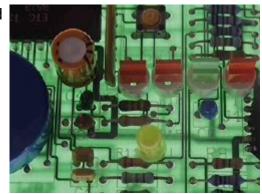# Sloan Career Cornerstone Center

Electrical Engineering Overview

The Field - Preparation - Industry Sectors - Day In The Life - Earnings - Employment - Career Path Forecast - Professional Organizations

The Field

Electrical and electronics engineers conduct research, and design, develop, test, and oversee the development of electronic systems and the manufacture of electrical and electronic equipment and devices. From the global positioning system that can continuously provide the location of a vehicle to giant electric power generators, electrical and electronics engineers are responsible for a wide range of technologies.

Electrical and electronics engineers design, develop, test, and supervise the manufacture of electrical and electronic equipment. Some of this equipment includes broadcast and communications systems; electric motors, machinery controls, lighting, and wiring in buildings, automobiles, aircraft, and radar and navigation systems; and power generating, controlling, and transmission devices used by electric utilities. Many electrical and electronics engineers also work in areas closely related to computers.

Preparation

If your goal is to achieve a fulfilling career, building the groundwork will take some care. While in school, keep your options as wide as possible -- the further you go, the narrower your focus must become. While the decision to major and minor is an important step, your decision should not be limited to an engineering curriculum or even to the classroom.

Accredited Programs

Those interested in a career in electrical engineering should consider reviewing engineering programs that are accredited by ABET, Inc. ABET accreditation is based on an evaluation of an engineering program's student achievement, program improvement, faculty, curricular content, facilities, and institutional commitment.

The following is a current list of all universities offering accredited degree programs in electrical engineering.

- Air Force Institute of Technology (Masters)
- The University of Akron
- Alabama A&M University
- University of Alabama at Birmingham
- The University of Alabama in Huntsville
- The University of Alabama
- University of Alaska Fairbanks
- Alfred University
- Arizona State University
- University of Arizona
- Arkansas Tech University
- University of Arkansas
- Auburn University
- Baylor University
- Boise State University
- Boston University
- Bradley University
- Brigham Young University
- Brown University
- Bucknell University
- California Institute of Technology
- California Polytechnic State University, San Luis Obispo
- California State Polytechnic University, Pomona
- California State University, Chico
- California State University, Fresno
- California State University, Fullerton
- California State University, Long Beach
- California State University, Los Angeles
- California State University, Northridge
- California State University, Sacramento
- University of California, Berkeley
- University of California, Davis
- University of California, Irvine
- University of California, Los Angeles
- University of California, Riverside
- University of California, San Diego
- University of California, Santa Barbara
- University of California, Santa Cruz
- Capitol College
- Carnegie Mellon University
- Case Western Reserve University
- The Catholic University of America
- Cedarville University
- University of Central Florida
- Christian Brothers University
- University of Cincinnati
- The Citadel
- Clarkson University
- Clemson University
- Cleveland State University

- Naval Postgraduate School (Masters)
- University of Nebraska-Lincoln
- University of Nevada-Las Vegas
- University of Nevada-Reno
- University of New Hampshire
- University of New Haven
- New Jersey Institute of Technology
- College of New Jersey
- New Mexico Institute of Mining and Technology
- New Mexico State University
- University of New Mexico
- University of New Orleans
- State University of New York at Binghamton
- State University of New York at Buffalo
- State University of New York at New Paltz
- New York Institute of Technology
- City University of New York, City College
- North Carolina Agricultural and Technical State University
- University of North Carolina at Charlotte
- North Carolina State University at Raleigh
- North Dakota State University
- University of North Dakota
- University of North Florida
- Northeastern University
- Northern Arizona University
- Northern Illinois University
- Northwestern University
- Norwich University
- University of Notre Dame
- Oakland University
- Ohio Northern University
- The Ohio State University
- Ohio University
- Oklahoma Christian University
- Oklahoma State University
- The University of Oklahoma
- Old Dominion University
- Franklin W. Olin College of Engineering
- Oregon State University
- University of the Pacific
- Pennsylvania State University
- Pennsylvania State University, Behrend College
- Pennsylvania State University, Harrisburg, The Capital College
- University of Pennsylvania
- University of Pittsburgh
- Polytechnic University
- Polytechnic University of Puerto Rico
- Portland State University
- University of Portland
- Prairie View A & M University

