Computer and Mathematics-Related Occupations

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Accountants and Auditors
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Nature of the Work
Managers must have up-to-date information in order to make important decisions. Accountants and auditors prepare, analyze, and verify financial reports that furnish this information to managers in all business, industrial, and government organizations.

Four major fields of accounting are public, management, and government accounting and internal auditing. Public accountants have their own businesses or work for accounting firms. Management accountants, also called industrial, corporate, or private accountants, record and summarize the financial information of their companies. Internal auditors verify the accuracy of their organization’s records and check for mismanagement, waste, or fraud. Government accountants and auditors maintain and examine the records of government agencies and audit private businesses and individuals whose activities are subject to government regulations or taxation.

Within each field, accountants often concentrate on one phase of accounting. For example, many public accountants work primarily in auditing (examining a client’s financial records and reporting to investors and authorities that the records have been prepared and reported correctly). Others concentrate on tax matters, such as preparing an individual’s income tax returns and advising companies of the tax advantages and disadvantages of certain business decisions. Still others concentrate on consulting and offer advice on matters such as the design of companies’ accounting and data processing systems and controls to safeguard assets. They may develop an accounting system for a new business or help a small business owner obtain financing.

Management accountants provide the financial information corporate executives need to make sound business decisions. They prepare financial reports according to the public disclosure requirements of various stock exchanges, the Securities and Exchange Commission, and other regulatory bodies. Within accounting departments, they may work in areas such as taxation, budgeting, costs, or investments.

Internal auditing is rapidly growing in importance. As computer systems make information more timely and available, top management can base its decisions on actual data rather than personal observation. Internal auditors examine and evaluate their firms’ financial and information systems, management procedures, and internal controls to ensure that records are accurate and controls are adequate to protect against fraud and waste. They also review company operations—evaluating their efficiency, effectiveness, and compliance with corporate policies and procedures, laws, and government regulations.

Accountants and auditors also work for Federal, State, and local governments. Government accountants see that revenues are received and expenditures are made in accordance with laws and regulations. Many persons with an accounting background work for the Federal Government as Internal Revenue Service agents or in financial management, financial institution examination, and budget administration.

In addition, a small number of persons trained as accountants teach and conduct research at business and professional schools. Some work part time as accountants or consultants.

Computers are widely used in accounting and auditing. With the aid of special computer software packages, accountants summarize transactions in standard formats for financial records, calculate projected financial ratios, or organize data in special formats for financial analysis. These accounting packages are easily learned and require few specialized computer skills, but greatly reduce the amount of tedious manual work associated with figures and records. Personal and portable computers enable accountants and auditors in all fields—even those who work independently—to use their clients’ computer systems and to extract information from large mainframe computers. Internal auditors may recommend controls for their organization’s computer system to ensure the reliability of the system and the integrity of the data. A growing number of accountants and auditors have extensive computer skills and specialize in correcting problems with software or developing software to meet unique data needs.

Working Conditions
Accountants and auditors work in offices, but public accountants may frequently visit the offices of clients while conducting audits. Self-employed accountants may be able to do part of their work at home. Accountants and auditors employed by large firms and government agencies may travel frequently to perform audits at clients’ places of business, branches of their firm, or government facilities.

The majority of accountants and auditors generally work a standard 40-hour week, but many work longer, particularly if they are self-employed and free to take on the work of as many clients as they choose. Tax specialists often work long hours during the tax season.

Employment
Accountants and auditors held about 985,000 jobs in 1990. The various states licensed over 400,000 as Certified Public Accountants (CPA’s) in 1990 and more than 19,000 as Public Accountants (PA’s) or Registered Public Accountants (RPA’s); the majority were unlicensed management and government accountants and auditors. Many accountants and auditors voluntarily earn professional designations that certify their professional competence in fields of accounting and auditing that are not State regulated: About 17,000 were Certified Internal Auditors, over 10,000 were Certified Management Accountants, about 7,000 were Certified Information Systems Auditors, and about 5,000 held certificates of accreditation in accounting or taxation awarded by the Accreditation Council for Accountancy and Taxation.

Most accountants and auditors work in urban areas where public accounting firms and central or regional offices of businesses are concentrated. About 10 percent of all accountants were self-employed and fewer than 10 percent worked part time.

Training, Other Qualifications, and Advancement
Most public accounting and business firms require applicants for accountant and internal auditor positions to have at least a bachelor’s degree in accounting or a related field. Some employers prefer those with a master’s degree in accounting or a master’s degree in business administration with a concentration in accounting. Most employers also prefer applicants who are familiar with computers and their applications in accounting and internal auditing.

For beginning accounting and auditing positions in the Federal Government, 4 years of college (including 24 semester hours in accounting or auditing) or an equivalent combination of education and experience is required.

Previous experience in accounting or auditing can help an appli-
They must be able to clearly communicate the results of their work, for mathematics, be able to analyze, compare, and interpret facts and systems. However, auditing or data processing experience and college education, current legislation, and computer systems. Perhaps most important, because millions of financial statement users rely on their services, accountants and auditors should have high standards of integrity.

Capable accountants and auditors should advance rapidly; those having inadequate academic preparation may be assigned routine jobs and find promotion difficult. Many graduates of junior colleges and business and correspondence schools, as well as bookkeepers and accounting clerks who meet the education and experience requirements set by their employers, can obtain junior accounting positions and advance to more responsible positions by demonstrating their accounting skills on the job.

Beginning public accountants usually start by assisting with work for several clients. They may advance to positions with more responsibility in 1 or 2 years and to senior positions within another few years. Those who excel may become supervisors, managers, or partners, or transfer to executive positions in private firms. Some open their own public accounting firms.

Beginning management accountants often start as cost accountants, junior internal auditors, or as trainees for other accounting positions. As they rise through the organization, they may advance to accounting manager, chief cost accountant, budget director, or manager of internal auditing. Some become controllers, treasurers, financial vice presidents, or corporation presidents. Many senior corporation executives have a background in accounting, internal auditing, or finance.

Job Outlook

Employment of accountants and auditors is expected to grow faster than the average for all occupations through the year 2005, reflecting the key role these workers play in the management of all types of organizations. Although increased demand will generate many new jobs, most openings will result from the need to replace workers who leave the occupation or retire. While accountants and auditors tend to leave the profession at a lower rate than members of most other occupations, replacement needs will be higher than for most occupations because the occupation is quite large.

As the economy grows, the number of business establishments increases, requiring more accountants and auditors to set up their books, prepare their taxes, and provide management advice. As these businesses grow, the volume and complexity of information developed by accountants and auditors on costs, expenditures, and taxes will increase as well. More complex requirements for accountants and auditors also arise from changes in legislation related to taxes, financial reporting standards, business investments, mergers, and other financial matters. Growing international competition is forcing many businesses to develop more cost information to help make their operations more efficient. Growth in demand for management advisory services may also contribute to growth for public accountants.

Many employers prefer graduates who have a broad background of education and experience. Computers now perform many accounting functions, allowing accountants and auditors to incorporate and analyze more information. This increasingly complex work requires greater knowledge of more specialized areas such as international business, current legislation, and computer systems.

Opportunities are expected to be favorable for college graduates seeking accounting and auditing jobs. While the demand for accountants and auditors is expected to continue to increase, the annual number of graduates with degrees in accounting has been virtually unchanged since the early 1980's. CPA's should have a wider range of job opportunities than other accountants. However, competition for jobs with prestigious accounting firms will remain keen; a master's degree in accounting would be an asset. Opportunities for accountants without a college degree will occur mainly in small businesses and accounting and tax preparation firms. The increasing use of computers in business should stimulate the demand for accountants and auditors familiar with their operation.

Accountants rarely lose their jobs when other workers are laid off during hard economic times. Financial information must be developed and tax reports prepared regardless of the state of the economy.
Earnings
According to a 1991 College Placement Council Salary Survey, bachelor's degree candidates in accounting received staring salary offers averaging $26,600 a year, inexperienced master's degree candidates, $31,100.

Beginning public accountants employed by public accounting firms averaged $25,300 a year in 1990. The middle 50 percent had starting salaries ranging from $23,900 to $26,700. Salaries of junior public accountants who were not owners or partners of their firms averaged $31,100, but some had salaries of more than $45,600. Many owners and partners of firms earned considerably more.

The starting salary of management accountants in private industry averaged $24,700 a year in 1990. The middle 50 percent had starting annual salaries ranging from $22,300 to $27,000. Salaries of non-supervisory management accountants averaged $37,000 in 1990, and some of the most experienced had salaries of over $80,000. Chief management accountants who direct the accounting program of a company or one of its establishments averaged $55,700 a year. Their salaries ranged from over $43,000 to more than $74,000, depending upon the scope of their authority and the size of their professional staff.

Internal auditor trainees averaged $28,600 a year in 1990. Experienced internal auditors averaged $36,800, but some of the most experienced had salaries of more than $53,000.

In the Federal Government, the starting annual salary for junior accountants and auditors was about $17,000 in 1991. Candidates who had a superior academic record could begin at about $21,000. Applicants with a master's degree or 2 years' professional experience began at $25,700. Accountants and auditors employed by the Federal Government averaged about $40,000 a year in 1990.

Related Occupations
Accountants and auditors design internal control systems and analyze financial data. Others for whom training in accounting is invaluable include appraisers, budget officers, loan officers, financial analysts, bank officers, actuaries, underwriters, tax collectors and revenue agents, FBI special agents, securities sales workers, and purchasing agents.

