Sloan Career Cornerstone Center

Software Engineering Overview

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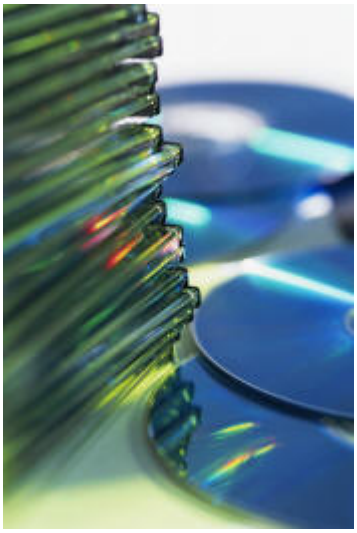
The Field



The explosive impact of computers and information technology on our everyday lives has generated a need to design and develop new computer software systems and to incorporate new technologies into a rapidly growing range of applications. The tasks performed by workers known as computer software engineers evolve quickly, 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. Software engineers working in applications or systems development analyze users' needs and design, construct, test, and maintain computer applications software or systems.

Software engineers can be involved in the design and development of many types of software, including software for operating systems and network distribution, and compilers, which convert programs for execution on a computer. In programming, or coding, software engineers instruct a computer, line by line, how to perform a function. They also solve technical problems that arise. Software engineers must possess strong programming skills, but are more concerned with developing algorithms and analyzing and solving programming problems than with actually writing code.

Specialty Areas

Computer Applications Software Engineers

Computer applications software engineers analyze users' needs and design, construct, and maintain general computer applications software or specialized utility programs. These workers use different programming languages, depending on the purpose of the program. The programming languages most often used are C, C++, and Java, with Fortran and COBOL used less commonly. Some software engineers develop both packaged systems and systems software or create customized applications.

Computer Systems Software Engineers

Computer systems software engineers coordinate the construction and maintenance of a company's computer systems and plan their future growth. Working with the company, they coordinate each department's computer needs -- ordering, inventory, billing, and payroll recordkeeping, for example -- and make suggestions about its technical direction. They also might set up the company's intranets -- networks that link computers within the organization and ease communication among the various departments.

Systems software engineers work for companies that configure, implement, and install complete computer systems. These workers may be members of the marketing or sales staff, serving as the primary technical resource for sales workers and customers. They also may be involved in product sales and in providing their customers with continuing technical support. Since the selling of complex computer systems often requires substantial customization for the purchaser's organization, software engineers help to explain the requirements necessary for installing and operating the new system in the purchaser's computing environment. In addition, systems software engineers are responsible for ensuring security across the systems they are configuring.

Preparation

A bachelor's degree in engineering is required for almost all entry-level engineering jobs. Academic programs in software engineering emphasize software and may be offered as a degree option or in conjunction with computer science degrees. Increasing emphasis on computer security suggests that software engineers with advanced degrees that include mathematics and systems design will be sought after by software developers, government agencies, and consulting firms specializing in information assurance and security.
Persons interested in jobs as computer software engineers must have strong problem-solving and analytical skills. They also must be able to communicate effectively with team members, other staff, and the customers they meet. Because they often deal with a number of tasks simultaneously, they must be able to concentrate and pay close attention to detail.

Admission Requirements

Admissions requirements for undergraduate engineering schools include a solid background in mathematics (algebra, geometry, trigonometry, and calculus) and science (biology, chemistry, and physics), and courses in English, social studies, humanities, and computer and information technology. Bachelor's degree programs in engineering typically are designed to last 4 years, but many students find that it takes between 4 and 5 years to complete their studies.

Co-ops

Internships and Coops provide students with a great opportunity to gain real-world experience while still in school. Students seeking software engineering jobs enhance their employment opportunities by participating in internship or co-op programs offered through their schools. These experiences provide the students with broad knowledge and experience, making them more attractive candidates to employers. Inexperienced college

graduates may be hired by large computer and consulting firms that train new employees in intensive, company-based programs. In many firms, new hires are mentored, and their mentors have an input into the performance evaluations of these new employees. Many universities offer co-op and internship programs for students studying software engineering. Click here for more information.

