Design Occupations

Aerospace Engineers

Chemical Engineers

Computer Hardware Engineers

Computer Software Engineers, Applications

Computer Software Engineers, Systems Software

Electrical and Electronic Engineering Technicians

Electrical and Electronics Engineers

Electrical, Electronic, and Mechanical Drafters

Graphic Designers

Industrial Engineers

Mechanical Engineers

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Aerospace Engineers

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What They Do

Aerospace Engineers develop new technologies for use in aviation, defense systems, and space exploration, often specializing in areas such as structural design, guidance, navigation and control, instrumentation and communication, or production methods. They often use Computer-Aided Design (CAD) software, robotics, and lasers and advanced electronic optics to assist them. They also may specialize in a particular type of aerospace product, such as commercial transports, military fighter jets, helicopters, spacecraft, or missiles and rockets. Aerospace Engineers may be experts in aerodynamics, thermodynamics, celestial mechanics, propulsion, acoustics, or guidance and control systems.

Aerospace Engineers typically are employed within the aerospace industry, although their skills are becoming increasingly valuable in other fields. For example, Aerospace Engineers in the motor vehicles manufacturing industry design vehicles that have lower air resistance, increasing fuel efficiency in vehicles.

Tasks

- Formulate conceptual design of aeronautical or aerospace products or systems to meet customer requirements.
- Direct and coordinate activities of engineering or technical personnel designing, fabricating, modifying, or testing of aircraft or aerospace products.
- Develop design criteria for aeronautical or aerospace products or systems, including testing methods, production costs, quality standards, and completion dates.
- Plan and conduct experimental, environmental, operational and stress tests on models and prototypes of aircraft and aerospace systems and equipment.
- Evaluate product data and design from inspections and reports for conformance to engineering principles, customer requirements, and quality standards.
- Formulate mathematical models or other methods of computer analysis to develop, evaluate, or modify design according to customer engineering requirements.
- Write technical reports and other documentation, such as handbooks and bulletins, for use by engineering staff, management, and customers.

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- Analyze project requests and proposals and engineering data to determine feasibility, productibility, cost, and production time of aerospace or aeronautical product.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.
- Time Management — Managing one's own time and the time of others.
- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Writing — Communicating effectively in writing as appropriate for the needs of the audience.
- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents.
- Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Physics — Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and subatomic structures and processes.
- Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
- Mathematical Reasoning — The ability to choose the right mathematical methods or formulas to solve a problem.
- Near Vision — The ability to see details at close range (within a few feet of the observer).

Work Environment

Aerospace Engineers generally work in well-equipped offices in engineering departments or research laboratories. Most engineers spend the majority of their time in modern, clean, temperature-controlled buildings. They often work on computer terminals, drafting tables, or with research and test equipment in a laboratory.

Aerospace Engineers may work at industrial plants, manufacturing operations, aviation facilities and aerospace launch pads. They usually supervise, direct, or inspect ongoing production or construction operations. Some engineers are required to travel. Engineers who work at aviation and flight test sites will often fly the test aircraft. This can be dangerous work.

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Most Aerospace Engineers work day shifts on a standard 40-hour workweek. They may occasionally work irregular or long hours to meet a deadline or when working on a special project.

What's the California Job Outlook?

The California Outlook and Wage table below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Aerospace Engineers				
17-2011	24,400	25,600	730	$36.91 to $54.10

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

Despite the expected slower-than-average growth in employment of Aerospace Engineers, favorable opportunities are expected through 2014 for two reasons. First, the number of degrees granted in aerospace engineering has declined greatly over the last decade due to the perceived lack of opportunities in this occupation. Second, the decline in degree production has reached the point that the number trained in aerospace engineering may not be adequate to replace the large numbers of Aerospace Engineers who are expected to leave the occupation, especially due to retirement, over the 2004-2014 period.

Training/Requirements/Apprenticeships

California offers bachelor and postgraduate degrees in aeronautical engineering at many universities and colleges. College students should enroll in a program approved by the Accreditation Board for Engineering and Technology (ABET). This accreditation is highly regarded and confirms the quality of education that students receive in this professional program. The completion of an accredited program is extremely important for any student who will be continuing on to graduate school. Often graduate study is limited to only those students that complete their undergraduate work at a college with an accredited program.

To be effective, Aerospace Engineers must continue to learn and study throughout their careers in order to keep up with the constant advancements being made in the field. This is especially true with computer applications, which are evolving and advancing constantly.

Aerospace Engineers typically are employed in the aerospace product and parts industry, although their skills are becoming increasingly valuable in other fields. For example, in the motor vehicle manufacturing industry, Aerospace Engineers design vehicles that have lower air resistance and, thus, increased fuel efficiency.

Recommended High School Course Work

Colleges and universities are usually specific in their entrance requirements. High school required courses usually include algebra, geometry, trigonometry, calculus, physics, chemistry, and English.

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Aerospace Engineers

Where Do I Find the Job?

Most colleges and universities have a placement center on campus to help graduates with their job search. Large aerospace and aircraft companies will often send recruiters to college campuses to interview seniors about to graduate. Students who have been working part-time as an intern at a company might immediately get hired upon graduation.

Direct application to employers remains one of the most effective job search methods.

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Aircraft
- Electric Power & Specialty Transformers
- Guided Missile
- Motor and Generator
- Physical/Engineering/Biological Research
- Relay & Industrial Control
- Social Science/Humanities Research
- Space
- Switchgear and Switchboard Apparatus

Search these **yellow page** headings for listings of private firms:

- Aircraft Parts
- Airlines
- Department of Defense (Govt. Pages)
- Engineers-Communications
- Engineers-Consulting
- Engineers-Industrial
- Engineers-Manufacturing
- Engineers-Power
- Federal Aviation Admin. (Govt. Pages)

Where Can the Job Lead?

Advancement opportunities are usually in the form of Senior or Supervising Aerospace Engineer, or to managerial positions in charge of large divisions within large organizations.

Lateral career moves are common, since those with engineering degrees can easily move into mechanical engineering jobs.

Other Sources of Information

American Institute of Aeronautics and Astronautics
www.aiaa.org

American Astronomical Society
www.aas.org

National Aeronautics and Space Administration (NASA)
www.nasa.gov

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Chemical Engineers

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What They Do

Chemical Engineers convert scientific discoveries into marketable products. They are involved in many aspects of chemical production, research, and design, as well as in the construction and operation of industrial plants. Chemical engineering is a diverse and complex profession. Frequently, Chemical Engineers specialize in one area, such as food, pharmaceuticals, heat transfer and energy conversion, petrochemicals, or consumer products such as plastics, detergents, paints, and synthetic textiles. Others specialize in one particular aspect of chemical production, such as oxidation, evaporation, or polymerization.

Chemical Engineers develop equipment for the manufacture of chemicals and related products and for the prevention of air, water, and soil pollution. They conduct research to develop new manufacturing processes, analyze operating procedures, equipment and machinery functions, and make recommendations for reducing processing time and cost. They design equipment for safe storage and transportation of chemical solids, liquids, and gases, as well as design control systems for chemical plants based upon data from lab experiments and pilot plant operations. Chemical Engineers also perform tests and take measurements in order to determine the most efficient production methods and develop instrumentation and control systems that will safely and economically produce the highest quality product.

Tasks

- Develop processes to separate components of liquids or gases or generate electrical currents, using controlled chemical processes.
- Conduct research to develop new and improved chemical manufacturing processes.
- Design and plan layout of equipment.
- Design measurement and control systems for chemical plants based on data collected in laboratory experiments and in pilot plant operations.
- Determine most effective arrangement of operations, such as mixing, crushing, heat transfer, distillation, and drying.
- Perform laboratory studies of steps in manufacture of new product and test proposed process in small scale operation (pilot plant).
- Perform tests throughout stages of production to determine degree of control over variables, including temperature, density, specific gravity, and pressure.

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- Develop safety procedures to be employed by workers operating equipment or working in proximity to on-going chemical reactions.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Science — Using scientific rules and methods to solve problems.
- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Operations Analysis — Analyzing needs and product requirements to create a design.
- Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.
- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents.
- Chemistry — Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Physics — Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atomic structures and processes.
- Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.
- Written Expression — The ability to communicate information and ideas in writing so others will understand.
- Originality — The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.
- Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
- Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

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Chemical Engineers

Work Environment

Most Chemical Engineers work in various locations at manufacturing plants. This includes planning and evaluating projects in an office setting, doing research and conducting tests in a lab, or troubleshooting on the production line. Some also work in their company's administrative offices, while others with advanced degrees are employed in research and teaching positions in colleges and universities.

Chemical Engineers usually work a regular 40-hour workweek. However, they may work irregular or long hours to meet deadlines when working on special projects. Also, some plants operate around-the-clock operations which may require shift work.

Many Chemical Engineers are members of the American Institute of Chemical Engineers and its local affiliates.

