50  **Independence** — Workers on this job do their work alone.

Source: U.S. Department of Labor - ONET