

to keep tuition costs down is also creating a growing need for directors of fundraising (also called development) and for public relations officials, whose mission is to boost community support and raise money.

Earnings

Salaries of education administrators depend on several factors, including the location and enrollment level in the school or school district. According to a survey of public schools, conducted by the Educational Research Service, average salaries for principals and assistant principals in the 1999-2000 school year were as follows:

Directors, managers, coordinators, and supervisors	\$73,499
Principals:	
Elementary school	\$69,407
Jr. high/middle school	73,877
Senior high school	79,839
Assistant principals:	
Elementary school	\$56,419
Jr. high/middle school	60,842
Senior high school	64,811

In 2000-01, according to the College and University Professional Association for Human Resources, median annual salaries for selected administrators in higher education were as follows:

Academic deans:	
Medicine	\$272,200
Law	180,150
Engineering	146,938
Business	101,082
Education	96,906
Arts and sciences	94,666
Social sciences	72,877
Mathematics	69,449
Other administrators:	
Dean, students	\$67,000
Director, admissions and registrar	58,241
Director, annual giving	46,800
Director, student activities	39,292

Benefits for education administrators are generally very good. Many get 4 or 5 weeks vacation every year and have generous health and pension packages. Many colleges and universities offer free tuition to employees' children.

Related Occupations

Education administrators apply organizational and leadership skills to provide services to individuals. Workers in related occupations include administrative services managers; office and administrative support worker supervisors and managers; human resource, training, and labor relations managers and specialists; and archivists, curators, and museum technicians. Education administrators also work with students and have backgrounds similar to those of counselors; librarians; instructional coordinators; teachers—pre-school, kindergarten, elementary, middle, and secondary; and teachers—postsecondary.

Sources of Additional Information

For information on elementary school principals, contact:

► The National Association of Elementary School Principals, 1615 Duke St., Alexandria, VA 22314-3483. Internet: <http://www.naesp.org>

For information on collegiate registrars and admissions officers, contact:

► American Association of Collegiate Registrars and Admissions Officers, One Dupont Circle NW., Suite 520, Washington, DC 20036-1171. Internet: <http://www.aacrao.org>

For information on professional development and graduate programs for college student affairs administrators, contact:

► NASPA, Student Affairs Administrators in Higher Education, 1875 Connecticut Ave. NW., Washington, DC 20009. Internet: <http://www.naspa.org>

Engineering and Natural Sciences Managers

(O*NET 11-9041.00, 11-9121.00)

Significant Points

- Most engineering and natural sciences managers have previous experience as engineers, scientists, or mathematicians.
- Employers prefer managers with advanced technical knowledge and strong communication and administrative skills.

Nature of the Work

Engineering and natural sciences managers plan, coordinate, and direct research, design, and production activities. They may supervise engineers, scientists, and technicians, along with support personnel. These managers use advanced technical knowledge of engineering and science to oversee a variety of activities. They determine scientific and technical goals within broad outlines provided by top executives, who are discussed elsewhere in the *Handbook*. These goals may include improving manufacturing processes, advancing scientific research, or redesigning aircraft. Managers make detailed plans to accomplish these goals—for example, they may develop the overall concepts of a new product or identify technical problems preventing the completion of a project.

To perform effectively, they also must possess knowledge of administrative procedures, such as budgeting, hiring, and supervision. These managers propose budgets for projects and programs and determine staff, training, and equipment purchases. They hire and assign scientists, engineers, and support personnel to carry out specific parts of each project. They also supervise the work of these employees, review their output, and establish administrative procedures and policies—including environmental standards, for example.

In addition, these managers use communication skills extensively. They spend a great deal of time coordinating the activities of their unit with those of other units or organizations. They confer with higher levels of management; with financial, production, marketing, and other managers; and with contractors and equipment and materials suppliers.

Engineering managers supervise people who design and develop machinery, products, systems, and processes; or direct and coordinate production, operations, quality assurance, testing, or maintenance in industrial plants. Many are plant engineers, who direct and coordinate the design, installation, operation, and maintenance of equipment and machinery in industrial plants. Others manage research and development teams that produce new products and processes or improve existing ones.

Natural sciences managers oversee the work of life and physical scientists, including agricultural scientists, chemists, biologists, geologists, medical scientists, and physicists. These managers direct research and development projects and coordinate activities such as testing, quality control, and production. They may work on basic research projects or on commercial activities. Science managers sometimes conduct their own research in addition to managing the work of others.



Managers oversee the design and installation of equipment and machinery in industrial plants.

