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ABSTRACT

Focusing on office machine and computer 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 business machine repairers, computer operating personnel, computer service technicians, office machine operators, programmers, systems analysts, and office machine and computer manufacturing occupations. 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)

# Office Machine and Computer Occupations

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

Bulletin 1955-6

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

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

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

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

Show that the equations are equivalent.

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) \qquad y - y_2 = \frac{y_1 - y_2}{x_1 - x_2}(x - x_2)$$

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

# BUSINESS MACHINE REPAIRERS

(D.O.T. 633.281)

## Nature of the Work

Business machine repairers maintain and repair the machines that are used to speed the paperwork in business and government. These include typewriters, adding and calculating machines, cash registers, dictating machines, postage meters, and duplicating and copying equipment. (Technicians who work on computer equipment are discussed in a separate statement elsewhere in the *Handbook*.)

Business machine repairers (often called field engineers or customer engineers) make regular vists for preventive maintenance to the offices and stores of customers in their assigned area. The frequency of these service calls depends upon the type of equipment being serviced. For example, an electric typewriter may require preventive maintenance only three or four times a year, while a more complex copier probably would require more frequent attention. During these calls, the engineer inspects the machine for unusual wear and replaces any worn or broken parts. Then the machine is cleaned, oiled, and adjusted to insure peak operating efficiency and to prevent future breakdowns. The engineer also may advise machine operators how to operate the equipment more efficiently and how to spot a problem in its early stages.

Despite frequent maintenance, business machines do occasionally malfunction. When a field engineer is notified by the supervisor of a breakdown, he or she will make a prompt service call to that customer. The engineer determines the cause of the malfunction by talking to the operator and examining the machine. Once the problem has been isolated, repairs can be made. Minor repairs generally can be made on the spot; for more serious repairs, however, the entire machine or a component of the machine will be taken to the repair shop where a specialist will work on it.

**Business machine repair is cleaner and lighter than the work in most mechanical trades.**

Business machine repairers generally specialize in one type of machine. Those employed by manufacturing companies or dealers usually are familiar only with the brand produced or sold by their employer. Repairers who work for small independent repair shops must be able to work on equipment from several different manufacturers.

Repairers use common handtools, such as screwdrivers, pliers, and wrenches, as well as other tools especially designed to fit certain kinds of business machines. In addition, they use meters and other types of test equipment to check for malfunctions in electronic circuits.

## Places of Employment

About 58,000 people worked as business machine repairers in 1976. About three-fourths of them worked mainly on typewriters, calculators and adding machines, and copiers and duplicators. Most of the rest serviced accounting-bookkeeping machines, cash registers, and postage and mailing equipment. A small number repaired dictating machines.

About 8 of 10 repairers worked for business machine manufacturers, dealers, and repair shops. The remainder worked for large organizations that had enough machines to justify full-time repairers.

Business machine repairers work throughout the country. Even relatively small communities usually have at least one or two repair shops. Most repairers, however, work in large cities.

## Training, Other Qualifications, and Advancement

The amount of formal education required for entry jobs as business machine repairers varies widely among employers. Some employers hire applicants with a high school education, while many others require at least 1 year of technical training in

basic electricity or electronics. Employers agree, however, that electronics training received in the Armed Forces is valuable.

Applicants for entry jobs may have to pass tests that measure mechanical aptitude, knowledge of electricity or electronics, manual dexterity, and general intelligence. Good eyesight, including color vision, is needed to inspect and work on small, delicate parts. Persons considering this type of work also should have good hearing in order to detect malfunctions revealed by sound.

Employers seek applicants who have a pleasant, cooperative manner. Because most machine servicing is done in customers' offices, the ability to work without interrupting the office routine is very important. A neat appearance and ability to converse effectively are essential.

Some employers require that business machine repairers be bonded. Applicants for these jobs must be honest and trustworthy because they sometimes are exposed to large sums of money and other valuables in banks and offices. In addition, these workers must be able to work without direct supervision. They must be able to set up a maintenance schedule for their customers' equipment and arrange their own schedule so that they can meet service deadlines and also handle emergency repairs.

