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ABSTRACT

Focusing on mathematics and related occupations, this document is one in a series of forty-one reprints from the Occupational Outlook Handbook providing current information and employment projections for individual occupations and industries through 1985. The specific occupations covered in this document include accountants, actuaries, mathematicians, programmers, statisticians, and systems analysts. The following information is presented for each occupation or occupational area: a code number referenced to the Dictionary of Occupational Titles; a description of the nature of the work; places of employment; training, other qualifications, and advancement; employment outlook; earnings and working conditions; and sources of additional information. In addition to the forty-one reprints covering individual occupations or occupational areas (CE 017 757-797), a companion document (CE 017 756) presents employment projections for the total labor market and discusses the relationship between job prospects and education. (BM)

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Mathematics and Related Occupations

Reprinted from the
Occupational Outlook Handbook,
1978-79 Edition.
U.S. Department of Labor
Bureau of Labor Statistics,
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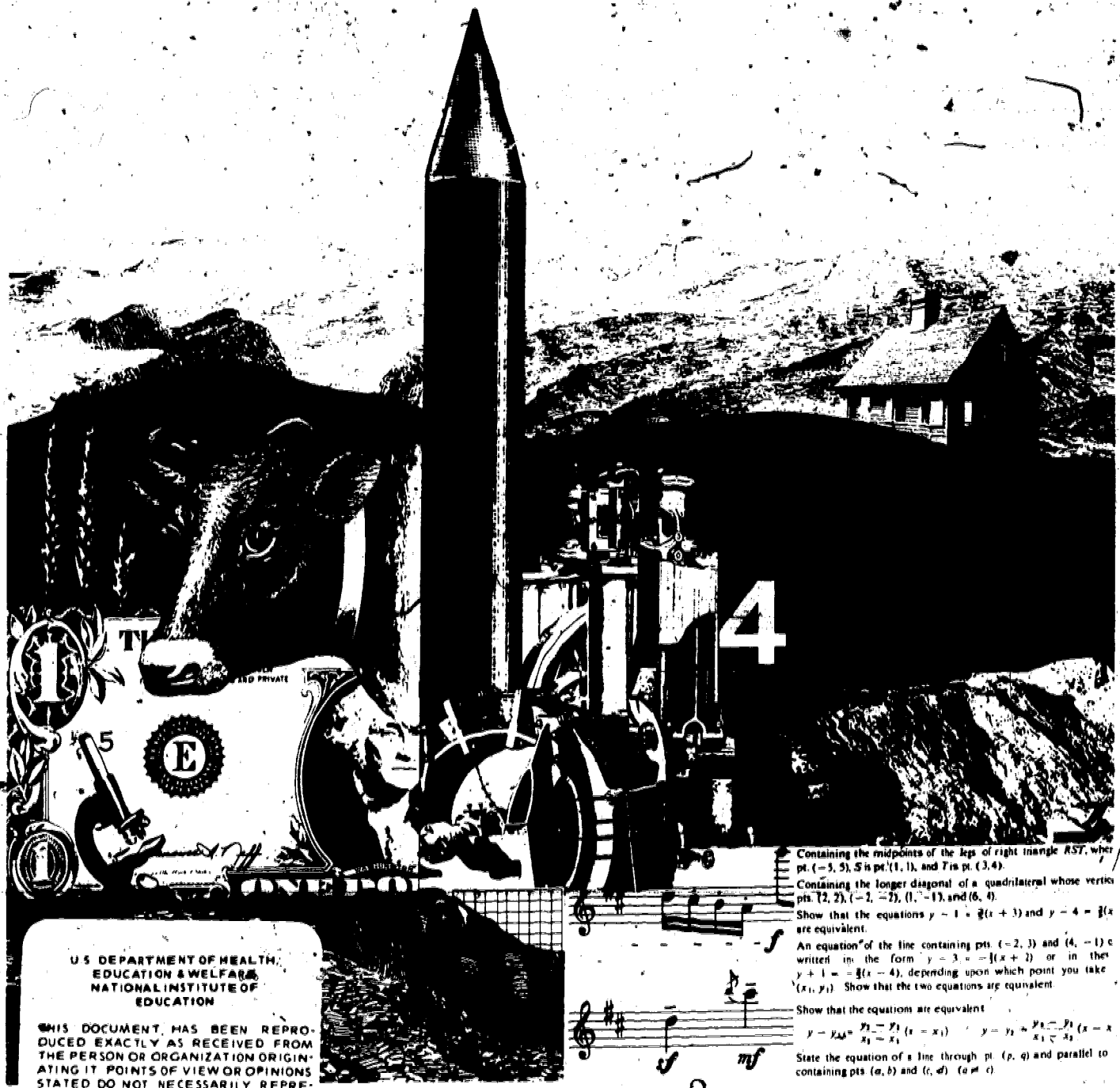
Bulletin 1955-22

CE 017 776



Containing the midpoints of the legs of right triangle *RST*, wher
pt. (−5, 5), *S* is pt. (1, 1), and *T* is pt. (3, 4).

Containing the longer diagonal of a quadrilateral whose vertic
pts. (2, 2), (−2, −2), (1, −1), and (6, 4).

Show that the equations $y - 1 = \frac{2}{3}(x + 3)$ and $y - 4 = \frac{2}{3}(x$
are equivalent.

An equation of the line containing pts. (−2, 3) and (4, −1) c
written in the form $y - 3 = -\frac{2}{3}(x + 2)$ or in the
$y + 1 = -\frac{2}{3}(x - 4)$, depending upon which point you take
(x_1, y_1). Show that the two equations are equivalent.

Show that the equations are equivalent.

$y - y_{AB} = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$ $\quad y = y_2 + \frac{y_2 - y_1}{x_2 - x_1}(x - x_2)$

State the equation of a line through pt. (p, q) and parallel to
containing pts. (a, b) and (c, d). $(a \neq c)$

U S DEPARTMENT OF HEALTH,
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ACCOUNTANTS

(D.O.T. 160.188)

Nature of the Work

Managers must have up-to-date financial information to make important decisions. Accountants prepare and analyze financial reports that furnish this kind of information.

Three major accounting fields are public, management, and government accounting. Public accountants have their own businesses or work for accounting firms. Management accountants, also called industrial or private accountants, handle the financial records of the company they work for. Government accountants examine the records of government agencies and audit private businesses and individuals whose dealings are subject to government regulations.

Accountants often concentrate on one particular phase of accounting. For example, many public accountants specialize in auditing (reviewing a client's financial records and reports to judge their reliability). Others specialize in tax matters, such as preparing income tax forms and advising their clients of the advantages and disadvantages of certain business decisions. Still others become specialists in management consulting and give advice on a variety of matters. They might develop or revise an accounting system to serve the needs of clients more effectively or give advice about different types of accounting equipment.

Management accountants provide the financial information executives need to make sound business decisions. They may choose to work in areas such as taxation, budgeting, or investments. Internal auditing is an area of specialization within management accounting that is rapidly growing in importance. Accountants who work as internal auditors examine and evaluate their firm's financial systems and management control procedures to ensure efficient and economical operation.

Many accountants in the Federal Government work as Internal Revenue agents, investigators, and bank examiners; other government accountants have regular accounting positions.