Sources of Additional Information
Information about careers in certified public accounting and about CPA standards and examinations may be obtained from:
- American Institute of Certified Public Accountants, 1211 Avenue of the Americas, New York, NY 10036-8775.
- Information on management and other specialized fields of accounting and auditing and on the Certified Management Accountant program is available from:
  - Institute of Management Accountants, 10 Paragon Dr., Montvale, NJ 07645.
  - National Society of Public Accountants and the Accreditation Council for Accountancy and Taxation, 1010 North Fairfax St., Alexandria, VA 22314.
  - The Institute of Internal Auditors, 249 Maitland Ave., Altamonte Springs, FL 32701-4201.
  - The EDP Auditors Association, 455 Kehoe Blvd., Suite 106, Carol Stream, IL 60188-0180.
- For information on accredited accounting programs and educational institutions offering a specialization in accounting or business management, contact:
  - American Assembly of Collegiate Schools of Business, 605 Old Dallas Rd., Suite 220, St. Louis, MO 63141.

Actuaries
(D.O.T. 020.167-010)

Nature of the Work
Why do young drivers pay more for automobile insurance than older drivers? How much should an insurance policy cost? How much should an organization contribute each year to its pension fund? Answers to these and similar questions are provided by actuaries, who design insurance and pension plans and ensure that they are maintained on a sound financial basis.

Actuaries assemble and analyze statistics to calculate probabilities of death, sickness, injury, disability, unemployment, retirement, and property loss. They use this information to determine the expected insured loss. For example, they may calculate the probability of claims due to automobile accidents, which can vary depending on the driver’s driving history, type of car, and many other factors. They must make sure that the price charged for the insurance will enable the company to pay all claims and expenses as they occur. Finally, this price must be profitable and yet be competitive with other insurance companies. In a similar manner, the actuary calculates premium rates and determines policy contract provisions for each type of insurance offered. Most actuaries specialize in either life and health insurance or property and casualty insurance; others specialize in pension plans or other employee benefits.

To perform their duties effectively, actuaries must keep informed about general economic and social trends and legislative, health, and other developments that may affect insurance practices. Because of their broad knowledge of insurance, company actuaries may work in investment, underwriting, or pension planning departments. Actuaries in executive positions help determine company policy. In that role, they may be called upon to explain complex technical matters to other company executives, government officials, policyholders, and the public. They may testify before public agencies on proposed legislation affecting the insurance business, for example, or explain changes in premium rates or contract provisions. They also may help companies develop plans to enter new lines of business.

The small number of actuaries who work for the Federal Government usually deal with a particular insurance or pension program, such as Social Security or life insurance for veterans and members of the Armed Forces. Actuaries in State government are usually employed by State insurance departments that regulate insurance companies, oversee the operations of State retirement or pension systems, handle unemployment insurance or workers' compensation problems, and assess the impact of proposed legislation. They might determine whether the rates charged by an insurance company are proper or whether an employee benefit plan is financially sound.

Consulting actuaries provide advice for a fee to various clients including insurance companies, corporations, hospitals, labor unions, government agencies, and attorneys. Consulting actuaries set up pension and welfare plans, calculate future benefits, and determine the amount of employer contributions. They may be called upon to testify in court regarding the value of potential lifetime earnings lost by a person who has been disabled or killed in an accident, the current value of future pension benefits in divorce cases, or the calculation of automobile insurance rates. Actuaries who are enrolled under the provisions of the Employee Retirement Income Security Act of 1974 (ERISA) evaluate these pension plans and report on their financial soundness.

Working Conditions
Actuaries have desk jobs that require no unusual physical activity; their offices generally are comfortable and pleasant. They usually work at least 40 hours a week. Some actuaries, particularly consulting actuaries, often travel to meet with clients. Consulting actuaries may also be expected to work longer than 40 hours per week.

Employment
Actuaries held about 13,000 jobs in 1990. Some actuaries were self-employed.

Over one-half of wage and salary actuaries worked in the insurance industry; many of these worked in their company headquarters in cities such as New York, Hartford, Chicago, Philadelphia, and Boston. Most worked for life insurance companies; others worked for property and casualty insurance companies. The number of actuaries employed by an insurance company depends on its volume of business and the types of insurance policies it offers. Large companies may employ over 100 actuaries; others, generally smaller companies, may rely instead on consulting firms or rating bureaus (associations
that supply actuarial data to member companies). Most of the remaining actuaries worked for firms providing services—especially consulting actuarial services—and for insurance agents and brokers. Other actuaries work for private organizations administering health benefits and welfare plans, accounting firms, or government agencies.

Training, Other Qualifications, and Advancement
A good educational background for a beginning job in a large life or casualty company is a bachelor's degree in a mathematically- or business-related discipline, such as actuarial science, mathematics, statistics, economics, finance, or accounting. Some companies hire applicants with a liberal arts major, provided the applicant has a working knowledge of mathematics, including calculus, probability, and statistics. Courses in accounting, computer science, and insurance also are useful. Companies increasingly prefer well-rounded individuals who, in addition to a strong technical background, have some training in liberal arts and business. Good communication and interpersonal skills are important, particularly for prospective consulting actuaries. Although only about 38 colleges and universities offer an actuarial science curriculum, hundreds of schools offer a degree in mathematics or statistics.

A strong background in mathematics is essential for persons interested in a career as an actuary. It is an advantage to pass, while still in school, one or more of the examinations offered by professional actuarial societies. Three societies sponsor programs leading to full professional status in their specialty. The Society of Actuaries gives a series of actuarial examinations for the life and health insurance and pension field and the Casualty Actuarial Society gives a series of examinations for the property and liability field. Because the first parts of the examination series of each society are jointly sponsored and cover the same material, students need not commit themselves to a specialty until they have taken the initial examinations, which test competence in subjects such as linear algebra, probability, calculus, statistics, risk theory, and actuarial mathematics. These first few examinations help students evaluate their potential as actuaries. Those who pass usually have better opportunities for employment and higher starting salaries.

Actuaries are encouraged to complete the entire series of examinations as soon as possible; completion generally takes from 5 to 10 years. Many students pass two or more actuarial examinations before graduating from college. Examinations are given twice each year. Extensive home study is required to pass the advanced examinations; many actuaries study for several months to prepare for an examination. Actuaries who complete approximately half of the total examinations in either the life insurance series or the pension series or seven examinations in the casualty series are awarded "associate" membership in their society. Those who pass an entire series receive full membership and the title "fellow."

The American Society of Pension Actuaries gives eight examinations covering the pension field. Membership status requires 3 years of pension experience and the passage of two enrolled actuarial exams. Fellowship status requires the passage of an additional, advanced actuarial exam and two consulting exams.

Consulting pension actuaries who service private pension plans and certify their solvency must be enrolled and licensed by the Joint Board for the Enrollment of Actuaries. Applicants for enrollment must meet certain experience, education, and examination requirements as stipulated by the Joint Board.

Beginning actuaries often rotate among jobs to learn various actuarial operations and different phases of insurance work, such as marketing, underwriting, or product development. At first, they prepare tabulations for actuarial tables or perform other simple tasks. As they gain experience, they may supervise clerks, prepare correspondence and reports, and do research.

Advancement to more responsible work as assistant, associate, and chief actuary depends largely on job performance and the number of actuarial examinations passed. Actuaries with a broad knowledge of the insurance, pension, and employee benefits fields often advance to administrative and executive positions in underwriting, accounting, or data processing departments. Actuaries with a business background and supervisory ability may advance to management positions involving marketing, advertising, or planning.

Job Outlook
Employment of actuaries is expected to grow faster than the average for all occupations through the year 2005. In addition to growth in the demand for actuarial services, job openings are expected to arise each year to replace actuaries who transfer to other occupations, retire, or stop working for other reasons. College graduates who have passed at least two actuarial examinations while still in school, have a strong mathematical and statistical background, and have strong communication and problem-solving skills should have the best prospects.

Employment growth will be spurred by the increasing volume and complexity of insurance policies and pension plans. Shifts in the age distribution of the population will result in a large increase in the number of people with established careers and family responsibilities. This is the group that traditionally has accounted for the bulk of private insurance sales.

As people live longer, they draw health and pension benefits for a longer period, and actuaries are needed to recalculate the probabilities of such factors as death, sickness, and length of retirement.

The liability of companies for damage resulting from their products has received much attention in recent years. Actuaries will continue to be involved in the development of product liability insurance, medical malpractice and workers' compensation coverage, and self-insurance—internal trust funds being established by some large corporations.

Despite expected employment growth, actuaries may face competition for jobs. Due to favorable publicity about the actuarial profession, the number of workers entering this small occupation has increased substantially in recent years.

Earnings
In 1990, starting salaries for actuaries averaged about $28,300 for those with a bachelor's degree, according to the College Placement Council. New college graduates entering the actuarial field without having passed any actuarial exams averaged slightly lower salaries.

Insurance companies and consulting firms give merit increases to actuaries as they gain experience and pass examinations. Some companies also offer cash bonuses for each exam passed. A 1990 salary survey of financial services companies, conducted by LOMA, the management association of life insurance companies, indicated that actuarial students who have been designated Associate, Society of Actuaries, received an average salary of $43,100. Newly designated Fellows, Society of Actuaries, received an average salary of $61,900. Fellows with additional years of experience can earn substantially more.

Actuaries typically receive other fringe benefits including vacation and sick leave, health and life insurance, and pension plans.

Related Occupations
Actuaries determine the probability of income or loss from various risk factors. Other workers whose jobs involve related skills include...
Computer Programmers

(D.O.T. 020.162-014 , 167-018,-022, .187-010, and .262-010)

Nature of the Work

Computers increasingly affect our daily lives. They control the temperature and air quality in office buildings, connect telephone conference calls, and make the complex mathematical computations that allow scientists and engineers to put up, position, and communicate with weather tracking satellites. Computer programmers write, update, and maintain the detailed instructions (called programs or software) that list in a logical order the steps that the computer must execute.

In many large organizations, programmers follow descriptions prepared by systems analysts who have carefully studied the task that the computer system is going to perform. These descriptions list the input required, the steps the computer must follow to process data, and the desired arrangement of the output. (A more detailed description of the work of systems analysts is presented elsewhere in the Handbook.) Some organizations, particularly smaller ones, do not employ systems analysts. Instead, workers called programmer-analysts are responsible for both systems analysis and programming. Programmers using computer-aided software engineering (CASE) can contribute of systems analysts. Instead, they may work directly with experts from various fields to create new software packages for specific applications like graphics, computer-aided design, animation, or educational instruction.

