CHAPTER 7

CAREER OPTIONS IN TECHNICAL FIELDS:

Operations – Engineering – Research

What jobs are available in technical fields?

Most organizations that offer a product or service to customers employ people to perform the function that *creates* the product or service. The operation may be an assembly line, a mining operation, a product processing operation, a paper flow process, or any other activity that requires the services of many people doing repetitive and/or skilled tasks.

Engineers help create the systems that make an operation function smoothly.

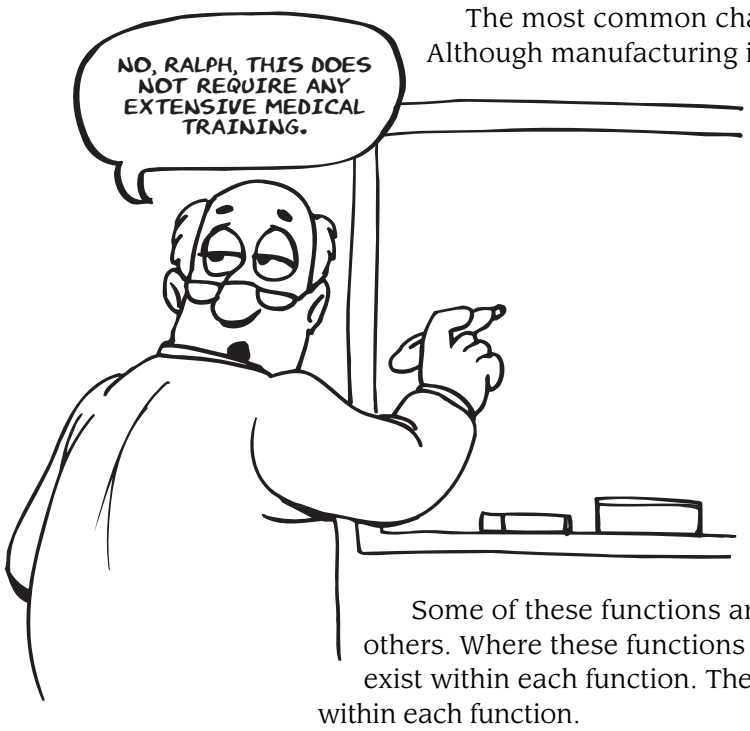
Operations

The operations (or production and manufacturing) function is the activity that manages people and other resources.

The operations is a management structure organized around the goal of producing a finished product or a service or accomplishing a series of tasks.

Banks manage an enormous flow of paperwork and deal with millions of individual personal transactions. Automobile plants assemble vehicles. Transportation firms manage motor vehicle fleets. Oil companies convert raw materials to products used by consumers and commercial organizations. Steel firms produce a basic commodity. Hospitals manage a patient flow process. Governments deliver services. All of these operations require people at all levels of responsibility.

Few organizations operate without a chain of command structure for managing people, materials, and other resources. This management function is called production, manufacturing, or operations, depending upon the industry and the type of activity involved.



The most common characteristic is that people are supervised. Although manufacturing is usually used as an example, you should realize that the same activities are performed in non-manufacturing organizations as well.

Functions

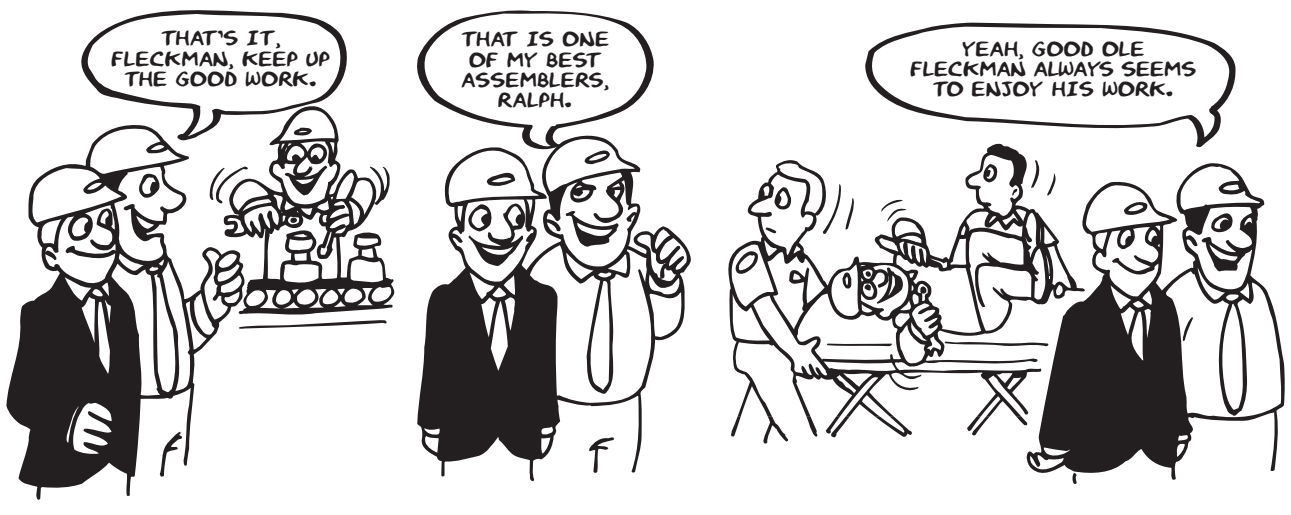
The production function is responsible for supervision and coordinating activities of people and processes. This may involve thousands of employees in many different locations for large corporations or only a few employees in a department within a service organization. Figure 7.1 lists the eight functions most often found in operations.