Traveling auditor reviewing financial records at a company plant.

Places of Employment

About 865,000 people worked as accountants in 1976. Almost 20 percent were Certified Public Accountants (CPA's) and nearly 12 percent were Certified Internal Auditors (CIA's).

About 60 percent of all accountants do management accounting work; one-fifth of these work as internal auditors. An additional 25 percent are engaged in public accounting as proprietors, partners, or employees of independent accounting firms. Other accountants work for Federal, State, and local government agencies, and a small number teach in colleges and universities.

Opportunities are plentiful for part-time work in accounting, particularly in smaller firms.

Accountants are found in all business, industrial, and government organizations. Most, however, work in large urban areas where many public accounting firms and central offices of large businesses are concentrated. For example, over 20 percent of all accountants are employed in just four major cities: Chicago; Los Angeles; New York; and Washington, D.C.

Training, Other Qualifications, and Advancement

Training in accounting is available at colleges and universities, accounting and business schools, and correspondence schools. Although many graduates of business and correspondence schools are successful in small firms, most large 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 closely related field. Many employers prefer those with the master's degree in accounting. A growing number of large employers prefer applicants who are familiar with computer technology for both accounting and internal auditor positions. For beginning accounting positions, the Federal Government requires 4 years of college training (including 24 semester hours in accounting) or an equivalent combination of education and experience. For teaching positions, most colleges and universities require at least the master's degree or the Certified Public Accountancy Certificate.

Previous work experience in accounting can help an applicant get a job. Many colleges offer students an opportunity to gain experience through internship programs conducted by public accounting or business firms.

Anyone working as a "certified public accountant" must hold a certificate issued by the State board of accountancy. All states use the CPA examination, prepared by the American Institute of Certified Public Accountants, to establish certification. Most successful candidates have college degrees, and three-fourths of the States require CPA candidates to be college graduates. Nearly all States require applicants to have at least 2 years of public accounting experience for a CPA certificate.

Requirements vary, but more than half the States restrict the title "public accountant" to those who are licensed or registered. Some States require only a high school diploma while others require 2 years of college or more. Information on requirements may be obtained directly from individual State boards of accountancy or from the National Society of Public Accountants.

The recognized mark of competence and experience in the field of internal auditing is the designation, Certified Internal Auditor (CIA). The Institute of Internal Auditors, Inc., confers this designation upon candidates who have completed 3 years' experience in internal auditing and who have passed a four-part examination. Beginning in 1978, a bachelor's degree from an accredited college or university also will be required.

Persons planning a career in accounting should have an aptitude for mathematics. Neatness and accuracy also are necessary. Employers seek applicants who can handle responsibility and work with little supervision.

To get to the top in the profession, accountants usually must continue their study of accounting even though they already have a college degree or professional certificates. They may participate in seminars sponsored by various professional associations or take courses offered by their employers. A growing number of States require both CPA's and licensed public accountants to complete a certain number of hours of continuing education courses before their licenses can be renewed. An increasing number of accountants study computer operation and programming to adapt accounting procedures to new data processing methods. Although capable accountants should advance rapidly, those having inadequate academic preparation may be assigned routine jobs and find promotion difficult.

Junior public accountants usually start by assisting with auditing work for several clients. They may advance to intermediate positions with more responsibility in 1 or 2 years and to senior positions within another few years. In larger firms, those who deal successfully with top industry executives often become supervisors, managers, or partners, or transfer to executive positions in private firms. Some open their own public accounting offices.

Beginning management accountants often start as ledger accountants, junior internal auditors, or as trainees for technical accounting positions. They may advance to jobs such as chief plant accountant, chief cost accountant, budget director, or manager of internal auditing. Some become controllers, treasurers, financial vice-presidents, or corporation presidents. In the Federal Government, beginners are hired as trainees and usually are promoted in a year or so. In college and university teaching, those having minimum training and experience may receive the rank of instructor without tenure; advancement and permanent faculty status depend upon further education and teaching experience.

Employment Outlook

Employment is expected to increase about as fast as the average for all occupations through the mid-1980's as businesses and government agencies continue to expand in size and complexity. In addition to jobs resulting from growth, many thousands of openings will result each year when workers die, retire, or leave the occupation.

Demand for skilled accountants will rise as managers rely more on accounting information to make business decisions. For example, officers of large corporations base their decisions concerning proposals such as plant expansion, mergers, or foreign investments on information about the financial condition of the firm, tax implications of the proposed action, and other considerations. On a smaller scale, owners of

small businesses are expected to rely more and more on the expertise of public accountants in planning their operations. Government legislation to monitor business activity also is expected to add to the demand for accountants. An example is the Pension Reform Act of 1974, which establishes minimum standards for private pension plans. This and other legislation should create many new jobs for management accountants to maintain new systems and public accountants to audit them.

Because of the growing complexity of business, college graduates will be in greater demand than applicants who lack this training. Many employers prefer graduates who have worked part time in a business or accounting firm while in school. Those who have been trained in a specific phase of accounting should find ample opportunities.

As data processing systems continue to replace manual preparation of accounting records and statements, the need for some accountants to perform routine tasks, particularly in large firms, may be reduced. However, many opportunities will arise for accountants without a college degree, mainly in small businesses and public accounting firms.

Earnings and Working Conditions

Starting salaries of beginning accountants in private industry were $11,500 a year in 1976, according to a survey in urban areas. Earnings of experienced accountants ranged between $15,400 and $23,400, depending on their level of responsibility and the complexity of the accounting system. In general, experienced accountants earn about twice as much as nonsupervisory workers in private industry, except farming. Chief accountants who direct the accounting program of a company or one of its establishments earned between $20,500 and $33,900, depending upon the scope of their authority and size of professional staff.

According to the same survey, beginning auditors averaged $11,800 a year in 1976, while experienced auditors' earnings ranged between $16,100 and $20,000.

In the Federal Civil Service, the entrance salary for junior accountants and auditors was about $9,300 in 1977. Candidates who had a superior academic record received a starting salary of about $11,500. Applicants with a master's degree or 2 years' professional experience began at about $14,100. Accountants in the Federal Government averaged about $21,800 a year in 1977.

Accountants who specialize in income tax preparation work long hours under heavy pressure during the tax season; those employed by national accounting firms may travel extensively to conduct audits and perform other services for their clients. The majority, however, work in one office between 35 and 40 hours a week, under the same general conditions as fellow office workers.

Sources of Additional Information

Information about CPA's and about aptitude tests in high schools, colleges, and public accounting firms may be obtained from:

American Institute of Certified Public Accountants, 1211 Avenue of the Americas, New York, N.Y. 10036.

Further information on specialized fields of accounting is available from:

National Association of Accountants, 919 Third Ave., New York, N.Y. 10022.

National Society of Public Accountants, 1717 Pennsylvania Ave. NW., Washington, D.C. 20006.

Institute of Internal Auditors, 249 Maitland Ave., Altamonte Springs, Fla. 32701.