Working Conditions

Engineering and natural sciences managers spend most of their time in an office. Some managers, however, also may work in laboratories, where they may be exposed to the same conditions as research scientists, or in industrial plants, where they may be exposed to the same conditions as production workers. Most managers work at least 40 hours a week and may work much longer on occasion to meet project deadlines. Some may experience considerable pressure to meet technical or scientific goals on a short deadline or within a tight budget.

Employment

Engineering and natural sciences managers held about 324,000 jobs in 2000. Nearly 3 out of 10 worked in services industries, primarily for firms providing computer and data processing, engineering and architectural, or research and testing services. Manufacturing industries employed one-third. Manufacturing industries with the largest employment include those producing industrial machinery and equipment, electronic and other electrical equipment, transportation equipment, instruments, and chemicals. Other large employers include government agencies and transportation, communications, and utilities companies.

Training, Other Qualifications, and Advancement

Strong technical knowledge is essential for engineering and natural sciences managers, who must understand and guide the work of their subordinates and explain the work in nontechnical terms to senior management and potential customers. Therefore, these management positions usually require work experience and formal education similar to that of engineers, scientists, or mathematicians.

Most engineering managers begin their careers as engineers, after completing a bachelor's degree in the field. To advance to higher level positions, engineers generally must assume management responsibility. To fill management positions, employers seek engineers who possess administrative and communications skills in addition to technical knowledge in their specialty. Many engineers gain these skills by obtaining a master's degree in engineering management or a master's degree in business administration (MBA). Employers often pay for such training. In large firms, some courses required in these degree programs may be offered

onsite. Engineers who prefer to manage in technical areas should get a master's degree in engineering management, while those interested in nontechnical management should get an MBA.

Many science managers begin their careers as scientists, such as chemists, biologists, geologists, or mathematicians. Most scientists or mathematicians engaged in basic research have a Ph.D.; some in applied research and other activities may have a bachelor's or master's degree. Science managers must be specialists in the work they supervise. In addition, employers prefer managers with good communication and administrative skills. Graduate programs allow scientists to augment their undergraduate training with instruction in other fields, such as management or computer technology. Given the rapid pace of scientific developments, science managers must continuously upgrade their knowledge.

Engineering and natural sciences managers may advance to progressively higher leadership positions within their discipline. Some may become managers in nontechnical areas such as marketing, human resources, or sales. In high technology firms, managers in nontechnical areas often must possess the same specialized knowledge as managers in technical areas. For example, employers in an engineering firm may prefer to hire experienced engineers as sales workers because the complex services offered by the firm can be marketed only by someone with specialized engineering knowledge.

Job Outlook

Employment of engineering and natural sciences managers is expected to increase more slowly than the average for all occupations through the year 2010—in line with projected employment growth in engineering and most sciences. However, many additional jobs will result from the need to replace managers who retire or move into other occupations. Opportunities for obtaining a management position will be best for workers with advanced technical knowledge and strong communication and administrative skills.

The job outlook for engineering and natural sciences managers should be closely related to the growth of the occupations they supervise and the industries in which they are found. For example, opportunities for managers should be better in rapidly growing areas of engineering, such as electrical, computer, and biomedical engineering than in more slowly growing areas of engineering or physical science. (See the statements on engineers, and life and physical scientists, elsewhere in the *Handbook*.) In addition, many employers are finding it more efficient to contract engineering and science management services to outside companies and consultants, creating good opportunities for managers in management services and management consulting firms.

Earnings

Earnings for engineering and natural sciences managers vary by specialty and level of responsibility. Median annual earnings of engineering managers were \$84,070 in 2000. The middle 50 percent earned between \$66,420 and \$105,630. The lowest 10 percent earned less than \$52,350, and the highest 10 percent earned more than \$130,350. Median annual earnings in the industries employing the largest numbers of engineering managers in 2000 were:

Electronic components and accessories	\$98,940
Computer and data processing services	98,890
Aircraft and parts	88,620
Federal government	83,840
Engineering and architectural services	83,390

Median annual earnings of natural sciences managers were \$75,880 in 2000. The middle 50 percent earned between \$56,320 and \$100,760. The lowest 10 percent earned less than \$43,110, and the highest 10 percent earned more than \$128,090. Median annual earnings in the industries employing the largest numbers of natural sciences managers in 2000 were:

Research and testing services	\$87,070
Federal government	74,780

A survey of manufacturing firms, conducted by Abbot, Langer & Associates, found that engineering department managers and superintendents earned a median annual income of \$85,154 in 1999, while research and development managers earned \$84,382.

In addition, engineering and natural sciences managers, especially those at higher levels, often receive more benefits—such as expense accounts, stock option plans, and bonuses—than do non-managerial workers in their organizations.