Courses of Study

In a typical 4-year college curriculum, the first 2 years are spent studying mathematics, basic sciences, introductory engineering, humanities, and social sciences. In the last 2 years, most courses are in engineering, usually with a concentration in one branch. For example, a software engineering program might include courses in digital circuit design, microprocessor systems, data structures and algorithms, organization of programming languages, analysis and design of software systems, software modeling, and software quality assurance and testing.

Ongoing Study

Technological advances come so rapidly in the computer software field that continuous study is necessary to keep one's skills up to date post graduation. Employers, hardware and software vendors, colleges and universities, and private training institutions offer continuing education. Additional training may come from professional development seminars offered by professional computing societies.

Accredited Programs

Those interested in a career in Software Engineering should consider reviewing engineering programs that are accredited by the Accreditation Board for Engineering and Technology, Inc. (ABET). ABET accreditation is based on an evaluation of an engineering program's student achievement, program improvement, faculty, curricular content, facilities, and institutional commitment. The following is a partial list of universities offering accredited degree programs in Software Engineering.

- **Auburn University**
- **Clarkson University**
- **Drexel University**
- **Embry-Riddle Aeronautical University - Daytona Beach**
- **Fairfield University-School of Engineering**
- **Florida Institute of Technology**
- **Milwaukee School of Engineering**
- **Mississippi State University**
- **Monmouth University**
- **Montana Tech of the University of Montana**
- **Pennsylvania State University, Behrend College**
- **Rochester Institute of Technology**
- **Rose-Hulman Institute of Technology**
- **University of Michigan-Dearborn**
- **University of Texas at Arlington**
- **University of Texas at Dallas**
- **University of Wisconsin-Platteville**

Day in the Life

Computer software engineers normally work in well-lighted and comfortable offices or laboratories in which computer equipment is located. Most software engineers work at least 40 hours a week; however, due to the project-oriented nature of the work, they also may have to work evenings or weekends to meet deadlines or solve unexpected technical problems. Like other workers who sit for hours at a computer, typing on a keyboard, software engineers are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome.

Teams and Coworkers

Almost all jobs in engineering require some sort of interaction with coworkers. Computer software engineers often work as part of a team that designs new hardware, software, and systems. A core team may comprise engineering, marketing, manufacturing, and design people, who work together until the product is released. Whether they are working in a team situation, or just asking for advice, most engineers have to have the ability to communicate and work with other people. Engineers should be creative, inquisitive, analytical, and detail-oriented. They should be able to work as part of a team and to communicate well, both orally and in writing. Communication abilities are important because engineers often interact with specialists in a wide range of fields outside engineering. Writing and presentation skills are also vital so engineers can share their research and experiences with colleagues through topical meetings, professional associations, and various publications.

Tasks

Computer engineers work on hardware, software and the interface between the two. They work in teams with other engineers and others from other areas to design, build, and maintain systems that incorporate or use computers. Working as a computer engineer requires expertise in both computer hardware and software, and requires the engineer to be able to recommend tradeoffs between hardware and software to create a system or product design that is cost effective and useful.

The Workplace

Software engineers usually work in offices or laboratories in comfortable surroundings. They usually work about 40 hours a week -- the same as many other professional or office workers do. As they strive to improve software for users, many computer software engineers interact with customers and coworkers. Computer software engineers who are employed by software vendors and consulting firms, for example, 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. As networks expand, 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, connecting to a customer's computer remotely to identify and correct developing problems.

Earnings

Earnings for engineers vary significantly by specialty, industry, and education. Even so, as a group, engineers earn some of the highest average starting salaries among those holding bachelor's degrees.

Salary Data

Median annual earnings of wage-and-salary computer applications software engineers were $79,780. The middle 50 percent earned between $62,830 and $98,470. The lowest 10 percent earned less than $49,350, and the highest 10 percent earned more than $119,770. Median annual earnings in the industries employing the largest numbers of computer applications software engineers are as follows:

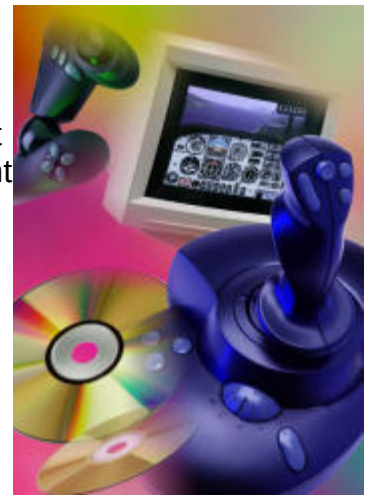
Software publishers	$84,560
Computer systems design and related services	$78,850
Management, scientific, and technical consulting services	$78,850
Management of companies and enterprises	$78,580
Insurance carriers	$74,230

Median annual earnings of wage-and-salary computer systems software engineers were $85,370. The middle 50 percent earned between $67,620 and $105,330. The lowest 10 percent earned less than $53,580, and the highest 10 percent earned more than $125,750. Median annual earnings in the industries employing the largest numbers of computer systems software engineers are as follows:

Research and development in the physical, engineering, and life sciences	$97,220
Scientific research and development services	$97,180
Computer and peripheral equipment manufacturing	$93,240
Software publishers	$87,450
Computer systems design and related services	$84,660
Data processing, hosting, and related services	$78,270

According to Robert Half Technology, starting salaries for software engineers in software development ranged from $66,500 to $99,750 in 2007. For network engineers, starting salaries ranged from $65,750 to $90,250.

Employment



Computer software engineers hold about 857,000 jobs in the United States. Approximately 507,000 were computer applications software engineers, and about 350,000 were computer systems software engineers. Although they are employed in most industries, the largest concentration of computer software engineers -- more than 29 percent -- is in computer systems design and related services.

Many computer software engineers also work for establishments in other industries, such as software publishers, government agencies, manufacturers of computers and related electronic equipment, financial institutions, insurance providers, and management of companies and enterprises.

An increasing number of computer software engineers work as independent consultants on a temporary or contract basis, many of whom are self-employed. About 17,000 computer software engineers are self-employed.

Employers of computer software engineers range from startup companies to established industry leaders. The proliferation of Internet, e-mail, and other communications systems is expanding electronics to engineering firms that are traditionally associated with unrelated disciplines. Engineering firms specializing in building bridges and power plants, for example, hire computer software engineers to design and develop new geographic data systems and automated drafting systems.

Communications firms need computer software engineers to tap into growth in the personal communications market. Major communications companies have many job openings for both computer software applications engineers and computer systems engineers.

As is the case with most occupations, advancement opportunities for computer software engineers increase with experience. Entry-level computer software engineers are likely to test and verify ongoing designs. As they become more experienced, they may become involved in designing and developing software. Eventually, they may advance to become a project manager, manager of information systems, or chief information officer. Some computer software engineers with several years of experience or expertise find lucrative opportunities working as systems designers or independent consultants or starting their own computer consulting firms.

The following is a partial list of employers of computer software engineers:

Technology Intensive Firms

- Apple Computer
- AT&T
- Cisco Systems
- Dell
- Fujitsu Siemens Computers
- Google
- Hewlett-Packard
- IBM
- Intel
- Iomega
- Microsoft
- Motorola
- Oracle
- Panasonic
- Peoplesoft (Oracle)
- Raytheon Company
- Sony Electronics
- Sun Microsystems
- Texas Instruments
- Toshiba
- Verizon
- Yahoo

U.S. Federal Government and State and Local Affiliates

- Federal Bureau of Investigation
- Federal Emergency Management Agency
- NASA
- National Institute of Standards and Technology
- US Air Force
- US Army
- US Central Intelligence Agency
- US Department of Energy
- US Department of Defense
- US Department of Transportation
- US Naval Research Lab
- US Navy

Other Firms

- 3M Worldwide
- Adelphia Communications
- ADT
- Advanced Micro Systems
- Alcatel
- Alcoa
- Ansys
- Applied Digital
- Blackberry
- BMW International
- Boeing
- Delphi-Packard Electric
- Toyota Motor Sales, USA, Inc.
- Federal Express
- Ford
- Genentech
- General Dynamics
- General Electric
- General Motors Corporation
- Honda
- Honeywell
- Hughes Network Systems
- Johnson & Johnson
- Lockheed Martin
- Meade Instruments Corporation
- Merrill Lynch & Co.
- New Piper Aircraft
- Nuance Communications, Inc.
- Procter & Gamble Company
- Samsung
- Siemens Automotive Corporation
- Toyota Motor Sales, Inc.
- UPS
- Westinghouse