ACTUARIES

(D.O.T. 020.188)

Nature of the Work

Why do young persons pay more for automobile insurance than older persons? How much should an insurance policy cost? Answers to these and similar questions are provided by actuaries who design insurance and pension plans that can be maintained on a sound financial basis. They assemble and analyze statistics to calculate probabilities of death, sickness, injury, disability, unemployment, retirement, and property loss from accident, theft, fire, and other potential hazards. Actuaries use this information to determine the expected insured loss. For example, they may calculate how many persons who are 21 years old today can be expected to live to age 65—the probability that an insured person might die during this period is a risk to the company. They then calculate a price for assuming this risk that will be profitable to the company yet be competitive with other insurance companies. Finally, they must make sure that the price charged for the insurance will enable the company to pay all claims and expenses as they occur. In the same 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 liability (casualty) insurance; a growing number specialize in pension plans.

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 on problems arising in their company's investment, group underwriting, or pension planning departments. Actuaries in executive positions help determine general company policy. In that role, they may be called upon to explain complex technical matters to 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 intended changes in premium rates or contract provisions.

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 positions regulate insurance companies, supervise the

Employment of actuaries is influenced by the volume of insurance sales.

operations of State retirement or pension systems, and work on problems connected with unemployment insurance or workers' compensation. Consulting actuaries set up pension and welfare plans for private companies, unions, and government agencies. They calculate future benefits and determine the amount of the annual employer contribution. Actuaries who are enrolled under the provisions of the Employee Retirement Income Security Act of 1974 (ERISA) evaluate these pension plans and submit reports certifying their financial soundness.

Places of Employment

Approximately 9,000 persons worked as actuaries in 1976. Four of every 10 actuaries worked in five major cities—New York, Hartford, Chicago, Philadelphia, and Boston.

About two-thirds of all actuaries worked for private insurance companies. Almost 90 percent of these worked for life insurance companies; the rest worked for property and liability (casualty) companies. The number of actuaries employed by an insurance company depends on the volume of its business and the number and types of insurance policies it offers. Large companies may employ over 100 actuaries on their staffs; others, generally smaller companies, may rely instead on consulting firms or rating bureaus (associations that supply actuarial data to member companies).

Consulting firms and rating bureaus employ about one-fifth of all actuaries. Other actuaries work for private organizations administering independent pension and welfare plans or for Federal and State government agencies. A few teach in colleges and universities.

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 with a major in mathematics or statistics; a degree in actuarial science is even better. Some companies hire applicants with a major in engineering, economics, or business administration, provided they demonstrate a thorough foundation in calculus, probability, and statistics (20-25 hours). Other desirable courses are insurance law, economics, and accounting. Although only 25 colleges and universities offer a degree in actuarial science, several hundred schools offer a degree in mathematics or statistics.

A strong background in mathematics is essential for persons interested in a career as an actuary. Of equal importance, however, is the need to pass while in school one or more of the examinations offered by professional societies. Three societies sponsor programs leading to full professional status in their speciality. The Society of Actuaries gives 9 actuarial examinations for the life and health insurance and pension field, the Casualty Actuarial Society gives 10 examinations for the property and liability field, and the American Society of Pension Actuaries gives nine examinations covering the pension field. Because the first parts of the examination series of each society cover similar materials, students need not commit themselves to a career specialty until they have taken about four examinations. Success in passing the first few examinations helps students evaluate their potential as actuaries. Those who pass these examinations usually have better opportunities for employment and receive a higher starting salary.

Actuaries are encouraged to complete an entire series of examinations as soon as possible. It generally takes from 5 to 10 years to complete the series required for full professional status. Examinations are given twice each year. Extensive home study is required in order to pass the advanced examinations; many actuaries spend as much as 20-25 hours a week studying. Actuaries who complete five examinations in either the life insurance series or the pension series or seven examinations in the casualty series are awarded "associate" membership in their respective society. Those who have passed an entire series receive full membership and the title "fellow."

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

Beginning actuaries often rotate among different jobs to learn various actuarial operations and to become familiar with different phases of insurance work. At first, their work may be rather routine, such as preparing calculations or tabulations for actuarial tables or reports. As they

gain experience, they may supervise actuarial 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. Many actuaries, because of their broad knowledge of insurance and related fields, are selected for administrative positions in other company activities, particularly in underwriting, accounting, or data processing departments. Many actuaries advance to top executive positions.

Employment Outlook

Employment of actuaries is expected to rise faster than the average for all occupations through the mid-1980's. In addition to job openings resulting from this growth, several hundred actuaries will be needed each year to replace those who retire, die, or transfer to other occupations. Job opportunities will be best for new college graduates who have passed at least two actuarial examinations while still in school and have a strong mathematical and statistical background. However, because of the large number of persons expected to receive degrees in actuarial science, mathematics, and statistics, and the large number of students taking actuarial examinations, competition for beginning jobs should remain keen.

Employment in this occupation is influenced to a great extent by the volume of insurance sales, which will continue to grow over the next decade. Shifts in the age distribution of the population through the mid-1980's will result in many more people with established careers and family responsibilities. This is the group that traditionally has accounted for the bulk of private insurance sales.

Increased sales, however, are only one determinant of the demand for actuaries. In addition, changes in existing insurance practices are creating a need for more actuarial services. As more and more insurance companies branch out into more than one kind of insurance coverage, a greater number of actuaries will be needed to establish the rates for the variety of insurance offered. Growth in sales of relatively new forms of protection, such as dental, prepaid legal, and kidnap insurance will create additional demand for actuaries. As more States pass competitive rating laws, many companies that previously relied on rating bureaus for actuarial data can be expected to expand existing actuarial departments or create new ones.

Recent court decisions concerning product liability have focused much attention on this complex area. In the years ahead, actuaries will be spending a lot of time developing better ways to provide product liability, medical malpractice, and workers' compensation insurance protection.

Adoption of a "no-fault" automobile insurance plan requires companies writing automobile insurance to reevaluate their pricing structures in light of no-fault requirements. It is uncertain whether Federal no-fault legislation will be enacted soon; however, the growing number of States enacting no-fault plans or revising existing ones indicates continued strong demand for actuaries to make the required analyses.

ERISA has imposed strict responsibilities on actuaries for the operation and funding of pension plans. As the number of pension plans continues to grow, there will be an increasing need for pension specialists to develop adequately financed plans and to prepare the reports that certify their solvency.

Earnings and Working Conditions

In 1976, actuaries had average salaries more than twice as high as the average for all nonsupervisory workers in private industry, except farming. New college graduates entering the life insurance field without having passed any actuarial exams averaged $10,600 in 1976, according to a survey of U.S. companies by the Life Office Management Association (LOMA). Applicants who had successfully completed the first exam received $11,200 and those who had passed two exams averaged $11,800.

In the Federal Government, new graduates with the bachelor's degree could start at $9,300 a year in 1977. Applicants with either 1 year of graduate study or relevant work experience were hired at $11,500, and those with the master's degree or 2 years' experience started at $14,100 a year. Actuaries in the Federal Government averaged $25,100 a year in 1977.

Beginning actuaries can look forward to a marked increase in earnings as they gain professional experience and advance in an actuarial society's examination program. Life insurance companies usually give merit increases averaging from $500 to $850 to their actuaries as they pass each successive examination leading to membership in the Society of Actuaries. Associates who received that designation in 1976 averaged $16,500 a year; salaries for actuaries who were awarded a full fellowship during that year averaged $24,800. Fellows with additional years of experience earned substantially more—top actuarial executives averaged about $43,000 in 1976.