- University of Colorado at Boulder
- University of Colorado at Colorado Springs
- University of Colorado at Denver and Health Sciences Center
- Colorado State University
- Colorado Technical University
- Columbia University
- University of Connecticut
- The Cooper Union
- Cornell University
- University of Dayton
- University of Delaware
- University of Denver
- University of Detroit Mercy
- University of the District of Columbia-Van Ness Campus
- Drexel University
- Duke University
- Embry-Riddle Aeronautical University - Prescott
- University of Evansville
- Fairfield University-School of Engineering
- Fairleigh Dickinson University (Metropolitan Campus)
- Florida A & M University/Florida State University (FAMU-FSU)
- Florida Atlantic University
- Florida Institute of Technology
- Florida International University (University Park)
- University of Florida
- Gannon University
- George Mason University
- The George Washington University
- Georgia Institute of Technology
- Gonzaga University
- Grand Valley State University
- Grove City College
- Hampton University
- University of Hartford
- University of Hawaii at Manoa
- Henry Cogswell College
- Hofstra University
- University of Houston
- Howard University
- Idaho State University
- University of Idaho
- University of Illinois at Chicago
- University of Illinois at Urbana-Champaign
- Illinois Institute of Technology
- Indiana Institute of Technology
- Indiana University-Purdue University Fort Wayne
- Indiana University-Purdue University Indianapolis
- Iowa State University
- Princeton University
- University of Puerto Rico, Mayaguez Campus
- Purdue University at West Lafayette
- Purdue University Calumet
- Rensselaer Polytechnic Institute
- University of Rhode Island
- Rice University
- Rochester Institute of Technology
- University of Rochester
- Rose-Hulman Institute of Technology
- Rowan University
- Rutgers, The State University of New Jersey
- Saginaw Valley State University
- Saint Louis University
- San Diego State University
- University of San Diego
- San Francisco State University
- San Jose State University
- Santa Clara University
- Seattle Pacific University
- Seattle University
- University of South Alabama
- University of South Carolina
- South Dakota School of Mines and Technology
- South Dakota State University
- University of South Florida
- University of Southern California
- Southern Illinois University at Carbondale
- Southern Illinois University-Edwardsville
- University of Southern Maine
- Southern Methodist University
- Southern University and Agricultural & Mechanical College
- St. Cloud State University
- St. Mary's University
- University of St. Thomas
- Stanford University
- Stevens Institute of Technology
- Stony Brook University
- Suffolk University
- Syracuse University
- Temple University
- University of Tennessee at Chattanooga
- University of Tennessee at Knoxville
- Tennessee State University
- Tennessee Technological University
- Texas A & M University
- Texas A & M University - Kingsville
- University of Texas at Arlington
- University of Texas at Austin
- University of Texas at Dallas
- University of Texas at El Paso
- The University of Texas at San Antonio
- University of Texas at Tyler
- Texas Tech University

- University of Iowa
- The Johns Hopkins University
- Kansas State University
- The University of Kansas
- University of Kentucky
- Kettering University
- Lafayette College
- Lake Superior State University
- Lamar University
- Lawrence Technological University
- Lehigh University
- University of Louisiana at Lafayette
- Louisiana State University and A&M College
- Louisiana Tech University
- University of Louisville
- Loyola Marymount University
- University of Maine
- Manhattan College
- Marquette University
- University of Maryland College Park
- University of Massachusetts Amherst
- University of Massachusetts Dartmouth
- Massachusetts Institute of Technology
- University of Massachusetts Lowell
- The University of Memphis
- Merrimack College
- University of Miami
- Michigan State University
- Michigan Technological University
- University of Michigan
- University of Michigan-Dearborn
- Milwaukee School of Engineering
- University of Minnesota Duluth
- Minnesota State University, Mankato
- University of Minnesota-Twin Cities
- Mississippi State University
- University of Mississippi
- Missouri University of Science and Technology
- University of Missouri-Columbia
- University of Missouri-Kansas City
- University of Missouri-St. Louis
- Montana State University - Bozeman
- Morgan State University
- The University of Texas-Pan American
- The University of Toledo
- Tri-State University
- Tufts University
- Tulane University
- The University of Tulsa
- Tuskegee University
- Union College
- United States Air Force Academy
- United States Coast Guard Academy
- United States Military Academy
- United States Naval Academy
- Utah State University
- University of Utah
- Valparaiso University
- Vanderbilt University
- University of Vermont
- Villanova University
- Virginia Commonwealth University
- Virginia Military Institute
- Virginia Polytechnic Institute and State University
- University of Virginia
- Washington State University
- Washington University
- University of Washington
- Wayne State University
- Wentworth Institute of Technology
- West Virginia University
- West Virginia University Institute of Technology
- Western Kentucky University
- Western Michigan University
- Western New England College
- Wichita State University
- Widener University
- Wilkes University
- University of Wisconsin-Madison
- University of Wisconsin-Milwaukee
- University of Wisconsin-Platteville
- Worcester Polytechnic Institute
- Wright State University
- University of Wyoming
- Yale University
- Youngstown State University

Concentrations in EE

Core courses taken by all EE students include such topics as circuits, electronics, digital design, and microprocessors. Laboratory courses play an important role in reinforcing the concepts learned in the lecture courses. The core curriculum builds on a foundation of basic courses in calculus, physics, chemistry, and the humanities. Additional courses draw heavily from other disciplines such as computer science, mechanical engineering, materials science, manufacturing, management, and finance. Concentration courses vary with the engineering

school, but generally offer studies in such topics as communications systems, power systems, and control and instrumentation, all with associated laboratory work. Many engineering schools also offer concentrations in medical instrumentation and in microwave and optical systems, for example.

