opportunities developing statistical software for computer software manufacturing firms.

Business firms will rely heavily on workers with a background in statistics to forecast sales, analyze business conditions, and help solve management problems in order to maximize profits. In addition, consulting firms increasingly will offer sophisticated statistical services to other businesses. Because of the widespread use of computers in this field, statisticians in all industries should have good computer programming skills and knowledge of statistical software.

Earnings

Median annual earnings of statisticians were $51,990 in 2000. The middle 50 percent earned between $37,160 and $69,220. The lowest 10 percent had earnings of less than $28,430, while the highest 10 percent earned more than $86,660.

The average annual salary for statisticians in the Federal Government in nonsupervisory, supervisory, and managerial positions was $68,900 in 2001, while mathematical statisticians averaged $76,530. According to a 2001 survey by the National Association of Colleges and Employers, starting salary offers for mathematics/statistics graduates with a bachelor's degree averaged $46,466 a year.

Related Occupations

People in numerous occupations work with statistics. Among these are actuaries; mathematicians; operations research analysts; systems analysts, computer scientists, and database administrators; computer programmers; computer software engineers; engineers; economists and market and survey researchers; financial analysts and personal financial advisors; and life, physical, and social science occupations.

Sources of Additional Information

For information about career opportunities in statistics, contact:
➤ American Statistical Association, 1429 Duke St., Alexandria, VA 22314. Internet: **http://www.amstat.org**

For more information on doctoral-level careers and training in mathematics, a field closely related to statistics, contact:
➤ American Mathematical Society, 201 Charles St., Providence, RI 02940. Internet: **http://www.ams.org**

Information on obtaining a statistician position with the Federal Government is available from the Office of Personnel Management (OPM) through a telephone-based system. Consult your telephone directory under U.S. Government for a local number or call (912) 757-3000; Federal Relay Service: (800) 877-8339. The first number is not tollfree, and charges may result. Information also is available from the OPM Internet site: **http://www.usajobs.opm.gov**.

Systems Analysts, Computer Scientists, and Database Administrators

(O*NET 15-1011.00, 15-1051.00, 15-1061.00, 15-1081.00, 15-1099.99)

Significant Points

- As computer applications expand, systems analysts, computer scientists, and database administrators are projected to be the among the fastest growing occupations.

- Relevant work experience and a bachelor's degree are prerequisites for many jobs; for more complex jobs, a graduate degree is preferred.

Nature of the Work

The rapid spread of computers and information technology has generated a need for highly trained workers to design and develop new hardware and software systems and to incorporate new technologies. These workers—computer systems analysts, computer scientists, and database administrators—include a wide range of computer specialists. Job tasks and occupational titles used to describe these workers evolve rapidly, reflecting new areas of specialization or changes in technology, as well as the preferences and practices of employers.

Systems analysts solve computer problems and enable computer technology to meet individual needs of an organization. They help an organization realize the maximum benefit from its investment in equipment, personnel, and business processes. This process may include planning and developing new computer systems or devising ways to apply existing systems' resources to additional operations. Systems analysts may design new systems, including both hardware and software, or add a new software application to harness more of the computer's power. Most systems analysts work with a specific type of system that varies with the type of organization they work for—for example, business, accounting, or financial systems, or scientific and engineering systems. Some systems analysts also are referred to as *systems developers* or *systems architects*.

Analysts begin an assignment by discussing the systems problem with managers and users to determine its exact nature. They define the goals of the system and divide the solutions into individual steps and separate procedures. Analysts use techniques such as structured analysis, data modeling, information engineering, mathematical model building, sampling, and cost accounting to plan the system. They specify the inputs to be accessed by the system, design the processing steps, and format the output to meet the users' needs. They also may prepare cost-benefit and return-on-investment analyses to help management decide whether implementing the proposed system will be financially feasible.