Although data are not available for salaries paid actuaries in casualty companies or consulting firms, it is believed that salaries for these specialists generally are comparable to those paid by life insurance companies.

Sources of Additional Information

For facts about actuarial opportunities and qualifications, contact:

American Society of Pension Actuaries, 1700 K St., NW., Washington, D.C. 20006.

Casualty Actuarial Society, 200 East 42nd St., New York, N.Y. 10017.

Society of Actuaries, 208 South LaSalle St., Chicago, Ill. 60604.

MATHEMATICIANS

(D.O.T. 020.088)

Nature of the Work

Mathematicians work with one of the oldest and most vital of all sciences. Mathematicians today are engaged in a wide variety of activities,

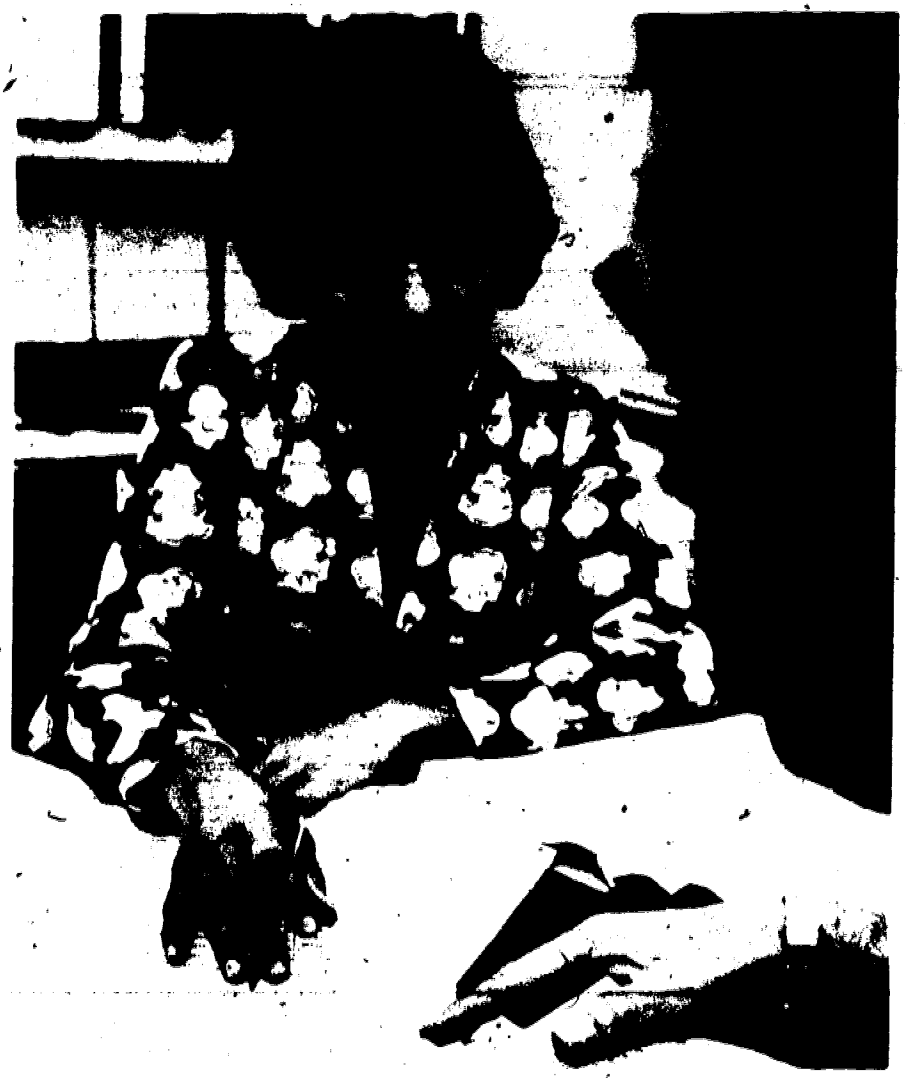
ranging from the creation of new theories to the translation of scientific and managerial problems into mathematical terms.

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. For example, in 1854 Bernard Riemann invented a seemingly impractical non-Euclidian geometry that was to become part of Albert Einstein's theory of relativity. Years later, this theory contributed to the creation of atomic power.

Mathematicians in applied work use mathematics to develop theories, techniques, and approaches to solve practical problems in business, government, engineering, and the natural and social sciences. Their work ranges from analysis of the mathematical aspects of launching earth satellites to studies of the effects of new drugs on disease.

Much work in applied mathematics, however, is carried on by persons other than mathematicians. In fact, the number of workers who depend upon mathematical expertise is many times greater than the number actually designated as mathematicians.



Mathematicians should have a good knowledge of computer programming since most complex mathematical computation is done by computer.

Places of Employment

About 38,000 persons worked as mathematicians in 1976. Roughly three-fourths of all mathematicians worked in colleges and universities. Most were teachers; some worked mainly in research and development with few or no teaching duties.

Most other mathematicians worked in private industry and government. In the private sector, major employers were the aerospace, communications, machinery, and electrical equipment industries. The Department of Defense and the National Aeronautics and Space Administration employed most of the mathematicians working in the Federal Government.

Mathematicians work in all States, but are concentrated in those with large industrial areas and large college and university enrollments. Nearly half of the total are employed in seven States—California, New York, Massachusetts, Pennsylvania, Illinois, Maryland, and New Jersey. Of the total, one-fourth live in three metropolitan areas—New York City; Washington, D.C.; and Los Angeles-Long Beach, California.

Training, Other Qualifications, and Advancement

An advanced degree is the basic requirement for beginning teaching jobs, as well as for most research positions. In most colleges and universities, the Ph. D. degree is necessary for full faculty status.

Although the bachelor's degree may be adequate preparation for some jobs in private industry and government, employers usually require an advanced degree. Those bachelor's degree holders who find jobs usually assist senior mathematicians by performing computations and solving less advanced problems in applied mathematics. However, advancement often depends on achieving an advanced degree. Other bachelor's degree holders work as research or teaching assistants in col-

leges and universities while studying for an advanced degree.

The bachelor's degree in mathematics is offered by most colleges and universities. Mathematics courses usually required for a degree are analytical geometry, calculus, differential equations, probability and statistics, mathematical analysis, and modern algebra. A prospective college mathematics student should take as many mathematics courses as possible while still enrolled in high school.

More than 400 colleges and universities have programs leading to the master's degree in mathematics; about 150 also offer the Ph. D. In graduate school, students build upon the basic knowledge acquired in earlier studies. They usually concentrate on a specific field of mathematics, such as algebra, mathematical analysis, or geometry, by conducting research and taking advanced courses.

For work in applied mathematics, training in the field in which the mathematics will be used is very important. Fields in which applied mathematics is used extensively include physics, engineering, and operations research; of increasing importance are business and industrial management, economics, statistics, chemistry and life sciences, and the behavioral sciences.

Mathematicians should have a good knowledge of computer programming since most complex mathematical computation is done by computer.

