Electrical/ Electronics Engineer

Snapshot

Career Cluster(s): Business, Management & Administration; Science, Technology, Engineering & Mathematics

Interests: Electronics; electrical systems; technology; design; creativity

Earnings (Yearly Average): $101,250

Employment & Outlook: As Fast As Average Growth Expected

OVERVIEW

Sphere of Work

Electrical engineers design, develop, test, and supervise the manufacture of electrical equipment, such as electric motors, radar and navigation systems, communications systems, or power generation equipment. Electrical engineers also design the electrical systems of automobiles and aircraft.

Electronics engineers design and develop electronic equipment, including broadcast and communications systems, such as portable music players and Global Positioning System (GPS) devices. Many also work in areas closely related to computer hardware.

A team of engineers at work. Photo via iStock.com/gorodenkoff [Used under license.]

Work Environment

Electrical and electronics engineers typically work in offices of various sizes,

although travel may be necessary to visit sites where their equipment is being installed and operated.

Occupation Interest

Electrical and electronics engineers are creative, math- and science-oriented individuals who want to apply their knowledge to the creation of new electrical and electronic systems, components, and equipment. Applications in this field are wide-ranging, and many engineers can transition into entrepreneurial activities when they identify areas they can improve upon or in which they can innovate.

Profile

Interests: Things, Data
Working Conditions: Both Inside and Outside
Education Needs: Bachelor's Degree
Licensure/Certification: Usually Not Required
Opportunities for Experience: Internship, Co-op
Interest Score: IR

Duties and Responsibilities

Electrical Engineer

- Designing new ways to use electrical power to develop or improve products
- Performing detailed calculations to develop manufacturing, construction, and installation standards and specifications
- Directing the manufacture, installation, and testing of electrical equipment to ensure that products meet specifications and codes
- Investigating complaints from customers or the public, evaluating problems, and recommending solutions
- Working with project managers on production efforts to ensure that projects are completed satisfactorily, on time, and within budget

A Day in the Life—Duties and Responsibilities

The work of electrical engineers and electronics engineers is often similar. Both use engineering and design software and equipment to do engineering tasks. Both types of engineers also must work with other engineers to discuss existing products and possibilities for engineering projects.

Electronics engineers who work for the federal government research, develop, and evaluate electronic devices used in a variety of areas, such as aviation, computing, transportation, and manufacturing. They work on federal electronic devices and systems, including satellites, flight systems, radar and sonar systems, and communications systems.

WORK ENVIRONMENT

Immediate Physical Environment

Electrical and electronics engineers generally work indoors in offices. However, they may visit sites to observe a problem or a piece of complex equipment. Most electrical and electronics engineers work full-time.

Human Environment

Electrical and electronics engineers may conduct solitary office and laboratory work, but team efforts are common, and engineers must be prepared to work with manufacturers, visit sites, interact with customers and the public, and troubleshoot issues. They also must report to superiors unless their business is self-owned. Entrepreneurial engineers are responsible for their own staffing, and, therefore, must handle all employment matters, including conflicts. They will likely also need to interact with financial backers to get their products or businesses off the ground.

Technological Environment

By their nature, electrical and electronics engineers must be intimately familiar with the equipment necessary to carry out their work and must stay apprised of new developments in their field. Computer-aided design (CAD) software is commonly used, as is analytical or scientific software, development environment software, and object- or component-oriented development software. Those who own their own businesses must also be familiar with standard applications such as accounting and payroll software and platforms.

Duties and Responsibilities

Electronics Engineer

- Designing electronic components, software, products, or systems for commercial, industrial, medical, military, or scientific applications
- Analyzing customer needs and determining the requirements, capacity, and cost for developing an electrical system plan
- Developing maintenance and testing procedures for electronic components and equipment
- Evaluating systems and recommending design modifications or equipment repair
- Inspecting electronic equipment, instruments, and systems to make sure they meet safety standards and applicable regulations
- Planning and developing applications and modifications for electronic properties used in parts and systems to improve technical performance

EDUCATION, TRAINING, AND ADVANCEMENT

High School/Secondary

High school students interested in studying electrical or electronics engineering benefit from taking courses in physics and math, including algebra, trigonometry, and calculus. Courses in drafting are also helpful, because electrical and electronics engineers often are required to prepare technical drawings. During high school, students can attend engineering summer camps to see what these and other engineers do. Attending these camps can help students plan their coursework for the remainder of their time in high school. The Engineering Education Service Center (EESC) has a directory of engineering summer camps.

