

SIGNIFICANT POINTS

- Telecommunications includes voice, video, and Internet communications services.
- Job growth will be limited by overcapacity, technological advances, mergers, and contracting out.
- With rapid technological changes in telecommunications, those with up-to-date technical skills will have the best job opportunities.
- Average earnings in telecommunications greatly exceed average earnings throughout private industry.

Nature of the Industry

Changes in technology, government regulation, and market conditions continue to transform the telecommunications industry. Whereas voice telephone communication was once the primary service of the industry, the transmission of a variety of information, including data, graphics, and video, is now commonplace. The widespread installation of fiber optic cables, which transmit light signals along glass strands, permits faster, higher capacity transmissions than those possible with traditional copper wirelines. In addition, networks of radio towers provide wireless telecommunications services. In the previous *Career Guide*, telecommunications and cable and other pay television services were described in separate sections. The convergence of the services provided by traditional telecommunications companies and cable companies has led to the combination of those sections into this one statement.

Changes in government regulation introduced competition into an industry that was once dominated by a single company. Competition from outside the industry increased as cable companies and public utilities expanded their own communications networks. During the late 1990s, the growth of the Internet, advances in a range of technologies, the deregulation of the telecommunications industry, and rapid increases in demand for telecommunications services helped fuel rapid growth. Consequently, many new competitors entered the markets and built additional transmission capacity. The massive investments in additional capacity by new competitors and existing companies eventually caused supply to significantly exceed demand, resulting in much lower prices for transmission capacity. The excess capacity and additional competition led to either declining revenues or slowing revenue growth, which caused many companies to reduce employment.

The principal sector of the telecommunications industry is telephone communications. Establishments in this sector operate both wireline and wireless networks. Wireline networks use wires and cables to connect customers' premises to central offices maintained by telecommunications companies. Central offices contain switching equipment that routes content to its final destination or to another switching center. For example, switching equipment may route local telephone calls directly from

the central office to their final destination; long-distance calls are routed to larger switching centers that determine the most efficient route for the call to take.

Wireless networks operate through the transmission of signals over networks of radio towers. For example, a wireless cellular telephone transmits radio signals to an antenna located on a radio tower. The signal is then transmitted through the antenna into the wireline network. Other wireless services include beeper, paging, and Internet access. Because these devices require no wireline connection, they are popular with customers who need to communicate as they travel, residents of areas with inadequate wireline service, and those who simply desire the convenience of portable communications. Increasing numbers of consumers are choosing to replace their home landlines with wireless phones.

Wireless providers plan to deploy additional technology called third generation (3G) wireless access. Conventional wireless Internet access is relatively slow, allowing cellular phones to display only limited amounts of text-based information. A 3G system allows higher speed data transmission and better Internet access. Fixed wireless service, which involves connecting the telephone and/or Internet wiring system in a home or business to an antenna, instead of a telephone line, is another source of competition. The replacement of landlines with cellular service should become increasingly common because 3G wireless will provide a level of service closer to that of landline systems.

The wireline sector also includes resellers of telecommunications services who compete with traditional local telephone service providers. These resellers lease transmission facilities, such as telephone lines, from existing telecommunications networks, and then resell the service to other customers. Other sectors in the industry include message communications services, such as e-mail and facsimile services, and operators of other communication services, ranging from radar stations to radio networks used by taxicab companies.

Voice telephone communications have long been the predominant service offered by telephone companies. With the rising popularity of the Internet, however, customers increasingly use their telephone service to transmit data and other electronic materials. The transmission of such content relies on digital tech-

nologies that use telecommunications networks more efficiently than do conventional systems. Digital signals consist of separate pieces of electronic code that can be broken apart during transmission and then reassembled at the destination. Telecommunications providers have built networks of computerized switching equipment, called packet switched networks, to route digital signals. Packet switches break the signals into small segments or “packets” and provide each with the necessary routing information. Segments may take separate paths to their destination and may share the paths with packets from other users. At the destination, the segments are reassembled, and the transmission is complete. Because packet switching considers alternate routes, and allows multiple transmissions to share the same route, it results in a more efficient use of telecommunications capacity. Voice communications are normally split up and reassembled by telecommunications companies’ switching and routing equipment. An increasingly popular option for businesses, which should eventually become more common in residential communications, is called Voice over Internet Protocol (VoIP). VoIP splits up the conversation into packets in the telephone, transmitting the conversation over the Internet. The telephone has an Internet address at which it receives and reassembles packets into voice communications.