Mathematicians need good reasoning ability, persistence, and the ability to apply basic principles to new types of problems. They must be able to communicate well with others since they often must listen to a nonmathematician describe a problem in general terms, and check and recheck to make sure they understand the mathematical solution that is needed.

Employment Outlook

Employment of mathematicians is expected to increase more slowly than the average for all occupations through the mid-1980's. Although the number of degrees granted in mathematics each year is expected to decline, the number of people seeking employment is expected to exceed job openings. As a result, persons seeking employment as mathematicians are likely to face keen competition throughout the period.

Theoretical mathematicians, who have traditionally found jobs in colleges and universities, are expected to experience the most difficulty in finding employment because colleges and universities are not expected to increase their employment of mathematicians much, if any, beyond present levels.

Holders of advanced degrees in applied mathematics should have the least difficulty in finding satisfactory employment. Although some limited opportunities may be available to theoretical mathematicians in nonacademic areas, most employers will seek applied mathematicians who are capable of applying their special mathematical skills to practical problems. Private industry and governmental agencies will need applied mathematicians for work in operations research, numerical analysis, computer systems programming, applied mathematical physics, market research and commercial surveys, and as consultants in industrial laboratories. Work in applied mathematics requires both a high degree of mathematical competence and a knowledge of the field of application.

Although mathematician jobs may be difficult to obtain, college graduates with degrees in mathematics should find their background helpful for careers in other areas. Many jobs rely heavily on the application of mathematical theories and methods. Mathematics majors are likely to find openings in statistics, actuarial work, computer programming, systems analysis, economics, engineering, and physical and life sciences. Employment opportunities in these fields will probably be best for those who combine a major in mathematics with a minor in one of these subjects.

New graduates may also find openings as high school mathematics teachers after completing professional education courses and other requirements for a State teaching certificate. (See statement on secondary school teachers elsewhere in the *Handbook*.)

Earnings and Working Conditions

In 1976, mathematicians earned average salaries over twice as high as the average for nonsupervisory workers in private industry, except farming. Starting salaries for mathematicians with a bachelor's degree averaged about $11,500 a year. Those with a master's degree could start at about $14,300 annually. Salaries for new graduates having the Ph. D., most of whom had some experience, averaged over $20,000.

In the Federal Government in 1977, mathematicians having the bachelor's degree and no experience could start at either $9,303 or $11,523 a year, depending on their college records. Those with the master's degree could start at $14,097 or $17,056; and persons having the Ph. D. degree could begin at either $17,056 or $20,442. The average salary for all mathematicians in the Federal Government was about $23,100 in 1977.

Salaries paid to college and university mathematics teachers are comparable to those for other faculty members. (See statement on college and university teachers elsewhere in the *Handbook*.)

Sources of Additional Information

Several brochures are available that give facts about the field of mathematics, including career opportunities, professional training, and colleges and universities with degree programs.

Seeking Employment in the Mathematical Sciences is available for 50 cents from:

American Mathematical Society, P.O. Box 6248, Providence, R.I. 02940.

Professional Opportunities in Mathematics (50 cents) and *Guide Book to Departments in the Mathematical Sciences* ($3.00) are provided by:

Mathematical Association of America, 1225 Connecticut Ave, NW., Washington, D.C. 20036.

For specific information on careers in applied mathematics, contact:

Society for Industrial and Applied Mathematics, 33 S. 17th St., Philadelphia, Pa. 19103.

For Federal Government career information, contact any regional office of the U.S. Civil Service Commission or:

Interagency Board of U.S. Civil Service Examiners, 1900 E St. NW., Washington, D.C. 20415.

PROGRAMMERS

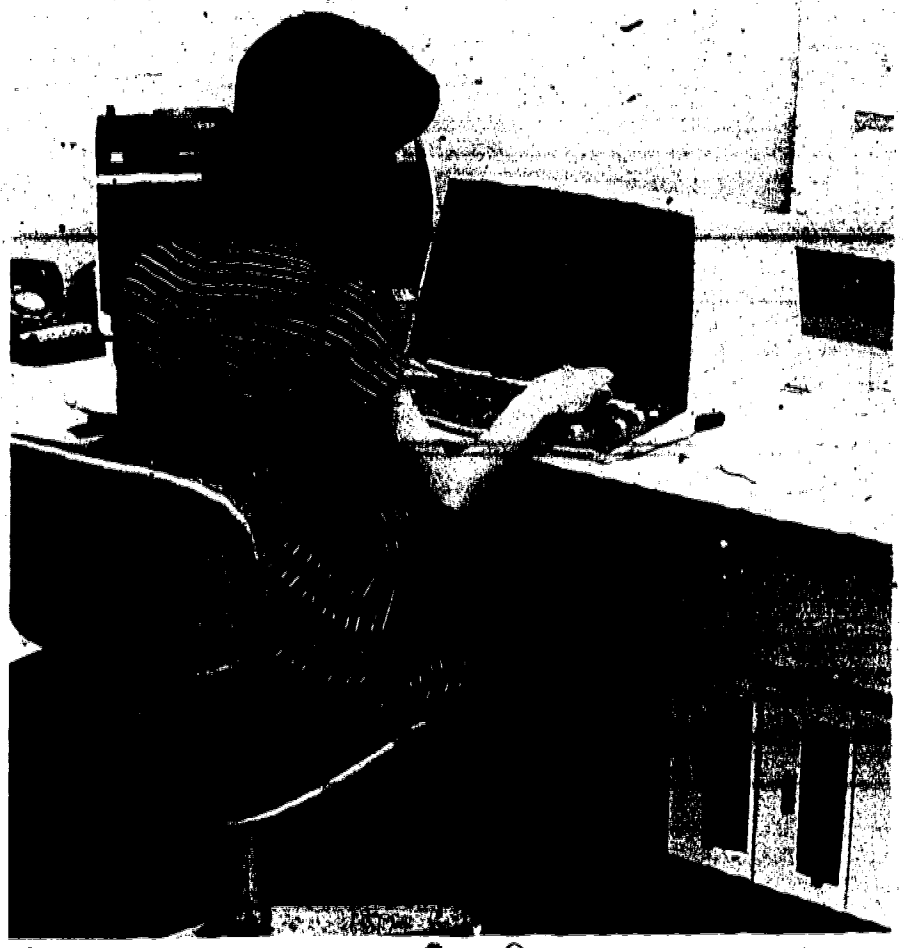
(D.O.T. 020.188)

Nature of the Work

Computers can process masses of information rapidly and accurately, but only if they are given step-by-step instructions to follow. Because the machines cannot think for themselves, computer programmers must write detailed instructions called programs that list in a logical order the steps the machine must follow to solve a problem.

Programmers usually work from problem descriptions prepared by systems analysts who have examined the problem and determined the steps necessary to achieve the desired results. (Systems analysts are described elsewhere in the *Handbook*.) In organizations that do not employ systems analysts, workers called programmer-analysts may be responsible for both systems analysis and programming. Once this analysis has been completed, a specialist called an applications programmer writes detailed instructions for processing the data, using one of the languages developed especially for computers.