Other Employers

- Colleges and Universities
- K-12 Schools
- Professional Associations
- Temporary Firms
- Consultants

Career Path Forecast

According to the U.S. Department of Labor, Bureau of Labor Statistics, employment of computer software engineers is projected to increase by 38 percent over the 2006 to 2016 period, which is much faster than the average for all occupations. This occupation will generate about 324,000 new jobs, over the projections decade, one of the largest employment increases of any occupation.

Employment growth will result as businesses and other organizations adopt and integrate new technologies and seek to maximize the efficiency of their computer systems. Competition among businesses will continue to create incentive for sophisticated technological innovations, and organizations will need more computer software engineers to implement these changes.

Demand for computer software engineers will also increase as computer networking continues to grow. For example, expanding Internet technologies have spurred demand for computer software engineers who can develop Internet, intranet, and World Wide Web applications. Likewise, electronic data-processing systems in business, telecommunications, government, and other settings continue to become more sophisticated and complex. Implementing, safeguarding, and updating computer systems and resolving problems will fuel the demand for growing numbers of systems software engineers.

New growth areas will also continue to arise from rapidly evolving technologies. The increasing uses of the Internet, the proliferation of Web sites, and mobile technology such as wireless Internet have created a demand for a wide variety of new products. As individuals and businesses rely more on hand-held computers and wireless networks, it will be necessary to integrate current computer systems with this new, more mobile technology.

In addition, information security concerns have given rise to new software needs. Concerns over “cyber security” should result in businesses and government continuing to invest heavily in software that protects their networks and vital electronic infrastructure from attack. The expansion of this technology in the next 10 years will lead to an increased need for computer engineers to design and develop the software and systems to run these new applications and integrate them into older systems.

As with other information technology jobs, outsourcing of software development to other countries may temper somewhat employment growth of computer software engineers. Firms may look to cut costs by shifting operations to foreign countries with lower prevailing wages and highly educated workers. Jobs in software engineering are less prone to being offshored than are jobs in other computer specialties, however, because software engineering requires innovation and intense research and development.

As a result of rapid employment growth over the 2006 to 2016 decade, job prospects for computer software engineers should be excellent. Those with practical experience and at least a bachelor’s degree in computer engineering or computer science should have the best opportunities. Employers will continue to seek computer professionals with strong programming, systems analysis, interpersonal, and business skills. In addition to jobs created through employment growth, many job openings will result from the need to replace workers who move into managerial positions, transfer to other occupations, or leave the labor force. Consulting opportunities for computer software engineers also should continue to grow as businesses seek help to manage, upgrade, and customize their increasingly **complicated computer systems.**

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Professional Organizations

Professional organizations and associations provide a wide range of resources for planning and navigating a career in software engineering. These groups can play a key role in your development and keep you abreast of what is happening in your industry.

Associations promote the interests of their members and provide a network of contacts that can help you find jobs and move your career forward. They can offer a variety of services including job referral services, continuing education courses, insurance, travel benefits, periodicals, and meeting and conference opportunities. A broader list of professional associations is also available at www.careercornerstone.org.

Association for Computing Machinery (www.acm.org)
ACM is the world's oldest and largest educational and scientific computing society. Since 1947 ACM has provided a vital forum for the exchange of information, ideas, and discoveries. Today, ACM serves a membership of computing professionals and students in more than 100 countries in all areas of industry, academia, and government.

Association for Women in Computing (www.awc-hq.org)
The Association for Women in Computing is a non-profit professional organization for women and men who have an interest in information and technology.

IEEE Computer Society (www.computer.org)
With nearly 100,000 members, the IEEE Computer Society is the world's leading organization of computer professionals. Founded in 1946, it is the largest of the 39 societies of the IEEE.

Software Engineering Association (http://sea.co.umist.ac.uk)
The Software Engineering Association (SEA) is an informal grouping of academic and practitioners working in the area of software engineering. SEA exists to promote and foster software engineering research, practice and education in the UK and internationally.