Trainees who work in a manufacturer's branch office or for a franchised dealer usually attend a school sponsored by the manufacturer. Training programs at company schools usually last several weeks to several months, depending on the type of machine the repairer will service. Trainees then receive from 1 to 3 years of practical experience and on-the-job training before they become fully qualified repairers. These workers generally learn to service only the company's line of equipment.

Training offered by independent repair shops usually is less formal. Trainees generally complete a self-study course coupled with on-the-job training under the supervision of an experienced repairer. Because small repair shops usually don't specialize in the more sophisticated types of equipment, their repairers are expected to be familiar with the more common machines produced by many manufacturers. For example, business machine repairers in small shops should be able to repair several different makes of typewriters, adding machines, and calculators.

Wherever they work, business machine repairers frequently attend training seminars sponsored by business equipment manufacturers for special instruction in new business machine developments. Also, business machine repairers are encouraged to broaden their technical knowledge during nonworking hours. Many companies pay the repairer's tuition for work-related courses in college and technical schools.

Business machine repairers may move into sales positions for greater earnings. Repairers who show management abilities also may advance to service manager or supervisor. Experienced repairers sometimes open their own repair shops; those who work in manufacturers' branch offices sometimes become independent dealers or buy sales franchises from the company.

## Employment Outlook

Employment of business machine repairers is expected to grow faster than the average for all occupations through the mid-1980's. In addition to jobs from employment growth, many openings will arise as experienced repairers retire, die, or change occupations.

Employment opportunities for qualified beginners are good. Business and government will buy more machines to handle the growing volume of paperwork and more people will be trained to maintain and repair these machines. In recent years, many technical changes have occurred in business machines. Electronic calculating machines have replaced mechanical models, for example, and electronic cash registers are replacing mechanical registers. Because of the greater use of such equipment, opportunities will be particularly favorable for repairers who have training in electronics; within several years training in basic electronics may even become a prerequisite for business machine repair jobs.

Business machine repairers work year round and have steadier employment than many other skilled workers. Office machines must be maintained, even when business slackens, since records must be kept, correspondence carried on, and statistical reports prepared.

## Earnings and Working Conditions

Information from a limited number of employers in 1976 indicated that trainees earned from $150 to $200 a week, depending on their level of training. For example, people who have previous electronics training in the Armed Forces or civilian technical schools generally receive somewhat higher beginning wages than high school graduates.

Experienced repairers generally earned from $200 to $280 a week. Earnings usually were highest for those who repaired electronic business machines and complex duplicating and copying equipment. Repairers who prepare themselves to work on more than one type of equipment can increase their earnings by about 20 percent. Specialists earned salaries ranging between $220 and $310 a week in 1976, according to the limited information available.

Servicing business machines is cleaner and less strenuous than the work in most other mechanical trades. Repairers generally wear business clothes and do most of their work in the customer's office. Injuries are uncommon.

Repairers generally use their own cars to travel to their customers' offices and are reimbursed on a mileage basis. Employers usually pay for all tools and other equipment.

## Sources of Additional Information

For more details about job opportunities, contact local firms that sell and service business machines and the local office of the State employment service.

The State department of education in your State capital can furnish information about approved technical

institutes, junior colleges, and other institutions offering postsecondary training in basic electronics. Additional information about these schools is available from:

U.S. Office of Education, Division of Vocational/Technical Education, Washington, DC. 20202.

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## COMPUTER OPERATING PERSONNEL

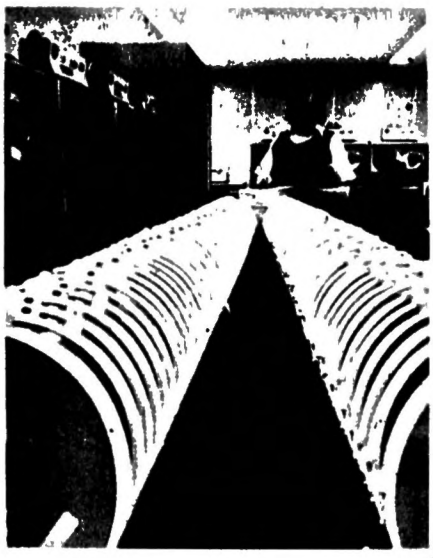
(D.O.T. 213.138, .382, .582, .588, and .885, and 223.387)

### Nature of the Work

All data systems require specialized workers to enter data and instructions, operate the computer, and retrieve the results. The data to be processed and the instructions for the computer are called "input;" the results are called "output."