Suggested High School Subjects

- Algebra
- Biology
- Chemistry
- Civics
- Computer Science
- Drafting
- Earth or Environmental Science
- Economics
- English
- Entrepreneurship
- Geometry
- History
- Physics
- Pre-Calculus
- Psychology
- Statistics
- Trigonometry

Related Career Pathways/Majors

Business, Management & Administration Career Cluster

- General Management Pathway

Science, Technology, Engineering & Mathematics Career Cluster

- Engineering & Technology Pathway
- Science & Mathematics Pathway

Transferable Skills and Abilities

Concentration

- Designing and developing complex electrical systems and electronic components and products
- Keeping track of multiple design elements and technical characteristics when performing these tasks

Initiative

- Applying knowledge to new tasks in every project undertaken
- Engaging in continuing education to keep up with changes in technology

Interpersonal Skills

- Working with others during the manufacturing process to ensure that plans are implemented correctly
- Monitoring technicians and devising remedies to problems as they arise

Math Skills

- Using the principles of calculus and other advanced math to analyze, design, and troubleshoot equipment

Speaking Skills

- Working closely with other engineers and technicians
- Explaining designs and reasoning clearly and relaying instructions during product development and production
- Explaining complex issues to customers who have little or no technical expertise

Writing Skills

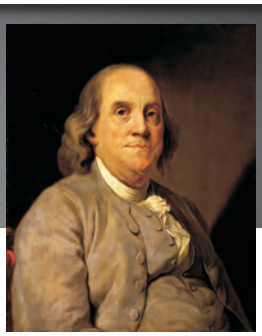
- Developing technical publications related to equipment they develop, including maintenance manuals, operation manuals, parts lists, product proposals, and design methods documents

Postsecondary

To enter the occupation, prospective electrical and electronics engineers need a bachelor's degree in electrical engineering, electronics engineering, electrical engineering technology, or a related engineering field. Programs include classroom, laboratory, and field studies. Courses include digital systems design, differential equations, and electrical circuit theory. Programs in electrical engineering, electronics engineering, or electrical engineering technology should be accredited by the Accreditation Board for Engineering and Technology, Inc. (ABET).

Famous First

We know about Benjamin Franklin flying his kite to discover electricity. But did you know he also invented bifocals?
Source: nbcnews.com



Portrait of Benjamin Franklin (1783), by Joseph Siffred Duplessis (1725-1802), National Portrait Gallery, Smithsonian Institution, via Wikimedia Commons.

Some colleges and universities offer cooperative programs in which students gain practical experience while completing their education. Cooperative programs combine classroom study with practical work. Internships provide similar experience and are growing in number.

At some universities, students can enroll in a 5-year program that leads to both a bachelor's degree and a master's degree. A graduate degree allows an engineer to work as an instructor at some universities, or in research and development.

Related College Majors

- Agricultural Business & Management
- Agricultural Production Workers & Managers
- Agricultural Supplies Retailing & Wholesaling
- Farm & Ranch Management
- Horticulture Science
- Horticulture Services Operations & Management
- International Agriculture
- Plant Sciences

Professional Certification and Licensure

Licensure is not required for entry-level positions as electrical and electronics engineers. A Professional Engineering (PE) license, which allows for higher levels of leadership and independence, can be acquired later in one's career. Licensed engineers are called professional engineers (PEs). A PE can oversee the work of other engineers, sign off on projects, and provide services directly to the public. State licensure generally requires:

- A degree from an ABET-accredited engineering program
- A passing score on the Fundamentals of Engineering (FE) exam
- Relevant work experience, typically at least 4 years
- A passing score on the Professional Engineering (PE) exam

The initial FE exam can be taken after earning a bachelor's degree. Engineers who pass this exam commonly are called engineers in training (EITs) or engineer interns (EIs). After meeting work experience requirements, EITs and EIs can take the second exam, called the Principles and Practice of Engineering (PE).

Each state issues its own licenses. Most states recognize licensure from other states if the licensing state's requirements meet or exceed their own licensure requirements. Several states require continuing education for engineers to keep their licenses.

EARNINGS AND ADVANCEMENT

Earnings depend on industry, experience, and project scope and scale. Median annual earnings of electrical engineers were $98,530 in 2019. The lowest 10 percent earned less than $63,020, and the highest 10 percent earned more than $155,880. Median annual earnings of electrical engineers were $105,570 in 2019. The lowest 10 percent earned less than $66,620, and the highest 10 percent earned more than $164,210.

Electrical and electronics engineers may receive paid vacations, holidays, and sick days; life and health insurance; and retirement benefits. These are usually paid by an employer if the business is not self-owned. Engineers who are required to travel may be able to recoup these expenses by their employer.