California's Job Outlook and Wages

The California Outlook and Wage chart below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Chemical Engineers				
17-2041	2,200	2,600	110	$31.53 to $47.20

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

The growth of Chemical Engineering jobs is expected to be faster than average compared with all occupations in the next few years. Chemical companies will continue to research and develop new chemicals and more efficient processes to increase output of existing chemicals. Among manufacturing industries, pharmaceuticals may provide the best opportunities for job seekers. Many of the jobs for Chemical Engineers, however, will be in nonmanufacturing industries, such as research and testing services. Additionally, about 700 openings will result from the need to replace Chemical Engineers who transfer to other occupations or leave the labor force.

Training/Requirements/Apprenticeships

A bachelor of science degree in chemical engineering is the most common entry-level requirement. A master's degree or higher is required for some research, teaching, consulting, and managerial positions. College graduates whose degrees are in mathematics or chemistry may also qualify for some positions. Employers look for applicants who can communicate ideas, are analytical and innovative, and are adept at solving problems.

Passing a State board exam given by the Department of Consumer Affairs is required to do consulting work. In order to keep up with rapid changes and advances in the field, many Chemical Engineers advance their education throughout their careers by attending continuing education courses.

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Chemical Engineers

Chemical Engineers must be able to communicate their ideas to managers, technicians, craftworkers, production workers, and customers, as written reports and oral presentations are often an important part of the job. They must be able to work closely with scientists and other engineers as part of a team, and be analytical and innovative. They must also be adept at solving problems and taking initiative, and be able to make sound, timely decisions. Because Chemical Engineers use computer technology to optimize all phases of research and production, they need to understand how to apply computer skills to chemical process analysis, automated control systems, and statistical quality control.

Recommended High School Course Work
High school preparation courses in mathematics and science courses including trigonometry, calculus, biology, chemistry, physics, and computer science are helpful. Other courses such as language arts, economics, and electronics are also useful to Chemical Engineers.

Where Do I Find the Job?

Employers who hire entry-level Chemical Engineers usually recruit applicants at colleges and universities. They conduct on-campus interviews with interested students. Chemical Engineers may also find employment by submitting résumés and applying directly to companies that hire engineers in their specialty, or by replying to ads in newspapers and professional journals. Personal contacts through professional organizations or recommendations by employees of a company are also common ways of finding work. Applying to federal and other governmental agencies and taking the appropriate examinations may also lead to employment in this field.

Direct application to employers remains one of the most effective job search methods.

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Electricity & Signal Testing Instruments
- Electromedical Apparatus
- Engineering Services
- Industrial Process Variable Instruments
- In-Vitro Diagnostic Substance
- Landscape Architectural Services
- Medicinal and Botanical
- Other Biological Product
- Pharmaceutical Preparation
- Physical/Engineering/Biological Research
- Search, Detection, & Navigation Instruments
- Social Science/Humanities Research
- Testing Laboratories

Search these **yellow page** headings for listings of private firms:

- Engineers-Chemical
- Engineers-Consulting
- Engineers-Hazardous Waste
- Engineers-Industrial
- Engineers-Manufacturing
- Engineers-Petroleum
- Engineers-Sanitary
- Engineers-Water Supply

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Chemical Engineers

Where Can the Job Lead?

Advancement opportunities exist along a structured career path for Chemical Engineers. They can advance to a Senior or Supervising Chemical Engineer within an organization. In some cases they may advance to managerial positions.

There are many lateral opportunities for Chemical Engineers. With their engineering college degree, they can actually move into many of the other occupations that might only require a degree in engineering.

Other Sources of Information

American Institute of Chemical Engineers
www.aiche.org

American Chemical Society
www.chemistry.org

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Computer Hardware Engineers

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View Career Video

What They Do

Computer Hardware Engineers research, design, develop, and test computer or computer-related equipment for commercial, industrial, military, or scientific use. They may supervise the manufacturing and installation of computer or computer-related equipment and components. Hardware refers to computer chips, circuit boards, computer systems, and related equipment, such as keyboards, modems, and printers. There are many areas of research in hardware development currently underway, such as "Neural Networks"—systems that mimic the behavior of the human brain and are used in robotics and medical diagnosis. The rapid advances in computer technology are largely a result of the research, development, and design efforts of Computer Hardware Engineers.

Tasks

- Analyze information to determine, recommend, and plan layout, including type of computers and peripheral equipment modifications.
- Analyze user needs and recommend appropriate hardware.
- Build, test and modify product prototypes, using working models or theoretical models constructed using computer simulation.
- Confer with engineering staff and consult specifications to evaluate interface between hardware and software and operational and performance requirements of overall system.
- Write detailed functional specifications that document the hardware development process and support hardware introduction.
- Design and develop computer hardware and support peripherals, including central processing units (CPUs), support logic, microprocessors, custom integrated circuits, printers, and disk drives.
- Evaluate factors such as reporting formats required, cost constraints, and need for security restrictions to determine hardware configuration.
- Monitor functioning of equipment and make necessary modifications to ensure system operates in conformance with specifications.
- Specify power supply requirements and configuration, drawing on system performance expectations and design specifications.
- Store, retrieve, and manipulate data for analysis of system capabilities and requirements.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Computer Hardware Engineers

Important Skills, Knowledge, and Abilities

- Operations Analysis — Analyzing needs and product requirements to create a design.
- Mathematics — Using mathematics to solve problems.
- Science — Using scientific rules and methods to solve problems.
- Programming — Writing computer programs for various purposes.
- Troubleshooting — Determining causes of operating errors and deciding what to do about it.
- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Speaking — Talking to others to convey information effectively.
- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Written Comprehension — The ability to read and understand information and ideas presented in writing.
- Oral Comprehension — The ability to listen to and understand information and ideas presented through spoken words and sentences.
- Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
- Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.

Work Environment

Most Computer Hardware Engineers work in well-equipped offices and laboratories. They do much of their work at a computer workstation. They also spend much of their time in manufacturing and production departments observing the installation or testing of equipment. Computer Hardware Engineers work closely with other professionals and plant workers.

They generally work a standard 40-hour week. However, Computer Hardware Engineers may work evenings or weekends to meet deadlines for special projects or when troubleshooting technical difficulties.

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Computer Hardware Engineers

California's Job Outlook and Wages

The California Outlook and Wage table below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Computer Hardware Engineers				
17-2061	22,100	25,800	740	$35.63 to $55.94

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

The growth rate of Computer Hardware Engineer jobs is expected to be average compared with all occupations in the next few years. New jobs are expected in computer systems design, research and development, and employment (temporary) services industry sectors.

Although the use of information technology continues to expand rapidly, the manufacture of computer hardware is expected to be adversely affected by intense foreign competition. The utilization of foreign computer hardware engineering services also will serve to limit growth. The main source of job opportunities for this occupation will result from the need to replace workers who move into managerial positions, transfer to other occupations, or retire.

Training/Requirements/Apprenticeships

A bachelor of science degree in computer science, information science, or related fields such as electronics or aerospace engineering is essential to secure an entry-level position. Since there are continuing technological advances, Computer Hardware Engineers frequently go on to graduate school after obtaining their four year degree. Graduate degrees are sometimes required for certain jobs and to attain promotions. Computer Hardware Engineers must continue to study, either formally or informally, throughout their careers to keep up with the latest technologies.

There is no license required to work as a Computer Hardware Engineer in California. Many who earn degrees in electrical, electronic engineering, industrial, or aerospace engineering earn their Professional Engineers license by passing exams and becoming registered with the State of California, which can give them an advantage when competing for desirable jobs.

Recommended High School Course Work

High school students interested in this kind of work should take courses in computers, information technology, calculus and trigonometry, physical science, as well as electrical and electronic courses.

Where Do I Find the Job?

Many firms employing Computer Hardware Engineers recruit on college campuses in both the fall and spring prior to graduation. Advertisements of open positions appear in professional journals, trade magazines, newspapers, and on-line job banks. Employers and applicants use the employment services of professional societies, private employment agencies, armed services, and the Employment Development Department.

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Computer Hardware Engineers

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Computer Storage Device
- Computer Systems Design Services
- Computer Terminal
- Custom Computer Programming
- Electronic Computer
- Industrial Process Variable Instrument
- Other Computer Peripheral Equipment
- Other Computer Related Services
- Physical/Engineering/Biological Research
- Social Science/Humanities Research

Search these **yellow page** headings for listings of private firms:

- Aircraft
- Computer Networks
- Computer Rooms, Installation & Equipment
- Computer Service & Repair
- Computer Wholesale and Manufacturers
- Engineers, Consulting
- Internet Equipment
- Telecommunications Installation & Repair
- Workstations & Servers

Where Can the Job Lead?

A career path for Computer Hardware Engineers might lead to supervisory or managerial positions within the Information Technology (IT) department of a firm, particularly for those who have high levels of communication and project management skills. Engineers with degrees in specialties such as electronics, aerospace, or industrial engineering will have many opportunities to make lateral moves into other departments and positions.

Other Sources of Information

Society of Manufacturing Engineers
www.sme.org

National Workforce Center for Emerging Technologies
www.nwcet.org

Association for Computing Machinery
www.acm.org

Institute for the Certification of Computing Professionals
www.iccp.org

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Computer Software Engineers, Applications

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What They Do

Computer Software Engineers, Applications design, develop, and maintain computer applications software or specialized utility programs. These Engineers develop many types of applications for operating systems, network distribution, and compilers, which convert programs for execution on a computer. Their work evolves rapidly, reflecting new areas of specialization or changes in technology, as well as the preferences and practices of employers. Computer Software Engineers apply the principles and techniques of computer science, engineering, and mathematical analysis to the design, development, testing, and evaluation of the software and systems that enable computers to perform their many applications.