When a system is accepted, analysts determine what computer hardware and software will be needed to set it up. They coordinate tests and observe initial use of the system to ensure it performs as planned. They prepare specifications, work diagrams, and structure charts for computer programmers to follow and then work with them to "debug," or eliminate errors from, the system. Analysts, who do more in-depth testing of products, may be referred to as *software quality assurance analysts*. In addition to running tests, these individuals diagnose problems, recommend solutions, and determine if program requirements have been met.

In some organizations, *programmer-analysts* design and update the software that runs a computer. Because they are responsible for both programming and systems analysis, these workers must be proficient in both areas. (A separate statement on computer programmers appears elsewhere in the *Handbook*.) As this becomes more commonplace, these analysts increasingly work with object-oriented programming languages, as well as client/server applications development, and multimedia and Internet technology.

One obstacle associated with expanding computer use is the need for different computer systems to communicate with each other. Because of the importance of maintaining up-to-date information—accounting records, sales figures, or budget projections, for example—systems analysts work on making the computer systems within an organization compatible so that information can be shared. Many systems analysts are involved with "networking," connecting all the computers internally—in an individual office, department, or establishment—or externally, because many organizations now rely on e-mail or the Internet. A primary goal of

networking is to allow users to retrieve data and information from a mainframe computer or a server and use it on their machine. Analysts must design the hardware and software to allow free exchange of data, custom applications, and the computer power to process it all.

Networks come in many variations and *network systems and data communications analysts* analyze, design, test, and evaluate systems such as local area networks (LAN), wide area networks (WAN), Internet, Intranets, and other data communications systems. These analysts perform network modeling, analysis and planning; they also may research related products and make necessary hardware and software recommendations. *Telecommunications specialists* focus on the interaction between computer and communications equipment.

The growth of the Internet and expansion of the World Wide Web, the graphical portion of the Internet, have generated a variety of occupations related to design, development, and maintenance of Web sites and their servers. For example, *webmasters* are responsible for all technical aspects of a website, including performance issues such as speed of access, and for approving site content. *Internet developers* or w*eb developers*, also called *web designers*, are responsible for day-to-day site design and creation.

Computer scientists work as theorists, researchers, or inventors. Their jobs are distinguished by the higher level of theoretical expertise and innovation they apply to complex problems and the creation or application of new technology. Those employed by academic institutions work in areas ranging from complexity theory, to hardware, to programming language design. Some work on multidisciplinary projects, such as developing and advancing uses of virtual reality, in human-computer interaction, or in robotics. Their counterparts in private industry work in areas such as applying theory, developing specialized languages or information technologies, or designing programming tools, knowledge-based systems, or even computer games.

With the Internet and electronic business creating tremendous volumes of data, there is growing need to be able to store, manage, and extract data effectively. *Database administrators* work with database management systems software and determine ways to organize and store data. They determine user requirements, set up computer databases, and test and coordinate changes. It is the responsibility of an organization's database administrator to ensure performance, understand the platform the database runs on, and add new users. Because they also may design and implement system
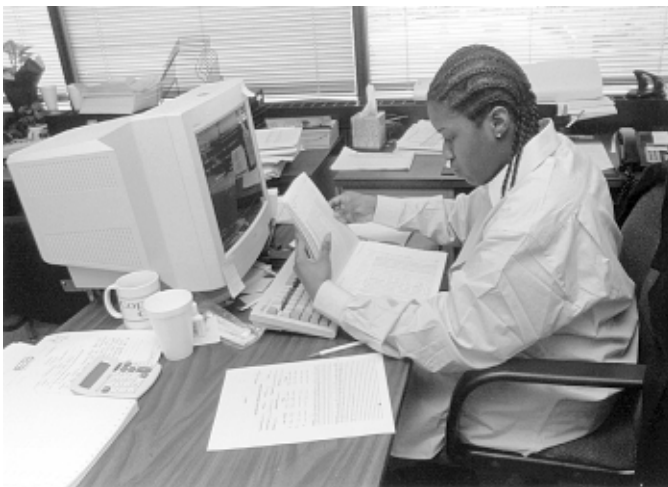
Systems analysts ensure that organizations get the maximum benefit from available technology.

security, database administrators often plan and coordinate security measures. With the volume of sensitive data generated every second growing rapidly, data integrity, backup, and keeping databases secure have become an increasingly important aspect of the job for database administrators.