Electrical and electronic engineers may advance to supervisory positions in which they lead a team of engineers and technicians. Some may move to management positions, working as engineering or program managers. Preparation for managerial positions usually requires working under the guidance of a more experienced engineer.

For sales work, an engineering background enables engineers to discuss a product's technical aspects and assist in product planning and use.

EMPLOYMENT AND OUTLOOK

Electrical and electronic engineers held 328,100 jobs in 2019. Employment is expected to grow as fast as average for all occupations through the year 2029, at a rate of 3 percent. Employment growth is expected to be tempered by slow growth or decline in some industries, such as manufacturing and utilities.

Job growth for electrical and electronics engineers is projected to occur largely in professional, scientific, and technical services firms, as more companies are expected to tap the expertise of engineers for projects involving electronic devices and systems. These engineers also will be needed to develop sophisticated consumer electronics.

The rapid pace of technological innovation will create some demand for electrical and electronics engineers in research and development, an area in which engineering expertise will be needed to design distribution systems related to new technologies. These engineers will play key roles in new developments with solar arrays, semiconductors, and communications technologies.

Related Occupations

- Aerospace Engineer
- Architectural/Engineering Manager
- Bioengineer/Biomedical Engineer
- Computer Hardware Engineer
- Electrical/Electronics Engineering Technician
- Electrical/Electronics Installer/Repairer
- Electrician
- Electro-mechanical Technician
- Network/Computer Systems Administrator
- Sales Engineer

MORE INFORMATION

Accreditation Board for Engineering and Technology, Inc. (ABET)
415 North Charles Street
Baltimore, MD 21201
410.347.7700
www.abet.org

American Association of Engineering Societies (AAES)
1801 Alexander Bell Drive
Reston, VA 20191
202.296.2237
orders@aaes.org
www.aaes.org

American Society for Engineering Education (ASEE)
1818 N Street NW, Suite 600
Washington, DC 20036
202.331.3500
www.asee.org

Engineering Education Service Center (EESC)
1411 Old Hardman Btms Road
Clarkesville, GA 30523
706.499.5011
www.engineeringedu.com

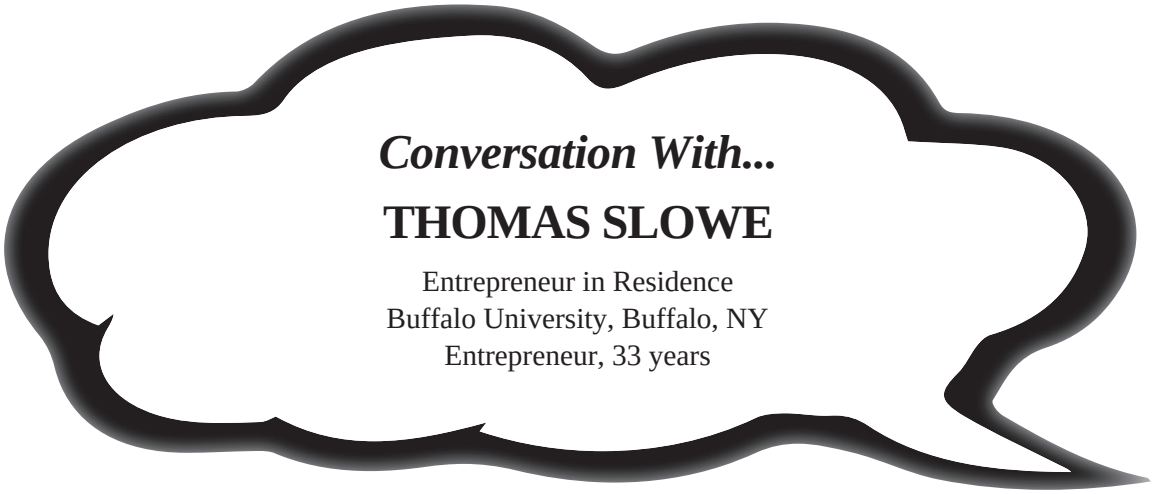
International Society of Automation (ISA)
67 T.W. Alexander Drive
Research Triangle Park, NC 27709
919.549.8411
www.isa.org

National Association of Power Engineers (NAPE)
1 Springfield Street, Suite 1
Chicopee, MA 01013
413.592.9273
www.powerengineers.com

National Council of Examiners for Engineering and Surveying (NCEES)
200 Verdae Boulevard
Greenville, SC 29607
800.250.3196
ncees.org

National Society of Professional Engineers (NSPE)
1420 King Street
Alexandria, VA 22314
888.285.6773
www.nspe.org

Technology Student Association (TSA)
1904 Association Drive
Reston, VA 20191-1540
703.860.9000
tsaweb.org



Conversation With...