As computer software is improved or enhancements are made to systems, Computer Software Engineers oversee the updating, revision, and changes to applications. They develop new computer languages, operating systems, and applications packages that make full use of the advanced capabilities of computer hardware. The programming languages most often used are C, C++, and Java, with Fortran and COBOL used less commonly. Some Computer Software Engineers develop both packaged systems and systems software or create customized applications.

Tasks

- Analyze information to determine, recommend, and plan computer specifications and layouts, and peripheral equipment modifications.
- Analyze user needs and software requirements to determine feasibility of design within time and cost constraints.
- Confer with systems analysts, engineers, programmers and others to design system and to obtain information on project limitations and capabilities, performance requirements and interfaces.
- Coordinate software system installation and monitor equipment functioning to ensure specifications are met.
- Design, develop, and modify software systems, using scientific analysis and mathematical models to predict and measure outcome and consequences of design.
- Determine system performance standards.
- Develop and direct software system testing and validation procedures, programming, and documentation.
- Modify existing software to correct errors, allow it to adapt to new hardware, or to improve its performance.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

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Computer Software Engineers, Applications

Important Skills, Knowledge and Abilities

- Operations Analysis — Analyzing needs and product requirements to create a design.
- Programming — Writing computer programs for various purposes.
- Troubleshooting — Determining causes of operating errors and deciding what to do about it.
- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Speaking — Talking to others to convey information effectively.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Written Comprehension — The ability to read and understand information and ideas presented in writing.
- Oral Comprehension — The ability to listen to and understand information and ideas presented through spoken words and sentences.
- Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
- Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.

Work Environment

Computer Software Engineers, Applications work in well-lighted and comfortable offices or computer laboratories in which the computer equipment is located. Computer Software Engineers who are employed by software vendors and consulting firms spend much of their time away from their offices, frequently traveling overnight to meet with customers. They call on customers in businesses ranging from manufacturing plants to financial institutions. Computer Software Engineers may be able to use modems, laptops, e-mail, and the Internet to provide more technical support and other services from their main office or home, connecting to a customer's computer remotely to identify and correct developing problems.

Computer Software Engineers may experience eye strain, back discomfort, and hand and wrist problems after sitting and typing for hours on a computer keyboard. Software Engineers often work more than 40 hours a week and, due to the project-oriented nature of their work, may work evenings and weekends to meet deadlines or solve technical problems.

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Computer Software Engineers, Applications

California's Job Outlook and Wages

The California Outlook and Wage chart below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Computer Software Engineers, Applications				
15-1031	84,400	123,600	4,750	$33.03 to $53.37

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

Computer Software Engineer jobs are projected to increase much faster than the average for all occupations in California, up 46% between 2004 and 2014. Additionally, there will be approximately 830 workers needed each year to replace workers who leave for other types of work or retirement.

The highest growth will be seen in computer systems design, software publishing, Internet service providers and web search portals, management of companies and enterprises, and management and technical consulting services firms. These sectors alone will add more than 25,000 new jobs to the California economy in the ten-year period.

Large growth will occur as businesses and other organizations continue to adopt and integrate new technologies and maximize the efficiency of their current computer systems. Employers will continue to seek computer professionals with strong programming, systems analysis, interpersonal, communications, and business skills. Competition among businesses will create an incentive for increasingly sophisticated technological innovations, and organizations will need more Computer Software Engineers to implement these new technological changes.

Training/Requirements/Apprenticeships

Most employers prefer to hire Computer Software Engineers, Applications who have at least a bachelor's degree and broad knowledge and experience with computer systems and technologies. Computer Software Engineers usually focus their studies on computer science or information systems. Employers with jobs that are more complex and require a high degree of technical knowledge often prefer a person with a master's degree.

Many students seeking software engineering jobs enhance their employment opportunities by participating in internships offered through their schools. These experiences provide students with broad knowledge and valuable hands on real world experience, making them attractive candidates to employers. In many firms, mentoring has become part of the evaluation process for new hires.

Professional certification is now offered by the Institute of Electrical and Electronics Engineers (IEEE) Computer Society. To be classified as a Certified Software Development Professional, individuals need a bachelor's degree and work experience that demonstrates that they have mastered a relevant body of knowledge, and must pass a written exam.

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Computer Software Engineers, Applications

Computer Software Engineers should be knowledgable about the different operating systems used by the industry. They must have the ability to problem-solve and configure operating systems to work with all kinds of hardware and adapt the systems to meet the needs of the organization.

Employers demand new skills as technology continually evolves and advances in the computer field. Software Engineers must acquire these new skills if they wish to remain in this extremely competitive and dynamic field. To help keep up with the changing technology, continuing education and professional development seminars are offered by employers and software vendors, colleges and universities, and private training institutions.

Recommended High School Course Work
High school students interested in this kind of work should take English (communications), mathematics, computer science, and software engineering courses.

Where Do I Find the Job?

The largest concentration of Computer Software Engineers work in computer systems design firms. Others work for government agencies, manufacturers of computers and related electronic equipment, colleges and universities, the military, and engineering services. Some consultants work for firms that specialize in developing and maintaining clients' Web sites and intranets.

Direct application to employers remains one of the most effective job search methods.

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Computer Storage Devices
- Computer Systems Design Services
- Custom Computer Programming Services
- Electricity & Signal Testing Instruments
- Electromedical Apparatus
- Electronic Computers
- Industrial Process Variable Instruments
- Other Computer Peripheral Equipment
- Other Computer Related Services
- Other Measuring and Controlling Devices
- Search, Detection, Navigation & Instrument
- Software Publishers

Search these **yellow page** headings for listings of private firms:

- Computer Manufacturers
- Data Networks
- Computer Networks
- Computer Software Developers
- Computer System Designers
- Information Technology Services
- Internet Software and Services
- Web Site Services

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Computer Software Engineers, Applications

Where Can the Job Lead?

A career path for Computer Software Engineers, Applications might lead to supervisory or managerial positions within the Information Technology (IT) department of a firm, particularly for those who have high levels of communication and project management skills. Engineers with degrees in specialties such as electronics, aerospace, or industrial engineering will have many opportunities to make lateral moves into other departments and positions.

Other Sources of Information

Association for Computing Machinery
www.acm.org

National Workforce Center for Emerging Technologies
www.nwcet.org

IEEE Computer Society
www.computer.org

Institute for the Certification of Computing Professionals
www.iccp.org

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Computer Software Engineers, Systems Software

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What They Do

Computer Software Engineers, Systems apply the principles and techniques of computer science, engineering, and mathematical analysis to the design, development, testing, and evaluation of the software and systems that enable computers to perform their many applications.

Systems Software Engineers working in applications or systems development analyze users' needs and design, create, and modify general computer systems. Engineers can be involved in the design and development of many types of software including software for operating systems, network distribution, and compilers, which convert programs for faster processing. In programming, or coding, Systems Software Engineers instruct a computer, line by line, how to perform a function. Engineers must possess strong programming skills, but are more concerned with developing algorithms and analyzing and solving programming problems than with actually writing code.

Systems Software Engineers coordinate the construction and maintenance of a company's computer systems, and plan their future growth. They coordinate each department's computer needs within a company and make recommendations on technical matters. They also might set up the company's intranets, networks that link computers within the organization and ease communication. Many engineers work for companies that configure, implement, and install complete computer systems. In addition, they often work as part of a team that designs new hardware, software, and systems.

Tasks

- Analyze information to determine, recommend and plan installation of a new system or modification of an existing system.
- Confer with data processing and project managers to obtain information on limitations and capabilities for data processing projects.
- Consult with engineering staff to evaluate interface between hardware and software, develop specifications and performance requirements and resolve customer problems.
- Modify existing software to correct errors, to adapt it to new hardware or to upgrade interfaces and improve performance.
- Design and develop software systems, using scientific analysis and mathematical models to predict and measure outcome and consequences of design.
- Develop and direct software system testing and validation procedures.
- Direct software programming and development of documentation.
- Evaluate factors such as reporting formats required, cost constraints, and need for security restrictions to determine hardware configuration.

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- Consult with customers and/or other departments on project status, proposals and technical issues such as software system design and maintenance.
- Advise customer about, or perform, maintenance of software system.
- Coordinate installation of software system.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
- Technology Design — Generating or adapting equipment and technology to serve user needs.
- Troubleshooting — Determining causes of operating errors and deciding what to do about it.
- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Programming — Writing computer programs for various purposes.
- Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
- Oral Comprehension — The ability to listen to and understand information and ideas presented through spoken words and sentences.

Work Environment

Systems Software Engineers normally work in well-lighted and comfortable offices or computer laboratories in which computer equipment is located. Most engineers work a minimum 40 hours a week, but due to the project-oriented nature of the work, they often work evenings or weekends

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to meet deadlines or solve unexpected technical problems. Due to the nature of the work, Systems Software Engineers are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome.