Some of these functions are found in some organizations but not in others. Where these functions are found, various levels of responsibility exist within each function. There are analysts, specialists, and managers within each function.

Many organizations carry out cross-functional training so that individuals in the operations function are exposed to all eight functions. Other firms tend to develop professionals in the respective fields for the purpose of making each of them an expert or manager in one of the eight functions.

Production Management. Production management is the function of directing the work of those who are responsible for producing and making products, and it is performed at various levels from first-line supervision to vice president.

Positions in production management afford high visibility and exposure to all levels of management including distribution, product planning, employee relations, finance, research, and marketing.



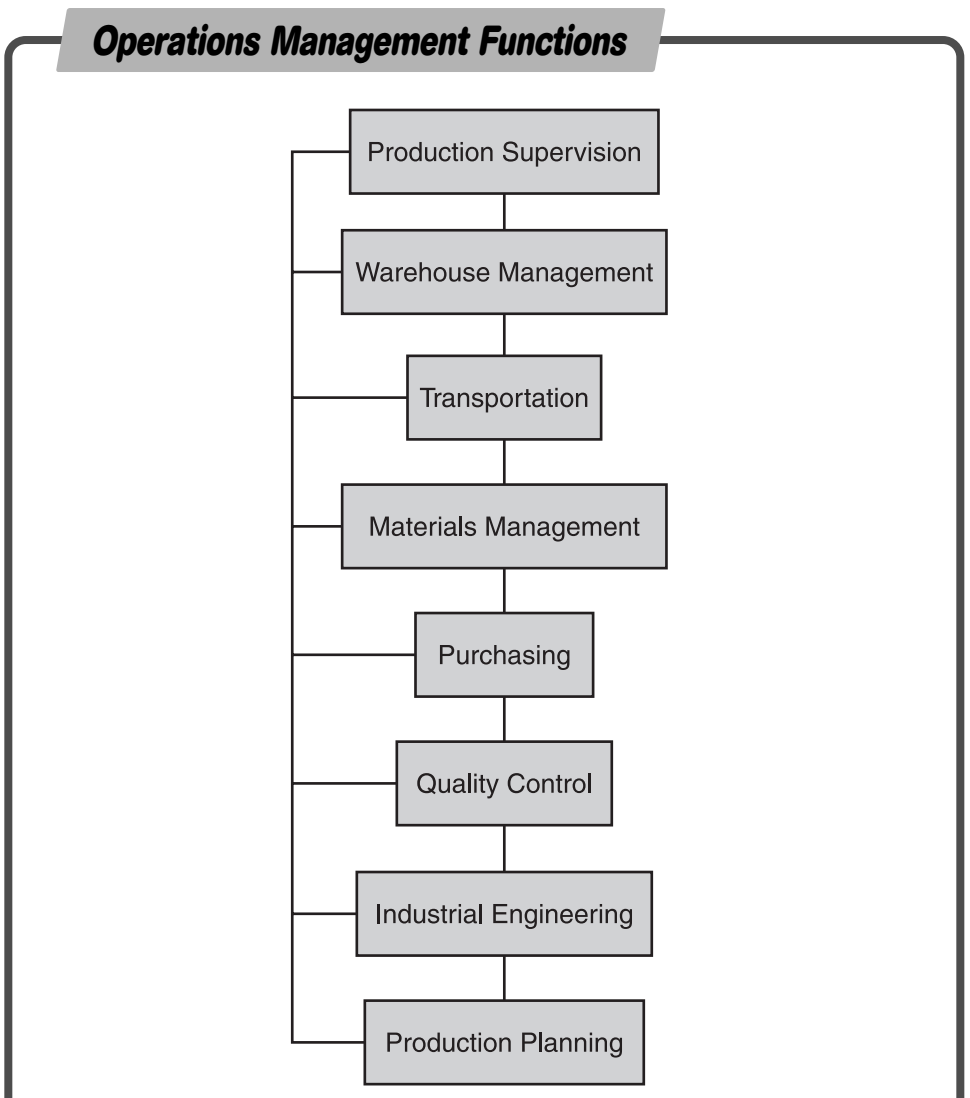


Figure 7.1

Most manufacturing firms have a 6- to 18-month training program in production management, with the length depending upon assignments covered and the individual's background and progress.

The first assignment might be as a first-line supervisor directing 25 to 100 production employees. One may be assigned to special projects dealing in quality control, process control, product development, pollution control, or safety. Over time, most individuals gain exposure to various levels of management from supervisor to department manager to plant manager.

Production Planning. Production planning involves the ordering of materials and supplies, the development and control of operating schedules, and the management of inventory in the firm's production facilities and distribution centers. The function uses sales estimates from marketing personnel,

production capacity figures, labor agreements, and inventory levels to arrive at appropriate production levels.

The goal is to minimize total costs by smoothing manufacturing processes over time and by keeping inventories low while still maintaining required top-quality customer demands and service.

