Computer

engineers

They're the binary bosses who dream up new computer hardware, software, and systems, making yesterday's science fiction today's fact. Without them, our computerized window on the world would be a vacant screen.

by Roger Moncarz

Who designs the increasingly complex computer chips that power new technology? Who develops the software that enables computers to perform their many applications?

Workers known as computer engineers perform these and other tasks related to creating and maintaining computer hardware, software, and systems. The Bureau of Labor Statistics (BLS) expects computer engineer to be the fastest growing occupation over the next decade.

Computers and their applications have become invaluable tools of our everyday lives. From e-mail to retail, computers make people's lives easier. If you think you want computers to be your life's work, keep reading. You'll learn more about computer engineers, including their jobs, employment outlook, earnings, and training.

Nature of the work

Computer engineers design, develop, test, and evaluate computer hardware and related equipment, software programs, and systems. They apply computer science, engineering, and mathematical analysis in designing hardware, software, and networks. They also solve technical problems.

One of the goals of computer engineering is to plan and produce computing devices that function efficiently and economically. Computer 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.

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Computer hardware engineers. Hardware engineers usually design, develop, and test computer hardware and supervise its manufacture and installation. Hardware refers to computer chips, circuit boards, computer systems, and related equipment such as keyboards, modems, and printers.

Although their work emphasizes applying theory, computer engineers often use Computer Aided Design (CAD) and testing to produce and analyze designs for computer chips, circuit boards, and other components. For example, they use CAD to create digital models of objects that can then be manipulated by computer. They might also use CAD to create complete prototypes of designs.

Hardware engineers develop improved designs and products that incorporate state-of-the-art technology. They are continually asked to design computer chips with greater capacity and power to handle the many tasks computers perform.

Computer software engineers. Software engineers design, develop, and test many types of software, including software for operating systems, network distribution, and compilers, which convert programs for faster processing. In programming, or coding, software engineers instruct a computer, line by line, how to perform a function.

Software engineers working on applications development analyze users' needs and design, create, and modify applications software or specialized programs. These engineers also have strong programming skills, but they concentrate on analyzing and solving problems. The programming languages most often used are C, C++, and Java, with Fortran and Cobol used less commonly. Some software engineers develop both

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packaged systems and systems software or create customized applications.

Computer systems engineers. Systems engineers work for companies that configure, implement, and install complete computer systems. They may be members of the marketing or sales staff, where they serve as the primary technical resource for salesworkers and customers. They also may be involved in product sales and in providing their customers with continuing technical support.

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

In the current job market for computer professionals, the term "engineer" is sometimes used loosely. Thus, some industry experts maintain that the job titles "systems engineer," as defined above, and "systems analyst" are interchangeable. And some of the occupational and training information about systems

engineers described in this article may be similar to those experts' perceptions of systems analysts. However, BLS defines systems analyst as a separate occupation that is less technical in scope. BLS data on employment, outlook, and earnings for systems analysts are not included in this article.

Working conditions

Computer engineers usually work in well lit, comfortable offices or computer laboratories. Every computer engineer uses a computer, and many also use other equipment such as logic analyzers.

Most computer engineers work about 40 hours a week but may also have to work evenings or weekends to meet deadlines or solve unexpected technical problems. And like other workers who sit for hours at a computer typing on a keyboard, computer engineers are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome.

Many computer engineers also interact with customers and coworkers as they strive to improve hardware and software for users. For example, engineers employed by computer vendors and consulting firms spend much of their time away from the office, frequently traveling overnight, to meet with customers. They call on customers in businesses ranging from manufacturing plants to financial institutions.

As networks expand, computer 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.

Employment and outlook

Computer engineers held about 299,000 jobs in 1998. Although they are increasingly employed in most industries, computer engineers are concentrated primarily in the computer and data processing services industry. This industry includes firms that develop and produce prepackaged software and firms that provide contractual computer services such as computer programming, systems integration, and information retrieval, including online databases and Internet services. Many computer engineers work in other industries, such as government agencies, manufacturers of computers and related electronic equipment, and colleges and universities.

Employers of computer engineers range from startup companies to established industry leaders. The proliferation of Internet, e-mail, and other communications systems expands electronics to engineering houses traditionally associated with unrelated disciplines. Engineering firms specializing in building bridges and power plants, for example, hire computer engineers to make use of new geographic data systems and automated drafting capabilities. Communications firms need computer

engineers to tap into growth in the personal communications market. Major communications companies have many job openings for both computer hardware and software engineers.

An increasing number of computer engineers are employed as temporary or contract workers—including many who are self-employed as consultants. Some consultants work for firms that specialize in developing and maintaining client companies' websites and intranets. Consulting opportunities for computer engineers should grow as businesses need help managing, upgrading, and customizing increasingly complex systems.