Information is entered into a computer system in a variety of ways. In many systems, *keypunch operators* (D.O.T. 213.582) prepare input by punching patterns of holes in cards to represent different letters, numbers, and special characters, using a machine similar to a typewriter. In others, *data typists* (D.O.T. 213.588) use special machines that convert the information they type to holes in cards or magnetic impulses on tapes or disks. Many newer systems are capable of remote data entry. The user sits at a machine equipped with a typewriter keyboard and an electronic screen that displays the data as it is entered directly into the computer.

Once the input is coded, prepared in a form the computer can read, it is ready to be processed. *Console operators* (D.O.T. 213.382) examine the programmer's instructions for processing the input, make sure the computer has been loaded with the correct cards, magnetic tapes, or disks and then start the computer. While it is running, they watch the machine, paying special attention to the error lights that could signal a malfunction. If the computer stops or one of the lights goes on, operators must locate the problem and remove the faulty input materials.



**Some operators work evenings or night shifts because computers are used 24 hours a day.**

In some systems, machines directly connected to the computer translate output into the form desired by the programmer. In others, high-speed printers or converters run by auxiliary equipment operators—*high-speed printer operators* (D.O.T. 213.382) and *converter operators* (D.O.T. 213.382)—perform this function.

Frequently, data on punched cards, magnetic tape, or disks are kept for future use. *Tape librarians* (D.O.T. 223.387) classify and catalog this material and maintain files of current and previous versions of programs, listings, and test data. In smaller organizations, librarians may do some keypunching as well as coordinate activities between the programmer and the operations department.

### Places of Employment

About 565,000 persons worked as console, auxiliary equipment, and keypunch operators in 1976.

Although workers in these occupations are employed in almost every industry, most work in manufacturing firms, wholesale and retail trade establishments, banks, and government agencies. Many computer and peripheral equipment operators work for insurance companies and firms that provide data processing services for a fee.

### Training, Other Qualifications, and Advancement

In firms that have just installed a new computer system, tabulating and bookkeeping machine operators may be transferred to jobs as keypunch or auxiliary equipment operators, or console operators. Most often, however, employers recruit workers from the outside. Some organizations train typists to operate keypunch machines, but most seek workers who already have this skill. Many high schools, public and private vocational schools, private computer schools, and business schools and colleges offer training in computer operating skills. Young men and women in military service also can learn valuable skills in computer operations. In addition, a growing number of business firms across the country hold weekend seminars on data processing for high school students.

Employers in private industry usually require applicants to have a high school education, and many prefer console operators to have some college training, especially in data processing. The Federal Government requires a high school diploma, unless applicants have had specialized training or experience. Many employers test applicants to determine their aptitude for computer work, particularly their ability to reason logically. Keypunch operators and other data entry personnel often are tested for their ability to work quickly and accurately.

Beginners usually are trained on the job. The length of training needed varies—auxiliary equipment operators can learn their jobs in a few weeks, but console operators require several months of training because they must become sufficiently familiar with the computer equipment to be able to trace the causes of failures.

Keypunch and auxiliary equipment operators should be able to work under close supervision as part of a team. They also must like working with machines and not become easily bored by repetitious tasks. Console operators must be capable of independent judgment, especially when working without supervision on second and third shifts.

Although advancement opportunities for keypunch and auxiliary equipment operators are limited, promotion to a supervisory position is possible after several years on the job. With additional training, often including college study, a few advance to jobs as console operators.

Console operators also may be promoted to supervisory positions, or to jobs that combine supervision and console operation. Through on-the-job-experience and additional training, some console operators advance to jobs as programmers.