Regardless of setting, programmers write specific programs by breaking down each step into a logical series of instructions the computer can follow. They then code these instructions in a programming language, such as COBOL—traditionally used for business applications—FORTRAN—the standard for scientific programming—or one of the more advanced artificial intelligence languages.

While programmers may write completely new programs, most programming work involves the updating and modification of code for existing programs. When making changes to a section of code, called a routine, they need to make other users aware of the task that the routine is to perform. They do this by inserting comments in the coded instructions so others can understand the program. Programmers using computer-aided software engineering (CASE) can concentrate on writing the unique parts of the program because the computer automates some of the more basic processes. This also yields more reliable and consistent programs and increases programmers' productivity by eliminating some of the routine steps.

When the program is ready to be tested, programmers run the program to be sure the instructions are correct and will produce the desired information. They prepare sample data that test every part of the program and, after trial runs, review the results to see if any errors were made. If errors did occur, the program must be changed and rechecked until it produces the correct results. This is called "debugging" the program.

Finally, programmers prepare an instruction sheet for the computer operator who will run the program. (The work of computer operators is described in the statement on computer and peripheral equipment operators elsewhere in the Handbook.) They may also assist in writing a user's manual for the program.

Programs vary with the type of information to be accessed or generated. For example, the data involved in updating school records are different from those required to simulate a flight on a pilot trainee's monitor. Although simple programs can be written in a few hours, programs that use complex mathematical formulas or many data files may require more than a year of work. In some cases, several programmers may work together as a team under a senior programmer's supervision.

Programmers often are grouped into two broad types: Applications programmers and systems programmers. Applications programmers usually are oriented toward business, engineering, or science. They write software to handle specific jobs, such as a program used in an inventory control system or one to guide a missile after it has been fired. They also may work alone to revise existing packaged software. Systems programmers, on the other hand, maintain the software that controls the operation of an entire computer system. These workers make changes in the sets of instructions that determine how the central processing unit of the system handles the various jobs it has been given and communicates with peripheral equipment, such as terminals, printers, and disk drives. Because of their knowledge of the entire computer system, systems programmers often help applications programmers determine the source of problems that may occur with their programs.

Working Conditions

Programmers work in offices in comfortable surroundings. They usually work about 40 hours a week, but their hours are not always from 9 to 5. Programmers may report early or work late to use the computer when it is available; occasionally, they work longer hours in order to meet deadlines or fix critical problems that occur during off hours.

Employment

Computer programmers held about 565,000 jobs in 1990. Most were employed by data processing service organizations, including firms that write and sell software; firms providing other business services; manufacturers of office, computing, and accounting machines; banks; and educational institutions.

Applications programmers work for all types of firms that use computer systems. Systems programmers, on the other hand, usually work for organizations with large computer centers and for firms that manufacture computers or develop software.

A small but growing number of programmers are employed on a temporary basis. A financial services firm, for example, may need the
services of several extra programmers to write and "debug" the software necessary to get a new data base management system running. Once the software is functioning, however, their services are no longer needed. Rather than hiring these programmers as permanent employees and then laying them off after the job is done, employers increasingly are contracting with temporary help agencies, consulting firms, or directly with programmers themselves. Such temporary jobs usually last several months but some last a year or longer.

Training, Other Qualifications, and Advancement
There are no universal training requirements for programmers because computer applications are so widespread and varied that employers' needs also vary greatly. Computer programming is taught at public and private vocational schools, community and junior colleges, and universities. High schools in many parts of the country also offer introductory courses in data processing. Many programmers are college graduates; others have taken special courses in computer programming to supplement their experience in fields such as accounting, inventory control, or other business areas.

Increasingly, the level of education and quality of training that employers seek have been rising due to the growth in the number of qualified applicants and the increasing complexity of some programming tasks. Bachelor's degrees are now commonly required; in the absence of a degree, substantial specialized experience may be needed.

Employers using computers for scientific or engineering applications prefer college graduates who have degrees in computer or information science, mathematics, engineering, or the physical sciences. Graduate degrees are required for some jobs.

Employers who use computers for business applications prefer to hire people who have had college courses in programming and business. Also, experience in accounting, management, and other business skills generally is preferred by employers. Some employers promote workers such as computer operators who have taken courses in programming to programmer jobs because of their particular work experience.

An indication of experience and professional competence at the senior programmer level is the Certificate in Computer Programming. This designation is conferred by the Institute for Certification of Computer Professionals upon candidates who have passed a core examination plus exams in two specialty areas. College graduates with little or no experience may be tested for certification as an Associate Computer Professional.

When hiring programmers, employers look for people who can think logically and who are capable of exacting analytical work. The job calls for patience, persistence, and the ability to work with extreme accuracy even under pressure. Ingenuity and imagination are also particularly important when programmers test their work for potential failures. Increasingly, interpersonal skills are valued because of the use of programmer teams and user support centers. The ability to work with abstract concepts and do technical analysis is especially important for systems programmers because they work with the software that controls the computer's operation.

Beginning programmers may spend their first weeks on the job attending training classes. After this initial instruction, they may work alone on simple assignments, or on a team with more experienced programmers. Either way, they generally must spend at least several months working under close supervision. Because of rapidly changing technology, programmers must continuously update their training by taking courses sponsored by their employer or software vendors.

For skilled workers, the prospects for advancement are good. In large organizations, they may be promoted to lead programmer and be given supervisory responsibilities. Some applications programmers become systems programmers after they gain experience and take courses in systems software. With general business experience, both applications programmers and systems programmers may become systems analysts or be promoted to a managerial position. Other programmers with specialized knowledge and experience with a language or operating system may work in research and development in artificial intelligence or CASE, for example.

Job Outlook
Employment of programmers is expected to grow much faster than the average for all occupations through the year 2005 as computer usage expands. The demand for programmers will increase as businesses, government, schools, and scientific organizations seek new applications for computers and improvements to the software already in use. The ever-increasing demand for information, further automation of offices and factories, advances in health and medicine, and continuing scientific research will drive the growth of programmer employment.

One important area of progress will be data communications. Networking computers so they can communicate with each other is necessary to achieve the greater efficiency that organizations require to remain competitive. Expert systems and other artificial intelligence principles and languages will increasingly be used in the years ahead, becoming productivity-enhancing tools available to programmers. Programmers will be creating and maintaining expert systems and embedding these technologies in more and more products.

Employment, however, is not expected to grow as rapidly as in the past as improved software and programming techniques, including CASE, simplify or eliminate some programming tasks. Data base management systems allow users to write simple programs to access data. The greater use of packaged software like word processing and spreadsheet packages also may moderate the growth in demand for applications programmers. These programmers will tailor these packages to fit users' specific requirements instead of writing original programs.

Although the proportion of programmers leaving the occupation each year is smaller than in most occupations, most of the job openings for programmers will result from replacement needs. Most of the programmers who leave the occupation transfer to other occupations, such as manager or systems analyst. Opportunities will exist throughout the economy, but jobs for both systems and applications programmers should be particularly plentiful in data processing service firms, software houses, and computer consulting businesses.

Because the number and quality of applicants have increased, employers have become more selective. Competition has increased for entry level positions, affecting even applicants with a bachelor's degree. Graduates of 2-year programs in data processing and people with less than a 2-year degree or its equivalent in work experience are facing especially strong competition for programming jobs. Prospects should be good for college graduates who are familiar with a variety of programming languages, particularly newer languages that apply to computer networking, data base management, and artificial intelligence.

Many employers prefer to hire applicants with previous experience in the field. Therefore, people who want to become programmers can enhance their chances by combining work experience with the appropriate formal training. Students have various options: Holding a summer or part-time job in a data processing department, participating in a college work-study program, or undertaking an internship. Students can greatly improve their employment prospects by also taking courses such as accounting, management, engineering, or science—allied fields in which applications programmers are in demand.

Earnings
Median earnings of programmers who worked full time in 1990 were about $34,000 a year. The middle 50 percent earned between $25,700 and $42,300 annually. The lowest 10 percent earned less than $19,000, and the highest 10 percent more than $52,100.

Programmers working in the West and Northeast earned somewhat more than those working in the South and Midwest. On average, systems programmers earn more than applications programmers.

In the Federal Government, the entrance salary for programmers with a college degree or qualifying experience was about $17,000 a year in 1991; for those with a superior academic record, $21,000.

Related Occupations
Programmers must pay great attention to detail as they write and "debug" programs. Other professional workers who must be detail-oriented include statisticians, engineers, financial analysts, accountants, auditors, actuaries, and operations research analysts.
Computer Systems Analysts

(D.O.T. 012.167-066; 020.062-010, .067-010, and .224-010; and 109.067-010)

Nature of the Work
Systems analysts define business, scientific, or engineering problems and design their solutions using computers. This process may include planning and developing new computer systems or devising ways to apply existing systems to operations still completed manually or by some less efficient method. They may design entirely new systems, including hardware and software, or add a single new software application to harness more of the computer’s power.

Analysts begin an assignment by discussing the data processing problem with managers and users to determine the exact nature of the problem. Much time is devoted to clearly defining the goals of the system so that it can be broken down into separate programmable procedures. Analysts then use techniques such as structured analysis, data modeling, information engineering, mathematical model building, sampling, and cost accounting to plan the system. Once the design has been developed, systems analysts prepare charts and diagrams that describe it in terms that managers and other users can understand. They may prepare a cost-benefit and return-on-investment analysis to help management decide whether the proposed system will be satisfactory and financially feasible.

Analysts must specify the files and records to be accessed by the system, design the processing steps, and design the format for the output that will meet the users’ needs. They ensure security of the data by making it unaccessible to those who are not authorized to use it.