Programs vary with the type of problem to be solved. For example, the mathematical calculations involved in payroll accounting procedures are different from those required to determine the flight path of a space probe. A business applications programmer developing instructions for billing customers would first decide what company records the computer would need and then draw a flow chart or diagram showing the steps the computer must follow to obtain old balances, add new charges, calculate finance charges, and deduct payments before determining a customer's bill. Using the flow chart, the programmer codes the actual instructions the computer will follow.



Computer programmers write instructions that list the steps the computer must take to solve a problem.

The programmer then checks the operation of the program to be sure the instructions are correct and will produce the desired information. This check is called "debugging." The programmer tries a sample of the data with the program and reviews the results to see if any errors are made. If errors occur, the program must be changed and rechecked until it produces the correct results.

Finally, an instruction sheet is prepared for the computer operator who will run the program. (The work of computer operators is described in the statement on Computer Operating Personnel.)

Although simple programs can be written in a few days, programs that use complex mathematical formulas or many data files may require more than a year of work. In such cases, several programmers may work together under an experienced programmer's supervision.

Applications programmers usually specialize in either business or scientific operations. A different type of specialist, the systems programmer, maintains the general instructions (called software) that control the operation of the entire computer system. These workers make changes in these sets of instructions that determine how the computer's resources are to be allotted among the various jobs it has been given. Because of their knowledge of operating systems, systems programmers often help applications programmers determine the source of problems with their programs.

Places of Employment

In 1976, about 230,000 persons worked as computer programmers. Most were employed by manufacturing firms, banks and insurance companies, data processing service organizations, and government agencies.

Programmers usually work in large firms that need and can afford extensive computer systems. Small firms generally require computers only for payroll or billing purposes and frequently pay data processing service organizations to do this work. Systems programmers usually work in research organizations, computer manufacturing firms, and large computer centers.

Training, Other Qualifications, and Advancement

There are no universal training requirements for progammers because employers' needs vary. Most programmers are college graduates; others have taken special courses in computer programming to supplement their experience in fields such as accounting or inventory control.

Employers using computers for scientific or engineering applications prefer college graduates with degrees in computer science, mathematics, engineering, or the physical sciences. Graduate degrees are required for some jobs. Very few scientific organizations are interested in applicants with no college training.

Although some employers who use computers for business applications do not require college degrees, they prefer applicants who have had college courses in data processing, accounting, and business administration. Occasionally, workers who are experienced in computer operation or payroll accounting but have no college training are promoted to programming jobs; however, they need additional data processing courses to become fully qualified programmers. Prior work experience is not essential for a job as a programmer; in fact, about half of all entrants to the occupation have no significant work experience.

Computer programming is taught at public and private vocational schools, colleges, and universities. Instruction ranges from introductory home study courses to advanced courses at the graduate level. High schools in many parts of the country also offer courses in computer programming.

In hiring programmers, employers look for people who can think logically and 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 particularly important when programmers must find new ways to solve a problem.

Beginning applications programmers usually spend their first weeks on the job attending training classes. After this initial instruction, they work on simple assignments while completing further specialized training programs. Programmers generally must spend at least several months working under close supervision before they can handle all aspects of their job. Because of rapidly changing technology, programmers must continue their training by taking courses offered by their employer and software vendors. For skilled workers, the prospects for further advancement are good. In large organizations, they may be promoted to lead programmers and be given supervisory responsibilties. Some applications programmers advance to systems programming. Both applications programmers and systems programmers often are promoted to the more demanding occupation of systems analyst.

Employment Outlook

Employment of programmers is expected to grow faster than the average for all occupations through the mid-1980's as computer usage expands, particularly in firms providing accounting and business management services and organizations involved in research and development. In addition to job openings resulting from growth of the occupation, several thousand openings will arise each year from the need to replace workers who leave the occupation. Because many programmers are relatively young, few openings will result from deaths or retirements. However, many vacancies will be created as experienced workers transfer into jobs as systems analysts.

The demand for applications programmers will increase as many processes once done by hand are automated, but employment will not grow as rapidly as in the past for several reasons. Improved software, such as utility programs that can be used by other than data processing personnel will simplify or eliminate some programming tasks. Also, employment of programmers in data processing firms is not expected to rise as fast as in recent years. Technology has reduced both the size and cost of computer hardware, bringing a computer system within reach of small businesses. As more small firms install their own computer, rather than rely on a data processing firm, employment growth in these data processing firms may slow somewhat. Demand

throughout the economy, however, should remain strong over the next decade. Prospects should be brightest for college graduates who have had computer-related courses, particularly for those with a major in computer science or a related field. Graduates of 2-year programs in data processing technologies also should find ample opportunities, although generally limited to business applications.

Earnings and Working Conditions

Average weekly earnings of programmer trainees in private industry ranged from $190 to $200 in 1976, according to surveys conducted in urban areas by the Bureau of Labor Statistics and firms engaged in research on data processing occupations. Systems programmers generally earn more than applications programmers. For example, experienced systems programmers averaged about $360 a week compared to $310 for applications programmers. Average salaries for lead programmers were $385 and $355, respectively. In general, programmers earn about twice as much as average earnings of all nonsupervisory workers in private industry, except farming.

In the Federal Civil Service, the entrance salary for persons with a college degree was about $180 a week in 1977. Salaries for Federal Government programmers at all levels are generally comparable to those in private industry.

Programmers working in the North and West earned somewhat more than those working in the South. Those working for data processing services and public utilities had higher earnings than programmers employed in banks, advertising, or educational institutions.

Programmers work about 40 hours a week, but their hours are not always from 9 to 5. Once or twice a week a programmer may report early or work late to use the computer when it is available. Occasionally, they work on weekends or are telephoned to advise computer operators working a second or third shift.

Sources of Additional Information

Additional information about the occupation of programmer is available from:

American Federation of Information Processing Societies, 210 Summit Ave., Montvale, N.J. 07645.

Association for Computing Machinery, 1133 Avenue of the Americas, New York, N.Y. 10036.

STATISTICIANS

(D.O.T. 020.188)

Nature of the Work

Statistics are numbers that help describe the characteristics of the world and its inhabitants. Statisticians devise, carry out, and interpret the numerical results of surveys and experiments. In doing so, they apply their knowledge of statistical methods to a particular subject area, such as economics, human behavior, natural science, or engineering. They may use statistical techniques to predict population growth or economic conditions, develop quality control tests for manufactured products, or help business managers and government officials make decisions and evaluate the results of new programs.

Often statisticians are able to obtain accurate information about a group of people or things by surveying a small portion, called a sample, rather than the whole group. For example, television rating services ask only a few thousand families, rather than all viewers, what programs they watch to determine the size of the audience. Statisticians decide where to get 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 tabulate the returns. Statisticians who design experiments prepare mathematical models to test a particular theory. Those in analytical work in-

Statisticians devise, carry out, and interpret the numerical results of surveys and experiments.

terpret collected data and summarize their findings in tables, charts, and written reports. Some statisticians, called mathematical statisticians, use mathematical theory to design and improve statistical methods.

Because the field of statistics has such a wide application, 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.