### Employment Outlook

Changes in data processing technology will have differing effects on computer operating occupations over the next decade. Employment of console and peripheral equipment operators is expected to rise about as fast as the average for all occupations while employment of keypunch operators should continue the decline of recent years. Recent advances in miniaturizing circuits have enabled manufacturers to reduce both the size and the cost of computer components. As this technology develops, a continued expansion in the use of computers is expected, especially by small businesses. Employment of console and peripheral equipment operators in data processing service firms may grow less rapidly than in the past as more small firms install their own computer systems, but overall demand for these workers should remain strong.

This same technology will further reduce demand for keypunch operators. The primary reason for this decline is the increased use of computer terminals. As direct data entry techniques become more efficient, the importance of punched cards as a form of input will diminish. Despite the anticipated decline in employment, several thousand openings will occur each year as workers die, retire, or transfer out of the occupation.

### Earnings and Working Conditions

Average weekly earnings of keypunch operator trainees in private industry ranged from $120 to $140 in 1976, according to surveys conducted in urban areas by the Bureau of Labor Statistics and firms engaged in research on data processing occupations. Lead operators earned from $150 to $180 weekly.

Average weekly earnings of beginning console operators averaged about $150. Experienced workers earned from $205 to $215, and lead operators earned from $230 to $260 weekly. The average weekly earnings for tape librarians in 1976 was $160.

In the Federal Government, console operators and keypunch operators without work experience started at $126 a week, and the average weekly salary was $245 for console operators and $160 for keypunch operators. Throughout the economy in 1976, console operators earned slightly more and keypunch operators earned slightly less than average earnings for all nonsupervisory workers in private industry, except farming.

Because electronic computers must be operated at carefully controlled temperatures, operators work in air-conditioned rooms. One disadvantage, however, is the high noise level generated by some auxiliary equipment. Some console and auxiliary equipment operators work evening or night shifts because many organizations use their computer 24 hours a day. Tape librarians usually work only day shifts.

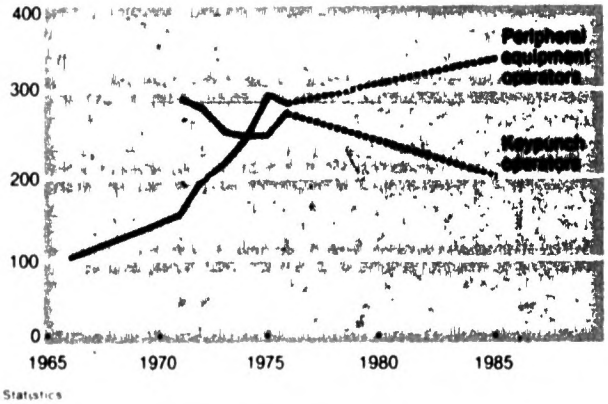
### Sources of Additional Information

Further information on data processing careers is available from:

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

**The discovery of new ways to prepare and enter data into computers has contributed to the growing need for peripheral equipment operators, but has caused demand for keypunch operators to decline**

Advances in technology create some jobs and eliminate others




Source: Bureau of Labor Statistics

## COMPUTER SERVICE TECHNICIANS

(D.O.T. 828.281)

### Nature of the Work

Computer systems play a vital role in our lives. They help us make telephone calls, receive paychecks on time, and reserve tickets for travel, hotels, and entertainment. In business and industry, computer systems perform a wide variety of complicated tasks—from maintaining business records to controlling manufacturing processes.

A computer system is the combination of a computer and computer-related machines, such as magnetic tape readers and high speed printers. Keeping this intricate set of machines in good working order is the job of the computer service technician.