Courses in mathematics and basic sciences are of course the foundation of an electrical engineering curriculum. EE courses build on this base by developing creativity and such engineering skills as use of modern design theory and methodology, formulation of design problem statements and specifications, and consideration of alternative solutions. Related courses in computer science are essential. Additional courses draw heavily from other disciplines such as mechanical engineering, materials science, manufacturing, management, and finance. Advanced EE courses prepare students for specialties such as computers, electronics, controls and robotics, power and energy, and telecommunications.

Automatic Controls

The field of automatic control spans a wide range of technologies, from aerospace to health care. The main goal of automatic control technology is to automatically guide or regulate a system under both steady-state and transient conditions, using feedback to adapt to unknown or changing conditions. Electrical engineers design and develop automatic control systems to guide aircraft and spacecraft. They apply control technology to automatically adjust processes and machinery in manufacturing such diverse products as chemicals, pharmaceuticals, automobiles, and integrated circuits. For the healthcare industry, electrical engineers design controls for medical assistance devices such as medication-injection machines and respirators.

Digital Systems (Computer Engineering)

Digital systems permeate technology in all its forms; the world has gone digital, with digital control, digital communications, and digital computation. Electrical engineers / computer engineers design, develop, and manufacture all kinds of digital products, including both hardware and software: laptops, personal computers; mainframes; supercomputers; workstations; virtual-reality systems; video games; modems; telephone switches; embedded microcontrollers for aircraft, cars, appliances, and machines of all types. Digital computer-aided design (CAD) systems are now commonplace in all branches of engineering design-machines, structures, circuits and computer graphics are indispensable in advertising and publishing; meanwhile engineers are continually developing improved hardware and software for such applications.

Electromagnetics

Electromagnetics deals with the transfer of energy by radiation, such as light waves, and radio waves, and the interaction of such radiation with matter. Engineers apply electromagnetics in optical-fiber communications, radio broadcasting, wireless communications, coaxial cable systems, radar, antennas, sensors, and microwave generators and detectors, for example. Engineering researchers are examining the potential of electromagnetics in advanced computation and switching systems. Electromagnetics is one of the most analytical fields of electrical engineering in that it relies heavily on mathematics to express physical effects such as the complex relationships among electric and magnetic intensities and flux densities and material properties in space and time.

Electronics

Electronics is a cornerstone of technology, supporting virtually all areas of science, engineering, and medicine with products ranging from sensitive instruments to machine controls to diagnostic equipment. Electronics deals with the release, transport, control, collection, and energy conversion of subatomic particles (such as electrons) having mass and charge. The field is a fast-changing one, as new technology supplants old in rapid succession. Electronics engineering deals with devices, equipment, and systems whose functions depend on such particles. Electronic engineers design, develop, and manufacture, for example -- computers; integrated circuits; sensors and transducers; audio, video, broadcasting, and telecommunications equipment; process control systems; navigation, guidance, and detection systems; prosthetic devices; and pollution monitoring instruments.

Electrical Power

The electrical power field is concerned with the generation, transmission, and distribution of electrical energy. Electrical power engineers design and develop equipment and systems to provide electricity in homes, offices, stores, and factories. The equipment includes devices to regulate the frequency and voltage of the power delivered to consumers, to correct its power factor, and to protect the network and its customers from lightning strikes, surges, and outages. Many power engineers design power systems for aircraft and spacecraft; others provide computer-controlled energy management systems that conserve energy in manufacturing facilities; and still others design electrical motors for applications ranging from appliances to processing plants.

Communication and Signal Processing

The field of communications encompasses transmission of information by electromagnetic signals through wired and wireless links and networks. The information may be voice, images (still photographs and drawings), video, data, software, or text messages. The closely related field of signal processing involves manipulating electromagnetic signals so that they can be transmitted with greater accuracy, speed, reliability, and efficiency. Communications engineers design and develop equipment and systems for a great variety of applications, including digital telephony, cellular telephony, broadcast TV and radio, satellite communications, optical fiber communications, deep space communications, local-area networks, and Internet and World Wide Web communications. Signal processing engineers direct their attention to data compression, modulation systems, radar, sonar, computer-aided tomography (CAT), ultrasound imaging, and magnetic resonance imaging (MRI).