Purchasing. Purchasing is responsible for the placement and administration of orders, contracts, and other agreements for the procurement of goods and services. This includes negotiating with suppliers on matters of quality, service, and price features. Purchasing follows up and expedites in order to ensure that the terms of various agreements are met.

Purchasing secures the materials, supplies, and equipment required for operation of the business or government agency. In addition to the actual buying of merchandise, it includes planning and policy activities.

It is the responsibility of the purchasing agent to buy materials of the right quality and in the right quantity, at the right time, and at the right price, from the right source, and with delivery at the right place.

Within any one firm the purchasing department includes the manager of purchasing, purchasing agent, assistant purchasing agent, buyers, assistant buyers, expediters, and traffic managers.

A purchasing agent must be willing and able to accept the responsibility for spending large amounts of money. He or she must be tactful in dealings with salespeople and have a good memory for detailed specifications.

Most employers, whether in business or government, who hire assistant purchasing agents at the entry-level position seek people with college degrees. Many employers fill needs internally by moving individuals from other areas into the purchasing function.

National Association of Purchasing Management ***www.ism.ws***
One of the most respected professional organizations in the United States, the National Association of Purchasing Management (NAPM) is a communication link with more than 47,000 purchasing and supply management professionals. Anyone can search the job database for free, but become a member and you receive: Purchasing Today®, the award-

winning monthly publication; access to an extensive database of information, articles and other resources; discounts of up to 50 percent on NAPM-sponsored programs, products, and annual conferences; and more.

Warehouse Management. Warehousing is the function that manages the warehousing and distribution operation to ensure customer service levels. This includes developing and maintaining a close liaison with sales personnel to help assure a cooperative response to customer needs.

It also coordinates operations with planning, order processing, and transportation activities to allow for the timely, efficient, and orderly flow of finished product to customers.

Materials Management. Materials management involves controlling the flow of materials from vendors to and through the production facility, to the warehouse and eventually to the customer. The objective is to ensure that raw materials, partially processed materials, and finished products are at the right place, at the right time, in the right quantities.

Materials management involves contact with almost every phase of a manufacturing firm's operations and offers a unique insider's view of the various aspects of the firm. Materials management activities include purchasing, transportation, packaging, production planning, distribution, and order processing.

Transportation. The physical distribution (as it is sometimes called) coordinates the movement of materials, supplies, and finished product to the production facilities, the warehouse, and the customer. This includes all phases of negotiations with carriers, their associations, and government regulatory bodies. The function also administers claims control, travel modes, and product movement.

Employment Characteristics

All of the individuals working in these functions usually report to a functional manager who reports to the equivalent of a plant manager, who is usually a high-level executive.

If there are multiple locations, a person in one function might move from one location to another within that function or move to another function at the same location. The move might depend upon the size of the organization, organization policy, and the individual's career interest.

Job Titles. Many different job titles are used in the operations management function, so it is impossible to describe each specific job. Titles at the entry level might include foreman, analyst, inspector, planner, industrial engineer, systems analyst, expediter, assistant, scheduler, agent, dispatcher, etc.

Higher-level management job titles might include plant manager, superintendent, general foreman, department manager, engineer, chief, senior, etc.

Job titles are most frequently assigned with functional department names attached to them. For example, an assistant manager would carry the designation of the department to which he or she is assigned.

Duties. There are so many possible duties of people involved in the operations process that every aspect could never be completely described. Some of the specific duties are noted in the abstract below which is designed to provide some idea of the variety of assignments possible.

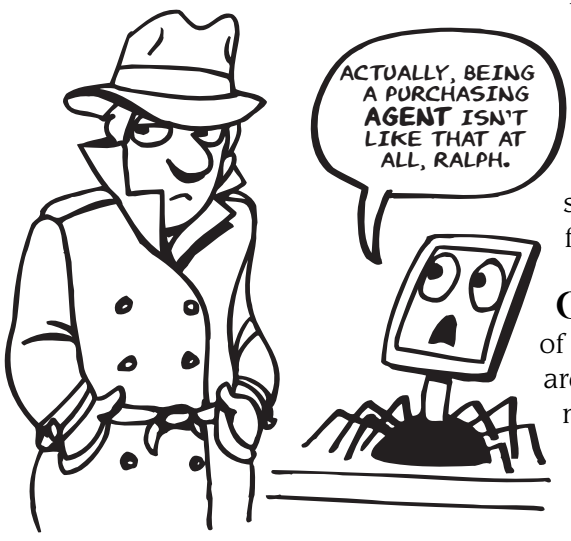
> Supervise production personnel . . . schedule work . . . review output quality . . . process raw materials . . . arrange transportation . . . order materials . . . analyze production processes . . . design production process . . . select transportation carriers . . . route raw materials and finished goods . . . manage warehouse . . . design control systems . . . analyze work methods of workers . . . develop quality standards.
>
> Improve efficiency of operations . . . conserve energy . . . design equipment . . . develop new products . . . establish safety standards . . . test products . . . design environmental control systems . . . create, design, and implement engineering projects . . . create managerial control systems for cost reduction . . . buy production equipment . . . order raw materials.

Requirements. Essential skills for positions in operations management include the ability to work well with others; mechanical aptitude; ability to analyze products, equipment, and people problems; and ability to manage time well.