BLS projects that computer engineers will grow faster than any other occupation between 1998 and 2008. Rapid employment growth in the computer and data processing services industry, which employs the greatest numbers of computer engineers, should result in favorable opportunities for those who qualify for computer engineering jobs.

Employment of computer engineers is expected to increase as businesses and other organizations continue to integrate new technologies and streamline their computer systems. More computer engineers will be needed to implement technological changes as innovations become more sophisticated. In addition to job openings arising from employment growth, thousands of openings will result annually from the need to replace workers who move into managerial positions, transfer to other occupations, or leave the labor force.

One of the emerging specialties in computer engineering is robotics, which will continue to increase in importance in the years ahead. Hardware engineers are designing more advanced robotic devices, while software engineers develop the programs to direct them.

Demand for computer engineers will increase as computer networking continues to grow. For example, the expanding integration of Internet technologies and the explosive growth in electronic commerce—doing business on the World Wide Web—have resulted in rising demand for computer engineers who can develop Internet, intranet, and other Web applications. Likewise, expanding electronic data processing systems in business, telecommunications, government, and other settings continue to become more sophisticated and complex. Growing numbers of systems engineers will be needed to implement, safeguard, and update systems and resolve problems.

Employers will continue to seek computer professionals with strong programming, systems analysis, interpersonal, and business skills. Favorable employment prospects are expected for people who have at least a computer-related bachelor's degree and practical experience working with computers. If the supply of computer-related degree holders does not keep pace with the demand for computer engineers, skilled persons who lack degrees should still be able to enter computer engineer jobs. However, they must have work experience demonstrating
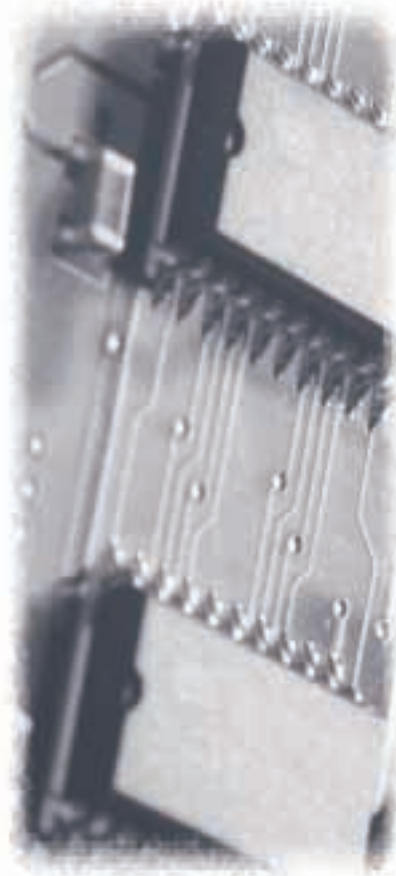
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these skills. (See the "Qualifications, training, and advancement" section below for more discussion of training requirements.)

Earnings

BLS data show full-time computer engineers earned a median salary of nearly $62,000 in 1998. The middle 50 percent earned between $46,240 and $80,500, the lowest 10 percent earned less than $37,150, and the highest 10 percent earned more than $92,850.

Computer engineers with a bachelor's degree have higher starting salaries than do bachelor's degree graduates in many other fields. According to a National Association of Colleges and Employers survey, July starting salary offers for computer engineering graduates with a bachelor's degree averaged about $49,505, compared to the $29,845 offered to bachelor's degree graduates in English. (For salary offers in other fields, see "Higher salaries for recent grads" in the Grab Bag, page 27.)

The Association surveys also found that master's degree graduates in computer engineering received starting salary offers of $58,700 in 1999, the most recent year for which reliable data are available.

According to Robert Half International, a specialized staffing

tion with electrical or electronics engineering degrees. As a result, graduates of computer engineering programs often find jobs designing and developing hardware or related equipment.

Academic programs in software engineering emphasize software and may be offered as a degree option or in conjunction with computer science degrees. Students seeking software engineering jobs enhance their employment opportunities by participating in internship or co-op programs offered through their schools. These experiences provide 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 hires in intensive, company-based programs. In many firms, mentoring has become part of the evaluation process for new employees.

For systems engineering jobs that require workers who have a college degree, a bachelor's in computer science or computer information systems is typical. For systems engineering jobs that place less emphasis on workers having a computer-related degree, there are several computer training programs offered by systems software vendors, including Microsoft, Novell, and Oracle. These training programs usually last from 1 to 4 weeks but are not required in order to sit for a certification exam; several study guides are also available to help prepare for the exams. However, many training authorities feel that program certification alone is not sufficient for most computer engineering jobs.