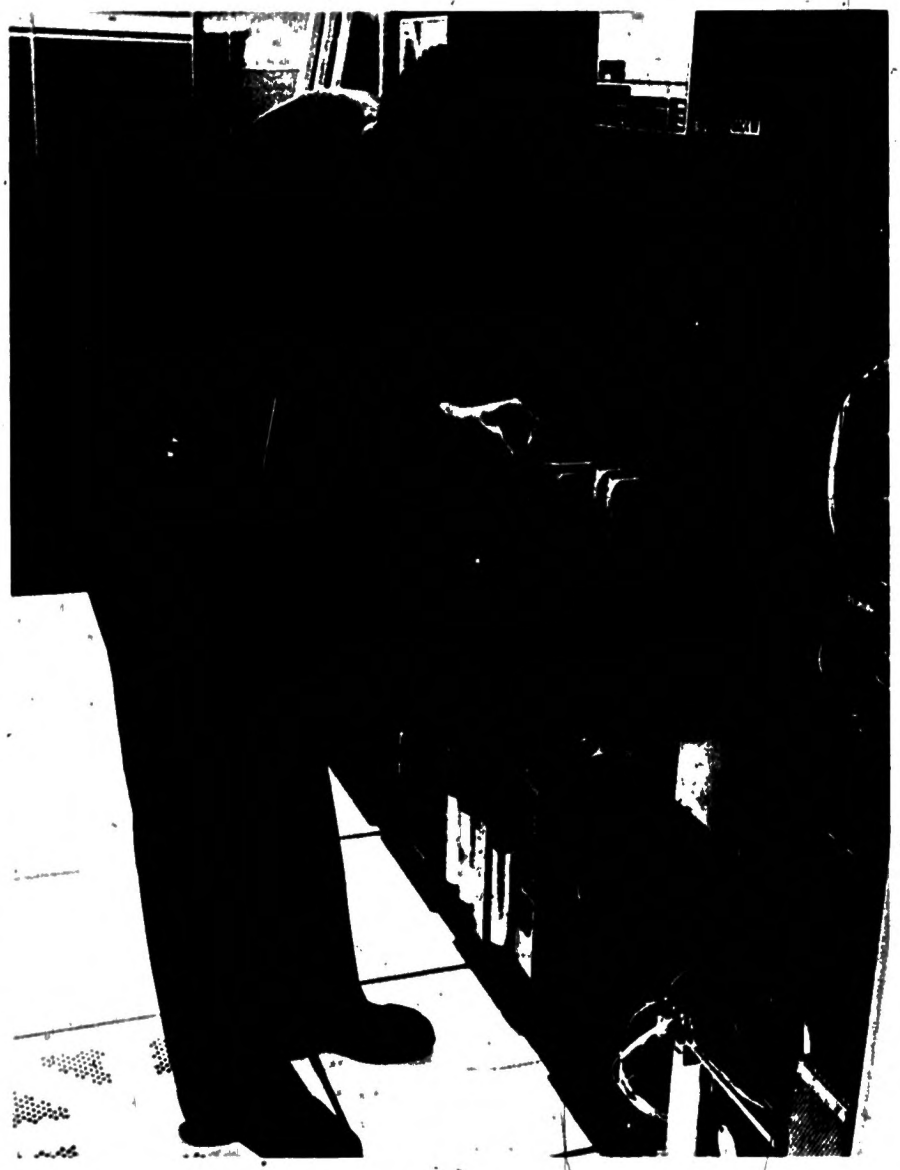
At regular intervals, computer service technicians (often called field engineers or customer engineers) service machines or systems to keep them operating efficiently. They routinely adjust, oil, and clean mechanical and electromechanical parts. They also check electronic equipment for loose connections and defective components or circuits.

When computer equipment breaks down technicians must find the cause of the failure and make repairs. Determining where in the system the malfunction has occurred is the most difficult part of the technician's job, and as computer systems have grown larger and more complex, the potential for malfunctions also has grown. The problem can be in the central processing unit itself, in one of the peripheral machines, such as a reader or a printer, or in the cables connecting these machines. Technicians use several kinds to test equipment, including voltmeters, ohmmeters, and oscilloscopes to check for electronic failures. They also run special diagnostic programs that help pinpoint certain malfunctions. Although it may take several hours to locate a problem, fixing the equipment may take just a few minutes. For repair jobs such as replacing a faulty circuit board, soldering a broken connection, or repairing a mechanical part, technicians use a variety of handtools, including needle-nosed pliers, wirestrippers, and soldering equipment. The employer supplies tools and test equipment, but technicians are responsible for keeping them in good working order.

Computer technicians often help install new equipment. They lay cables, hook up electrical connections between machines, thoroughly test the new equipment, and correct any problems before the customer uses the machine.

Some technicians specialize in maintaining a particular computer model or system, or in doing a certain type of repair. For example, some technicians are experts in correcting problems caused by errors in the computer's internal programming.