The person must be self-motivating, have a positive attitude, be imaginative, be assertive, and be a decision maker. The person must be able to take calculated risks based on sound analysis of technical and nontechnical data.

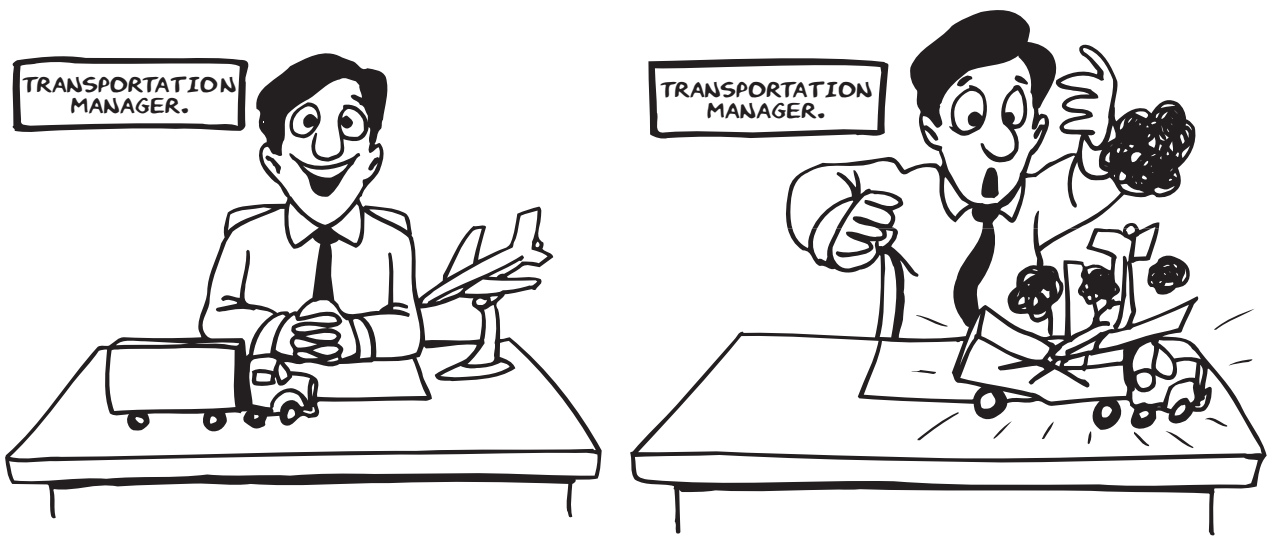
Although many employers require technical or engineering academic backgrounds, many other firms look for leadership factors, coupled with educational backgrounds that involve the study of people. Even with applicants for nontechnical positions, most employers still look for some mechanical aptitude and quantitative courses in the academic background.

A bachelor's degree in some phase of engineering is preferred, but employers often hire candidates with backgrounds in related fields such as industrial management, production, mathematics, physics, chemistry, and other fields that require the use of quantitative and analytic experiences.



A few nontechnical candidates are hired in supervision, scheduling, warehousing, purchasing, and other fields where the technical and analytical skills are not necessary. Some jobs require a strong people-orientation while others are analytical and project-centered. Some jobs require specific backgrounds in given disciplines of science or engineering. Many times people are promoted from blue-collar jobs into these management assignments.

Career Path. An entry-level assignment may be as part of a team project concerned with some aspect or problem area in production or operations design. Upward movement may be within a given professional field rather than into management if individuals in that field do not desire management responsibility.



It is common for individuals to remain operations professionals throughout their careers and to assume more complex projects as their experience warrants. The management option is to move into people supervision, systems, or unit management, plant manager, superintendent, etc.

In the long run these people can become divisional manufacturing heads, research and development managers, and corporate vice presidents.

Training. Much of the initial training is on-the-job since candidates often have high levels of technical competence. To maintain this high level of skill in a fast-changing technology, many organizations operate in-house technical centers through which employees are rotated on a regular basis.

These team-oriented projects help people keep current as they learn from each other. There are frequent plant and corporate level seminars. Most firms pay tuition for employees who want to continue their education on a part-time basis.

Salary. Individuals going into the field command earnings that are among the highest of all occupations. As long as the supply-demand trend continues to raise starting rates so rapidly, employees within the firms will continue to enjoy large pay increases.

Annual raises above inflation rates are not uncommon for the top 25 percent. Chief plant technical people and managers in middle management earn substantial salaries.

Entry level people entering this function will find top salaries, challenges, and long-term opportunity. All is not glory, though, because dirt, noise, long hours, shift work, daily change, people problems, production foul-ups, etc., are integral parts of the everyday picture.

Nontechnical entrants need to begin early in their careers to prepare themselves technically in order to compete for the higher-level assignments. Top management in certain highly technical industries traditionally come from the engineering and manufacturing ranks.

Engineering

The engineering function built the American enterprise system to the apex of all industrialized nations of the world. Engineers created and developed technology to the fine-tuned science that now provides us with one of the highest standards of living in the world.

The initial thrust related technology to the manufacturing process, which brought about a highly productive system.

More recently, the same technological innovations applied in the manufacturing process have been extended to increasing the productivity of white-collar workers. There is a growing trend for engineers to be employed in service-providing industries as well as in the product-producing industries.