When the system is accepted, systems analysts may determine what computer hardware and software will be needed to set up the system or implement changes to it. They coordinate tests and observe initial use of the system to ensure it performs as planned. They prepare specifications and work diagrams for computer programmers to follow and work with them to “debug,” or eliminate errors from the system. Some organizations do not employ programmers; instead, a single worker called a programmer-analyst is responsible for both systems analysis and programming. (The work of programmers is described elsewhere in the Handbook.)

One of the biggest obstacles to wider computer use is the inability of different computers to communicate with each other. Many systems analysts are involved with connecting all the computers in an individual office, department, or establishment. This “networking” has many variations; they may be called local area networks, wide area networks, or multiuser systems, for example. A primary goal of networking is to allow users of microcomputers (also known as personal computers or PC’s) to retrieve data from a mainframe computer and use it on their machine. This connection also allows data to be entered into the mainframe from the PC.

Because up-to-date information—accounting records, sales figures, or budget projections, for example—is so important in modern organizations, systems analysts may be instructed to make the computer systems in each department compatible with each other so facts and figures can be shared by those who create the figures and those who use them. Similarly, electronic mail requires open pathways to send messages, documents, and data from one computer “mailbox” to another across different equipment and program lines. The analyst must design the gates in the hardware and software to allow free exchange of data, custom applications, and the computer power to process it all. They study the seemingly incompatible pieces and create ways to link them so that users can access information from any part of the system.

Because the possible uses of computers are so varied and complex, analysts usually specialize in either business, scientific, or engineering applications. Previous experience or training in a particular area usually dictates the field in which they are most qualified to develop computer systems.

Working Conditions
Systems analysts work in offices in comfortable surroundings. They usually work about 40 hours a week—the same as other professional and office workers. Occasionally, however, evening or weekend work may be necessary to meet deadlines.

Employment
Systems analysts held about 463,000 jobs in 1990. Most systems analysts work in urban areas for data processing service firms, government agencies, insurance companies, banks, and firms that manufacture durable goods.

A small but growing number of systems analysts are employed on a temporary basis. 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 directly with the systems analysts themselves or with a temporary help agency or consulting firm. The company would contract for their services on a temporary basis; temporary jobs usually are for several months at least, and some last up to 2 years or more.

Training, Other Qualifications, and Advancement
There is no universally accepted way to prepare for a job as a systems analyst because employers’ preferences depend on the work being done. Prior work experience is very important. Many persons entering this occupation transfer from another occupation, such as computer programmer or engineer. For example, an auditor in an accounting department may become a systems analyst specializing in accounting systems development.

College graduates almost always are sought for systems analyst positions, and, for some of the more complex jobs, persons with graduate degrees are preferred. Employers usually want analysts with a background in business management or a closely related field for work in a business environment, while a background in the physical sciences, applied mathematics, or engineering is preferred for work in scientifically oriented organizations. Many employers seek applicants who have a degree in computer science, information science, computer information systems, or data processing. Regardless of college major, employers look for people who are familiar with programming languages and have a broad knowledge of computer systems and technologies. Courses in computer programming or systems design offer good preparation for a job in this field.
Systems analysts must be able to think logically, have good communication skills, and like working with ideas and people. They often deal with a number of tasks simultaneously. The ability to concentrate and pay close attention to detail also is important. Although systems analysts often work independently, they also work in teams on large projects. They must be able to communicate effectively with technical personnel, such as programmers and managers, as well as with other staff who have no technical computer background.

Technological advances come so rapidly in the computer field that continuous study is necessary to keep skills up to date. Continuing education is usually offered by employers, hardware and software vendors, colleges and universities, or private training institutions. Additional training may come from professional development seminars offered by professional computing societies.

Certification is an indication of experience and professional competence. The designations Certified Data Processor and Certified Systems Professional are conferred by the Institute for Certification of Computer Professionals upon candidates who have 5 years of experience and who have passed a core examination plus exams in two specialty areas.

Systems analysts may be promoted to senior or lead systems analysts after several years of experience. Those who show leadership ability also can advance to management positions such as manager of information systems or chief information officer. Systems analysts with several years of experience may start their own computer consulting firms.

Job Outlook

Employment of systems analysts is expected to grow much faster than the average for all occupations through the year 2005. The demand for systems analysts is expected to rise as organizations attempt to maximize the efficiency of their computer systems. As international and domestic competition increases, organizations will face growing pressure to use technological advances in areas such as office and factory automation, telecommunications technology, and scientific research. Many more systems analysts will be needed to incorporate these advances in new or existing systems.

As users develop a more sophisticated knowledge of computers, they become more aware of the machine's potential and better able to suggest operations that will increase their own productivity and that of the organization. The need to design computer networks that will facilitate the sharing of information will be a major factor in the rising demand for systems analysts. In addition, falling prices of computer hardware and software are inducing more small businesses to computerize their operations, further stimulating demand for systems analysts.

Despite this rapid growth in employment, most job openings will result from the need to replace workers who leave the occupation—although a smaller proportion of systems analysts than of all other professional workers leave their occupation each year. Most of the systems analysts who leave the occupation transfer to other jobs such as manager or senior administrative assistant.

College graduates who have had courses in computer programming, systems analysis, and other data processing areas as well as training or experience in an applied field should enjoy very good prospects for employment. Persons without a college degree and college graduates unfamiliar with data processing will face keen competition from the large number of experienced workers seeking jobs as systems analysts.

Earnings

Median annual earnings of systems analysts who worked full time in 1990 were about $38,700. The middle 50 percent earned between $30,900 and $50,700 a year. The lowest 10 percent earned less than $23,000; the highest tenth, more than $62,400. Systems analysts working in the Northeast had the highest earnings; those in the Midwest, the lowest.

In the Federal Government, the entrance salary for recent college graduates with a bachelor's degree was about $17,000 a year in 1991; for those with a superior academic record, $21,000.

Related Occupations

Other workers who use research, logic, and creativity to solve business problems are computer programmers, financial analysts, urban planners, engineers, operations research analysts, management analysts, and actuaries.

Sources of Additional Information

Further information about the occupation of systems analyst is available from:

- Association for Systems Management, 24587 Bagley Rd., Cleveland, OH 44138.

**Economists and Marketing Research Analysts**

(D.O.T. 050.067)

**Nature of the Work**

**Economists.** Economists study the ways a society uses scarce resources such as land, labor, raw materials, and machinery to produce goods and services. They analyze the costs and benefits of distributing and consuming these goods and services. Economists conduct research, collect and analyze data, monitor economic trends, and develop forecasts. Their research might focus on topics such as energy costs, inflation, interest rates, farm prices, rents, imports, or employment.

Most economists are concerned with practical applications of economic policy in a particular area, such as finance, labor, agriculture, transportation, real estate, energy, or health. They use their understanding of economic relationships to advise business firms, insurance companies, banks, securities firms, industry associations, labor unions, government agencies, and others. On the other hand, economists who are primarily theoreticians may use mathematical models to develop theories on the causes of business cycles and inflation or the effects of unemployment and tax policy.

Depending on the topic under study, economists devise methods and procedures for obtaining the data they need. For example, sampling techniques may be used to conduct a survey, and econometric modeling techniques may be used to develop projections. Preparing reports usually is an important part of the economist's job. He or she may be called upon to review and analyze all the relevant data, prepare tables and charts, and write up the results in clear, concise language. Being able to present economic and statistical concepts in a meaningful way is particularly important for economists whose research is policy directed.

Economists who work for government agencies assess economic conditions in the United States and abroad and estimate the economic impact of specific changes in legislation or public policy. For example, they may study how the dollar's fluctuation against foreign currencies affects import and export markets. Most government economists are in the fields of agriculture, business, finance, labor, transportation, utilities, urban economics, or international trade. Economists in the U.S. Department of Commerce study domestic production, distribution, and consumption of commodities or services; those in the Federal Trade Commission prepare industry analyses to assist in enforacing Federal statutes designed to eliminate unfair, deceptive, or monopolistic practices in interstate commerce; and those in the Bureau of Labor Statistics analyze data on prices, wages, employment, productivity, and safety and health, among other things.

**Marketing Research Analysts.** Marketing research analysts are concerned with the design, promotion, price, and distribution of a product or service. They provide information which is used to identify and define marketing opportunities; generate, refine, and evaluate marketing actions; and monitor marketing performance. Like economists, marketing research analysts devise methods and procedures for data collection and analysis.
obtaining data they need. Marketing research analysts often design surveys and questionnaires; conduct telephone, personal, or mail interviews; and sometimes offer product samples to assess consumer preferences and indicate current trends. Once the data are compiled, marketing research analysts code, tabulate, and evaluate the data. They then make recommendations to management based upon their findings and suggest a course of action. They may provide management with information to make decisions on the promotion, distribution, design, and pricing of company products or services; or to determine the advisability of adding new lines of merchandise, opening new branches, or diversifying the company’s operations.

Marketing research analysts employed by large organizations often work with statisticians who help them select a group of people to be interviewed who will accurately represent the prospective customers. Under an experienced marketing research analyst’s direction, trained interviewers conduct surveys and office workers tabulate the results.

Working Conditions
Economists and marketing research analysts working for government agencies and private firms have structured work schedules. They may work alone and may spend long hours on independent study and problem solving. At the same time, they must be able to work well with others.

Employment
Economists and marketing research analysts held about 37,000 jobs in 1990. Private industry—particularly economic and marketing research firms, management consulting firms, banks, and securities, investment, and insurance companies—employed over half of all salaried workers. The remainder, primarily economists, were employed by a wide range of government agencies, primarily in the Federal Government. The Departments of State, Labor, Agriculture, and Commerce are the largest Federal employers of economists. A number of economists and marketing research analysts combine a full-time job in government or business with part-time or consulting work in another setting.

Employment of economists and marketing research analysts is concentrated in large cities—for example, New York City, Washington, D.C., and Chicago. Some economists work abroad for companies with major international operations; for the Department of State and other U.S. Government agencies; and for international organizations, including the World Bank and the United Nations.