Places of Employment

Approximately 24,000 persons worked as statisticians in 1976. About two out of three statisticians were in private industry, primarily in manufacturing, public utilities, finance, and insurance companies. Roughly one-eighth worked for the Federal Government, primarily in the Departments of Commerce; Health, Education, and Welfare; Agriculture; and Defense. Others worked in State and local government and colleges and universities.

Although statisticians work in all parts of the country, most are in metropolitan areas, and about one fourth work in three areas: New York City; Washington, D.C.; and Los Angeles-Long Beach, California.

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. For other beginning statistical jobs, however, a bachelor's degree with a major in an applied field such as economics or natural science and a minor in statistics is preferable. A graduate degree in mathematics or statistics is essential for college and university teaching. Most mathematical statisticians have at least a bachelor's degree in mathematics and an advanced degree in statistics.

About 145 colleges and universities offered statistics as a concentration for a bachelor's degree in 1976. Many schools also offer either a degree in mathematics or a sufficient number of courses in statistics to qualify graduates for beginning positions. Required subjects for statistics majors include mathematics through differential and integral calculus, statistical methods, and probability theory. Courses in computer uses and techniques, if not required, are highly recommended. For quality control positions, training in engineering or a physical or biological science and in the application of statistical methods to manufacturing processes is desirable. For many market research, business analysis, and forecasting jobs, courses in economics and business administration are helpful.

Over 100 colleges and universities offered graduate degrees in statistics in 1976, and many other schools offered one or two graduate level statistics courses. Acceptance into graduate programs does not require an undergraduate degree in statistics although a good mathematics background is essential.

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

Employment Outlook

Employment opportunities for persons who combine training in statistics with knowledge of a field of application are expected to be favorable through the mid-1980's. Besides the faster than average growth expected in this field, additional statisticians will be needed to replace those who die, retire, or transfer to other occupations.

Private industry will require increasing numbers of statisticians for quality control in manufacturing. Statisticians with a 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.

Many fields such as law and history are discovering the usefulness of statistics. As the use of statistics expands into new areas, more statisticians will be needed to apply their special knowledge.

Federal, State, and local government agencies will need statisticians for existing and new programs in fields such as social security, health, and education. Colleges and universities will employ others to teach a growing number of students, as the broader use of statistical methods makes such courses increasingly important to persons majoring in fields other than mathematics and statistics.

Earnings and Working Conditions

In the Federal Government in 1977, statisticians who had the bachelor's degree and no experience could start at either $9,303 or $11,523 a year, depending on their college grades. Beginning statisticians with the master's degree could start at $14,097 or $17,056. Those with the Ph. D. could begin at $17,056 or $20,442. The average annual salary for statisticians in the Federal Government was $24,000 in 1977.

Salaries in private industry were comparable to those in the Federal Government, according to the limited data available.

Statisticians employed by colleges and universities generally receive salaries comparable to those paid other faculty members. (See statement on college and university teachers.) In addition to their regular salaries, statisticians in educational institutions sometimes earn extra income from outside research projects, consulting, and writing.

Sources of Additional Information

For information about career opportunities in statistics, contact:

American Statistical Association, 806 15th St. NW., Washington, D.C. 20005.

Facts on Federal Government jobs are available from:

Interagency Board of U.S. Civil Service Examiners for Washington, D.C., 1900 E St. NW., Washington, D.C. 20414.

For information on a career as a mathematical statistician, contact:

Institute of Mathematical Statistics, 1367 Laurel St., San Carlos, Calif. 94070.

SYSTEMS ANALYSTS

(D.O.T. 003.187, 012.168, 020.081 and 020.088)

Nature of the Work

Many essential business functions and scientific research projects depend on systems analysts to plan efficient methods of processing data and handling the results. Analysts begin an assignment by discussing the data processing problem with managers or specialists to determine the exact nature of the problem and to break it down into its component parts. If a new inventory system is desired, for example, systems analysts must determine what new data need to be collected, the equipment needed for computation, and the steps to be followed in processing the information.

Analysts use various techniques, such as cost accounting, sampling, and mathematical model building to analyze a problem and devise a new system. Once a system has been developed, they prepare charts and diagrams that describe its operation in terms that managers or customers can understand. They also may prepare a cost-benefit analysis to help the client decide whether the proposed system is satisfactory.

If the system is accepted, systems analysts translate the logical requirements of the system into the capabilities of the computer machinery or "hardware." They also prepare specifications for programmers to follow and work with them to "debug," or eliminate errors from the system. (The job of the computer programmer is described elsewhere in the *Handbook*.)

The problems systems analysts must solve range from monitoring nuclear fission in a powerplant to forecasting sales for an appliance manufacturing firm. Because the work is so varied and complex, analysts specialize in either business or scientific and engineering applications.

Some analysts improve systems already in use by developing better procedures or adapting the system to handle additional types of data. Others do research, called advanced systems design, to devise new methods of systems analysis.

System analysts devising a new system.

Places of Employment

About 160,000 persons worked as systems analysts in 1976. Employment of these workers is concentrated in two geographic regions—more than one-third of the total are employed in the Midwest and about one-fourth work in the northeastern portion of the United States. Most systems analysts worked in urban areas for manufacturing firms, banks, insurance companies, and data processing service organizations. In addition, large numbers worked for wholesale and retail businesses and government agencies.

Training, Other Qualifications, and Advancement

There is no universally acceptable way of preparing for a job as a systems analyst because employers' preferences depend on the work being done. However, college graduates generally are sought for these jobs, and for some of the more complex jobs, persons with graduate degrees are preferred. Employers usually want analysts with a background in accounting, business management, or economics for work in a business environment while a background in the physical sciences, mathematics, or engineering is preferred for work in scientifically oriented organizations. A growing number of employers seek applicants with a degree in computer science, information science, or data processing. Regardless of college major, most employers look for people who are familiar with programming languages. Courses in computer concepts, systems analysis, and data retrieval techniques offer good preparation for a job in this field.

Prior work experience is important. Nearly half of all persons entering this occupation have transferred from other occupations, especially from computer programmer. In many industries, all systems analysts begin as programmers and are pro-

moted to analyst positions after gaining experience.

Systems analysts must be able to think logically and should like working with ideas. The ability to concentrate and pay close attention to details also is important. Although most systems analysts work independently, they sometimes work in teams on large projects. They must be able to communicate effectively with technical personnel such as programmers as well as with clients who have no computer background.

In order to advance, systems analysts must continue their technical education. Technological advances come so rapidly in the computer field that continuous study is necessary to keep one's skills up to date. Training usually takes the form of 1- and 2-week courses offered by employers and software vendors.

An indication of experience and professional competence is the Certificate in Data Processing (CDP). This designation is conferred by the Institute for Certification of Computer Professionals upon candidates who have completed 5 years' experience and passed a five-part examination.

In large data processing departments, persons who begin as junior systems analysts may be promoted to senior or lead systems analysts after several years of experience. Systems analysts who show leadership ability also can advance to jobs as managers of systems analysis or data processing departments.

Employment Outlook

Employment of systems analysts is expected to grow faster than the average for all occupations through the mid-1980's as computer usage expands, particularly in accounting firms and organizations engaged in research and development. In addition to opportunities that will result from growth, some openings will occur as systems analysts advance to managerial positions or enter other occupations. Because many of these workers are relatively young, few positions will result from retirement or death.