The transmission of voice signals requires relatively small amounts of capacity on telecommunications networks. By contrast, the transmission of data, video, and graphics requires much higher capacity. This transmission capacity is referred to as bandwidth. As the demand increases for high-capacity transmissions—especially with the rising volume of Internet data—telecommunications companies have expanded and upgraded their networks to increase the amount of available bandwidth.

Wireline providers have massively expanded their networks by laying additional fiber optic cable, which provides higher bandwidth and transmission speed than does copper wire. The capacity of fiber optic cables is increasing due to advances in transmission speed and improvements in technologies such as wavelength division multiplexing (WDM). Within each glass fiber optic line within a cable, WDM uses the different colors of the spectrum; each color can carry a separate stream of data, increasing overall capacity. Providers also offer upgraded service on the copper wirelines that connect most residential customers with central offices. Technologies such as digital subscriber lines (DSL) allow simultaneous transmission of voice and data communications at relatively high speeds.

Changes in technology and regulation now allow cable and satellite television providers to compete with telephone companies. An important change has been the rapid increase in two-way communications capacity. Conventional pay television services provided communications only from the distributor to the customer. These services could not provide effective communications from the customer back to other points in the system, due to signal interference and the limited capacity of conventional cable systems. Cable operators implemented new technologies to reduce signal interference. The capacity of distribution systems also has increased, due to the installation of fiber optic cables and improved data compression. As a result, some pay television systems now offer two-way telecommunications services, such as telephone service and high-speed Internet access. The

high cost of building cable telephony systems has limited growth. New technologies being developed to reduce construction costs should help overcome this problem.

Cable and other program distribution is another sector of the telecommunications industry. Establishments in this sector provide television and other services on a subscription or fee basis. These establishments do not include cable networks. (Information on cable networks is included in the statement on broadcasting, which appears elsewhere in the *Career Guide*.) Distributors of pay television services transmit programming through two basic types of systems. Cable systems transmit programs over fiber optic and coaxial cables. Direct broadcasting satellite (DBS) operators constitute a rapidly growing segment of the pay television industry. DBS operators transmit programming from orbiting satellites to customer receivers, known as minidishes. The dishes are about 18 inches in diameter, although newer dishes that provide Internet access are slightly larger.

Establishments in this industry generate revenue through subscriptions, special service fees, and advertising sales. Pay television systems charge installation and subscription fees to set up and provide service. They also charge fees for special services, such as the transmission of specialty pay-per-view or video-on-demand programs; these often are popular movies or sporting events.

Subscription television services are widely used. In 2002, more than 80 percent of households with television sets received pay television services. Most of these customers subscribed to cable service; however, subscriptions to satellite services are growing rapidly.

Some upgraded systems facilitate the transmission of digital television signals. Digital signals consist of simple electronic code that can carry more information than conventional television signals. Digital transmission creates higher resolution television images and improved sound quality. It also allows the transmission of a variety of other information. Another feature of digital television is more channels, thanks to compression technology.

Satellite-based systems have experienced rapid growth, with more than 19 million subscribers in 2002. The growth of the satellite subscription industry stems from several factors. Prices for minidish subscriptions have dropped dramatically, and are now competitive with cable. In addition, regulatory changes allowed satellite services to begin carrying local network channels. Most recently, satellite services have begun offering Internet access.

Working Conditions

The telecommunications industry offers steady, year-round employment. Overtime sometimes is required, especially during emergencies such as floods or hurricanes when employees may need to report to work with little notice.

Telecommunications line installers and repairers work in a variety of places, both indoors and outdoors, and in all kinds of weather. Their work involves lifting, climbing, reaching, stooping, crouching, and crawling. They must work in high places such as rooftops and telephone poles, or below ground when working with buried lines. Their jobs bring them into proximity with electrical wires and circuits, so they must take precautions

to avoid shocks. These workers must wear safety equipment when entering manholes, and test for the presence of gas before going underground.