Electives

A technical curriculum is rigorous; however, electives play an important role. Engineers and computer professionals are called upon to make presentations and write reports that must be understood by other technical professionals as well as lay people. Taking classes that sharpen these skills can be a good decision. The humanities, languages, and social sciences instill a thought process that will broaden you as an individual and make you more attractive to employers. Technical courses in disciplines outside your focus could help you work more effectively with engineers of different backgrounds.

Extracurricular Activities

Employers look for well-rounded employees, especially those who have demonstrated leadership. Graduate schools also look for applicants who have done more than spend every moment in the books. Participating in extracurricular activities is an excellent way to round yourself out and demonstrate your ability to take an interest in the world around you. Most colleges offer a variety of activities for their students based on ethnic, social, cultural, educational, religious, or political interests. As a member, you have the opportunity to sharpen your interpersonal skills, take a leadership position (formally or informally), strengthen your writing and speaking competencies, and learn more about those in your group.

Many colleges and universities sponsor extracurricular activities to encourage students to become well-rounded. There are competitive and intramural sports. If you are looking for a sport that is likely to extend into your adult life, consider golf, tennis, skiing, or sailing. You certainly want to hone your organizational skills by joining and becoming a leader in an organization. One cannot underestimate the value of skills in public speaking and running meetings. You might also seek opportunities involving finances in developing and managing a budget for extracurricular activities, such as a social or cultural event. Use your time in school to see what makes people tick and how best to work with others to get the job done.

Don't overlook your professional society, which very likely has a student branch at your institution. If there is none, start one with the help of a faculty member. You can hone your leadership skills by becoming active in a professional society. Professional society activities are a great way to meet people with similar interests and to make contacts in the field. You can certainly broaden your technical horizons this way. Look for opportunities to present student research at professional conferences. Student branches encompass many of its technical societies with local chapters that sponsor professional events, including speakers and short courses.

Advanced Degrees

In engineering, the higher the level of formal education, the higher the salary. At the very least, consideration should be given to obtaining a post-baccalaureate degree. Depending on your career interests, education at the master's or doctoral level could be in an engineering or related discipline or in the field of business. Be aware that there are various degree options for electrical engineers, including a master's of engineering (ME), which does not require a thesis, and a master's of science, MSc, which does.

If you are interested in management or entrepreneurship, a master's degree in business could bring balance to the subject matter gained from your undergraduate degree. Other options are advanced degrees in law and medicine.

Planning

Prepare yourself for the possibility of graduate study by researching graduate schools early in your undergraduate career. Look at the entrance requirements and tailor your choice of courses to get a step ahead. Think about your extracurricular activities, investigate research experiences and special programs, and cultivate relationships with faculty in your major. Professors can be crucial in advising you, providing worthwhile out-of-classroom learning experiences, and recommendations for graduate school.

Growth of PhDs by Gender

There has been a steady growth of the number of engineering PhD recipients during the past thirty years. According to the National Science Foundation, the annual number of engineering PhDs awarded has grown dramatically since 1965. The proportion of female PhDs in engineering and the physical sciences recipients is modest in comparison with the life sciences, social sciences, humanities, and other professions. The median time to doctorate from baccalaureate award for engineers is about 9.1 years. Median registered time is 6.4 years to doctorate. PhDs in engineering and physical sciences compare favorably with other fields for time needed to complete.

Coops/Internships/Research

Cooperative education and internships offer you a chance to learn in a different environment: the workplace. Employers are looking for people who have a proven track record -- besides the classroom, actual work experience is one of the best ways to train yourself to become a professional engineer. Research Experiences for Undergraduates (REUs) have played a significant role in bringing students into the field. These have involved academic and industrial research.

Cooperative Education

Cooperative education is offered through your school and usually requires you to take a semester off from full-time study to work in a major-related job assignment. They can be full-time or part-time, as long as ten weeks or even six months. Depending upon your school's policy, you may be able to receive academic credit and maintain full-time student status. As a cooperative education student, you can earn a competitive salary while you learn the ins and outs of corporate life, develop professional, technical, and social skills, begin to make network contacts, help clarify your interests and goals, appreciate the relevance of classroom learning to the real world, and enhance your resume. Increasingly, co-op employers use a student's co-op experience as a way to measure whether or not you would make a good permanent employee upon graduation. Be aware that each cooperative education job or internship may delay your graduation. However, the experience you gain can shorten the amount of time you spend looking for the right first job or lead directly to a position with a former co-op employer.