As networks expand, Systems Software Engineers may be able to use modems, laptops, e-mails, and the Internet to provide more technical support and other services from their main office, connecting to a customer's computer remotely to identify and correct developing problems.

California's Job Outlook and Wages

The California Outlook and Wage chart below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Computer Software Engineers, Systems Software				
15-1032	51,100	74,500	2,850	$35.85 to $54.86

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

The number of Systems Software Engineers is projected to grow much faster than average, particularly in the computer systems design industry, which alone expects 8,200 new Engineers between 2004 and 2014. In fact, new job opportunities for this job are expected in all industries, as businesses and other organizations continue to adopt and integrate new technologies and seek to maximize the efficiency of their computer system. Employers continue to seek computer professionals with strong programming, systems analysis, interpersonal, and business skills. Competition among businesses will continue to create an incentive for increasingly sophisticated technological innovations, and organizations will need more Systems Software Engineers to implement these new technological changes.

Training/Requirements/Apprenticeships

Most employers prefer to hire persons who have at least a bachelor's degree and broad knowledge and experience with computer systems and technologies. System Software Engineers usually focus their studies on computer science or computer information systems. Jobs that are more complex and require a high degree of technical knowledge often require candidates with a master's degree.

Many students seeking software engineering jobs enhance their employment opportunities by participating in internships offered through their schools. These experiences provide students with broad knowledge and valuable hands-on experience, making them attractive candidates to employers. In many firms, mentoring has become part of the evaluation process for new hires.

Systems Software Engineers should be knowledgeable about the different operating systems used by the industry. They must have the ability to problem-solve and configure operating systems to work with all kinds of hardware and adapt the systems to meet the needs of the organization.

Computer Software Engineers, Systems Software

Employers demand new skills as technology continually evolves and advances in the computer field. Systems Software Engineers must acquire these new skills if they wish to remain in this extremely competitive dynamic field. To help keep up with the changing technology, continuing education and professional development seminars are offered by employers and software vendors, colleges and universities, and private training institutions.

Recommended High School Course Work
High school students interested in this kind of work should take computer science and information technology courses, as well as math, sciences, and language arts, in order to develop the skills requirements such as problem solving, reading comprehension, and critical thinking.

Where Do I Find the Job?

Direct application to employers remains one of the most effective job search methods. Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Computer Storage Device
- Computer Systems Design Services
- Custom Computer Programming Services
- Electricity & Signal Testing Instruments
- Electronic Computer
- Industrial Process Variable Instruments
- Other Computer Peripheral Equipment
- Other Computer Related Services
- Physical/Engineering/Biological Research
- Search, Detection & Navigation Instruments
- Social Science/Humanities Research
- Software Publishers

Search these **yellow page** headings for listings of private firms:

- Computer Manufacturers
- Computer Networks
- Computer Software Developers
- Computer System Designers
- Engineers-Consulting
- Engineers-Industrial
- Engineers-Manufacturing

Where Can the Job Lead?

A career path for Systems Software Engineers might lead to supervisory or managerial positions within a firm, particularly those who have high levels of communication and project management skills. Engineers with degrees in specialties such as electronics, aerospace, or industrial engineering will have many opportunities to make lateral moves into other departments and positions. Those with persuasive and people skills sometimes move into sales positions, which can be lucrative.

Other Sources of Information

Institute for the Certification of Computing Professionals
www.iccp.org

National Workforce Center for Emerging Technologies
www.nwcet.org

Association for Computing Machinery
www.acm.org

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Electrical and Electronic Engineering Technicians

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What They Do

Electrical and Electronic Engineering Technicians perform work essential to research and development, manufacture, modification, and maintenance of a wide range of products and equipment. They usually work as assistants to engineers and are often identified by titles similar to those given to the engineers. Some common titles are Design Engineering Technician, Systems Development Technician, and Product Engineering Technician. Experienced technicians often work in research and development.

Engineering Technicians use their knowledge of electronics theory and circuitry, test procedures, mathematics, and physics to sketch, make layouts, and build experimental circuitry, prototype and production models, and production equipment. They design and modify basic circuits, and recommend changes in circuitry or specifications. They troubleshoot failed units, often down to the level of the individual components, analyze the cause of failures, and perform necessary repairs. They use voltmeters, ohmmeters, signal generators, ammeters, and oscilloscopes.

Engineering Technicians set up and run a variety of environmental, operational, and functional tests on components, systems, and new products, and sometimes devise new test procedures as well. They analyze and interpret test data, write technical reports, develop graphs or charts to describe operating characteristics, failures, and limitations for the engineers to consider. They may also write computer programs to test new systems. They also may run diagnostic programs that help pinpoint malfunctions.

Some Engineering Technicians are primarily involved with the manufacturing process. They maintain production and quality control equipment, develop tests to assure product quality, and investigate various manufacturing problems. Other Engineering Technicians install and maintain equipment and systems at customer worksites. In addition to providing preventive and corrective maintenance, they often train the customers' employees and advise them of proper procedures to avoid unnecessary equipment breakdowns.

Tasks

Electrical Engineering Technicians

- Provide technical assistance and resolution when electrical or engineering problems are encountered before, during, and after construction.
- Assemble electrical and electronic systems and prototypes according to engineering data and knowledge of electrical principles, using hand tools and measuring instruments.

Electrical and Electronic Engineering Technicians

- Install and maintain electrical control systems and solid state equipment.
- Modify electrical prototypes, parts, assemblies, and systems to correct functional deviations.

Electronic Engineering Technicians

- Test electronics units, using standard test equipment, and analyze results to evaluate performance and determine need for adjustment.
- Perform preventative maintenance and calibration of equipment and systems.
- Read blueprints, wiring diagrams, schematic drawings, and engineering instructions for assembling electronics units, applying knowledge of electronic theory and components.
- Identify and resolve equipment malfunctions, working with manufacturers and field representatives as necessary to procure replacement parts.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Troubleshooting — Determining causes of operating errors and deciding what to do about it.
- Repairing — Repairing machines or systems using the needed tools.
- Equipment Maintenance — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
- Equipment Selection — Determining the kind of tools and equipment needed to do a job.
- Time Management — Managing one's own time and the time of others.
- Mathematics — Using mathematics to solve problems.
- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents.
- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

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Electrical and Electronic Engineering Technicians

Work Environment

Most Electrical and Electronic Engineering Technicians work in offices, laboratories, and industrial plants. The laboratories are very clean and well equipped facilities because of the materials they work with, such as silicon chips that must be completely free of contamination. Those that work in manufacturing or industrial plants may be exposed to hazardous materials that are used in their operations. Teamwork is a very important part of the operations for a technician.

Electrical and Electronic Engineering Technicians usually work a standard 40-hour workweek, Monday through Friday. However, they may work swing and night shifts at plants that operate around-the-clock. Occasionally, Electrical and Electronic Engineering Technicians may work overtime hours to meet production deadlines.

California's Job Outlook and Wages

The California Outlook and Wage table below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Electrical and Electronic Engineering Technicians				
17-3023	25,700	30,400	1,010	$19.86 to $31.30

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

The occupation of Electrical and Electronic Engineering Technicians will grow faster than average compared with all occupations in California, with the greatest number of job opportunities created by workers retiring or permanently leaving the field. The largest growth is projected for the employment services and computer systems design industries.

Training/Requirements/Apprenticeships

Most employers expect applicants to have an associate degree in electronics technology or equivalent technical training.

Technicians often find it valuable to take additional courses and study technical manuals to keep up on the frequent changes and developments in the field of electronics. They should be detail-minded and have the initiative to work independently much of the time. They should be able to work from schematic diagrams, sketches, and verbal instructions. Good communication skills, both oral and written, are necessary, since reports and verbal explanations are usually part of the job. Other important traits are manual dexterity, good vision, and color perception.

Many of California's community colleges offer degree programs in electronics technology, as well as courses in related subjects. Technicians who work on radio transmission equipment are required to obtain a radiotelephone operator's license issued by the Federal Communications Commission. They may prepare for this license at most community colleges or through home-study courses.

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Electrical and Electronic Engineering Technicians

A four-year Electronics Technician apprenticeship program run by the California Department of Industrial Relations, Division of Apprenticeship Standards is in effect in various locations throughout California.

Recommended High School Course Work
High school students interested in this kind of work should take as many mathematics and science courses as possible. Computer technology, electronics, and shop classes are also helpful.

Where Do I Find the Job?

School placement offices may help students find jobs. School counselors and job service agencies may have information on apprenticeships and jobs. Beginning technicians can apply to the personnel departments of large manufacturing, engineering, or contracting firms. Federal, state, local government and private employment agencies also list jobs. Newspapers, professional journals, trade publications, and the Internet may list openings. Some companies hire beginning technicians as temporary workers. After three to six months, if their work is satisfactory, they may become a regular employee of the company.