Engineer

Engineering is one of the largest professional occupations. More than one million people practice the profession, and over 50,000 new people enter the field each year. Engineers are employed in all sectors of the economy, so if you desire to work in education, government, private industry, a nonprofit group, or your own business, you should be able to find the appropriate work environment.

Most engineers specialize in one of the more than twenty-five areas recognized by professional societies. Each of the major areas is further subdivided, so specialization is exceedingly common. The largest engineering specialties are discussed briefly in the career profiles that follow, and they are the aerospace, chemical, civil, electrical, industrial, and mechanical engineering fields.

These areas were selected solely on the basis of the number of employment possibilities within them. Employment possibilities that are equally as attractive exist in most of the other engineering disciplines and their subspecialties.

Although by definition, a narrow specialty field limits the number of jobs available, it has the countering effect of balancing the opportunity by permitting one to become a "scarce" expert. Personality style and academic interests help to determine the engineering specialty a person chooses.

The duties and responsibilities of the various types of engineers differ substantially, but there are certain commonalities in other facets of the field. The requirements for entering the profession, career paths, and the general outlook are very similar in the various engineering specialties.

Requirements. A bachelor of science degree in the special field is required. In many technical fields, employers request a master's degree. For those individuals wishing to work in a research setting or at a university, a doctorate is a common requirement.

Career Path. Most engineers progress through the ranks of assistant, associate, senior, and executive engineer. Common paths involve heavy exposure to production, design, and research applications of technical knowledge.

Many engineers move into management positions at plant, division, and corporate levels later in their careers. For those electing the management route, the typical progression is from supervisor to manager to director. Many continue to advance into the executive ranks of vice president, chief operating officer, and chief executive officer.

Another common career path is for the engineer to move out of the manufacturing or analysis function of the operation and into the marketing function.

Many employers desperately need technically trained personnel to deal with customers and potential customers. This requires individuals who are intimately involved in all technical aspects of a product, service, or process. The work may entail direct selling, a service working relationship, or consulting work.

The upward mobility is nearly identical in the two different career paths. Which route to accept is largely a personal choice. Both routes can be extremely rewarding financially.

Outlook. In nearly all fields, the outlook is very good and superior to that found in most other occupations. Demand occasionally is influenced by short-term fluctuations in the overall economy, but the underlying strength indicates good opportunities for nearly all new entrants into the field of engineering as well as great mobility for experienced engineers.

The growth of complex manufacturing processes and automated work devices and services will keep the demand strong. The supply is expected to remain constant as nearly all seats in the colleges are currently occupied, and no new expansion in the colleges seems evident.

The recent phenomena of college students leaning toward more vocationally oriented courses of study suggests that the seats will remain filled. This relationship should have a stabilizing influence on employment in the engineering profession.

Earnings. The favorable supply and the demand situation should keep earnings growing faster than inflation. Engineers' salaries tend to start at much higher levels than those of most other disciplines. This initial advantage keeps others from catching up rapidly, but over time engineers' earnings as a group do tend to plateau. This plateau is at a rather high level compared to other occupational groups, however.

As a profession, engineers tend to be a highly mobile group; that is, they move to wherever the best opportunities are available. This mobility is among the highest for all occupational groups, and it has served as an explanation for the high earnings and rapid ascent to corporate leadership within the engineering profession.

Specialties. The many specialties in engineering enrich the scope of the opportunities available. The six basic fields whose profiles are presented next form the bulk of the job possibilities normally available, but there are hundreds of spin-offs associated with these six fields and other engineering specialties. The profiles are designed to present only a quick overview of the field and to spark enthusiasm for a more in-depth exploration.

NSPE ***www.nspe.org***
The society publishes "Engineering Times." Excellent career information for engineers, computer technologists, consultants, and anyone interested in a technical or semi-technical assignment. This site has a good list of firms interested in technical talent.

Aerospace Engineers

Aerospace engineers work with all types of commercial and government aircraft and spacecraft including missiles, rockets, satellites, and airplanes. They develop products from the initial planning and design to the final assembly, testing, and maintenance. The actual duties relate to the following:

> Structural design . . . navigational guidance and control . . . instrumentation . . . communication gear . . . power distribution . . . theoretical flight simulation . . . stress analysis . . . design formations . . . field testing . . . manufacturing technology . . . aerodynamics . . . vibration analysis . . . cycle analysis . . . acoustics.
>
> Product life evaluation . . . performance testing . . . aeromechanics . . . thrust control . . . structural engineering . . . instrumentation testing . . . teardown analysis . . . maintenance and repairability . . . manufacturing assembly . . . quality control . . . cost-to-design analysis . . . manufacturing planning and processes . . . production supervision . . . production scheduling . . . space utilization . . . technical marketing . . . service engineering.

Chemical Engineer

Chemical engineers design, develop, and install processes that change the chemical or physical properties of materials to the forms needed in production processes. The chemical engineer turns a chemical process into an eco-

nomical reality which will advance progress and still retain a reasonable profit for an industrial organization. They work in research, laboratories, and manufacturing facilities.

Although most chemical engineers work for chemical and petroleum firms, nearly all industrial firms employ them in a variety of capacities. The employment outlook is extremely bright, and advancement continues at a rapid pace. Some of the typical duties are listed here.