Besides knowing how to use specialized tools and test equipment, computer technicians must be familiar with technical and repair manuals for each piece of equipment. They also must keep up with the technical information and revised maintenance procedures issued periodically by computer manufacturers.



**Some technicians specialize in maintaining a particular computer model or system.**

Technicians keep a record of preventive maintenance and repairs on each machine they service. In addition, they fill out time and expense reports, keep parts inventories, and order parts.

Although technicians spend most of their time working on machines, they work with people also. They listen to customers' complaints, answer questions, and sometimes offer technical advice on ways to keep equipment in good condition. Experienced technicians often help train new technicians and sometimes have limited supervisory duties.

### Places of Employment

In 1976, about 50,000 persons worked as computer service technicians. Most were employed by firms that provide maintenance services for a fee and by manufacturers of computer equipment. A small number were employed directly by organizations that have a large computer installation.

Computer technicians generally work out of regional offices located in major urban centers, where computer equipment is concentrated. For



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example, about one-fourth of these workers are employed in one of these major cities: New York City; Philadelphia; Washington, D.C.; Chicago; and Los Angeles. Most are assigned to several clients, depending on the technician's specialty and the type of equipment the user has. Workers with several accounts must travel from place to place to maintain these systems and to make emergency repairs. In some cases, more than one technician will share an account, and service different parts of a system. In other cases, an experienced technician may be assigned to work full time at a client's installation in order to maintain all phases of that operation. Technicians who work for a nationwide organization must sometimes transfer to another city or State.

### Training, Other Qualifications, and Advancement

Most employers require applicants for technician trainee jobs to have 1 to 2 years' post-high school training in basic electronics or electrical engineering. This training may be from a public or private vocational school, a college, or a junior college. Basic electronics training offered by the Armed Forces is excellent preparation for technician trainees.

A high school student interested in becoming a computer service technician should take courses in mathematics and physics. High school courses in electronics and computer programming also are helpful. Hobbies that involve electronics, such as operating ham or CB radios or building stereo equipment, also provide valuable experience.

Besides technical training, applicants for trainee jobs must have good close vision and normal color perception to work with small parts and color-coded wiring. Normal hearing is needed since some breakdowns are diagnosed by sound. Because technicians usually handle jobs alone, they must have the initiative to work without close supervision. Also important are a pleasant personality and neat appearance, since the work involves frequent contact with customers. Another important asset for the successful technician is patience, because some malfunctions occur infrequently and are very difficult to pinpoint. Applicants must pass a physical examination and, in some cases, get a security clearance.

Trainees usually attend company training centers for 3 to 6 months to learn elementary computer theory, computer math, and circuitry theory and to further their study of electronics. Classroom work is accompanied by practical training in operating computer equipment, doing basic maintenance, and using test equipment to locate malfunctions.

In addition to formal instruction, trainees must complete 6 months to 2 years of on-the-job training. At first they work closely with experienced technicians, learning to maintain card readers, printers, and other machines that are relatively simple, but that have the basic mechanical and electronic features of a large computer system. As trainees gain experience they work on more complex equipment.

Because manufacturers continually redesign equipment and develop new uses for computers, experienced technicians frequently must attend training sessions to keep up with these changes and to broaden their technical skills. Many technicians take advanced training to specialize in a particular computer system or type of repair. Instruction also may include programming, systems analysis, and other subjects that improve the technician's general knowledge of the computer field.

Experienced technicians with advanced training may become specialists or "troubleshooters" who help technicians throughout their territory diagnose difficult problems. They also may work with engineers in designing equipment and developing maintenance procedures. Technicians with leadership ability may become supervisors or service managers.

Most computer equipment operates on the same basic principles, but machines built by different companies may be unique in design and construction. For this reason, technicians may find it difficult to transfer between companies that mantain different brands of equipment. Because of the pressing need for experienced technicians, however, many opportunities exist for well-qualified workers to transfer to other firms that handle the same type of computer hardware.

Training and experience in computer maintenance may also qualify a technician for a job in programming, management, or equipment sales. (See statements on Programmers and Office Machine and Computer Manufacturing elsewhere in the *Handbook*.)