Besides the jobs described above, many economists and marketing research analysts held economics and marketing faculty positions in colleges and universities. (For information about this occupation, see the statement on college and university faculty elsewhere in the Handbook.)

Training, Other Qualifications, and Advancement
A bachelor’s degree with a major in economics or marketing is sufficient for many beginning research, administrative, management trainees, and sales jobs. A strong economics background is recommended. Students can choose from a variety of economics courses, ranging from microeconomics and macroeconomics, to history of economic thought or mathematical economics. For marketing majors, courses in business, marketing, and consumer behavior are recommended. Courses in related disciplines, such as political science, psychology, organizational behavior, sociology, finance, business law, and international relations, are suggested. Because of the importance of quantitative skills to economists and marketing researchers, courses in calculus, linear algebra, statistics, sampling theory and survey design, and computer science are highly recommended.

Aspiring marketing research analysts should gain experience conducting interviews or surveys while in college. This experience can prove invaluable later in obtaining a full-time position in the field since many of their work in the beginning centers around conducting interviews and writing reports on findings. Beginning analysts also do considerable clerical work such as copying data, editing and coding questions, and tabulating survey results. With further experience, marketing research analysts are eventually assigned their own research projects.

Graduate training increasingly is required for most economist and some marketing research analyst jobs and for advancement to more responsible positions. There are many areas of specialization at the graduate level for economists, including advanced economic theory, mathematical economics, econometrics, history of economic thought, international economics, and comparative economic systems and planning. Students should select graduate schools strong in specialties in which they are interested. Marketing research analysts may earn a master’s degree in business administration, marketing, statistics, or some related discipline. Some schools help graduate students find internships or part-time employment in government agencies, economic consulting firms, financial institutions, or marketing research firms. Work experience and contacts can be useful in testing career preferences and learning about the job market for economists and marketing research analysts.

In the Federal Government, candidates for beginning economist positions generally need a college degree with a minimum of 21 semester hours of economics and 3 hours of statistics, accounting, or calculus. However, because competition is keen, additional education or experience may be required.

For a job as a college instructor in many junior colleges and small 4-year schools, a master’s degree generally is the minimum requirement. In some colleges and universities, however, a Ph.D. is necessary for appointment as an instructor. The Ph.D. and extensive publication are required for a professorship and for tenure.

In government, industry, research organizations, and consulting firms, economists and marketing research analysts who have a graduate degree usually can qualify for more responsible research and administrative positions. A Ph.D. is necessary for top positions in many organizations. Many corporation and government executives have a strong background in economics or marketing.

Persons considering careers as economists or marketing research analysts should be able to work accurately with detail since much time is spent on data analysis. Patience and persistence are necessary qualities for economists and marketing research analysts since they may spend long hours on independent study and problem solving. At the same time, they must be able to work well with others. Economists and marketing research analysts must be objective and systematic in their work and be able to present their findings, both orally and in writing, in a clear, meaningful way. Creativity and intellectual curiosity are essential for success in these fields, just as they are in other areas of scientific endeavor.
Job Outlook

Employment of economists and marketing research analysts is expected to grow about as fast as the average for all occupations through the year 2005. Most job openings, however, will result from the need to replace experienced workers who transfer to other occupations, or retire or leave the labor force for other reasons.

Opportunities for economists should be best in financial services, research organizations, and consulting firms, reflecting the complexity of the domestic and international economies and increased reliance on quantitative methods of analyzing business trends, forecasting sales, and planning of purchasing and production. The continued need for economic analyses by lawyers, accountants, engineers, health services administrators, urban and regional planners, environmental scientists, and others also will increase the number of jobs for economists. Other employment opportunities for economists exist in nonprofit organizations and trade associations. Little or no change is expected in the employment of economists in the Federal Government—in line with the rate of growth projected for the Federal workforce as a whole. Employment of economists in State and local government is expected to grow about as fast as the average.

A strong background in economic theory, calculus, statistics, and econometrics provides the tools for acquiring any specialty within the field. Those skilled in quantitative techniques and their application to economic modeling and forecasting and marketing research, including the use of computers, should have the best job opportunities.

Persons who graduate with a bachelor’s degree in economics through the year 2005 should face very favorable competition for the limited number of economist positions for which they qualify. Related work experience—conducting research, developing surveys, or analyzing data, for example—while in school is a major asset in this competitive job market. Many graduates will find employment in government, industry, and business as management or sales trainees, or as research or administrative assistants. Those with strong backgrounds in mathematics, statistics, survey design, and computer science may be hired by private firms for marketing research work. Those who meet State certification requirements may become high school economics teachers. The demand for secondary school economics teachers is expected to grow as more States make economics a required course. (For additional information, see the statement on secondary school teachers elsewhere in the Handbook.)

Candidates who hold a master’s degree in economics have better employment prospects than bachelor’s degree holders. They face competition for teaching positions in colleges and universities; however, some may gain positions in junior and community colleges. Those with a strong background in marketing and finance may have the best prospects in business, banking, and management consulting firms.

Opportunities will be best for Ph.D.’s. Employment prospects for economists in colleges and universities should improve due to an expected wave of retirements among college faculty. Ph.D. graduates should also have favorable opportunities to work as economists in government, industry, educational and research organizations, and consulting firms.

Demand for marketing research analysts should be strong due to increasing competition in business and industry. Marketing research provides organizations valuable feedback from purchasers, allowing companies to evaluate customer satisfaction and more effectively plan for the future. As companies seek to expand their market, economists become better informed, the need for marketing professionals is increasing. Opportunities for marketing research analysts should be good in a wide range of employment settings, particularly in marketing research firms, as companies find it more profitable to contract out for marketing research services rather than having their own marketing department. Other employment opportunities exist in financial organizations, health care institutions, and insurance companies. Like economists, graduates with related work experience or an advanced degree in marketing or a closely related business field should have the best job opportunities.

Earnings

Median annual earnings of full-time economists and marketing research analysts were about $35,800 in 1990. The middle 50 percent earned between $26,200 and $51,800. The lowest 10 percent earned under $18,800, while the top 10 percent earned over $67,800.

According to a 1990 salary survey by the College Placement Council, persons with a bachelor’s degree in economics received offers averaging $25,200 a year, in marketing, $23,500.

The median base salary of business economists in 1990 was $60,000, according to a survey by the National Association of Business Economists. Ninety percent of the respondents held advanced degrees. The highest salaries were reported by those who had a Ph.D., with a median salary of $67,500. Master’s degree holders earned a median salary of $54,000, while bachelor’s degree holders earned $41,700. Over half of those responding also had income from secondary employment. The highest paid business economists were in the securities and investment, nondurable manufacturing, banking, real estate, and consulting industries. The lowest paid were in academia and government.

The Federal Government recognizes education and experience in certifying applicants for entry level positions. In general, the entrance salary for economists having a bachelor’s degree averaged about $17,000 a year in 1991; however, those with superior academic records could begin at $21,000. Those having a master’s degree could qualify for positions at an annual salary of $25,700. Those with a Ph.D. could begin at $31,100, while some individuals with experience could start at $37,300. Economists in the Federal Government averaged around $50,100 a year in 1991.

As in many other professional occupations, economists and marketing research analysts often receive a basic benefit package which includes vacation and sick leave, health and life insurance, and a pension plan. For those entering academic careers, benefits may include summer research money, computer access, housing, and secretarial support.

Related Occupations

Economists are concerned with understanding and interpreting financial matters, among other subjects. Others with jobs in this area include financial managers, financial analysts, accountants and auditors, underwriters, actuaries, securities and financial services sales workers, credit analysts, loan officers, and budget officers.

Marketing research analysts are involved in social research, including the planning, implementation, and analysis of surveys to determine people’s needs and preferences. Other jobs using these skills include social welfare research workers, employment research and planning directors, sociologists, and urban and regional planners.

Sources of Additional Information

For information on careers in business economics, contact:
- National Association of Business Economists, 28790 Chagrin Blvd., Suite 300, Cleveland, OH 44122.
- American Marketing Association, 250 South Wacker Dr., Suite 200, Chicago, IL 60606.
- Marketing Research Association, 2189 Silas Deane Hwy., Suite 5, Rocky Hill, CT 06067.

Engineering, Science, and Data Processing Managers

(D.O.T. 003.167-034 and -070; 005.167-010 and 022; 007.167-014; 008.167-010; 010.161-014 and -018; 011.161-010; 012.167-058 and -062; 018.167-020; 019.167-014; 022.161-010; 029.167-014; 162.117-030; 169.167-030; and 189.117-014)

Nature of the Work

Engineering, science, and data processing managers plan, coordinate, and direct technical, scientific, and computer related activities. They...
supervise a staff of engineers, scientists, technicians, computer specialists, data processing workers, and support personnel.

Engineering, science, and data processing managers determine scientific and technical goals within broad outlines provided by top management. These goals may include the redesign of an industrial machine, improvements in manufacturing processes, the development of a large computer program, or advances in basic scientific research. Managers make detailed plans for the accomplishment of these goals—for example, they may develop the overall concepts of new products or identify problems standing in the way of project completion. They forecast costs and equipment and personnel needs for projects and programs. They hire and assign scientists, engineers, technicians, computer specialists, data processing workers, and support personnel to carry out specific parts of the projects, supervise their work, and review their designs, programs, and reports.

Managers coordinate the activities of their unit with other units or organizations. They confer with higher levels of management; with financial, industrial production, marketing, and other managers; and with contractors and equipment suppliers. They also establish working and administrative procedures and policies.

Engineering managers direct and coordinate production, operations, quality assurance, testing, or maintenance in industrial plants; or plan and coordinate the design and development of machinery, products, systems, and processes. Many are plant engineers, directing and coordinating the maintenance, operation, design, and installation of equipment and machinery in industrial plants. Others manage research and development activities that produce new products and processes or improve existing ones.

Natural science managers oversee activities in agricultural science, chemistry, biology, geology, meteorology, or physics. They manage research and development projects and direct and coordinate testing, quality control, and production activities in industrial plants.