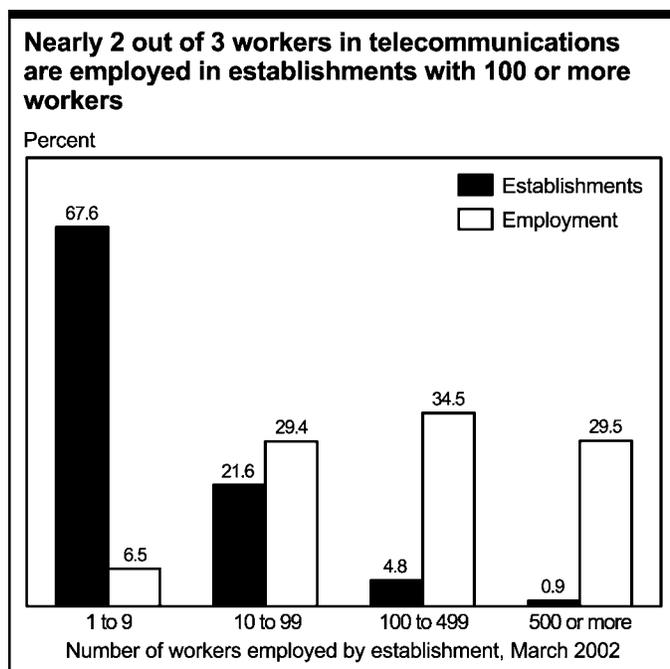
Telecommunications equipment installers and repairers, except line installers, generally work indoors—most often in a telecommunication company’s central office or a customer’s place of business. They may have to stand for long periods; climb ladders; and do some reaching, stooping, and light lifting. Adherence to safety precautions is essential to guard against work injuries such as minor burns and electrical shock.

Most communications equipment operators, such as telephone operators, work at video display terminals in pleasant, well-lighted, air-conditioned surroundings. If the worksite is not well designed, however, operators may experience eye strain and back discomfort. The rapid pace of the job and close supervision may cause stress. Some workplaces have introduced innovative practices among their operators to reduce job-related stress.

The number of disabling injuries in telephone communications, the principal sector of the telecommunications industry, has been well below the average for all industries in past years. In 2001, cases of work-related injury and illness were 3.0 per 100 full-time workers, significantly lower than the 5.3 per 100 full-time workers for the entire private sector.

Employment

The telecommunications industry provided 1.2 million wage and salary jobs in 2002. Most telecommunications employees work in large establishments. Sixty-four percent of employment is in establishments with 100 or more employees (chart 1). With continuing deregulation, however, the number of small contractors has been increasing. Telecommunications jobs are found in almost every community, but most employees work in cities that have large concentrations of industrial and business establishments.



Occupations in the Industry

Although the telecommunications industry employs workers in many different occupations, 56 percent of all workers are employed in either office and administrative support occupations or installation, maintenance, and repair occupations (table 1).

Telephone craftworkers install, repair, and maintain telephone equipment, cables and access lines, and telecommunications systems. These workers can be grouped by the type of work

Table 1. Employment of wage and salary workers in telecommunications by occupation, 2002 and projected change, 2002-2012

(Employment in thousands)

Occupation	Employment, 2002 Number	Percent	Percent change, 2002-12
All occupations	1,201	100.0	6.7
Management, business, and financial occupations			
Top executives	176	14.7	11.6
Advertising, marketing, promotions, public relations, and sales managers	20	1.6	14.7
Operations specialties managers	14	1.2	24.9
Management analysts	24	2.0	15.2
Financial specialists	13	1.0	-1.0
	18	1.5	13.5
Professional and related occupations			
Computer software engineers	169	14.1	14.5
Computer support specialists	26	2.2	15.1
Network and computer systems administrators	12	1.0	14.7
Electrical and electronics engineers	14	1.2	16.9
Electrical and electronic engineering technicians	24	2.0	10.8
	16	1.3	4.3
Sales and related occupations			
First-line supervisors/managers of non-retail sales workers	164	13.7	16.3
Retail salespersons	15	1.2	9.1
Sales representatives, wholesale and manufacturing	23	1.9	29.4
Telemarketers	42	3.5	22.1
	20	1.7	-16.7
Office and administrative support occupations			
First-line supervisors/managers of office and administrative support workers	364	30.3	0.2
Telephone operators	29	2.4	-1.4
Bill and account collectors	38	3.1	-57.3
Customer service representatives	13	1.1	10.3
Production, planning, and expediting clerks	134	11.1	20.4
Secretaries and administrative assistants	12	1.0	4.0
Office clerks, general	18	1.5	-3.1
	30	2.5	-2.6
Installation, maintenance, and repair occupations			
First-line supervisors/managers of mechanics, installers, and repairers	312	26.0	2.0
Telecommunications equipment installers and repairers, except line installers	25	2.1	9.4
Telecommunications line installers and repairers	152	12.7	-6.9
	91	7.6	12.2

NOTE: May not add to totals due to omission of occupations with small employment.

they perform. *Line installers and repairers* connect central offices to customers' buildings. They install poles and terminals, and place wires and cables that lead to a consumer's premises. They use power-driven equipment to dig holes and set telephone poles. Line installers climb the poles or use truck-mounted buckets (aerial work platforms) and attach the cables using various handtools. After line installers place cables on poles or towers or in underground conduits and trenches, they complete the line connections.