### Employment Outlook

Employment of computer technicians is expected to grow much faster than the average for all occupations through the mid-1980's. As the Nation's economy expands, more computer equipment will be used and more technicians will be needed to install and maintain it. Business, government, and other organizations will buy, lease, or rent additional equipment to manage vast amounts of information, control manufacturing processes, and aid in scientific research. The development of new uses for computers in fields such as education, medicine, and traffic control also will spur demand.

Because most technicians are young, relatively few openings will stem from deaths and retirements. Most job openings will result from rising demand for the services of computer service technicians. Most openings will occur in metropolitan areas.

The rising demand for computer technicians is related to the growing number of computers in operation and the geographic distribution of these computers. Continued reductions in the size and cost of computer hardware will bring the computer within reach of a rapidly increasing number of small organizations. As more and more of these small systems are installed, the amount of time technicians must spend traveling between clients also will increase.

Downturns in the economy will tend to have a less negative effect on job openings for computer service technicians than for most occupations because even when business is declining firms will continue to use

computers for accounting and other data processing.

### Earnings and Working Conditions

Average weekly earnings of computer service technician trainees ranged from about $180 to $200 a week in 1976, according to a private survey of firms engaged in computer maintenance. Experienced workers earned about $235 a week, while senior technicians, those with 8-10 years' experience, earned between $250 and $285. Highly skilled specialists averaged from $310 to $340 a week.

Because computer installations generally run around the clock, working time lost during a computer breakdown can be very expensive. For this reason, technicians must be available to make emergency repairs at any time, day or night. Although the normal workweek is 40 hours, overtime is standard. The method of assigning overtime varies by employer. Some technicians are on call 24 hours a day. Others work rotating shifts—days 1 week, nights the next. However it is implemented, computer technicians can expect substantial amounts of overtime; in many cases, annual overtime pay can be as much as 20 percent of base salary. For most technicians, travel is local and they usually are not away from home overnight. Employers pay for travel, including reimbursement for job-related uses of the technician's car, as well as work-related education expenses.

Although some bending and lifting is necessary, the computer technician's job is not strenuous. Work hazards are limited mainly to burns and electrical shock, and can be avoided if safety practices are followed.

### Sources of Additional Information

For general information on careers in computer maintenance, contact the personnel department of computer manufacturers and computer maintenance firms in your area. The State department of education in your State capital can furnish information about approved technical institutes, junior colleges, and other institutions offering postsecondary training in basic electronics. Additional information about these schools is available from:

U.S. Office of Education, Division of Vocational/Technical Education, Washington, DC. 20202.

The State employment service office in your area may also be able to provide information about local job opportunities.

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## OFFICE MACHINE OPERATORS

(D.O.T. 207.782, .884, and .885; 208.782; 213.782; 214.488; 215.388; 216.488; and 234.)

### Nature of the Work

To speed the paperwork involved in operating a business, most firms employ office machine operators to record information, determine bills and inventories, and perform other calculations. This statement describes some of the more common machine operating jobs.

*Billing machine operators* (D.O.T. 214.488) prepare customer statements by typing information, such as customers' names, purchases, and amount of sales, on a billing machine that automatically computes the balances and required payments.

**Advances in data transmission devices will enable large employers to centralize recordkeeping.**

*Bookkeeping machine operators* (D.O.T. 215.388) record a firm's financial transactions on a bookkeeping machine and calculate trial balances, summary reports, and other necessary data.

*Adding and calculating machine operators* (D.O.T. 216.488) use mechanical adding machines and electronic calculators to compute payrolls and invoices and do other statistical work. Some calculators can also be used to compute square roots and percent distributions.

*Mail preparing and mail handling machine operators* (D.O.T. 234.) use machines to open incoming mail and prepare bills and letters for mailing. Some machines fold and insert enclosures, while others address, seal, and stamp envelopes. Addressing machines print addresses on envelopes using stencils or metal plates prepared by *embossing machine operators* (D.O.T. 208.782) using special typewriters.