Direct application to employers remains one of the most effective job search methods. Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Analytical Laboratory Instruments
- Bare Printed Circuit Board
- Broadcast & Wireless Communication Equip.
- Computer Systems Design Services
- Electricity & Signal Testing Instruments
- Electromedical Apparatus
- Engineering Services
- Industrial Process Variable Instruments
- Other Electronic Component
- Other Measuring and Controlling Devices
- Search, Detection, & Navigation Instrumnts
- Semiconductor and Related Devices
- Testing Laboratories

Search these **yellow page** headings for listings of private firms:

- Electrical Power Systems Testing
- Electric Contractors
- Electric Service & Utility Providers
- Electronic Testing Equipment
- Electronics Consulting & Research Dev.
- Engineers-Communication
- Engineers-Electrical
- Engineers-Electronic

Where Can the Job Lead?

Engineering Technician occupations have limited promotional opportunities. Persons in these occupations must take additional college courses and obtain a degree in order to be promoted to the engineering occupations. Lateral movement is quite easy and there seems to be a wide range of technician occupations that one can move into with very little difficulty. With the proper educational preparation, the primary advancement is from a technician to an engineer.

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Electrical and Electronic Engineering Technicians

Other Sources of Information

Institute of Electrical and Electronics Engineers, Inc.
www.ieee.org

American Society for Engineering Education
www.asee.org

Electronics Technicians Association, International
www.eta-i.org

Junior Engineering Technical Society (JETS)
www.jets.org

American Society of Certified Engineering Technicians
www.ascet.org

California Department of Industrial Relations
Division of Apprenticeship Standards
www.dir.ca.gov/das

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Electrical and Electronics Engineers

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What They Do

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. Electrical Engineers specialize in the production, transmission, and uses of electrical power. Electronics Engineers are more involved with low power applications including radio, television, computers and telephones.

Most of California's Electrical and Electronics Engineers are employed in manufacturing industries such as electronic instruments, semiconductor components, motion picture and video production, and architectural and engineering services. Many work for federal, state, and local governments. Engineers in manufacturing and government may be researchers and investigate issues related to possible applications, such as chemical interactions and new materials. Engineers who actually do product design and development use CAD/CAE (computer-aided design and computer-aided engineering) tools to draw up plans for efficient production. The Production Engineers are the "hands on" engineers. They guide products through all stages of the manufacturing process. They also determine performance standards for new products and write maintenance schedules to ensure that these standards will be met. Many engineers also write technical manuals, instructional pamphlets, and installation instructions.

Electrical and Electronics Engineers work in other fields including power plant construction and design, nuclear research, field service and teaching. Engineers are also employed by consulting firms, public utilities, and government. Other engineers skilled in the marketing and sales of technical products are in demand as Sales Engineers.

Tasks

Electrical Engineers

- Confer with engineers, customers, and others to discuss existing or potential engineering projects and products.
- Design, implement, maintain, and improve electrical instruments, equipment, facilities, components, products, and systems for commercial, industrial, and domestic purposes.
- Operate computer-assisted engineering and design software and equipment to perform engineering tasks.

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Electrical and Electronics Engineers

- Direct and coordinate manufacturing, construction, installation, maintenance, support, documentation, and testing activities to ensure compliance with specifications, codes, and customer requirements.
- Perform detailed calculations to compute and establish manufacturing, construction, and installation standards and specifications.
- Inspect completed installations and observe operations, to ensure conformance to design and equipment specifications and compliance with operational and safety standards.
- Plan and implement research methodology and procedures to apply principles of electrical theory to engineering projects.
- Prepare specifications for purchase of materials and equipment.

Electronics Engineers (except Computer)

- Analyze system requirements, capacity, cost, and customer needs to determine feasibility of project and develop system plan.
- Confer with engineers, customers, vendors, and others to discuss existing and potential engineering projects or products.
- Design electronic components and software, products and systems for commercial, industrial, medical, military, and scientific applications.
- Plan and implement research, methodology, and procedures to apply principles of electronic theory to engineering projects.
- Prepare engineering sketches and specifications for construction, relocation, and installation of equipment, facilities, products, and systems.
- Develop and perform operational, maintenance, and testing procedures for electronic products, components, equipment, and systems.
- Direct and coordinate activities concerned with manufacture, construction, installation, maintenance, operation, and modification of electronic equipment, products, and systems.
- Evaluate operational systems, prototypes and proposals and recommend repair or design modifications based on factors such as environment, service, cost, and system capabilities.
- Inspect electronic equipment, instruments, products, and systems to ensure conformance to specifications, safety standards, and applicable codes and regulations.
- Plan and develop applications and modifications for electronic properties used in components, products, and systems, to improve technical performance.

*Detailed descriptions of these occupations may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.
- Mathematics — Using mathematics to solve problems.
- Science — Using scientific rules and methods to solve problems.

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Electrical and Electronics Engineers

- Troubleshooting — Determining causes of operating errors and deciding what to do about it.
- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents.
- Technology Design — Generating or adapting equipment and technology to serve user needs.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Near Vision — The ability to see details at close range (within a few feet of the observer).
- Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
- Oral Expression — The ability to communicate information and ideas in speaking so others will understand.
- Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
- Science — Using scientific rules and methods to solve problems.

Work Environment

Electrical and Electronics Engineers generally work in well-equipped offices and laboratories. Some positions require more active or outdoor work, such as directing operations in manufacturing plants or at construction sites, while some require sitting at a desk most of the day.

Technological advances have created the need for most engineers to work as part of a team, requiring the development of interpersonal as well as technical skills. The intensely competitive nature of high technology manufacturers can cause emotional strain, as each company pushes to develop and introduce new products faster and more cheaply than its competitors.

Most Electrical and Electronics Engineers work a standard 40-hour week; however, overtime and weekend work is sometimes necessary. Many engineers are members of the Institute for Electrical and Electronics Engineers or other professional organizations.

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Electrical and Electronics Engineers

California's Job Outlook and Wages

The California Outlook and Wage table below represents the occupations across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Electrical Engineers				
17-2071	21,200	24,700	770	$31.41 to $50.42
Electronics Engineers (except Computer)				
17-2072	27,700	32,500	1,030	$34.32 to $53.55

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

The projected job growth for Electrical and Electronics Engineers is at an average rate for all occupations. A need for more Electrical Engineers is expected in the motion picture and video industry, while opportunities for Electronics Engineers are expected in computer systems design, electronic instrument manufacturing, electronic components, and federal government. However, most hiring activity expected between 2004 and 2014 will be to replace workers who have left for retirement or other types of work.

Training/Requirements/Apprenticeships

A bachelor of science degree in Electrical or Electronics Engineering is essential to secure an entry-level position. Engineers frequently go on to graduate school after obtaining their four-year degree. Research or faculty positions usually require a masters or doctoral degree. Graduate degrees are also sometimes required for promotions. Electrical and Electronics Engineers must continue to study throughout their career to keep up with the latest technologies.

Electrical and Electronics Engineers must be licensed by the California Board for Professional Engineers and Land Surveyors.

Recommended High School Course Work

Colleges and universities are usually very specific in their entrance requirements. Required high school courses usually include calculus, algebra, geometry, trigonometry, physics, and chemistry. Computer classes are also highly recommended. Engineers must have an aptitude for science and mathematics, as well as an analytical mind and the ability to do detailed work.

Where Do I Find the Job?

Firms employing Electrical and Electronics Engineers frequently recruit for entry level positions on college campuses in both the fall and spring. Advertisements of open positions appear in professional journals, trade magazines, and newspapers. Employers and applicants use the employment services of professional societies, private employment agencies, and the Employment Development Department.

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Electrical and Electronics Engineers

Direct application to employers remains one of the most effective job search methods.

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Architectural Services
- Bare Printed Circuit Board
- Electricity & Signal Testing Instruments
- Electromedical Apparatus
- Electronic Computer
- Engineering Services
- Industrial Process Variable Instruments
- Landscape Architectural Services
- Motion Picture and Video Production
- Other Electronic Component
- Other Measuring and Controlling Devices
- Search, Detection, & Navigation Instrumnt
- Semiconductor and Related Devices
- Testing Laboratories

Search these **yellow page** headings for listings of private firms:

- Engineers

Search the **white pages** under *Government Listings*:

- Government, State or Local

Where Can the Job Lead?

Advancement opportunities exist along a structured career path for both the Electrical and Electronics Engineers. They can advance to a Senior Engineer and to a Supervising Engineer. In some cases they may be able to advance to managerial positions.

Lateral movement to other occupations is quite easy with a college degree in electrical or electronic engineering. Many companies across many industries welcome employees with an educational background in Electrical and Electronic Engineering.

Other Sources of Information

Institute of Electrical and Electronics Engineers
www.ieee.org

California Board for Professional Engineers and Land Surveyors
www.dca.ca.gov/pels

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Electrical, Electronic, and Mechanical Drafters

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What They Do

Drafters prepare technical drawings and plans used by production and construction workers to build everything from manufactured products, such as toys, toasters, industrial machinery, or spacecraft, to structures such as houses, office buildings, or oil and gas pipelines. Their drawings provide visual guidelines, showing the technical details of the products and structures and specifying dimensions, materials to be used, and procedures and processes to be followed. Drafters fill in the details, using drawings, rough sketches, specifications, codes, and calculations previously made by engineers, surveyors, architects, or scientists.