Electronic data processing managers direct, plan, and coordinate data processing activities. Top level managers direct all computer-related activities in an organization. Others manage computer operations, software development, or data bases. They analyze the data processing requirements of their organization and assign, schedule, and review the work of systems analysts, computer programmers, and computer operators.

Some engineering, science, and data processing managers head a section of perhaps 3 to 10 or more scientists, engineers, or computer professionals. Above them are heads of divisions composed of a number of sections, with as many as 15 to 50 scientists or engineers. A few are directors of large laboratories or directors of research.

**Working Conditions**

Engineering, science, and data processing managers spend most of their time in an office. Some managers, however, may also work in laboratories or industrial plants, where they normally are exposed to the same conditions as research scientists and may occasionally be exposed to the same conditions as production workers. Most work at least 40 hours a week and may work much longer on occasion to meet project deadlines. Some may experience considerable pressure to meet technical or scientific goals within a short time or within a tight budget.

**Employment**

Engineering, science, and data processing managers held about 315,000 jobs in 1990. Although these managers are found in almost all industries, almost half are employed in manufacturing, especially in the industrial machinery and equipment, electrical and electronic equipment, transportation equipment, and chemicals industries. They also work for engineering, management, and computer and data processing services companies; as well as for government, colleges and universities, and nonprofit research organizations. The majority are engineering managers, often managing industrial research, development, and design projects.

**Training, Other Qualifications, and Advancement**

Experience as an engineer, mathematician, natural scientist, or computer professional is the usual requirement for becoming an engineer, science, or data processing manager. Consequently, educational requirements are similar to those for scientists, engineers, and data processing professionals.

Engineering managers start as engineers. A bachelor’s degree in engineering from an accredited engineering program is acceptable for beginning engineering jobs, but many engineers increase their chances for promotion to manager by obtaining a master’s degree in engineering or business administration. A degree in business administration or engineering management is especially useful for becoming a general manager.

Natural science managers usually start as a chemist, physicist, biologist, or other natural scientist. A large proportion of natural scientists have a Ph.D. degree, especially those engaged in basic research, although some in applied research and other activities have lesser degrees. First-level science managers are usually specialists in the work they supervise. For example, the manager of a group of physicists doing optical research is almost always a physicist who is an expert in optics.

Most data processing managers have been systems analysts, although some may have experience as programmers or in other computer specialties. There is no universally accepted way of preparing for a job as a systems analyst, but a bachelor’s degree is usually required. A graduate degree often is preferred. Many systems analysts have degrees in computer or information science, computer information systems, or data processing and have experience as computer programmers. A typical career advancement progression in a large organization would be from programmer to programmer/analyst, to systems analyst, and then to project leader or senior analyst. The first real managerial position might be as project manager, programming supervisor, systems supervisor, or software manager.

In addition to educational requirements, scientists, engineers, or computer specialists generally must have demonstrated above-average technical skills to be considered for promotion to manager. Superiors also look for leadership and communication skills, as well as managerial attributes such as the ability to make rational decisions, to manage time well, to organize and coordinate work effectively, to establish good working and personal relationships, and to motivate others. Also, a successful manager must have the desire to manage. Many scientists, engineers, and computer specialists want to be promoted but actually prefer doing technical work.

Some scientists and engineers become managers in marketing, personnel, purchasing, or other areas or become general managers.

**Job Outlook**

Employment of engineering and science managers is expected to increase faster than the average for all occupations through the year 2005. Employment growth of each type of manager is expected to correspond closely with growth of the occupation they supervise. (See the statements on natural scientists, engineers, computer programmers, and systems analysts elsewhere in the *Handbook.*)

Underlying much of the growth of managers in science and engineering is the expected continued growth of research and develop-
ment as companies update and improve products more frequently. Increased research and investment in plants to expand output of goods and services and to raise productivity also will add to employment requirements for science and engineering managers involved in research and development, design, and the operation and maintenance of production facilities. The development of new technologies in new areas such as superconductivity, medical diagnostics, and advanced materials also will help to develop newer, higher quality products. Employment of data processing managers will increase as the economy expands and as advances in technology lead to broader applications for computers.

Despite growth in employment, most job openings will result from the need to replace workers who leave the occupation.

Because many engineers, natural scientists, and computer specialists are eligible for management and seek promotion, there is substantial competition for these jobs.

Earnings
Earnings for engineering, science, and data processing managers vary by specialty and level of management. Salaries in 1990 ranged from about $40,000 for first level data processing managers to well over $100,000 for the most senior managers in large organizations, according to the limited data available. Managers often earn about 15 to 25 percent more than those they directly supervise, although there are cases where some employees are paid more than the manager who supervises them.

In addition, engineering, science, and data processing managers, especially those at higher levels, often are provided more fringe benefits than non-managerial workers in their organizations. Higher level managers often are provided with expense accounts, stock option plans, and bonuses.

Related Occupations
The work of engineering, science, and data processing managers is closely related to that of engineers, natural scientists, computer personnel, and mathematicians. It is also related to the work of other managers, especially general managers and top executives.

Sources of Additional Information
Contact the sources of additional information on engineers, natural scientists, and systems analysts that are listed in statements on these occupations elsewhere in the Handbook.

Mathematicians
(D.O.T. 020.067-014, .187-018, 199.267-014)

Nature of the Work
Mathematics is one of the oldest and most basic sciences. Mathematicians today are engaged in a wide variety of activities, ranging from the creation of new theories and techniques to the translation of economic, scientific, engineering, and managerial problems into mathematical terms.

Mathematical work falls into two broad classes: Theoretical (pure) mathematics; and applied mathematics. However, these classes are not sharply defined and often overlap.

Theoretical mathematicians advance mathematical science by developing new principles and new relationships between existing principles of mathematics. Although they seek to increase basic knowledge without necessarily considering its practical use, this pure and abstract knowledge has been instrumental in producing many scientific and engineering achievements.

Applied mathematicians use mathematics to develop theories and techniques, such as mathematical modeling and computational methods, to solve practical problems in business, government, engineering, and the physical, life, and social sciences. For example, they may analyze the mathematical aspects of launching communications satellites, the effects of new drugs on disease, the aerodynamic characteristics of objects, and the distribution costs of businesses. Some mathematicians, called cryptanalysts, analyze and decipher encryption systems designed to transmit national security-related information.

Mathematicians use computers extensively in many phases of their work—analyzing relationships among variables, solving complex problems, developing models, and processing large amounts of data.

Much work in applied mathematics, however, is carried on by persons other than mathematicians. In fact, because mathematics is the foundation upon which many other academic disciplines are built, the number of workers using mathematical techniques is many times greater than the number actually designated as mathematicians. Engineers, computer scientists, and economists are among those who use mathematics extensively but have job titles other than mathematician. Some workers, such as statisticians, actuaries, and operations research analysts, actually are specialists in a particular branch of mathematics. (See statements on actuaries, operations research analysts, and statisticians elsewhere in the Handbook.)

Working Conditions
Mathematicians working for government agencies and private firms usually have structured work schedules. They may work alone, in a small group of mathematicians, or be an integral part of a team that includes engineers, computer scientists, and others. Deadlines, overtime work, special requests for information or analysis, and travel to attend seminars or conferences may be part of their jobs.

Mathematics faculty have flexible work schedules, dividing their time among teaching, research, consulting, and administrative responsibilities.

Employment
Mathematicians held about 22,000 jobs in 1990. In addition, several thousand persons held mathematics faculty positions in colleges and universities. (See the statement on college and university faculty elsewhere in the Handbook.)

Most mathematicians work in the government and in service and manufacturing industries. The Department of Defense is the primary Federal employer of mathematicians. Smaller numbers work for the National Aeronautics and Space Administration and the Department of Commerce. Major employers within the services sector include educational services; computer and data processing services; research and testing services; and management and public relations firms. Within manufacturing, the aircraft and chemicals industries are key
employers. Some mathematicians also work for banks, insurance companies, and public utilities.

**Training, Other Qualifications, and Advancement**

A bachelor’s degree in mathematics is the minimum education needed for prospective mathematicians. A master’s degree in mathematics is sufficient preparation for some research positions and for teaching jobs in most junior or community colleges and in some small 4-year colleges. However, in most 4-year colleges and universities, a Ph.D. degree is necessary for full faculty status.

In the Federal Government, job candidates must have a 4-year degree with a major in mathematics or a 4-year degree with the equivalent of a mathematics major—24 semester hours of mathematics courses.

In private industry, job candidates generally need a master’s degree to obtain jobs as mathematicians. The majority of bachelor’s and master’s degree holders in private industry work, not as mathematicians, but in related fields such as computer science, where they are called computer programmers, systems analysts, or systems engineers.

A bachelor’s degree in mathematics is offered by most colleges and universities. Mathematics courses usually required for this degree are analytical geometry, calculus, differential equations, and linear algebra. Additional coursework might include probability theory and statistics, mathematical analysis, numerical analysis, topology, modern algebra, discrete mathematics, and mathematical logic. Many colleges and universities urge or even require students majoring in mathematics to take several courses in a field that uses or is closely related to mathematics, such as computer science, engineering, operations research, a physical science, statistics, or economics. A double major in mathematics and either computer science, or one of the sciences is particularly desirable. A prospective college mathematics major should take as many mathematics courses as possible while in high school.

In 1990, 258 colleges and universities offered a master’s degree in mathematics; 175 also offered a Ph.D. in pure or applied mathematics. In graduate school, students conduct research and take advanced courses, usually specializing in a subfield of mathematics. Some areas of concentration are algebra, number theory, real or complex analysis, geometry, topology, logic, and applied mathematics.

In addition, a strong background in mathematics facilitates employment in fields such as engineering, economics, finance, and physics.

**Related Occupations**

Other occupations that require a degree in or extensive knowledge of mathematics include actuary, statistician, computer programmer, systems analyst, systems engineer, and operations research analyst. In addition, an increasing number of workers have job titles which reflect the end product of their work rather than the discipline of mathematics used in that work. Therefore, although employment of mathematicians will not increase much, those with degrees in mathematics should have good job opportunities.