Internships and Externships

An internship is not just a temporary or part-time job. It is a carefully monitored career-related work or service experience in which an individual has intentional learning goals and actively reflects on what is learned through the experience. Some internships are taken during the summer and others during the school year. They may, in some cases, delay your graduation. Unlike co-op jobs, internships do not necessarily pay a competitive salary. In many cases, there is no salary. However, the experience, if relevant to your interests and career goals, can be valuable. It can shorten the amount of time you spend looking for the right first job or lead directly to a position with a former internship employer. In some instances, academic credit is given for internships.

Externships are short-term work experiences, anywhere from one day to several weeks. They are usually non-paid work experiences that take place during winter, spring, or summer breaks. While these involve mostly shadowing, there might also be real work assignments. Check with your school for internship and externship programs and how you can make use of local referral services.

Research Experience

Research experiences enable you to hone your skills and knowledge within your field of study while also opening several doors to future career opportunities. Such experiences can lead to exposure in the field through journal publishing or the presentation of your findings among more experienced colleagues. You might form an early mentoring relationship through a grad student or professor who can offer advice on future career options. Overall, any type of independent study project will make you look more attractive to potential employers. The NSF has an important program for undergraduate students, Research Experiences for Undergraduates. The purpose of this program is to help attract a diversified pool of talented students into research careers in these fields, and to help ensure that they receive the best education possible. The undergraduate years are critical in the education sequence, as career-choice points and as the first real opportunities for in-depth study. Another important program for graduate students is the Integrative Graduate Education and Research Training (IGERT) Program. The goal of this program is to enable the development of innovative, research-based, graduate education and training activities that will produce a diverse group of new scientists and engineers well-prepared for a broad spectrum of career opportunities. Supported projects must be based upon a multidisciplinary research theme and organized around a diverse group of investigators from U.S. Ph.D.-granting institutions with appropriate research and teaching interests and expertise.

Industry Sectors

These are ten key industry sectors that employ electrical engineers, computer engineers and computer scientists.

Telecommunications

Telecommunications is a prime growth area for electrical/electronics engineers. Growth is spurred by deregulation, which draws more players to the field. The number of employers is expanding in such services as:

- Local-area networks, both radio and wired within buildings and campuses
- Wire and optical links to homes and businesses
- Satellite communications in unwired Third World countries
- Satellite communications for mobile telephone users everywhere
- Satellite, microwave, and fiber-optic trunks for intercity traffic
- Databases ranging from internet sites to collections of specialized technical information

Energy and Electric Power

Power engineers deal with energy generation by a variety of methods -- turbine, hydro, fuel cell, solar, geothermal, and wind, for example. They also deal with electrical power distribution from source to consumer and within factories, offices, hospitals, laboratories, and they design electric motors and batteries. In industry, power engineers are employed wherever electrical energy is used to manufacture or produce an end product -- petrochemicals, pulp, paper, textiles, metals, and rubber, for example. They are needed to design electrical distribution systems and instrumentation and control systems for the safe, effective, efficient operation of the production facilities. As the average age of the engineers in this job area approaches the mid-to-late forties, companies will begin to hire young engineers in large numbers. Jobs in these industries should be plentiful.

Computers

The computer industry serves many industry sectors, including aerospace, transportation, construction, telecommunications, power, medicine, and automated manufacturing. The industry is strong and growing, in part because of the desire of corporate America to reduce its dependence on large, expensive centralized systems based on mainframes, and instead to opt for more flexible architectures like client/server networks, or private "intranets" based on Internet technology, separated by a protective firewall to maintain local security for proprietary materials. Even more compelling, individuals and companies alike have embraced the World Wide Web as an information source, communication medium, and market for goods, creating a seemingly insatiable demand for advanced software, high-speed modems, and more powerful PCs. Many employers in the computer industry find it difficult to fill the positions created by growth. Demand is especially strong for those whose knowledge and skills integrate hardware and software, as hardware/software codesign gains in popularity.

Semiconductors

The chief enabling technology at the heart of the electronic components booming computer industry is semiconductor technology, in particular the development and manufacture of integrated circuits. As integrated circuits companies strive to search for faster and more powerful chips, they seek engineers to investigate new materials and improved packaging -- engineers who can handle the challenge of competitive pressure and ever-shorter development time. Manufacturers of microprocessors and memory chips for example, continuously improve existing products and introduce new ones to beat the competition and meet customers' expectations of ever-higher performance. Semiconductor products include not just digital ICs but also analog chips, mixed-signal (analog and digital) integrated circuits, and radio-frequency (RF) integrated circuits. Another important sector deals with power semiconductor devices for power control in manufacturing, transportation, and electrical distribution.