Telecommunications equipment installers and repairers, except line installers, install, repair, and maintain the array of increasingly complex and sophisticated communications equipment and cables. Their work includes setting up, rearranging, and removing the complex switching and dialing equipment used in central offices. They may also solve network-related problems and program equipment to provide special features.

Some telecommunications equipment installers are referred to as telephone station installers and repairers. They install, service, and repair telephone systems and other communications equipment on customers' property. When customers move or request new types of service, such as a high-speed Internet connection, a fax, or an additional line, installers relocate telephones or make changes in existing equipment. They assemble equipment and install wiring. They also connect telephones to outside service wires and sometimes must climb poles or ladders to make these connections.

Cable installers travel to customers' premises to set up pay television service so that customers can receive programming. Cable service installers connect a customer's television set to the cable serving the entire neighborhood. Wireless and satellite service installers attach antennas or satellite dishes to the sides of customers' houses. These devices must be positioned to provide clear lines of sight to satellite locations. (Satellite installation may be handled by employees of retail stores that sell satellite dishes. Such workers are not employed by cable and other pay television services.)

Installers check the strength and clarity of the television signal before completing the installation. They may need to explain to the subscriber how pay television services operate. As these services expand to include telephone and high-speed Internet access, an understanding of the basic technology and an ability to communicate that knowledge are increasingly important.

Telephone operators make telephone connections, assist customers with specialized services such as reverse-charge calls, provide telephone numbers, and may provide emergency assistance.

Customer service representatives help customers understand the new and varied types of services offered by telecommunications providers. Some customer service representatives also are expected to sell services and may work on a commission basis. Other administrative support workers include *financial, information, and records clerks; secretaries and administrative assistants; and first-line supervisors/managers of office and administrative support workers*. These workers keep service records, compile and send bills to customers, and prepare statistical and other company reports, among other duties.

Fourteen percent of the industry's employees are professional workers. Many of these are scientific and technical personnel such as engineers and computer specialists. *Engineers* plan cable and microwave routes, central office and PBX equipment installations, and the expansion of existing structures, and solve other engineering problems. Some engineers also engage in research and development of new equipment. Many specialize in telecommunications design or voice, video, or data communications systems, and integrate communications equipment with computer networks. They work closely with clients, who may not understand sophisticated communications systems, and design systems that meet their customers' needs. *Computer software engineers and network systems and data communications analysts* design, develop, test, and debug software products. These include computer-assisted engineering programs for schematic cabling projects; modeling programs for cellular and satellite systems; and programs for telephone options, such as voice mail, e-mail, and call waiting. Telecommunications specialists coordinate the installation of these systems and may provide followup maintenance and training. In addition, the industry employs many other managerial, professional, and technical workers, such as *financial information and record clerks; accountants and auditors; human resources, training, and labor relations managers; engineering technicians; and computer programmers*.

Fourteen percent of the industry's employees are in sales and related occupations. These workers sell telecommunications services, such as long-distance service, personal answering services, voice mail, e-mail, and call-waiting telephone options.

New occupational specialties have emerged based on the industry's innovations and new technologies. For example, some engineers research, design, and develop gas lasers and related equipment needed to send messages through fiber optic cable transmission. They study the limitations and uses of lasers and fiber optics; find new applications for them; and oversee the building, testing, and operations of the new applications.

Training and Advancement

The telecommunications industry offers employment in jobs requiring a variety of skills and training. Many jobs require a high school education in addition to on-the-job training. Other jobs require particular skills that may take several years of experience to learn completely. For some managerial and professional jobs, employers require a college education.