Bachelor’s degree holders in mathematics with a strong background in computer science, electrical or mechanical engineering, or operations research should have very good opportunities in industry and government. Those who meet state certification requirements may become high school mathematics teachers. (For additional information, see the statement on secondary school teachers elsewhere in the Handbook.)

Holders of a master’s degree in mathematics may face competition for jobs in college teaching or theoretical research. However, job opportunities in applied mathematics and related areas such as computer science and data processing in industry and government will be more numerous.

In industry, holders of the doctorate in applied mathematics are expected to have better employment prospects than their theoretically oriented colleagues. Holders of a doctorate in theoretical mathematics should have improved opportunities for teaching and research jobs in colleges and universities by the late 1990’s, when large numbers of mathematics faculty will reach retirement age.

**Earnings**

According to a 1990 College Placement Council Survey, starting salary offers for mathematics graduates with a bachelor’s degree averaged about $27,000 a year; for those with a master’s degree, $30,100; and for new graduates having the Ph.D., $42,800. Starting salaries were generally higher in industry than in government or educational institutions. For example, the American Mathematical Society reported that, based on a 1990 survey, median annual earnings for new recipients of doctorates in research were $30,000; for those in teaching or teaching and research, $36,500; for those in government, $37,800; and for those in business and industry, $49,500.

In the Federal Government in 1991, the average annual salary for all mathematicians in supervisory, nonsupervisory, and managerial positions was $48,000; for mathematical statisticians, $48,427; and for cryptanalysts, $34,885.

Benefits for mathematicians tend to be similar to those offered to most professionals who work in office settings: Vacation and sick leave, health and life insurance, and a retirement plan, among others.

**Sources of Additional Information**

For more information about the field of mathematics, including career opportunities and professional training, contact:

- American Mathematical Society, P.O. Box 6248, Providence, RI 02940.
- Mathematical Association of America, 1529 18th St. NW., Washington, DC 20036.

For specific information on careers in applied mathematics, contact:

- Society for Industrial and Applied Mathematics, 3600 University City Science Center, Philadelphia, PA 19104-2688.

- National Council of Teachers of Mathematics, 1906 Association Dr., Reston, VA 22091.

Information on Federal job opportunities is available from area offices of the State employment service and the U.S. Office of Personnel Management’s Federal Job Information Centers located in various large cities throughout the country.

**Operations Research Analysts**

(D.O.T. 020.067-018)

**Nature of the Work**

Running a complex organization or operation such as a large manufacturing plant, an airline, or a military deployment requires the precise coordination of materials, machines, and people. Operations research analysts help organizations coordinate and operate in the most efficient manner by applying scientific methods and mathematical principles to organizational problems. Managers can then evaluate alternatives and choose the course of action that best suits the organization.
Operations research analysts, also called management science analysts, are problem solvers. The problems they tackle are for the most part those encountered in large business organizations: Strategy, forecasting, resource allocation, facilities layout, inventory control, personnel schedules, and distribution systems. The method they use generally revolves about a mathematical model or set of equations that explains how things happen within the organization. Models are simplified representations that enable the analyst to break down systems into their component parts, assign numerical values to each component, and examine the mathematical relationships between them. These values can be altered to determine what will happen to the system under different sets of circumstances. Types of models include simulation, linear optimization, networks, waiting lines, and game theory.

Operations research analysts use computers extensively in their work. They are typically proficient in database management, programming, and in the development and use of sophisticated software programs. Most of the models built by operations research analysts are so complicated that only a computer can solve them efficiently. The type of problem they usually handle varies by industry. For example, an analyst for an airline would coordinate flight and maintenance scheduling, passenger level estimates, and fuel consumption to produce a schedule that optimizes all of these factors to ensure safety and produce the most profits. An analyst employed by a hospital would concentrate on a different set of problems—scheduling admissions, managing patient flow, assigning shifts, monitoring use of pharmacy and laboratory services, or forecasting demand for new hospital services.

The role of the operations research analyst varies according to the structure and management philosophy of the firm. Some centralize operations research in one department; others disperse operations research personnel throughout all divisions. Some operations research analysts specialize in one type of application; others are generalists.

The degree of supervision varies by organizational structure and experience. In some organizations, analysts have a great deal of professional autonomy; in others, analysts are more closely supervised. Operations research analysts work closely with senior managers, who have a wide variety of support needs. Analysts must adapt their work to reflect these requirements.

Regardless of the industry or structure of the organization, operations research entails a similar set of procedures. Managers begin the process by describing the symptoms of a problem to the analyst. The analyst then defines the problem, which sometimes is general in nature and at other times specific. For example, an operations research analyst for an auto manufacturer may want to determine the most efficient amount of steel to be kept on hand, for example, operating scheduling, passenger level estimates, and fuel consumption to produce a schedule that optimizes all of these factors to ensure safety and produce the most profits. An analyst employed by a hospital would concentrate on a different set of problems—scheduling admissions, managing patient flow, assigning shifts, monitoring use of pharmacy and laboratory services, or forecasting demand for new hospital services.

Beginning analysts usually do routine work under the supervision of experienced analysts. As they gain knowledge and experience, they are assigned more complex tasks, with greater autonomy to reflect these requirements.

Regardless of the industry or structure of the organization, operations research entails a similar set of procedures. Managers begin the process by describing the symptoms of a problem to the analyst. The analyst then defines the problem, which sometimes is general in nature and at other times specific. For example, an operations research analyst for an auto manufacturer may want to determine the most efficient amount of steel to be kept on hand, for example, operating scheduling, passenger level estimates, and fuel consumption to produce a schedule that optimizes all of these factors to ensure safety and produce the most profits. An analyst employed by a hospital would concentrate on a different set of problems—scheduling admissions, managing patient flow, assigning shifts, monitoring use of pharmacy and laboratory services, or forecasting demand for new hospital services.

With this information in hand, the operations research analyst is ready to select the most appropriate analytical technique. There may be several techniques that could be used, or there may be one standard model or technique that is used in all instances. In a few cases, the analyst must construct an original model to examine and explain the system. In almost all cases, the selected model must be modified to reflect the specific circumstances of the situation.

A model for airline flight scheduling, for example, might take into account the amount of fuel required to fly the routes, several project levels of passenger demand, varying ticket prices, pilot scheduling, and maintenance costs. The analyst chooses the values for these variables, enters them into a computer, which has already been programmed to make the calculations required, and runs the program to produce the best flight schedule consistent with several sets of assumptions. The analyst would probably design a model that would take into account wide variations in the different variables.

At this point, the operations research analyst presents the final work to management along with recommendations based on the results of the analysis. Additional runs based on different assumptions may be needed to help in making the final decision. Once a decision has been reached, the analyst works with the staff to ensure its successful implementation.

**Working Conditions**

Operations research analysts generally work regular hours in an office environment. Because they work on projects that are of immediate interest to management, analysts often are under pressure to meet deadlines and may work more than a 40-hour week. The work is sedentary in nature, and very little physical strength or stamina is required.

**Employment**

Operations research analysts held about 57,000 jobs in 1990. They are employed in most industries. Major employers include manufacturers of chemicals, machinery, and transportation equipment; firms providing transportation and telecommunications services; public utilities; banks; insurance agencies; and government agencies at all levels. Some analysts work for management consulting agencies that develop operations research applications for firms that do not have an in-house operations research staff.

Most analysts in the Federal Government work for the Armed Forces. In addition, many operations research analysts who work in private industry do work directly or indirectly related to National defense.

**Training, Other Qualifications, and Advancement**

Employers strongly prefer applicants with at least a master's degree in operations research or management science, mathematics, statistics, business administration, computer science, industrial engineering, or other quantitative disciplines. A high level of computer skills is also required.

The organizations often sponsor skill-improvement training for experienced workers, helping them keep up with new developments in operations research techniques as well as advances in computer science. Some analysts attend advanced university classes on these subjects.

Operations research analysts must be able to think logically and work well with people. Thus, employers prefer workers with good oral and written communication skills. The computer is the most important tool for quantitative analysis, and training or experience in programming is a must.

Beginning analysts usually do routine work under the supervision of experienced analysts. As they gain knowledge and experience, they are assigned more complex tasks, with greater autonomy to reflect these requirements.

Powerful personal computers and businesses' needs mean that employment of operations researchers likely will continue to grow rapidly.
design models and solve problems. Operations research analysts advance by assuming positions as technical specialists or supervisors. The skills acquired by operations research analysts are useful for upper level jobs in an organization, and experienced analysts with leadership potential often leave the field altogether to assume non-technical managerial or administrative positions.

Job Outlook
Employment of operations research analysts is expected to grow much faster than the average for all occupations through the year 2005 due to the increasing importance of quantitative analysis in decisionmaking and the increasing availability of computing resources. In addition to jobs arising from the increased demand for these workers, many openings will occur each year as workers transfer to other occupations or leave the labor force altogether.

More and more organizations are using operations research techniques to improve productivity and reduce costs. This reflects growing acceptance of a systematic approach to decisionmaking as well as more affordable computers, which give even small firms access to operations research applications. The interplay of these two trends should greatly stimulate demand for these workers in the years ahead.

Much of the job growth is expected to occur in the transportation, manufacturing, finance, and services sectors. Firms in these sectors recognize that quantitative analysis can achieve dramatic improvements in operating efficiency and profitability. More airlines, for example, are using operations research to determine the best flight and maintenance schedules, select the best routes to service, analyze customer characteristics, and control fuel consumption, among other things. Motel chains are beginning to utilize operations research analysis to improve their efficiency. For example, they analyze automotive traffic patterns and customer attitudes to determine location, size, and style of new motels. Like other management support functions, operations research is spread by its own success. When one firm in an industry increases productivity by adopting a new procedure, its competitors usually follow. This competitive pressure will contribute to demand for operations research analysts.