The demand for systems analysts is expected to rise as computer capabilities are increased and computers are used to solve problems in a larger variety of areas. Sophisticated accounting systems, telecommunications networks, and complex mathematical systems used in scientific research are examples of new approaches in problem-solving. Over the next decade, we can expect systems analysts to be harnessing the computer's resources to solve problems we have not yet recognized. Advances in technology that have drastically reduced the size and cost of computer hardware will have differing effects on employment of systems analysts. Employment in data processing firms may not grow as rapidly as in recent years as more small businesses install their own computer rather than rely on a data processing service. This will be offset, however, by a rising demand for analysts to design systems especially for the small computer and geared specifically for the problems of small firms.

The outlook for graduates of computer related curriculums should be excellent. College graduates who have had courses in computer programming, systems analysis, and other data processing areas should also find many opportunities. Persons without a college degree and college graduates unfamiliar with data processing may face competition from the large number of experienced workers seeking jobs as systems analysts.

Earnings and Working Conditions

Salaries for beginning systems analysts in private industry averaged $250 a week in 1976, according to surveys conducted in urban areas by the Bureau of Labor Statistics and private firms engaged in research on computer occupations. Experienced workers earned from $340 to $380, and lead systems analysts earned from $385 to $400 weekly. Overall, systems analysts earn well over twice as much as the average for all nonsupervisory workers in private industry, except farming.

In the Federal Government, the entrance salary for recent college graduates was about $180 a week in 1977. Salaries for systems analysts at all levels of responsibility generally are comparable to those in private industry.

Systems analysts working in the North and West earned somewhat more than those in the South and generally their earnings were greater in data processing service firms or in heavy manufacturing than in insurance companies or educational institutions.

Systems analysts usually work about 40 hours a week—the same as other professional and office workers. Unlike many computer operators, systems analysts are not assigned to evening or night shifts. Occasionally, however, evening or weekend work may be necessary to complete emergency projects.

Sources of Additional Information

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

American Federation of Information Processing Societies, 210 Summit Ave., Montvale, N.J. 07645

Association for Systems Management, 24587 Bagley Rd., Cleveland, Ohio 44138

Information about the Certificate in Data Processing is available from:

The Institute for Certification of Computer Professionals, 35 E. Wacker Dr., Suite 2828, Chicago, Ill. 60601

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What to Look For in this Reprint

To make the *Occupational Outlook Handbook* easier to use, each occupation or industry follows the same outline. Separate sections describe basic elements, such as work on the job, education and training needed, and salaries or wages. Some sections will be more useful if you know how to interpret the information as explained below.

The TRAINING, OTHER QUALIFICATIONS, AND ADVANCEMENT section indicates the preferred way to enter each occupation and alternative ways to obtain training. Read this section carefully because early planning makes many fields easier to enter. Also, the level at which you enter and the speed with which you advance often depend on your training. If you are a student, you may want to consider taking those courses thought useful for the occupations which interest you.

Besides training, you may need a State license or certificate. The training section indicates which occupations generally require these. Check requirements in the State where you plan to work because State regulations vary.

Whether an occupation suits your personality is another important area to explore. For some, you may have to make responsible decisions in a highly competitive atmosphere. For others, you may do only routine tasks under close supervision. To work successfully in a particular job, you may have to do one or more of the following:

- motivate others
- direct and supe[illegible]
- work with all types [illegible]
- work with things [illegible] need
  - and manual dexterity
- [illegible]k independently [illegible]
  - self discipline
- [illegible]k as part of a t[illegible]
- work with details [illegible]
  - or laboratory reports
- help people
- use [illegible]
- [illegible]
- do physically hard [illegible]
- work outside [illegible] all types [illegible]

[illegible]

[illegible] you

The EMPLOYMENT OUTLOOK [illegible] job market is likely to be favorable. [illegible] expected growth is compared to the average [illegible] rate for all occupations (20 percent between 1976 and 1985). The following phrases are used:

Much faster	[illegible]
Faster	25.0 [illegible]
About as fa[illegible]	15.0 to 24.9 [illegible]
Slower	4.0 to 14.9%
Little change	3.9 to 3.9%
Decline	4.0 % [illegible]

Generally, job [illegible] growing at least as fast as [illegible] the economy as [illegible]

But, you would have to know the number [illegible] competing with you to be sure of your prospects. Unfortunately, supply information is lacking for most occupations.

There are exceptions, however, especially among professional occupations. Nearly everyone who earns a medical degree, for example, becomes a practicing physician. When the number of people pursuing relevant types of education and training and then entering the field can be compared with the demand, the outlook section indicates the supply/demand relationship as follows:

Excellent	Demand much greater than supply
Very good	Demand greater than supply
Good or favorable	Rough balance between demand and supply
May face competition	Likelihood of more supply than demand
Keen competition	Supply greater than demand

[illegible]mpetition or few job openings should not stop your pursu[illegible] a career that matches your aptitudes and interests. Even small or overcrowded occupations provide some jobs. So do those in which employment is growing very slowly or declining.

Growth in an occupation is not the only source of job openings because the number of openings from turnover can be substantial in large occupations. In fact, replacement needs are expected to create 70 percent of all openings between 1976 and 1985.

Finally, job prospects in your area may differ from those in the Nation as a whole. Your State employment service can furnish local information.

The EARNINGS section tells what workers were earning in [illegible]

Which jobs pay the most is a hard question to answer because good information is available for only one type of earnings—wages and salaries—and not even this for all occupations. Although 9 out of 10 workers receive this form of income, many earn extra money by working overtime, night shifts, or irregular schedules. In some occupations, workers also receive tips or commissions based on sales or service. Some factory workers are paid a piece rate—an extra payment for each item they make.

The remaining 10 percent of all workers—the self-employed—includes people in many occupations—physicians, barbers, writers, and farmers, for example. Earnings for self-employed workers even in the same occupation differ widely because much depends on whether one is just starting out or has an established business.

Most wage and salary workers receive fringe benefits [illegible] as paid vacations, holidays, and sick leave.

Workers also receive income in goods and services (pay [illegible] in kind). Sales workers in department stores, for example, often receive discounts on merchandise.

Despite difficulties in determining exactly what people earn [illegible] the job, the Earnings section does compare occupational earnings by indicating whether a certain job pays more or less than the average for all nonsupervisors in private industry, excluding farming.

Each occupation has many pay levels. Beginners almost always earn less than workers who have been on the job for some time. Earnings also vary by geographic location but cities that offer the highest earnings often are those where living costs are most expensive.

What's an ad for the OOQ doing in a place like this?

The career information contained in the reprint you are reading was taken from the 1978–79 edition of the Occupational Outlook Handbook. But the Handbook is not the only source of useful career information published by the Bureau of Labor Statistics. The Handbook's companion, the Occupational Outlook Quarterly, is published four times during the school year to keep subscribers up to date on new occupational studies completed between editions of the Handbook. The Quarterly also gives practical information on training and educational opportunities, salary trends, and new and emerging jobs—just what people need to know to plan careers.

If you were a subscriber to recent issues of the Occupational Outlook Quarterly, you could have learned

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