Working Conditions
Systems analysts, computer scientists, and database administrators normally 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. However, evening or weekend work may be necessary to meet deadlines or solve specific problems. Given the technology available today, telecommuting is common for computer professionals. As networks expand, more work can be done from remote locations using modems, laptops, electronic mail, and the Internet.

Like other workers who spend long periods in front of a computer terminal typing on a keyboard, they are susceptible to eye strain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome or cumulative trauma disorder.

Employment
Systems analysts, computer scientists, and database administrators held about 887,000 jobs in 2000, including about 71,000 who were self-employed. Employment was distributed among the following detailed occupations:

Computer system analysts	431,000
Network systems and data communications analysts	119,000
Database administrators	106,000
Computer and information scientists, research	28,000
All other computer specialists	203,000

Although they are increasingly employed in every sector of the economy, the greatest concentration of these workers is in the computer and data processing services industry. Firms in this industry provide nearly every service related to commercial computer use on a contract basis. Services include systems integration, networking, and reengineering; data processing and preparation; information retrieval, including on-line databases and Internet; onsite computer facilities management; development and management of databases; and a variety of specialized consulting. Many systems analysts, computer scientists, and database administrators work for other employers, such as government, manufacturers of computer and related electronic equipment, insurance companies, financial institutions, and universities.

A growing number of computer specialists, such as systems analysts and network and data communications analysts, are employed on a temporary or contract basis—many of whom are self-employed, working independently as contractors or self-employed consultants. For example, a company installing a new computer system may need the services of several systems analysts just to get the system running. Because not all of them would be needed once the system is functioning, the company might contract with systems analysts or a temporary help agency or consulting firm. Such jobs may last from several months up to 2 years or more. This growing practice enables companies to bring in people with the exact skills they need to complete a particular project, rather than having to spend time or money training or retraining existing workers. Often, experienced consultants then train a company's in-house staff as a project develops.

Training, Other Qualifications, and Advancement
Rapidly changing technology means an increasing level of skill and education demanded by employers. Companies are looking

for professionals with a broader background and range of skills, including not only technical knowledge, but also communication and other interpersonal skills. This shift from requiring workers to possess solely sound technical knowledge emphasizes workers who can handle various responsibilities. While there is no universally accepted way to prepare for a job as a systems analyst, computer scientist, or database administrator, most employers place a premium on some formal college education. A bachelor's degree is a prerequisite for many jobs; however, some jobs may require only a 2-year degree. Relevant work experience also is very important. For more technically complex jobs, persons with graduate degrees are preferred.

For systems analyst, programmer-analyst, as well as database administrator positions, many employers seek applicants who have a bachelor's degree in computer science, information science, or management information systems (MIS). MIS programs usually are part of the business school or college. These programs differ considerably from computer science programs, emphasizing business and management-oriented coursework and business computing courses. Many employers increasingly seek individuals with a master's degree in business administration (MBA) with a concentration in information systems, as more firms move their business to the Internet. For some networks systems and data communication analysts, such as webmasters, an associate degree or certificate generally is sufficient, although more advanced positions might require a computer-related bachelor's degree. For computer and information scientists, a doctoral degree generally is required due to the highly technical nature of their work.

Despite the preference towards technical degrees, persons with degrees in a variety of majors find employment in these computer occupations. The level of education and type of training employers require depend on their needs. One factor affecting these needs is changes in technology. As demonstrated by the current demand for workers with skills related to the Internet, employers often scramble to find workers capable of implementing "hot" new technologies. Another factor driving employers' needs is the time frame in which a project must be completed.