Electrical Drafters make wiring diagrams and schematics of electrical circuits for use by those who install and repair electrical systems such as those found in buildings, communication centers, and power plants. Most Electrical Drafters use computer-aided drafting (CAD) systems to prepare drawings.

Electronic Drafters make drawings of the layout and schematics of electronic devices and components. They may specialize in the drafting of drawings used to make one or several related types of devices or components or they may be involved with many kinds of electronic items. Most Electronic Drafters use CAD systems to prepare drawings.

Mechanical Drafters use CAD systems to prepare drawings. These systems permit them to easily and quickly prepare variations of a design. They use their knowledge of engineering and manufacturing theory and standards to draw the parts of a machine in order to determine design elements, such as the number and kind of fasteners needed to assemble it. Despite the near-universal use of CAD systems, manual drafting using pencils, pens, compasses, protractors, triangles, and other drafting devices is still used in certain applications.

Tasks

Electrical Drafters

- Study work order requests to determine type of service demanded, such as lighting or power.
- Visit proposed installation sites and draw rough sketches of location.
- Assemble documentation packages and produce drawing sets which are then checked by an engineer or an architect.
- Confer with engineering staff and other personnel to resolve problems.
- Draft working drawings, wiring diagrams, wiring connection specifications or cross-sections of underground cables, as required for instructions to installation crew.

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- Draw master sketches to scale showing relation of proposed installations to existing facilities and exact specifications and dimensions.
- Measure factors that affect installation and arrangement of equipment, such as distances to be spanned by wire and cable.

Electronic Drafters

- Compare logic element configuration on display screen with engineering schematics and calculate figures to convert, redesign, and modify element.
- Consult with engineers to discuss and interpret design concepts, and determine requirements of detailed working drawings.
- Draft detail and assembly drawings of design components, circuitry and printed circuit boards, using computer-assisted equipment or standard drafting techniques and devices.
- Examine electronic schematics and supporting documents to develop, compute, and verify specifications for drafting data, such as configuration of parts, dimensions, and tolerances.
- Key and program specified commands and engineering specifications into computer system to change functions and test final layout.
- Plot electrical test points on layout sheets, and draw schematics for wiring test fixture heads to frames.
- Review work orders and procedural manuals and confer with vendors and design staff to resolve problems and modify designs.

Mechanical Drafters

- Develop detailed design drawings and specifications for mechanical equipment, dies/tools, and controls, using computer-assisted drafting (CAD) equipment.
- Coordinate with and consult other workers to design, lay out, or detail components and systems and to resolve design or other problems.
- Review and analyze specifications, sketches, drawings, ideas, and related data to assess factors affecting component designs and the procedures and instructions to be followed.
- Compute mathematical formulas to develop and design detailed specifications for components or machinery, using computer-assisted drafting programs.
- Position instructions and comments onto drawings.
- Modify and revise designs to correct operating deficiencies or to reduce production problems.
- Design scale or full-size blueprints of specialty items, such as furniture and automobile body or chassis components.

*Detailed descriptions of these occupations may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

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Electrical, Electronic, and Mechanical Drafters

- Engineering and Technology — (Electronics Drafters) Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.
- Physics — Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub- atomic structures and processes.
- Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- Instructing — Teaching others how to do something.
- Technology Design — Generating or adapting equipment and technology to serve user needs.
- Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
- Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
- Mathematics — Using mathematics to solve problems.
- Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
- Operations Analysis — Analyzing needs and product requirements to create a design.
- Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
- Visualization — The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.
- Near Vision — The ability to see details at close range (within a few feet of the observer).
- Written Comprehension — The ability to read and understand information and ideas presented in writing.

Work Environment

Drafters usually work in well-furnished offices. They mostly work at computer terminals, although some may sit at adjustable drawing boards or drafting tables when doing manual drawings. Drafters often spend long periods of time in front of computers doing detailed work, which can cause eyestrain, back discomfort, and hand and wrist problems. They sometimes are required to travel to construction sites or other locations to gather additional information concerning a particular project that requires more detail.

Most Drafters work a standard 40-hour workweek. Occasionally, long or irregular hours may be necessary to meet special project deadlines.

Electrical, Electronic, and Mechanical Drafters

California's Job Outlook and Wages

The California Outlook and Wage table below represents the occupations across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Electrical and Electronic Drafters				
17-3012	4,900	5,800	230	$19.91 to $32.83
Mechanical Drafters				
17-3013	4,600	5,000	170	$17.54 to $28.92

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

The projected job growth for Electrical and Electronic Drafters is expected to grow faster than average compared to all occupations between 2004 and 2014. The growth for Mechanical Drafters is expected to grow slower than average between 2004 and 2014. Some need for more Drafters is expected in the computer systems design and services industry sector, as well as temporary help agencies; however, most new job opportunities will come from a need to replace Drafters who retire or leave for other types of work. Opportunities will be best for individuals who have at least two years of post-secondary training in a drafting program, can demonstrate strong technical skills, and who have considerable skill and experience using current CAD systems.

Training/Requirements/Apprenticeships

Employers prefer applicants who have completed training programs in drafting from adult education, community college, private post-secondary, or four-year college training programs. Common program titles used in California are Electrical/Electronics Drafting & Electrical/Electronics CAD; Architectural Drafting and Architectural CAD; Automotive Engineering Technology/Technician; CAD Drafting and/or Design Technology/Technician; and Civil Drafting and Civil Engineering CAD/CADD. Technical training and experience obtained in the armed forces can sometimes be applied toward civilian drafting jobs. Go to the LaborMarketInfo Web site www.labormarketinfo.edd.ca.gov to locate training programs in your area.

Employers are most interested in applicants who have knowledge of drafting standards, mathematics, science, and engineering technology, plus a solid background in computer-aided drafting and design programs such as AutoCAD, Land Development Desktop (LDD), or TurboCAD.

Interpersonal and problem-solving skills are important, as drafters often work closely with engineers, surveyors, architects, other professionals, and sometimes customers. The American Design Drafting Association (ADDA) has established a certification program for drafters. Although drafters are not required to be certified by employers, certification demonstrates the understanding of nationally recognized practices and that knowledge standards have been met. Individuals who wish to become certified must pass the Drafters Certification Test, which is administered periodically at ADDA-authorized test sites.

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Electrical, Electronic, and Mechanical Drafters

Recommended High School Course Work
High school students interested in this career should take math, science, computer technology, computer graphics, electronics, and drafting courses.

Where Do I Find the Job?

Direct application to employers remains one of the most effective job search methods.

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Architectural Services
- Building Inspection Services
- Computer Systems Design Services
- Custom Computer Programming Services
- Drafting Services
- Electricity & Signal Testing Instruments
- Engineering Services
- Industrial Process Variable Instruments
- Landscape Architectural Services
- Other Surveying and Mapping Services
- Search, Detection, & Navigation Instruments
- Testing Laboratories

Search these **yellow page** headings for listings of private firms:

- Architects
- CAD Systems & Services
- Computer Graphics & Digital Imaging
- Drafting Services
- Engineers-Consulting
- Engineers-Mechanical
- Graphic Designers
- Graphic Services

School placement offices often help students find jobs. Beginning drafters can apply to the personnel departments of large manufacturing, engineering, or contracting firms. Newspapers, professional journals, trade publications, and the Internet may list openings.

Where Can the Job Lead?

Drafters have many opportunities to move upward or into related occupations. Related specialties include engineering technicians, land surveyors, map editors, technical illustrators, tool designers, and cartographers. Each specialty can open opportunities for advancement to a Senior Draftsman level or even Engineering Technician.

Other Sources of Information

American Design Drafting Association
www.adda.org

Accrediting Commission of Career Schools and Colleges of Technology
www.accsct.org

Skills USA
www.skillsusa.org

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Graphic Designers

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What They Do

Graphic Designers analyze, plan, and create visual solutions to communications problems. They use a variety of print, electronic, and film media and technologies to achieve a design that meets the clients' needs. Graphic Designers consider cultural, physical, and social factors when planning and executing appropriate designs for a given product line. They use computer software to develop the overall layout and production design of magazines, newspapers, journals, corporate reports, and other publications. Graphic Designers also produce promotional displays and marketing brochures for products and services. They design distinctive logos for products and businesses. Increasingly, Graphic Designers develop material for Internet Web pages, computer interfaces, and multimedia projects.

Tasks

- Create designs, concepts, and sample layouts based on knowledge of layout principles and esthetic design concepts.
- Determine size and arrangement of illustrative material and copy; select style and size of type.
- Use computer software to generate new images.
- Mark up, paste, and assemble final layouts to prepare layouts for printer.
- Draw and print charts, graphs, illustrations, and other artwork, using computer.
- Review final layouts and suggest improvements as needed.
- Confer with clients to discuss and determine layout design.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Time Management — Managing one's own time and the time of others.
- Coordination — Adjusting actions in relation to others' actions.
- Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

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Graphic Designers

- Communications and Media — Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.
- Originality — The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.
- Fluency of Ideas — The ability to come up with a number of ideas about a topic (the number of ideas is important, not their quality, correctness, or creativity).
- Near Vision — The ability to see details at close range (within a few feet of the observer).