Professional certification is offered by the Institute for Certification of Computing Professionals. This voluntary certification is available to those who have a college degree and at least 2 years of experience. Candidates must pass an examination covering general knowledge and two specialty areas or one specialty area and two computer programming languages. In addition, the Institute of Electrical and Electronics Engineers Computer Society recently announced plans to certify software engineers who pass an examination.

As is the case with most occupations, advancement opportunities for computer engineers increase with experience. Entry-level computer engineers are likely to test and verify ongoing designs. As they become more experienced, computer engineers may design hardware and software. They eventually may advance to become a project manager, manager of information systems, or chief information officer. Some computer 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.

As technological advances continue, computer engineers must continually update their skills. To assist them, continuing education and professional development seminars are offered by employers, hardware and software vendors, colleges and universities, private training institutions, and professional computing societies.

services firm, 1999 starting salaries for software engineers in software development ranged from $55,000 to $80,000.

Computer engineers usually receive standard benefits such as paid vacations and holidays, medical insurance, and pension plans. Additional benefits may include profitsharing, stock options, and a company car and mileage allowance.

Qualifications, training, and advancement

Computer engineers must have strong problemsolving and analytical skills. They also must be able to communicate effectively with team members, other staff, and the customers they meet. And because they often deal with a number of tasks simultaneously, computer engineers must be able to concentrate and pay attention to detail.

Most employers prefer to hire persons who have at least a bachelor's degree. Usual bachelor's degree concentrations for hardware engineers are computer engineering or electrical engineering; for software engineers, computer science or software engineering; and for systems engineers, computer science or computer information systems. Employers prefer candidates with graduate degrees for more complex jobs.

Academic programs in computer engineering emphasize hardware and may be offered as a degree option or in conjunc-

Sources of additional information

Your local library has information about computer engineering careers and the computer industry. Additional information on a career in computer engineering is available from:

Association for Computing Machinery (ACM)
1515 Broadway
New York, NY 10036-5701
(212) 869-7440
http://www.acm.org

Institute of Electrical and Electronics Engineers—United
  States of America
1828 L St., NW., Suite 1202
Washington, DC 20036-5104
(202) 785-0017
http://www.ieee.org

IEEE Computer Society
Headquarters Office
1730 Massachusetts Ave., NW.
Washington, DC 20036-1992
(202) 371-0101
http://www.computer.org

NorthWest Center for Emerging Technologies
3000 Landerholm Circle SE., N258
Bellevue, WA 98007
(425) 564-4215
http://www.nwcet.org

Further information about the designation Certified Computing Professional is available from:

Institute for Certification of Computer Professionals (ICCP)
2200 E. Devon Ave., Suite 247
Des Plaines, IL 60018
1 (800) U-GET-CCP (843-8227)
(847) 229-4227
http://www.iccp.org

For information on training leading to Microsoft certifications, contact:

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
1 (800) 636-7544
http://www.microsoft.com/train_cert

Information on training leading to Oracle certifications is available from:
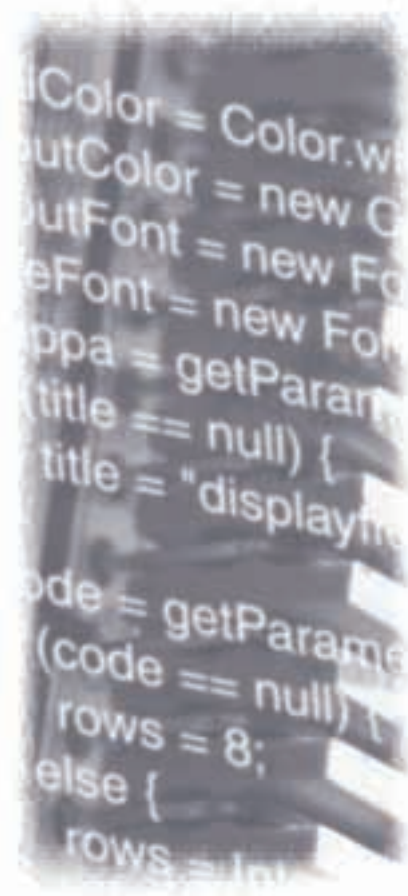
Persons without computer-related degrees may complete one of several training programs offered by systems software vendors.

Oracle Corporation
500 Oracle Parkway
Redwood Shores, CA 94065
1 (800) 529-0165
http://education.oracle.com/certification

For information on training leading to Cisco certifications, contact:

Cisco Systems, Inc.
170 W. Tasman Dr.
San Jose, CA 95134
1 (800) 829-6387
http://www.cisco.com/warp/public/10/wwtraining

Information on training leading to Novell certifications is available from:

Novell, Inc.
2211 N. First St.
San Jose, CA 95131
(800) 233-3382
http://education.novell.com/certinfo   OOQ