Most community colleges and many independent technical institutes and proprietary schools offer an associate degree in computer science or a related information technology field. Many of these programs may be more geared toward meeting the needs of local businesses and are more occupation-specific than those designed for a 4-year degree. Some jobs may be better suited to the level of training these programs offer. Employers usually look for people who have broad knowledge and experience related to computer systems and technologies, strong problem-solving and analytical skills, and good interpersonal skills. Courses in computer science or systems design offer good preparation for a job in these computer occupations. For jobs in a business environment, employers usually want systems analysts to have business management or closely related skills, while a background in the physical sciences, applied mathematics, or engineering is preferred for work in scientifically oriented organizations. Art or graphic design skills may be desirable for webmasters or Web developers.

Jobseekers can enhance their employment opportunities by participating in internship or co-op programs offered through their schools. Because many people develop advanced computer skills in one occupation and then transfer those skills into a computer occupation, a related background in the industry in which the job is located, such as financial services, banking, or accounting, can be important. Others have taken computer science courses to supplement their study in fields such as accounting, inventory control, or other business areas. For example, a financial analyst proficient in

computers might become a systems analyst or computer support specialist in financial systems development, while a computer programmer might move into a systems analyst job.

Systems analysts, computer scientists, and database administrators must be able to think logically and have good communication skills. They often deal with a number of tasks simultaneously; the ability to concentrate and pay close attention to detail is important. Although these computer specialists sometimes work independently, they often work in teams on large projects. They must be able to communicate effectively with computer personnel, such as programmers and managers, as well as with users or other staff who may have no technical computer background.

Computer scientists employed in private industry may advance into managerial or project leadership positions. Those employed in academic institutions can become heads of research departments or published authorities in their field. Systems analysts may be promoted to senior or lead systems analyst. Those who show leadership ability also can become project managers or advance into management positions such as manager of information systems or chief information officer. Database administrators also may advance into managerial positions such as chief technology officer, based on their experience managing data and enforcing security. Computer specialists with work experience and considerable expertise in a particular subject area or application may find lucrative opportunities as independent consultants or choose to start their own computer consulting firms.

Technological advances come so rapidly in the computer field that continuous study is necessary to keep skills up to date. 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.

Technical or professional certification is a way to demonstrate a level of competency or quality in a particular field. Product vendors or software firms also offer certification and may require professionals who work with their products to be certified. Many employers regard these certifications as the industry standard. For example, one method of acquiring enough knowledge to get a job as a database administrator is to become certified in a specific type of database management. Voluntary certification also is available through other organizations. Professional certification may provide a job seeker a competitive advantage.

Job Outlook

Systems analysts, computers scientists, and database administrators are expected to be the among the fastest growing occupations through 2010. Employment of these computer specialists is expected to increase much faster than the average for all occupations as organizations continue to adopt and integrate increasingly sophisticated technologies. Growth will be driven by very rapid growth in computer and data processing services, which is projected to be the fastest growing industry in the U.S. economy. In addition, many job openings will arise annually from the need to replace workers who move into managerial positions or other occupations or who leave the labor force.

The demand for networking to facilitate the sharing of information, the expansion of client/server environments, and the need for computer specialists to use their knowledge and skills in a problem-solving capacity will be major factors in the rising demand for systems analysts, computer scientists, and database administrators. Moreover, falling prices of computer hardware and software should continue to induce more businesses to expand computerized operations and integrate new technologies. In order to maintain a competitive edge and operate more efficiently, firms will continue to

demand computer specialists who are knowledgeable about the latest technologies and are able to apply them to meet the needs of businesses.

Increasingly, more sophisticated and complex technology is being implemented across all organizations, which should fuel the demand for these computer occupations. There is a growing demand for system analysts to help firms maximize their efficiency using available technology. The explosive growth in electronic commerce—doing business on the Internet—and the continuing need to build and maintain databases that store critical information on customers, inventory, and projects is fueling demand for database administrators familiar with the latest technology.

The development of new technologies usually leads to demand for various workers. The expanding integration of Internet technologies by businesses, for example, has resulted in a growing need for specialists who can develop and support Internet and intranet applications. The growth of electronic commerce means more establishments use the Internet to conduct their business online. This translates into a need for information technology professionals who can help organizations use technology to communicate with employees, clients, and consumers. Explosive growth in these areas also is expected to fuel demand for specialists knowledgeable about network, data, and communications security.