Work Environment

Graphic Designers employed by large corporations or design firms usually work regular hours. However, occasionally they may need to work additional hours to meet deadlines. Designers in smaller design consulting firms, or those who freelance, generally work on a contract, or job basis. They frequently adjust their workday to suit their clients' schedules and deadlines, meeting with the clients during evening or weekend hours when needed.

Generally, most work environments are brightly lit and temperature-controlled, with drawing tables and easels arranged for the quick and efficient production of commercial art. Because Graphic Designers work with a variety of people under sometimes stressful situations, they must be resilient, efficient, and able to relate well with people. The work also requires visual acuity and color vision.

What's the California Job Outlook?

The California Outlook and Wage table below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Graphic Designers 27-1024	31,700	36,200	870	$16.18 to $28.59

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

Self-employment as a freelance Graphic Designer is common in the commercial art industry, especially for the experienced worker with a network of contacts. Employers increasingly expect new designers to be familiar with computer-aided design software as a design tool. Competition is stiff for both the new entrant and the seasoned Graphic Designer in the current job market. However, the demand for Graphic Designers will continue due to the rapidly expanding market for Web-based information and expansion of the video entertainment market.

Training/Requirements/Apprenticeships

Graphic Designers usually follow one of the following training paths:

- Bachelor's degree
- Community College
- Vocational school/Art Institute

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Most employers prefer applicants with a bachelor's degree for most entry-level Graphic Design positions. Formal training programs may range from two to four years of academic or vocational art education. It is important to select a school where students train under the direction of professional, working artists. Graphic Designers need a solid base in design and color, practice in drawing, and knowledge of reproduction techniques. Aspiring Graphic Designers also need to learn the latest computer-graphic techniques. Graphic Designers usually participate in lifelong learning programs, especially computer training, to stay current in their field.

Recommended High School Course Work
High School preparation courses in art, art history, sketching, lettering, mechanical drawing, principles of design, and computerized design are helpful.

Where Do I Find the Job?

Direct application to employers remains one of the most effective job search methods. Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search under the following manufacturing industry names to get a list of private firms and their addresses:

- Advertising Agencies
- Advertising Material Distribution Svc
- All Other Publishers
- Book Publishers
- Direct Mail Advertising
- Graphic Design Services
- Interior Design Services
- Newspaper Publishers
- Other Services Related to Advertising
- Other Specialized Design Services
- Periodical Publishers
- Public Relations Agencies

Search these **yellow page** headings for listings of private firms:

- Artists Commercial
- CAD Systems & Services
- Computer Graphics and Digital Imaging
- Designers-Industrial
- Desktop Publishing & Service Bureaus
- Graphic Designers

Where Can the Job Lead?

Beginning Graphic Designers usually receive on-the-job training and need one to three years of training before they can advance to higher level positions. Experienced designers in large firms may advance to design department head, or other supervisory positions. Some designers leave the occupation to become teachers in design schools or in colleges and universities. Others enter self-employment as consultants or open small design studios.

Other Sources of Information

American Institute of Graphic Arts
www.aiga.org

Graphic Artists Guild
www.gag.org

Graphic Artitsts Guild California/Northern
http://norcal.gag.org

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Industrial Engineers

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What They Do

Industrial Engineers combine solid engineering background with effective business management practices to improve quality and efficiency. Industrial Engineers recommend the best use of facilities, equipment, material, and people to make or process a product at lower cost, faster, and better. They look at the total operations process to improve work environment and safety. Industrial Engineers also concern themselves with office automation, cost-containment, and consolidation efforts.

Industrial Engineers may specialize in information technology, information systems and design, material management, logistics and distribution, plant layout and design, production planning, or work methods analysis. Industrial Engineers' job titles reflect the range of their assignments: business process engineer, manufacturing engineer, operations engineer, facilities engineer, plant engineer, quality engineer, reliability engineer, productivity engineer, systems engineer, ergonomist, and management engineer. Industrial Engineers work in manufacturing, government, hospitals, food processing, transportation, retail, amusement parks, and large business organizations.

Industrial Engineers who specialize in production planning determine how much a plant can produce. They depend upon computers, CAD/CAM (computer-aided design and computer-aided manufacturing) software and computer simulation to figure out the best methods for production, distribution, equipment, and transportation. They may also be responsible for quality control and inventory. They consider handling and storage of incoming material, and set inventory size, as well as packaging and shipping methods.

Tasks

Operations

- Review schedules or forecasts, specifications, and customer requirements to understand what activities, and in what order, things should be done.
- Develop methods, labor utilization standards, and cost analysis systems for efficient staff and facility operation.
- Monitor workflow schedules according to established best practices to come up with improved cycle time.
- Study operations sequence, material flow, functional statements, organization charts, and project information to determine systems (labor, tools, computers) design and workplace layout.

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Industrial Engineers

- Apply statistical methods to determine processes, staff requirements, and production standards.
- Project system deliveries based on marketing forecasts, supply chain design, storage and handling facilities, and maintenance requirements.

Logistics and Distribution (Supply Chain Management)

- Design methods of transporting goods from one location to another. This could mean locating, designing, and building of warehouses for large national merchandisers so their stores can be stocked on a timely basis. It could mean designing the system of trucks, rail and air to supply parts for assembly or repair (as in the auto industry).
- Design systems for handling materials from differing transportation modes and redistributing them in a minimum amount of time; for example, long haul trucks, local trucks, air cargo delivery, and containers.
- Design systems for automated replenishment of stock; such as, scanning a bar coded product in a store triggers a system that orders new stock to be delivered back to that same store.
- Design systems for the transport of people in a municipal setting, such as rail, bus, and train.
- With architects, design public facilities, such as parking garages, public transportation stations or centers, for the efficient flow and safety of people.

Facilities Planning

- Draft and design layout of equipment, materials, and workspace to illustrate maximum efficiency, using drafting tools and computer simulation.
- Plan and establish sequence of operations to fabricate or assemble parts or products, or service customers, and to promote efficient utilization of resources.

Quality Control

- Coordinate quality control objectives and activities to resolve production problems, increase product reliability, and minimize cost with partners around the world.
- Analyze statistical data and product specifications to establish quality and reliability objectives of finished product.
- Formulate sampling procedures and forms for recording, evaluating, and reporting quality and reliability data.
- Implement methods for disposition of defective material or parts, and assesses cost and responsibility.
- Estimate production cost and effect of product design changes for management review, action, and control.
- Record or oversee recording of information to ensure currency of engineering drawings and documentation of production problems.
- Direct workers engaged in product measurement, inspection, and testing activities to ensure quality control and reliability.

*Detailed descriptions of these occupations may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

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Industrial Engineers

Important Skills, Knowledge, and Abilities

- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- Time Management — Managing one's own time and the time of others.
- Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
- Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
- Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.
- Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.
- Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.
- Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
- Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
- Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
- Speech Clarity — The ability to speak clearly so others can understand you.

Industrial Engineers

Work Environment

Industrial engineering is not physically demanding, but frequently takes the Engineer out of the office into production and manufacturing areas. Today, this often means traveling across the country or around the world to the manufacturing site. Industrial Engineers spend much of their time asking questions. They may talk with production workers, as well as technical or administrative staff. It is not unusual for these Engineers to be involved in several projects at once. Therefore, they must be flexible enough to drop one project and pick up another at a moment's notice.

Much of an Industrial Engineer's output is used by management for making decisions. As a result, these workers must be accurate; their recommendations may affect the size of their firm's profits, its labor relations, as well as its productions costs. Because of this, stress may be considerable at times.

Industrial Engineers usually work a 40-hour workweek. However, long or irregular hours may be necessary to meet deadlines or when working on special projects.

California's Job Outlook and Wages

The California Outlook and Wage table below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Industrial Engineers				
17-2112	19,600	24,100	920	$30.68 to $46.69

Wages do not reflect self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

Overall employment of Industrial Engineers, including health and safety, is expected to grow faster than the average for all occupations through 2014. Most opportunities will arise as existing workers retire or leave for other kinds of work. New jobs are expected in computer systems design firms, semiconductor plants, and in temporary employment services companies, where Industrial Engineers may be hired for the duration of a specific project.

Training/Requirements/Apprenticeships

A bachelor's degree in Industrial Engineering or a related engineering degree is almost always necessary for entering this occupation. In addition, many employers will hire only those who have at least two years' successful experience in this field. Eight California universities offer degrees in Industrial Engineering accredited by the Accreditation Board for Engineering and Technology (ABET). Industrial Engineers planning careers in management find that obtaining a master's degree in business administration (MBA) is helpful.

Engineers working for government agencies or whose work may affect the public welfare are required to be registered by the State Board of Professional Engineers and Land Surveyors (See Other Sources of Information). To obtain registration, Engineers must pass the Engineer-in-Training examination, obtain at least two years' engineering experience (without a bachelor's degree in

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Industrial Engineering, six years of experience is required), and then pass the professional examination in industrial engineering. While registration is not required for all jobs, a registered Engineer will have a competitive edge for advancement to more responsible positions.

Recommended High School Course Work
High school students should take courses in mathematics and physical, social, and computer sciences to prepare for this career field. They should also develop drafting and drawing skills. Electives in electronics, business administration, and computer science will provide valuable background for a successful career in industrial engineering.