THOMAS SLOWE

Entrepreneur in Residence
Buffalo University, Buffalo, NY
Entrepreneur, 33 years

What was your individual career path in terms of education/training, entry-level job, or other significant opportunity?

Both of my parents were entrepreneurs, so I had a lot of guidance in terms of understanding the basic questions involved: what can you make, and how do you sell it? How do you identify what is going to be something people are interested in obtaining, what are they actually going to cough up money for, how much, and how much time, energy, and what materials do you need to produce that thing?

I started my first company when I was fourteen, and my family lived in Rochester, New York. At that time, neckties were conservative in style. I decided I wanted to make ties. My mom had been running a quilt-making business and had the sewing machines and fabric. My dad was involved in the arts community, and they had art shows. I used all sorts of flashy eighties and nineties colors and sold my completely wild ties at shows and made several thousand dollars.

I'm from a family of engineers and went on to earn my BS in electrical engineering and computer science from Rutgers University, then went straight to Massachusetts Institute of Technology and earned an MS in media arts and sciences from their Media Lab. This was during the dotcom boom of 1996-1998.

At Rutgers, I worked on making automated recognition systems to find things in video and images, and I graduated with published work. I also did a lot of artwork during school. I carried that research to MIT, where the Media Lab is all about the integration of art and science.

After graduating, I moved to Stockholm, Sweden, for 2 years to work for Ericsson Telecom, a company that had been a Media Lab sponsor. I enjoyed my time there and set up a lab for them but, overall, that experience validated that big companies were not for me.

I returned and got a job at a startup company called ObjectVideo in Reston, Virginia, outside Washington, DC. We worked with the intelligence community, and I was a senior scientist there for several years, although during this time I realized that I was not only interested in en-

gineering. After a while I decided to start my own company and moved back to my hometown of Buffalo.

I've been involved with a number of startup companies, but Nervve was the biggest one that was cleanly founded by me. It centered on my experience working with the US intelligence community. I saw that they have and continue to acquire huge volumes of video and imagery. The published data point we had at the time showed that less than 2 percent of that video was ever seen by a human. The use of video for defense and intelligence was largely relegated to understanding what happened after the bomb already had gone off.

We essentially invented the core algorithm that made it possible to scan—very, very efficiently—a huge volume of video 1000 times faster than the competing technology at the time. We got investment from the intelligence community alongside a bunch of other people. We worked with foreign and domestic spy agencies, and then branched into sports media and worked with many major league teams. We were able to use the technology to measure the output of branding in an entire season's worth of games and combine that with viewership data to put a value on in-screen advertising. The company was sold in 2017.

I've always got five or six side hustles. I've built furniture. I've done designs for construction projects. I've got a few entrepreneurial ventures now with high hopes things will be solidified over the next 3 months. I'm also an Entrepreneur-in-Residence at Buffalo University and work with 10 to 12 companies—or embryonic ideas for companies—at any one time.

What are the most important skills and/or qualities for someone in your profession?
Risk tolerance, self-generated motivation, broad interests, and a willingness to constantly acquire new skills. You need an ability to withdraw from the situation from time to time to look at the big picture so you can validate whether what you're doing or who you are collaborating with makes sense. You need to be willing to try new things.

What do you wish you had known going into this profession?
I wish I had known to much more strictly judge individuals I do business with. As the stakes get higher, that tends to attract a higher percentage of bad players. My perceptions going in have been far more optimistic than they should have been because a lot of people are pretty Machiavellian.

Are there many job opportunities in your profession? In what specific areas?
There are an infinite number of job opportunities. It's all about you creating it and taking responsibility for it.

How do you see your profession changing in the next 5 years? How will technology impact that change, and what skills will be required?
I think that integration between traditionally siloed knowledge spaces is going to accelerate significantly. When I was a kid, lawyers did their thing, accountants did theirs. Now all that has changed. If you're a super geek who wants to go to engineering school, stretch yourself and do different things. Learn to cook. Take a class in fashion design.

What do you like most about your job? What do you like least about your job?

I love the feeling you get when you sell something you spent time working on. I love working with smart, motivated people. I really detest working with people who are not motivated and don't finish their work, or their work is of poor quality.

Can you suggest a "try this" for a student who may be considering a career in your field?

I would advise coming up with an idea and then figuring out what you can make or produce. That really is the crux of it. If you can get an internship or work with a small company, that's going to help you.