As technology becomes more sophisticated and complex, employers demand a higher level of skill and expertise. Individuals with an advanced degree in computer science, computer engineering, or an MBA with a concentration in information systems should enjoy very favorable employment prospects. College graduates with a bachelor's degree in computer science, computer engineering, information science, or management information systems also should enjoy favorable prospects for employment, particularly if they have supplemented their formal education with practical experience. Because employers continue to seek computer specialists who can combine strong technical skills with good interpersonal and business skills, graduates with non-computer science degrees but who have had courses in computer programming, systems analysis, and other information technology areas, also should continue to find jobs in these computer fields. In fact, individuals with the right experience and training can work in these computer occupations regardless of their college major or level of formal education.

Earnings

Median annual earnings of computer systems analysts were $59,330 in 2000. The middle 50 percent earned between $46,980 and $73,210 a year. The lowest 10 percent earned less than $37,460, and the highest 10 percent earned more than $89,040. Median annual earnings in the industries employing the largest numbers of computer systems analysts in 2000 were:

Computer and data processing services	$64,110
Professional and commercial equipment	63,530
Federal Government	59,470
Local government	52,490
State government	51,230

Median annual earnings of database administrators were $51,990 in 2000. The middle 50 percent earned between $38,210 and $71,440. The lowest 10 percent earned less than $29,400, and the highest 10 percent earned more than $89,320. In 2000, median annual earnings of database administrators employed in computer and data processing services were $63,710, and in telephone communication, $52,230.

Median annual earnings of network systems and data communication analysts were $54,510 in 2000. The middle 50 percent earned between $42,310 and $69,970. The lowest 10 percent earned less than $33,360, and the highest 10 percent earned more than $88,620. Median annual earnings in the industries employing the largest numbers of network systems and data communications analysts in 2000 were:

Management and public relations	$60,260
Commercial banks	59,910
Computer and data processing services	59,160
Telephone communications	51,780
State government	42,000

Median annual earnings of computer and information scientists, research, were $70,590 in 2000. The middle 50 percent earned between $54,700 and $89,990. The lowest 10 percent earned less than $41,390, and the highest 10 percent earned more than $113,510. Median annual earnings of computer and information scientists employed in computer and data processing services in 2000 were $71,940.

Median annual earnings of all other computer specialists were $50,590 in 2000. Median annual earnings of all other computer specialists employed in computer and data processing services were $51,970, and in professional and commercial equipment, $80,270 in 2000.

According to the National Association of Colleges and Employers, starting offers for graduates with a master's degree in computer science averaged $61,453 in 2001. Starting offers for graduates with a bachelor's degree in computer science averaged $52,723; in computer programming, $48,602; in computer systems analysis, $45,643; in information sciences and systems, $45,182; and in management information systems, $45,585.

According to Robert Half International, starting salaries in 2001 ranged from $72,500 to $105,750 for database administrators. Salaries for Internet-related occupations ranged from $58,000 to $82,500 for webmasters and $56,250 to $76,750 for Internet/Intranet developers.

Related Occupations

Other workers who use logic and creativity to solve business and technical problems are computer programmers, computer software engineers, computer and information systems managers, financial analysts and personal financial advisors, urban and regional planners, engineers, mathematicians, statisticians, operations research analysts, management analysts, and actuaries.

Sources of Additional Information

Further information about computer careers is available from:
➤ Association for Computing Machinery (ACM), 1515 Broadway, New York, NY 10036. Internet: **http://www.acm.org**
➤ IEEE Computer Society, Headquarters Office, 1730 Massachusetts Ave. NW., Washington, DC 20036-1992. Internet: **http://www.computer.org**
➤ National Workforce Center for Emerging Technologies, 3000 Landerholm Circle SE., Bellevue, WA 98007. Internet: **http://www.nwcet.org**

Information about becoming a Certified Computing Professional is available from:
➤ Institute for Certification of Computing Professionals (ICCP), 2350 East Devon Ave., Suite 115, Des Plaines, IL 60018. Internet: **http://www.iccp.org**