Produce chemicals and chemical products . . . design equipment . . . design plants . . . devise methods of chemical manufacturing . . . operate pilot plants . . . develop new processes . . . improve current processes . . . reconstitute materials . . . participate in environmental control activities . . . analyze compounds . . . estimate costs . . . prepare budget requests . . . lay out facilities . . . install and "debug" production processes.

Design equipment for handling complex specialty or bulk chemical products . . . conduct testing programs . . . evaluate methods . . . supervise production personnel . . . manufacture and transport polymers, liquids, and gases . . . perform laboratory analysis . . . participate in technical marketing . . . carry out basic research.

Civil Engineer

Civil engineers design and supervise the construction of roads, harbors, airports, tunnels, bridges, water supply systems, sewage and waste systems, and buildings. Specific concerns in civil engineering include the following:

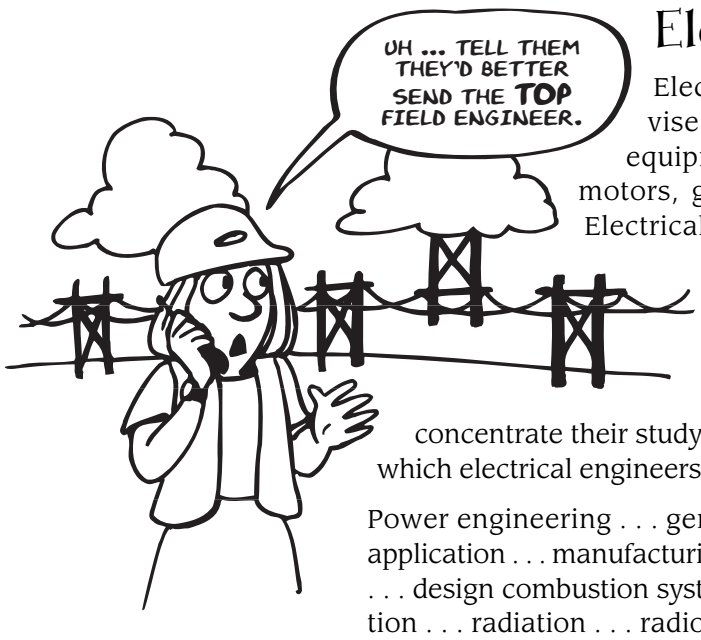
Nearly all types of manufacturing and construction firms employ civil engineers in every part of the nation.

Surveying . . . facility layout . . . construction development . . . economical use of materials . . . functional structures . . . load bearing capacities . . . materials strengths and properties . . . water demand analysis . . . sewage capacities . . . distribution and collection systems . . . population trends . . . suburban growth trends . . . urban planning . . . municipal engineering.

Community social needs analysis . . . environmental impact . . . pollution control . . . impact statements and recommendations . . . materials testing . . . bridge design . . . highway construction supervision . . . street location and construction . . . contractor/government liaison . . . design requirements.

Civil engineers work with architects, other engineers, government leaders, and industrial organizations in analyzing, planning, and constructing major projects. They often work outdoors as well as designing and writing elaborate plans and project proposals at their desks.

The employment outlook and earnings potential in civil engineering place it among the best-rated growth occupations for the next decade. The short-term demand for civil engineers can be highly cyclical depending upon construction expenditures, the supply of funds, and the general economy.



These diverse activities make electrical engineering one of the fastest growing fields of engineering.

Electrical Engineer

Electrical engineers design, develop, and supervise the manufacture of electrical and electronic equipment. These include such things as electric motors, generators, and communication equipment. Electrical engineers also design and operate facilities for generating and distributing electric power.

Electrical engineers generally specialize in electronics, computers, electrical equipment, communications, or power. There are several other subspecialties in which many elect to concentrate their study. Listed below are some of the activity areas in which electrical engineers spend time.

Power engineering . . . generation . . . transmission . . . distribution . . . application . . . manufacturing . . . machine design . . . hydro-electric power . . . design combustion systems . . . pollution analysis . . . nuclear generation . . . radiation . . . radioactive waste disposal . . . solar electrical production . . . collectors . . . power distribution networks . . . cost estimates . . . peak power loads . . . conductors . . . insulation . . . tower design . . . stress . . . power applications . . . illumination . . . light reflection, absorption, and distribution.

Communications engineering . . . information transmittal and delivery . . . audio and visual forms . . . signal channels design . . . amplification . . . transmission apparatus: relays, switches, keys . . . circuit design . . . switching systems.