Aerospace

Electrical and electronics engineers in the aerospace field design and develop electronics and power equipment for aircraft, helicopters, and spacecraft. Displays, controls, communications, and navigation are important aspects of the field, as are simulators for training and development. Military systems for land, sea, and air also come under the aerospace category. Defense and aerospace companies still employ hundreds of thousands of engineers, even though the aerospace industry has faced some hard times in recent years. Prospects in the two major branches of the industry are looking brighter. Commercial airlines are regaining profitability, and R&D for defense and space exploration will continue at more sustainable and appropriate levels, given changes in world politics and limited tax dollars. While defense systems are not a major priority for the United States anymore, interest in space exploration and travel is reviving, and new satellites are needed to meet swelling demand for global communications.

Bioengineering

This wide-ranging field, alternatively referred to as biomedical engineering, was created some 30 years ago by the merging interests of engineering and the biological /medical sciences. Some of the representative bioengineering activities include the design of diagnostic and therapeutic devices for clinical use, the design of prosthetic devices, the development of biologically compatible materials, and the application of state-of-the-art technology to biological research. This field has grown tremendously since its inception; now more than 100 universities offer training programs that are funded by hundreds of millions of dollars from

government and private sectors. Bioengineering is an interdisciplinary field with employers in many sectors. Bioengineers work with other health care professionals as members of a team. The biomedical engineer must learn to think of biology in new ways in order to develop new tools for diagnosing disease and to repair or replace diseased organs. Many of the major advances in this field now seem almost commonplace: pacemakers, blood analyzers, cochlear implants, medical imaging, lasers, prosthetic implants, and life support systems are just a few of the results of the team efforts of biomedical engineers and health professionals.

Manufacturing

Manufacturing technology has become more important in recent years as global economic reality has forced companies to reevaluate basic manufacturing techniques in order to remain competitive. In pursuit of increased productivity, companies have introduced such innovations as just-in-time parts supply, six-sigma quality goals, statistical process control, and robotic assembly cells. Even small companies have transformed their ad hoc approach to process development into rigidly controlled and monitored systems, well understood in terms of mathematical models, where the effects of random events can be quickly detected and corrected. Thus there is a widespread application of the manufacturing sciences in the workplace today, from automation on the production line to management techniques to environmentally friendly methods of manufacturing.

Services and Other Professions

Many electrical and computer engineers and computer scientists find that their technical background makes them well suited for a variety of work in other industries. For example, the service industry has become a major employer of engineers and computer professionals. Some find work that directly corresponds to their professional training. The entertainment industry hires engineers for a variety of projects; Disney, for example, recruits imagineers to develop amusement parks, while Pixar hires computer scientists/engineers to help create animated films. The banking and finance industry has many computer-related positions that need engineers to manage rapid-trading activities. Many organizations use the talents of computer professionals to create, store, and transmit data and to create and manage systems for operation. Although individually these industries do not employ a large number of engineers, in combination they add up to a large whole. Engineering majors can thus look to industries where they can apply their technical knowledge and skills in fields that may not be high-tech in themselves.

Education and Research

Many electrical engineers, computer engineers, and computer scientists interact with educational and research institutions or industrial labs. Some go straight into college and university teaching and research after completing their PhD degrees. Others, including those with master's degrees, may teach on a part-time basis while holding a full-time job with another organization or as an independent consultant. Still others teach for corporate universities instituted by companies such as Motorola, Intel, and Bellcore. Opportunities also abound in continuing professional education, such as short courses designed to update engineers. Taught by faculty as well as consultants with industry experience, these courses are offered to employees on site as well as off site. Engineers with expertise in timely subjects can also give papers and publish articles and books that bring them recognition and put them in line for consulting work.

Transportation and Automotive

This industry spans many areas. Transportation can include railroads, shipbuilding, and traffic management. What these disparate areas have in common is that employers rely on increased use of electronics merged with other engineering disciplines. It includes electronics for internal and external communication, navigation, failure detection, and displays of many types. Many vehicles are directed and accelerated by fault-tolerant electronics. Electric power is generated and distributed within most vehicles. Ships are wired like small cities for power and information. Once the domain of mechanical and civil engineering, transportation and automotive areas have many job opportunities for electrical engineers from various technical specialties, including communications, computers, and control systems.

Day in the Life

Working as an engineer is much different than training to be an engineer. Unlike school, there is no typical day. The matrix of your job function, interactions with coworkers, type of industry, and the culture of your company will govern your job satisfaction, and it is important that you fully understand the parameters.