Demand also should be strong in the manufacturing sector as firms expand existing operations research staffs in the face of growing foreign competition. More and more manufacturers are using mathematical models to study parts of the organization for the first time. For example, analysts will be needed to determine the best way to distribute finished products and to find out where sales offices should be based. In addition, increasing factory automation will require more operations research analysts to alter existing models or develop new ones for production layout, robotics installation, work schedules, and inventory control.

The Department of Defense and defense contractors employ many operations research analysts. For example, operations researchers helped plan the 1990 military deployment to Saudi Arabia. They determined the best air and water transport schedules to move the maximum amount of personnel and equipment in the shortest time, making optimal use of people, ships, aircraft, and fuel. Since defense expenditures are likely to be cut in the future, there will be fewer jobs available in the military and defense-related industries for these workers. However, high demand outside the military should more than offset reductions in defense-related demand.

Earnings
According to recruiters and national operations research associations, operations research analysts with a master's degree generally earned starting salaries of about $30,000 to $35,000 a year in 1990. Experienced operations research analysts earned about $50,000 a year in 1990, with top salaries exceeding $90,000.

Operations research analysts employed by the Federal Government averaged about $32,100 a year in 1991.

Related Occupations
Operations research analysts apply mathematical principles to organizational problems. Workers in other occupations that stress quantitative analysis include computer scientists, applied mathematicians, statisticians, and economists. Operations research is closely allied to managerial occupations in that its goal is improved organizational efficiency.

Sources of Additional Information
Information on career opportunities for operations research analysts is available from:
- The Operations Research Society of America, 428 East Preston St., Baltimore, MD 21202.
- The Institute for Management Science, 290 Westminster St., Providence, RI 02903.
For information on careers in the Armed Forces and Department of Defense, contact:

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Statisticians
(D.O.T. 020.067-022, 167-026)

Nature of the Work
Statistics is the collection, analysis, and presentation of numerical data. Statisticians design, implement, and interpret the numerical results of surveys and experiments. In doing so, they often apply their knowledge of statistical methods to a particular subject area, such as biology, economics, engineering, medicine, or psychology. They may use statistical techniques to predict population growth or economic conditions, develop quality control tests for manufactured products, assess the nature of environmental problems, analyze legal and social problems, or help business managers and government officials make decisions and evaluate the results of new programs.

Often statisticians are able to obtain information about a group of people or things by surveying a small portion, called a sample, of the group. For example, to determine the size of the total audience for particular programs, television rating services ask only a few thousand families, rather than all viewers, what programs they watch. Statisticians decide where and how to gather the data, determine the type and size of the sample group, and develop the survey questionnaire or reporting form. They also prepare instructions for workers who will collect and tabulate the data. Statisticians use computers extensively to process large amounts of data for statistical modeling and graphic analysis.

Since statistics are used in so many areas, it sometimes is difficult to distinguish statisticians from specialists in other fields who use statistics. For example, a statistician working with data on economic conditions may have the title of economist.

Working Conditions
Statisticians usually work regular hours in offices. Some statisticians may travel occasionally to supervise or set up a survey, or to gather statistical data. Some may have fairly repetitive tasks, while others may have a variety of tasks, such as in designing experiments.

Employment
Statisticians held about 16,000 jobs in 1990. Over one-fourth of these jobs were in the Federal Government, where statisticians were concentrated in the Departments of Commerce—especially the Bureau of the Census; Agriculture; and Health and Human Services. Most of the remaining jobs were in private industry, especially in the insurance, transportation equipment, research and testing services, management and public relations, and computer and data processing services industries. Others worked in colleges and universities, non-commercial research organizations, and membership organizations.

Training, Other Qualifications, and Advancement
A bachelor's degree with a major in statistics or mathematics is the minimum educational requirement for many beginning jobs in statistics. The training required for employment as an entry level statistician in the Federal Government is a college degree including at least 15 semester hours of statistics—or a combination of 15 hours of math-
matistics and statistics if at least 6 semester hours are in statistics. An additional 9 semester hours in another academic discipline, such as economics, physical or biological science, medicine, education, engineering, or social science, are also required. Teaching and research positions in institutions of higher education and many positions in private industry require a graduate degree, often a doctorate, in statistics.

Over 70 colleges and universities offered bachelor’s degrees in statistics in 1990. Many other schools also offered degrees in mathematics, operations research, and other fields which included a sufficient number of courses in statistics to qualify graduates for some beginning positions. Required subjects for statistics majors include mathematics through differential and integral calculus, statistical methods, mathematical modeling, and probability theory. Additional courses that undergraduates should take include linear algebra, design and analysis of experiments, applied multivariate analysis, and mathematical statistics. Because computers are used extensively for statistical applications, a strong background in computer science is highly recommended; a double major in statistics and computer science is particularly desirable. For positions involving quality control, training in engineering or physical science is desirable. A background in biological or health science is useful in positions involving the preparation and testing of pharmaceutical or agricultural products. For many jobs in market research, business analysis, and forecasting, courses in economics and business administration are helpful.

In 1990, approximately 100 universities offered a master’s degree program in statistics, and about 70 had statistics departments which offered a doctoral degree program. Many other schools also offered graduate level courses in applied statistics for students majoring in biology, business, economics, education, engineering, psychology, and other fields. Acceptance into graduate statistics programs does not require an undergraduate degree in statistics although a good mathematics background is essential.

Good communications skills are important for prospective statisticians, not only for those who plan to teach, but also to qualify for many positions in industry, where the need to explain statistical processes to non-statisticians is common.

Beginning statisticians who have only the bachelor’s degree often spend much of their time doing routine work supervised by an experienced statistician. With experience, they may advance to positions of greater technical and supervisory responsibility. However, opportunities for promotion are best for those with advanced degrees.

Job Outlook
Although employment of statisticians is expected to grow more slowly than the average for all occupations through the year 2005, job opportunities should remain favorable. Many statistics majors, particularly at the bachelor’s degree level, but also at the master’s degree level, may find positions in which they do not have the title of statistician. This is especially true for those involved in analyzing and interpreting data from other disciplines such as economics, biological science, psychology, or engineering.

Among graduates with a bachelor’s degree in statistics, those with a strong background in mathematics and computer science should have the best prospects of finding jobs related to their field of study in private industry or government. Federal Government agencies will need statisticians in fields such as agriculture, demography, consumer and producer surveys, transportation, Social Security, health, education, energy conservation, and environmental quality control. However, competition for entry level positions in the Federal Government is expected to be strong for those just meeting the minimum qualification standards for statisticians. Those who meet State certification requirements may become high school statistics teachers, a newly emerging field. (For additional information, see the statement on secondary school teachers elsewhere in the Handbook.)

Private industry, in the face of increasing competition and strong government regulation, will require increasing numbers of statisticians, especially at the master’s degree level, to monitor productivity and quality in the manufacture of various products including pharmaceuticals, motor vehicles, chemicals, and food products. For example, pharmaceutical firms will need more statisticians to assess the safety and effectiveness of the rapidly expanding number of drugs. In an effort to meet growing competition, motor vehicle manufacturers will need more statisticians to monitor the quality of automobiles, trucks, and their components. Statisticians with knowledge of engineering and the physical sciences will find jobs working with scientists and engineers in research and development. Business firms will rely more heavily than in the past on statisticians to forecast sales, analyze business conditions, modernize accounting procedures, and help solve management problems. In addition, sophisticated statistical services will increasingly be contracted out to consulting firms.

Ph.D.’s in statistics should have excellent employment prospects, especially in large corporations and in colleges and universities. Large numbers of college and university faculty are expected to retire within 10 to 15 years, creating many openings for Ph.D. statisticians.

Earnings
The average annual salary for all statisticians in the Federal Government in nonsupervisory, supervisory, and managerial positions was about $47,618 in 1991; mathematical statisticians averaged $48,427. According to a 1990 American Statistical Association salary survey of statisticians in departments with programs in statistics, the starting median salary for assistant professors was $38,600; for associate professors, $43,000; and for professors, $54,700. Statisticians who hold advanced degrees and work in private industry generally earn higher starting salaries than their counterparts in academic settings and in government.

Benefits for statisticians tend to be similar to those offered most professionals who work in an office setting: Vacation and sick leave, health and life insurance, and a retirement plan, among others.

Related Occupations
People in numerous occupations work with statistics. Among them are actuaries, computer programmers, computer systems analysts, educators, engineers, economists, environmental scientists, financial analysts, health scientists, information scientists, life scientists, mathematicians, operations research analysts, physical scientists, and social scientists.

Sources of Additional Information
For information about career opportunities in statistics, contact:
- Institute of Mathematical Statistics, 3401 Investment Blvd., No. 7, Hayward, CA 94545.

Information on Federal job opportunities is available from area offices of the State employment service and the U.S. Office of Personnel Management or from Federal Job Information Centers located in various large cities throughout the country.
Related Publications

Occupational Projections and Training Data, 1992 Edition

This supplement to the Occupational Outlook Handbook provides the statistical and technical data supporting the information presented in the Handbook. Education and training planners, career counselors, and jobseekers can find valuable information that ranks occupations by employment growth, earnings, susceptibility to unemployment, separation rates, and part-time work.

Outlook 1990-2005

Every 2 years, the Bureau of Labor Statistics produces detailed projections of the U.S. economy and labor force. This bulletin presents the Bureau's latest analyses of economic and industrial growth, the labor force, and trends in occupational employment into the 21st century. An overview article focuses on important issues raised by these projections.

Note:
At press time, prices for these publications were not available. For prices and ordering information, contact any of the Bureau of Labor Statistics Regional Offices listed on the inside of the front cover, or the Division of Occupational Outlook, Bureau of Labor Statistics, Washington, DC 20212.
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Note: At press time, the price for this publication was not available. Contact any of the Bureau of Labor Statistics Regional Offices listed on the inside front cover, or the Division of Occupational Outlook, Bureau of Labor Statistics, Washington, DC 20212.
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