Where Do I Find the Job?

Those still in school can interview with employers recruiting on campus and reply to job advertisements. Engineers may also find work through professional engineering associations, advertisements in newspapers, and professional and trade journals. Recommendations by company employees, contacts with employers, and referrals by the present employer are all common ways to find a position.

Direct application to employers remains one of the most effective job search methods. Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search using keywords from the following manufacturing industry names to get a list of private firms and their addresses:

- Aircraft
- Aircraft Engine and Engine Parts
- Bare Printed Circuit Board
- Custom Computer Programming Services
- Electricity & Signal Testing Instruments
- Electromedical Apparatus
- Electronic Connector
- Engineering Services
- Guided Missiles and Space Vehicles
- Industrial Process Variable Instruments
- Other Aircraft Parts and Equipment
- Other Electronic Component
- Search, Detection & Navigation Instrument
- Semiconductor and Related Devices

Search these **yellow page** headings for listings of private firms:

- Engineers-Consulting
- Engineers-Environmental
- Engineers-Industrial
- Engineers-Manufacturing
- Engineers-Petroleum
- Engineers-Pollution Control
- Engineers-Safety
- Engineers-Sanitary

Where Can the Job Lead?

As they gain experience, they may advance to associate and senior level positions. From the senior level, Engineers may advance into project management or production supervision. Industrial Engineers planning careers in management find that obtaining a master's degree in business administration (MBA) is particularly helpful. Industrial engineering education and experience is a solid background for advancement in many kinds of work. Many top level managers and executives across many industries have an industrial engineering background.

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Industrial Engineers

Other Sources of Information

California Board for Professional Engineers and Land Surveyors
www.dca.ca.gov/pels

Institute of Industrial Engineers
www.iienet.org

The American Society of Safety Engineers
www.asse.org

Board of Certified Safety Professionals
www.bcsp.org

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Mechanical Engineers

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What They Do

Mechanical Engineers design, produce, maintain, and improve all kinds of mechanical devices, components, engines, and systems. Examples include transportation equipment, environmental control systems, materials handling systems, machine tools, robots, and automated manufacturing equipment. Mechanical Engineers are also involved with power conversion systems ranging from internal combustion engines to large power-generating stations. They need to know about all forms of energy needed to produce motion or heat—solar, water, wind, and nuclear energy, as well as conventional fuels. The field is diverse, and Mechanical Engineers can work in many different areas including design, testing, manufacturing, sales, or teaching.

Manufacturing Engineers played a very important part in the creation of the mass production factories of the 1920's. Today, U.S. manufacturing industries are turning to cost-saving technologies including automated processing and robotics to improve their competitiveness and productivity. Using computer-aided design (CAD), they are developing new types of automated systems utilizing laser-processing and machining, and advanced sensor and imaging technologies. Mechanical Engineers also design and develop service, or mobile robots, and automated guided vehicles, including space exploration vehicles. Many Mechanical Engineers work in machinery and systems design. Design engineers are mainly concerned with new product development but also upgrade existing designs to achieve desired performance goals.

Mechanical Engineers who work in manufacturing are responsible for all aspects of production, from development or selection of manufacturing methods, to overseeing day-to-day operations on the factory floor. Engineers must be able to design, install, and operate complex manufacturing systems made up of people, materials, robotics, and other automated equipment. Along with this, they develop and monitor preventive maintenance programs. They may work on teams with design and/or test engineers, and often develop the product and the production process concurrently.

Tasks

- Read and interpret blueprints, technical drawings, schematics, and computer-generated reports.
- Confer with engineers and other personnel to implement operating procedures, resolve system malfunctions, and provide technical information.
- Research and analyze customer design proposals, specifications, manuals, and other data to evaluate the feasibility, cost, and maintenance requirements of designs or applications.

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Mechanical Engineers

- Specify system components or direct modification of products to ensure conformance with engineering design and performance specifications.
- Research, design, evaluate, install, operate, and maintain mechanical products, equipment, systems, and processes to meet requirements, applying knowledge of engineering principles.
- Investigate equipment failures and difficulties to diagnose faulty operation and to make recommendations to maintenance crew.
- Assist drafters in developing the structural design of products, using drafting tools or computer-assisted design/drafting equipment and software.
- Provide feedback to design engineers on customer problems and needs.
- Oversee installation, operation, maintenance, and repair to ensure that machines and equipment are installed and functioning according to specifications.
- Conduct research that tests and analyzes the feasibility, design, operation, and performance of equipment, components, and systems.

*Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.*

Important Skills, Knowledge, and Abilities

- Mathematics — Using mathematics to solve problems.
- Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
- Critical thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
- Science — Using scientific rules and methods to solve problems.
- Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.
- Written Comprehension — The ability to read and understand information and ideas presented in writing.
- Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
- Oral Expression — The ability to communicate information and ideas in speaking so others will understand.

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Mechanical Engineers

- Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.
- Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
- Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

Work Environment

Mechanical Engineers are employed in virtually every industry, with most working for manufacturing firms. Although some engineers spend most of their time in temperature controlled, comfortable offices, many jobs require working part of the time in a plant, testing laboratory, machine shop, or installation site. Work schedules are generally 40 hours per week, although occasional project deadlines will require engineers to work overtime. Mechanical Engineers also travel to professional conferences and training sessions to keep abreast of recent advances in the field. Many belong to the American Society of Mechanical Engineers or the National Society of Professional Engineers.

California's Job Outlook and Wages

The California Outlook and Wage table below represents the occupation across all industries.

Standard Occupational Classification	Estimated Number of Workers 2004	Estimated Number of Workers 2014	Average Annual Openings	2006 Wage Range (per hour)
Mechanical Engineers				
17-2141	23,200	26,500	970	$30.11 to $46.38

Wages do not include self-employment.
***Average annual openings** include new jobs plus net replacements.*
Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

A slower-than-average growth is expected for Mechanical Engineers in California through 2014, with slight declines expected in aerospace and some manufacturing. However, an increased need for engineers hired through consulting or temporary agencies is expected to offset the decline. Replacement needs for Mechanical Engineers who retire or leave for other types of work will create the bulk of job opportunities—nearly 640 openings per year. Emerging technologies in the fields of information technology, biotechnology, and nanotechnology will create new job opportunities for Mechanical Engineers, especially those who have knowledge in biology, chemistry, information technology, or other specialties now commonly integrated into engineering projects.

Training/Requirements/Apprenticeships

A bachelor of science in mechanical engineering (BSME) or a related engineering degree is the minimum requirement for most entry-level positions. Some employers prefer a master's degree; others hire only those who have at least two years of experience.

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Mechanical Engineers

Mechanical Engineers who work for manufacturing companies are not required to have a license with the California State Board of Registration for Professional Engineers; however, those who work in engineering firms, are self-employed, or otherwise work outside of manufacturing and use the title Professional Engineer or Mechanical Engineer are required to obtain a license. To become licensed, engineers must have at least a BSME degree, two years of engineering experience, and pass an eight-hour engineering exam. Another path to licensure is to pass the Engineer-in-Training exam and, later, the professional examination in mechanical engineering. Increasingly, experienced Mechanical Engineers are heading back to the classroom to update their skills and add to their knowledge of science, math, or computer science, particularly those who wish to work in fields such as biotechnology and robotics.

Recommended High School Course Work
Important college preparation classes include algebra, geometry, trigonometry, and physics. Courses in mechanical drawing and drafting, computer science, machine shop, and business administration are helpful.

Where Do I Find the Job?

Prior to graduation, students may sign up for interviews with recruiters on campus. Job seekers may also reply to ads in campus, local, or national newspapers and in professional journals. Networking through professional society meetings could also lead to jobs.

Direct application to employers remains one of the most effective job search methods.

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search under the following industry names to get a list of private firms and their addresses:

- Aircraft Engine and Engine Parts
- Aircraft
- Architectural Services
- Electricity & Signal Testing Instruments
- Electromedical Apparatus
- Engineering Services
- Guided Missiles and Space Vehicles
- Industrial Process Variable Instruments
- Landscape Architectural Services
- Other Aircraft Parts and Equipment
- Search, Detection, & Navigation Instruments
- Testing Laboratories

Search these **yellow page** headings for listings of private firms:

- Engineers-Consulting
- Engineers-Foundation
- Engineers-Industrial
- Engineers-Manufacturing
- Engineers-Mechanical
- Engineers-Petroleum
- Engineers-Power

Where Can the Job Lead?

Advancement opportunities exist along a structured career path for Mechanical Engineers. They can advance to a Senior or Supervising Mechanical Engineer within an organization. In some cases, they may advance to managerial positions.

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Mechanical Engineers

There are many job opportunities for existing Mechanical Engineers who want to work in other specialty fields such as biotechnology or robotics. The best candidates for higher paying or more prestigious jobs are those who can demonstrate current knowledge in chemistry, biology, business, computer science, or other fields necessary in today's engineered products.

Other Sources of Information

California Board for Professional Engineers and Land Surveyors
www.dca.ca.gov/pels

American Society of Mechanical Engineers
www.asme.org

California Society of Professional Engineers
www.cspe.com

Junior Engineering Technical Society
www.jets.org

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