Related Occupations

The work of engineering and natural sciences managers is closely related to that of engineers; mathematicians; and physical and life scientists, including agricultural and food scientists, biological and medical scientists, conservation scientists and foresters, atmospheric scientists, chemists and materials scientists, environmental scientists and geoscientists, and physicists and astronomers. It also is related to the work of other managers, especially top executives.

Sources of Additional Information

For information about a career as an engineering and natural sciences manager, contact the sources of additional information for engineers, life scientists, and physical scientists that are listed in statements on these occupations elsewhere in the *Handbook*.

Farmers, Ranchers, and Agricultural Managers

(O*NET 11-9011.01, 11-9011.02, 11-9011.03, 11-9012.00)

Significant Points

- Modern farming requires college training in agriculture and work experience acquired through growing up on a farm or through a small number of internships now available.
- Overall employment is projected to decline because of increasing productivity and consolidation of farms.
- Aquaculture should provide some new employment opportunities; in addition, developments in value-added marketing and organic farming are making small-scale farming economically viable again.
- Self-employed farmers' and ranchers' incomes vary greatly from year to year.

Nature of the Work

American farmers, ranchers, and agricultural managers direct the activities of one of the world's largest and most productive agricultural sectors. They produce enough food and fiber to meet the needs of the United States and produce a surplus for export.

Farmers and ranchers may be owners or tenants who rent the use of land. The type of farm they operate determines their specific

tasks. On crop farms—farms growing grain, cotton, and other fibers, fruit, and vegetables—farmers are responsible for planning, tilling, planting, fertilizing, cultivating, spraying, and harvesting. After the harvest, they make sure the crops are properly packaged, stored, or marketed. Livestock, dairy, and poultry farmers must feed, plan, and care for the animals and keep barns, pens, coops, and other farm buildings clean and in good condition. They also oversee breeding and marketing activities. Horticultural specialty farmers oversee the production of ornamental plants, nursery products—such as flowers, bulbs, shrubbery, and sod—and fruits and vegetables grown in greenhouses. Aquaculture farmers raise fish and shellfish in marine, brackish, or fresh water, usually in ponds, floating net pens, raceways, or recirculating systems. They stock, feed, protect, and otherwise manage aquatic life sold for consumption or used for recreational fishing.

Farmers and ranchers make many managerial decisions. Their farm output is strongly influenced by the weather, disease, fluctuations in prices of domestic and foreign farm products, and Federal farm programs. In a crop operation, farmers usually determine the best time to plant seed, apply fertilizer and chemicals, harvest, and market. They use different strategies to protect themselves from unpredictable changes in the markets for agricultural products. Many farmers carefully plan the combination of crops they grow so that if the price of one crop drops, they will have sufficient income from another to make up for the loss. Others, particularly operators of smaller farms, may choose to sell their goods directly through farmers' markets, or use cooperatives to reduce their financial risk and to gain a larger share of consumers' expenditures on food. For example, in Community Supported Agriculture (CSA), cooperatives sell to consumers shares of a harvest prior to the planting season, thus freeing the farmer from having to bear all the financial risks and ensuring the farmer a market for the produce of the coming season.

Farmers and ranchers who plan ahead may be able to store their crops or keep their livestock to take advantage of better prices later in the year. Those who participate in the risky futures market—in which contracts and options on futures contracts on commodities are traded through stockbrokers—try to anticipate or track changes in the supply of and demand for agricultural commodities, and thus changes in the prices of farm products. By buying or selling futures contracts, or by pricing their products in advance of future sales, they attempt to either limit their risk or reap greater profits than would normally be realized. They may have to secure loans from credit agencies to finance the purchase of machinery, fertilizer, livestock, and feed. Like other businesses, farming operations have become more complex in recent years, so many farmers use computers to keep financial and inventory records. They also use computer databases and spreadsheets to manage breeding, dairy, and other farm operations.

Responsibilities of farmers and ranchers range from caring for livestock, to operating machinery, to maintaining equipment and facilities. The size of the farm or ranch often determines which of these tasks farmers and ranchers will handle themselves. Operators of small farms usually perform all tasks, physical and administrative. They keep records for tax purposes, service machinery, maintain buildings, and grow vegetables and raise animals. Operators of large farms, on the other hand, have employees who help with the physical work that small-farm operators do themselves. Although employment on most farms is limited to the farmer and one or two family workers or hired employees, some large farms have 100 or more full-time and seasonal workers. Some of these employees are in nonfarm occupations, working as truck drivers, sales representatives, bookkeepers, and computer specialists.

Agricultural managers guide and assist farmers and ranchers in maximizing the financial returns to their land by managing the day-