Working in Teams

In the working world it is the success of the team that counts. The team itself may be formal with a designated leader and everyone with defined roles, or loosely constructed and informal in nature. The team may be made up of several people or just you and one other person. Often, teams draw from several departments in an organization. You will encounter colleagues of diverse backgrounds, temperaments, and levels of ability and education. It is up to you to work successfully in the group. Tips:

- o Do not be afraid to ask questions, especially those that help you define your responsibilities.
- o Solicit feedback informally on progress checks, deadlines, and changes in procedures or priorities.
- o Be thorough but don't lose pace with the project by getting lost in details.
- o Voice your ideas but develop sensitivity to when to press your point and when to let it go.
- o Be receptive to criticism, even if not given in a constructive manner.
- o Keep a cool head during disagreements. It will do more for you and your reputation than an angry response.
- o Check with the team leader to determine if you can contribute more when your share of the project is completed.

What Do Engineers Do?

In the United States, there are more than two million engineers. More than 25% of engineering jobs are in electrical engineering. Other engineers include mechanical, civil, industrial, aeronautical, chemical, materials, nuclear, petroleum, mining, and others. Most engineers specialize in a branch, such as electrical and electronic engineering. They further specialize in a discipline within a branch, such as controls systems, and in an application area, such as medical, computer, missile guidance, and power distribution. All engineers have in common the work they do: applying scientific knowledge to solve technical problems and develop products and services that benefit society. Engineering work is by its very nature

interdisciplinary, often bringing together engineers with diverse expertise in not only electronics and power engineering, but also in mechanics, chemistry, physics, mathematics, materials sciences, and many other areas. The basic functions of engineering are defined by the sequencing of engineering work: research, design and development, testing, manufacturing, construction, service and maintenance, and management. Engineers also apply their expertise in non-engineering jobs such as purchasing, sales, law, human resources, education, and consulting.

Research

Research jobs often involve starting with an idea or a need. Theories are formulated, tested and prototyped. Jobs in research can be found at universities, national laboratories as well as private institutions and corporations.

Design and Development

In design and development, the results of research are applied to practical problems. The term, development, refers to the early stages of a project. Design refers more to the later stages of a project when the basic methodology is established. In some companies, research and development are combined.

Testing and Evaluation

Testing and evaluation can take place in the lab or in the field, often working with equipment, software, systems and the end users. Those who test are not the designers.

Application / Manufacturing

Jobs oriented towards the mass production of the product or delivery of the service. Although usually not directly in charge of production personnel, engineers are responsible for solving problems associated with the manufacturing process.

Maintenance / Service

Engineering and technical jobs concerned with operations-maintaining and making modifications to hardware and systems.

Management

Management jobs often require elements of leadership, planning, coordination, supervision; working with staff, budgets and administration.

Other Functions

Sales engineers sell technical solutions to clients. Customer service reps solve critical problems that occur in the field. Engineers serve on marketing teams and some have gone from engineering to a career in human resources.

Earnings

Along with a sense of satisfaction, being compensated well for the work you do is a primary concern. Many factors can affect what you earn. These include your level of education, job function, occupation, and where you live.

Salary Data

According the U.S. Department of Labor, Bureau of Labor Statistics, the median income for electrical engineers is $75,930.

In terms of starting salaries, the average starting salary for agricultural engineers who have earned a Bachelor's degree is $55,292, while those with a Master's were offered $66,309. Ph.D. electrical engineers received average starting salaries of $75,982.

According to a 2007 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in electrical engineering received starting salary offers averaging $54,915 a year.

Salaries and Employer Size

IEEE's studies of engineering pay and the Engineering Workforce Commission's annual employer-based surveys of compensation show that salaries for young engineers are usually best in the largest U.S. employers--those with more than 500 employees of all types. Like any general finding, there are many exceptions. The largest of all employers of engineers is the federal government, but while federal scales have improved, they are still not as good as those in private industry. There also is a great deal of variance in pay within all of these broad classes, and the better-paying smaller employers will easily beat out the poorer-paying big ones.

As experience increases, the general relationship between good pay and working for big private organizations changes. Experienced engineers do best in very small organizations with less than 10 employees. Usually these are consulting firms that specialize in these engineers' services; often, the engineer is the owner or a partner in the firm.

Salaries and Location

The cost of living can vary greatly depending on where you reside in the United States. For example, the salary range for a communications network engineer in Orlando, Florida is $34,000 to $54,000. The same position in Boston, Massachusetts is comparable in pay. However, to enjoy the same lifestyle in Boston as you would in Orlando requires a much different salary. Using the City-by-City Cost of Living Index, developed by the American Chamber of Commerce Researchers Association, the following starting salary in Boston would be required:

136.8 (Boston Index) divided by 98.9 (Orlando Index) times $35,000 = $48,412.53 (Boston)

For this kind of data, a customized source of help is available on the World Wide Web in the form of the international salary calculator for relocations, cost of living comparisons, and real estate.