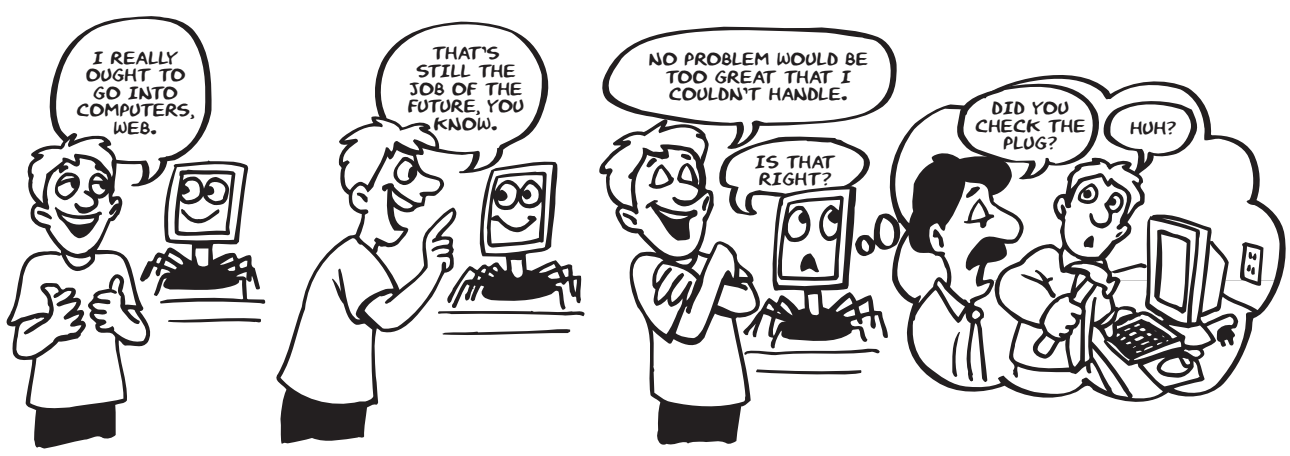
Electronics engineering . . . computer technology . . . networking . . . navigational controls . . . calculators . . . radar . . . radio signals . . . miniaturization . . . chips control application.

The common element in the work of all electrical engineers is the movement of the electron—electrical engineers harness its immense power by designing, developing, supervising, and controlling equipment, processes, and materials.

There are numerous opportunities available each year for entry-level and experienced engineers in all parts of the nation.

IEEE ***www.ieee.org/portal/index.jsp***

The Institute of Electrical and Electronic Engineers has over 300,000 members and dominates recruiting through its professional membership. It allows job seekers to view positions by location, keyword, entry-level, or international locations. Contact information is available and members can post their resumes for free. There are many career articles in salary information posted on the site. It contains a long list of job links to various professional organizations.



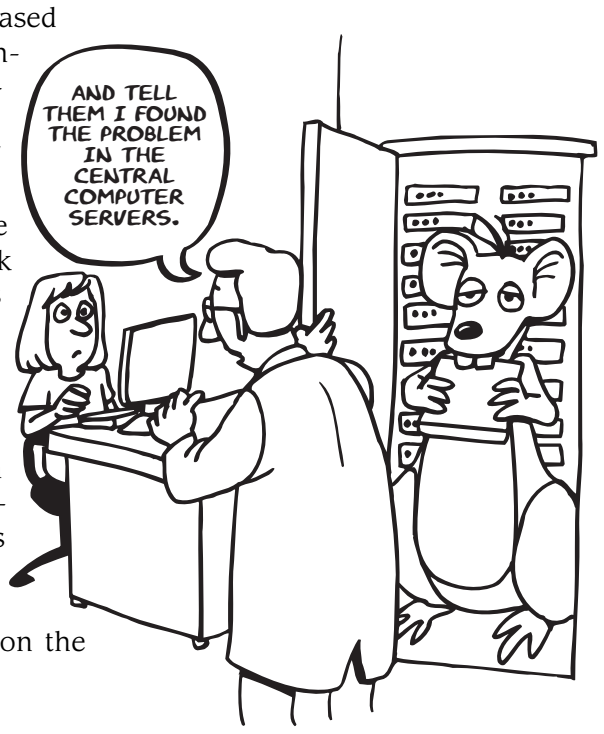
Industrial Engineer

The major goal of industrial engineering is to improve operating efficiency, and this cuts across all industry and occupational lines.

Industrial engineers determine the most effective ways to use the basic factors of production, personnel, machines, and materials. They are more concerned with people and work organization than most other types of engineers. Industrial engineers may be employed in any type of industry from manufacturing to service industries such as banks, retail organizations, and hospitals.

Industrial engineers are employed in all geographical sectors of the nation, but they are most heavily concentrated in the heavily industrialized areas of the Midwest and the Northeast.

The increasing complexity of industrial operations, the expansion of autodated processes, and the continued growth of the economy will contribute to an increasing demand for industrial engineers. The needs for scientific management, safety engineering, cost reduction programs, environmental pollution control, and increased productivity foster the continuing demand for industrial engineers.



The actual duties of industrial engineers vary greatly depending upon the industry and size of the work force, but the duties always relate to the goal of saving time, money, and other resources. Most industrial engineers have great latitude on how they approach this goal, but certain techniques are common across industries and work settings. The basic duties may be similar to those listed on the next page.

Design data processing systems . . . apply operations research techniques . . . analyze organizational reporting relationships . . . develop management control systems . . . install cost reduction programs . . . design production planning processes . . . coordinate quality control processes.

Organize physical distribution routes . . . conduct surveys . . . analyze plant location potentials . . . plan raw material acquisition arrangements . . . develop wage plans . . . install job evaluation programs . . . evaluate new operations . . . select equipment . . . examine make, buy, or lease alternatives . . . study work flow patterns.

Mechanical Engineer

Mechanical engineers design and develop machines that produce and use power.

Mechanical engineers are concerned with the production, transmission, and use of power.

The field of mechanical engineering incorporates:

- The conversion of energy from one form to another
- The design of all types of machines
- The instrumentation and control of all types of physical processes
- The control of human and machine environments

Activities of mechanical engineers include research, consulting, engineering instruction, applied research, design, testing, production, distribution, handling, and sales. Mechanical engineers are usually involved in many facets of these activities over their careers.