Line installers often are hired initially as helpers, grounds workers, or tree trimmers who clear branches from lines. Because the work entails a lot of climbing, applicants should have physical stamina and be unafraid of heights. The ability to distinguish colors is important because wires and cables are coded by color. Although line installers may not complete a formal apprenticeship, they generally receive several years of on-the-job training. Line installers may transfer to other highly skilled jobs, such as telecommunications equipment installer and repairer, or may move into other kinds of work, such as sales. Promotion to crew supervisor, technical staff, or instructor of new employees also is possible.

Most companies prefer to hire telecommunications equipment installers and repairers with postsecondary training in elec-

tronics; some choose to hire persons with experience as line installers. Training sources include 2- and 4-year college programs in electronics or communications, trade schools, and training provided by telecommunications companies and/or equipment and software manufacturers. Telecommunications equipment installers and repairers may advance to jobs maintaining more sophisticated equipment or to engineering technician positions.

Communications equipment operators should have clear speech and good hearing; computer literacy and keyboarding skills also are important. New operators learn equipment operation and procedures for maximizing efficiency. Instructors monitor both the time and quality of trainees' responses to customer requests. Formal classroom instruction and on-the-job training may last several weeks.

A bachelor's degree in engineering usually is required for entry-level jobs as electrical and electronics engineers. Continuing education is important for these engineers; those who fail to keep up with the rapid changes in technology risk technological obsolescence, which makes them more susceptible to layoffs or, at a minimum, more likely to be passed over for advancement.

While there is no universally accepted way to prepare for a job as a computer professional, most employers place a premium on some formal college education. Computer software engineers usually hold a degree in computer science or in software engineering. For systems analyst, computer scientist, or database administrator positions, many employers seek applicants who have a bachelor's degree in computer science, information science, or management information systems.

Due to the rapid introduction of new technologies and services, the telecommunications industry is among the most rapidly changing in the economy. This means workers must keep their job skills up to date. From managers to communications equipment operators, increased knowledge of both computer hardware and software is of paramount importance. Several major companies and the telecommunications unions have created a Web site that provides free training for employees, enabling them to keep their knowledge current and helping them to advance. Telecommunications industry employers now look for workers with knowledge of and skills in computer programming and software design; voice telephone technology, known as telephony; laser and fiber optic technology; wireless technology; and data compression. Individuals with sales ability enhanced by interpersonal skills and knowledge of telecommunications terminology also are sought.

Earnings

Average weekly earnings of nonsupervisory workers in the telecommunications industry were \$761 in 2002, significantly higher than average earnings of \$506 in private industry. Table 2 presents earnings in selected occupations in telecommunications in 2002.

Twenty-four percent of employees in the industry are union members or covered by union contracts, compared with about 15 percent for all industries. Most telecommunications employees belong to 1 of 2 unions—the Communications Workers of America or the International Brotherhood of Electrical Workers.

Table 2. Median hourly earnings of the largest occupations in telecommunications, 2002

Occupation	Telecommunications	All industries
Managers, all other	\$34.41	\$32.16
First-line supervisors/managers of mechanics, installers, and repairers ...	27.84	22.87
First-line supervisors/managers of office and administrative support workers	23.83	18.66
Telecommunications equipment installers and repairers, except line installers	23.68	22.78
Telecommunications line installers and repairers	22.10	19.06
Sales representatives, wholesale and manufacturing, except technical and scientific products	18.21	20.54
Office clerks, general	16.80	10.71
Telephone operators	15.89	13.75
Customer service representatives	15.33	12.62
Retail salespersons	12.52	8.51

Outlook

Employment in the telecommunications industry is expected to increase 7 percent over the 2002-12 period, somewhat less than the 16 percent projected for all industries combined. Currently, excess transmission capacity and significant debt among telecommunications firms should limit employment. However, rising demand for telecommunications services will eventually result in a resumption of job growth in the industry.

Increases in both residential and business demand for high-capacity communications will eventually lead to upgrades of telecommunications networks. Rapidly increasing wireless demand, and the construction of a new generation of wireless systems, will help the wireless portion of the industry. However, technological improvements, such as fiberoptic lines and advanced switching equipment, have massively increased the data transmission capacity of telecommunications networks, and the resulting productivity gains have limited employment growth. Individuals with up-to-date technical skills should have the best employment opportunities.