Salaries and Type of Employer

The employment and industry sector that you are in can be a major determinant of your pay. Once out of school, distinctions between engineering disciplines can become blurred, and the type and line of business of your employer can become more important than your specialty.

Alternative Compensation

Engineering compensation is not limited to your base salary. IEEE tracks four other broad components of income as well as a large number of added benefits. For appropriately employed engineers working full time, commissions and bonuses can add value to base pay. Those kinds of rewards can fluctuate widely from one year to the next.

Small additions to base pay are reported by some members of IEEE from second jobs or overtime. For older engineers, retirement plans and profit sharing become significant, especially when engineers retire from one job but continue to work full time somewhere else (retired military officers, who are often qualified engineers, are a good example).

Most engineers enjoy excellent benefit packages, covering all of their health and retirement needs and frequently providing full health coverage for dependents. Stock options may be a factor and their use is reported to be rising. What the options are worth is a matter of speculation.

Employment

Employment

According to the U.S. Bureau of Labor Statistics, electrical and electronics engineers hold about 291,000 jobs in the U.S. This represents 19.4% of the 1.5 million jobs held by engineers in the U.S. Almost every industry has a need to employ electrical engineers.

Primary Job Functions

There are hundreds of job titles which employers use to describe the job functions and responsibilities relating to electrical and electronics engineering. It is taken for granted that EE's draw heavily from mathematics. Industry job titles are not necessarily consistent from one employer to the next. Job titles often reflect a particular discipline or industry; for example, computer engineers, aerospace engineers, control systems engineers, and bioengineers. Titles also refer to the basic functions that engineers perform, such as research, design, testing and evaluation, manufacturing and applications, maintenance and field service. Often employers refer to a specific technical specialization or technology, such as, "Software and Signal Processing Engineers for IBM / Microelectronics," to describe the kind of engineer wanted. Some engineers have titles that are associated with other functions, such as management, human resources, sales and law. A good way to ascertain commonly used job titles is to scan company web sites and employment ads placed in newspapers and other publications.

Industries

According to a survey of IEEE Spectrum readers, employment of EEs and computer scientists is concentrated in a small number of Fortune 1000 companies. 37 percent worked in computer or electronics firms. Of those, two thirds worked at 64 large computer / electronics firms. The rest worked for 503 smaller companies. One of six Spectrum readers was employed in the utilities industry. A smaller percentage were employed in professional service providers, aerospace companies, diversified-service companies, government, universities, and other sectors. Although these figures are instructive for EEs, the employment breakdown of computer professionals, many of them who are not EEs, is more widely distributed in all industry sectors.

Career Path Forecast

According to the US Department of Labor, Bureau of Labor Statistics, electrical engineers are expected to have employment growth of 6 percent over the projections decade of 2006-2016. This is slower than the average for all occupations.

Although strong demand for electrical devices -- including electric power generators, wireless phone transmitters, high-density batteries, and navigation systems -- should spur job growth, international competition and the use of engineering services performed in other countries will limit employment growth. Electrical engineers working in firms providing engineering expertise and design services to manufacturers should have better job prospects.

Electronics engineers (not including computer engineers) are expected to have employment growth of 4 percent during the projections decade, again, slower than the average for all occupations. Growth is expected to be fastest in service-providing industries -- particularly in firms that provide engineering and design services.

Professional Organizations

Professional organizations and associations can play a key role in your development and keep you abreast of what is happening in your industry. Associations promote the interests of their members and provide a network of contacts that can help you find jobs and move your career forward. They can offer a variety of services including job referral services, continuing education courses, insurance, travel benefits, periodicals, and meeting and conference opportunities.

The following is a partial list of professional associations serving electrical engineers and employers. A broader list of professional associations is available at www.careercornerstone.org.

IEEE (www.ieee.org)

Through its global membership, IEEE is a leading authority on areas ranging from aerospace systems, computers and telecommunications to biomedical engineering, electric power and consumer electronics among others. IEEE is divided geographically into 10 regions, which encompass nearly 300 units known as Sections which sponsor approximately 5,000 meetings and events per year. IEEE organizes more than 300 conferences a year. It is responsible for nearly one-fourth the annual output of the world's literature in electrical, electronics and computer engineering and science. This includes nearly 100 periodicals and more than 200 conference proceedings. IEEE Spectrum is the Institute's award-winning flagship publication. IEEE has published about 700 standards and issues approximately 80 new standards each year.   IEEE-USA supports the career and technology policy interests of approximately 250,000 U.S. members. Globally, there are more than 375,000 members including nearly 80,000 student members in more than 160 countries.