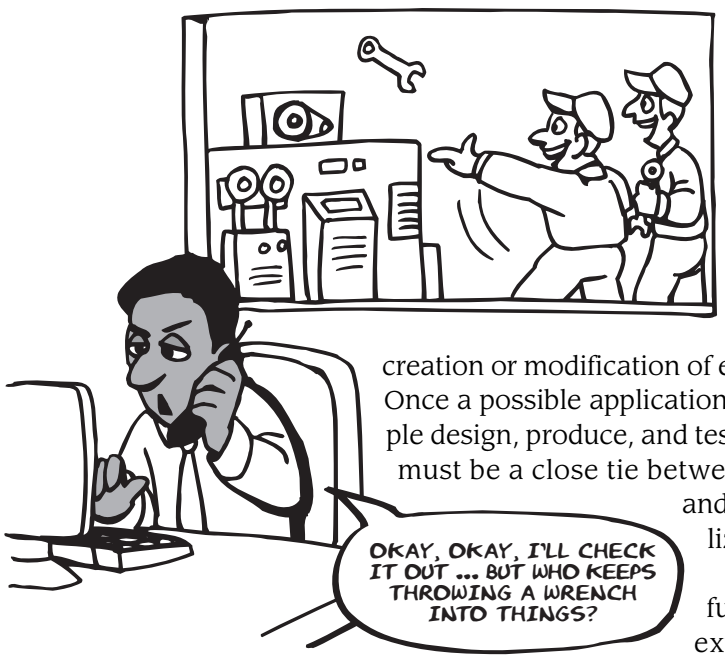
Mechanical engineers apply their scientific-technical backgrounds to problems that need solutions. They draw from such areas as statistics, dynamics, thermodynamics, heat transfer, gas dynamics, gas systems, electrical principles, instrumentation, materials processing, and computer technology. They creatively integrate ideas from each relevant area to solve specific problems.

American Society of Mechanical Engineers ***www.asme.org***
Articles on the profession/current news and hot topics/job postings by title, location, duties, and requirements.

National Society of Professional Engineers ***www.nspe.org***
Lists jobs for certified engineers/must be a member/professional engineering news.

Research and Development

Most manufacturing firms maintain research and development functions in order to stay at the forefront of new product technology and invention. A hallmark of American progress has been the strong commitment to regular and sustained research activity. This is especially true of firms in high technology fields such as the chemical, petroleum, electronic, pharmaceutical, and computer industries.



Research activity includes the systematic and intensive exploration designed to expand the horizons of current knowledge in the field. Many times this research is initiated without reference to a specific application, but, of course, the purpose of the overall research activity is to provide for product improvement and the development of new products.

The research may be directed toward creation or modification of equipment, materials, systems, or techniques. Once a possible application is found via the research, development people design, produce, and test the new product or other application. There must be a close tie between marketing, manufacturing, engineering, and finance if the production process is to be utilized to its fullest.

Although the research and development function is best characterized by discussing its experimental activities, it nonetheless must eventually serve as a profit-producing center. The work must, therefore, be somewhat more application-oriented than that done by scientists in government and university research settings.

Once major development plans are set, the project is usually turned over to the engineering and manufacturing staffs if the marketing and finance functions see a profitable market.

Most individuals going into the research and development function hold advanced degrees in very specialized fields. Doctorate and post-doctorate-degreed individuals find employment in research, but some master-degreed people may be employed.

Most research and development activity in industry is centralized and reports to top executive levels. Top management often closely supervises expenditures and encourages applied product, process, and new technology development in addition to new concept research.

Most firms maintain pilot test facilities, laboratories, professional service units, technical libraries, and appropriate offices. The corporate legal staff works closely with this unit in patent work.

The scientific occupations most frequently found in research and development include geologists, geophysicists, meteorologists, oceanographers, biochemists, astronomers, chemists, food scientists, and petroleum scientists. Most of these scientists specialize at great depth within their fields of study and their work

is largely dependent on their specialty, the type of work, and any geographical considerations related to their occupation.

The number of job possibilities in these specialized fields is very low because of the very narrow specialization. Growth is expected to keep up or move faster than that of most other occupations. Most job seekers must be extremely flexible as to geographical location. The likelihood of multiple offers is uncommon except for established, highly recognized scientists. The protege concept is widely recognized as a channel for employment.

Most firms have several levels of professional scientific personnel grades. Typical job titles are:

- Scientist
- Research scientist
- Senior research scientist
- Research associate
- Principal research associate

Most titles carry the designation of the research *discipline* such as biochemist, chemist, physicist, geologist, etc.

Job responsibilities range from functioning as a project team member to the complete handling of projects that require more in-depth knowledge and are by nature more complex and challenging. Some scientists work as individualists and others function as group leaders.

Manager positions almost always exist in the research environment for people who have been on the staff for some time as technical persons. A common practice is to move into a managerial position after some years rather than opting to stay in a scientific role indefinitely.

The reward structure is extremely good for those taking either the scientist or managerial route. A few people also elect to leave the research and development environment for positions in manufacturing and marketing. A few even move into top executive ranks after many years of experience with a given organization.