Residential demand will increase as technology and competition lower the price of premium services, such as high-speed Internet access, video-on-demand, and wireless telephone service. The lower prices resulting from increasing capacity and competition will continue to limit revenues, curbing employment growth. Demand also will increase because deregulation has allowed providers to offer combined services, making it easier for households to obtain a wide variety of telecommunications services. Wireless carriers are competing directly with the residential service business, providing increasingly reliable cellular service and Internet service. Therefore, the lines between cable and satellite TV, wireless, and wireline telephone systems will become blurred.

Business demand will rise as companies increasingly rely on their telecommunications systems to conduct electronic commerce. In order to remain competitive, businesses will require higher speed access to the Internet for a variety of purposes including purchasing, marketing, sales, and customer service, but the increased demand will not result in significant employment gains. Some employment loss will result from improved

laborsaving technologies, such as self-monitoring equipment, and from layoffs due to mergers and consolidation in the de-regulated industry.

Technology will continue to transform the industry. The installation and upgrading of fiber optic networks will bring ever-faster communications closer to residential customers. Internet telephony, which transmits voice, video, fax, and e-mail communications over the Internet, will blur the boundaries between telecommunications providers and Internet service providers. Wireless providers will continue to increase the capacity of their radio networks and introduce improved portable, lightweight devices capable of transmitting voice, data, and video. Under-sea cables and orbiting satellites are integrating wireline and wireless customers into a global system of high bandwidth communications. The installation of computerized switching systems designed for digital content makes transmitting data, video, and graphics as easy as making voice telephone calls.

The removal of competitive barriers has increased competition from providers outside the traditional telecommunications industry. Cable TV providers are using their wireline networks to offer customers a combination of services including telephone service, Internet access, and cable TV programming. With advances in VoIP technology, cable companies will offer voice telephone communications to more customers. These same advances to their networks will allow them to offer more channels of pay-per-view and, in some cases, true video-on-demand. Satellite TV providers also are offering Internet access.

Employment growth will differ among the various occupations in the telecommunications industry, largely as a result of technology change. Employment of communications equipment operators is expected to decline due to increasing automation. Computer voice recognition technology lessens the need for central office operators, as customers can obtain help with long-distance calls from automated systems. This technology, which also enables callers to request numbers from a computer instead of a person, is expected to reduce the number of directory assistance operators. The numbers of these workers may drop further as more customers use automated directory assistance resources on the Internet.

Employment of line installers and repairers is expected to grow as telecommunications providers maintain and expand their networks in response to customer demand. Businesses will request more wireline installations to provide increased connections to suppliers and customers. Residential customers who are not able to obtain upgrades to their copper wirelines will install additional wirelines in order to use voice and data communications simultaneously.

Employment of telecommunications equipment installers and repairers is expected to decrease because newer, more reliable technologies will reduce the need for equipment maintenance. Employment of these workers also will be limited by the tendency of many companies to contract out maintenance and construction work to specialized contractors that are part of the construction industry. However, there still will be many openings available for individuals with the necessary technical skills.

Employment of electrical and electronics engineers and computer professionals is expected to grow faster than that of the overall telecommunications industry. The expansion of communications networks, and the need for telecommunications providers to invest in research and development, will create job opportunities for electrical and electronics engineers. The use of increasingly sophisticated computer technology will increase employment of computer professionals, including computer software engineers, computer support specialists, and computer systems analysts. Growth among these occupations will, in turn, create employment opportunities for engineering and computer and information systems managers.

Sources of Additional Information

For information about employment opportunities, contact your local telecommunications company, or:

- International Brotherhood of Electrical Workers, Telecommunications Department, 1125 15th St. NW., Washington, DC 20005.
- Communications Workers of America, 501 3rd St. NW., Washington, DC 20001.

For information about certifications and courses on satellite dish installation, contact:

- Satellite Broadcasting and Communications Association (SBCA), 225 Reinekers Lane, Suite 600, Alexandria, VA 22314.

For information about certifications and courses on cable and telecommunications technology, contact:

- Society of Cable and Telecommunications Engineers (SCTE), 140 Phillips Rd., Exton, PA 19341-1318. Internet: <http://www.scte.org>

For general information on the cable and telecommunications industries, contact:

- National Cable and Telecommunications Association (NCTA), 1724 Massachusetts Ave. NW., Washington, DC 20036.

More information about the following occupations in the telecommunications industry appears in the 2004-05 edition of the *Occupational Outlook Handbook*.

- Communications equipment operators
- Customer service representatives
- Electrical and electronics engineers, except computer
- Line installers and repairers
- Office clerks, general
- Radio and telecommunications equipment installers and repairers