*Duplicating machine operators* (D.O.T. 207.782, .884, and .885) operate equipment that can reproduce letters, bills, invoices, and other documents. Included are mimeograph, stencil, and copying machines. These workers keep the machines loaded with paper, see that they are properly adjusted for the number of copies to be made, and may collate—put together—pages of lengthy documents by hand or machine.

*Tabulating machine operators* (D.O.T. 213.782) operate machines that sort and total large quantities of accounting and statistical information and print the results on special business forms.

Information about workers in several other occupations that use office machines can be found elsewhere in the *Handbook*, in the statements on computer and peripheral equipment operators, typists, and statistical clerks.

### Places of Employment

In 1976, about 163,000 people worked as office machine operators.



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About one-fifth worked for manufacturing companies; large numbers also were employed by banks, insurance companies, and wholesale and retail stores. Many office machine operators work for service firms that prepare monthly bills and mailing circulars for businesses that do not have their own office machinery.

### Training, Other Qualifications, and Advancement

Employers prefer high school or business school graduates for jobs as office machine operators. Most newly hired workers are expected to be able to type and operate adding machines and calculators. A knowledge of business arithmetic is helpful.

The amount of instruction and on-the-job training beginners receive depends on the types of machines they operate. Although a few days of training usually are sufficient to train duplicating machine operators, several weeks may be needed to train bookkeeping machine operators. Some office machine operators are trained at company expense in schools run by equipment manufacturers.

Finger dexterity, good eye and hand coordination, and good vision are important for most office machine operator jobs. Billing and calculating machine operators should know simple arithmetic so they can detect obvious errors in computations. Some mechanical ability is advantageous, especially for duplicating and tabulating machine operators.

Most employers promote from within and give strong consideration to seniority and job performance as shown by supervisors' ratings. Promotion may be from a routine machine job to a more complex one, or to a related clerical job. Employers often provide any additional training that may be required. In firms having large clerical staffs, office machine operators may advance to jobs where they train beginners or to supervisory positions as section or department heads.

### Employment Outlook

Employment of office machine operators is expected to grow more slowly than the average for all occupations through the mid-1980's. Most openings will result from the need to replace workers who die, retire, or leave the occupation.

Despite expected growth in the volume of billing, computing, and duplicating work, the occupation will expand slowly as computerized recordkeeping and processing systems spread. In addition, advances in data transmission devices will enable large employers to centralize recordkeeping, and to reduce the requirements for operators in branch offices.

### Earnings and Working Conditions

A 1975 Bureau of Labor Statistics survey of earnings for several office machine operator occupations in urban areas showed that the lowest salaries were paid in the South and the highest in the North and West.

For some occupations averages are given separately for different skill groups. Operators in Class A were very experienced and performed comparatively difficult work. Those in Classes B and C had some or no experience, worked on more routine assignments, and used simpler equipment. The average weekly salaries reported in this survey are shown in the accompanying tabulation:

| | *Average weekly salaries, 1976* |
|---|---|
| Billing machine operators | $160 |
| Bookkeeping machine operators: | |
| Class A | 170 |
| Class B | 140 |
| Tabulating machine operators: | |
| Class A | 240 |
| Class B | 200 |
| Class C | 160 |

Billing and bookkeeping machine operators earned slightly less than the average for all nonsupervisory workers in private industry, except farming.

Because some types of office machines are very noisy, operators may work in special areas apart from other company offices. In other respects, their working conditions are similar to those of other office workers in the same firms. (See the statement on clerical occupations for further information on working conditions and for sources of additional information.)

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## 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

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

codes the actual instructions the computer will follow.

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.

## 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.

### 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.

System analysts devising a new system.

### 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 promoted 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



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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

Earnings 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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## OFFICE MACHINE AND COMPUTER MANUFACTURING OCCUPATIONS

During the last decade, employment in the office machine and computer industry grew much faster than employment in manufacturing as a whole. Growth was spearheaded by a rapid expansion in the production of computers. For many years, the industry's chief products were typewriters, adding machines, calculators, and other conventional office machines. Today, plants that make computers and related equipment account for about three-fourths of the industry's production.

## Nature and Location of the Industry

In 1976, the office machine and computer manufacturing industry employed 290,000 workers in approximately 1,050 plants. About 6 out of every 10 of them worked in plants that produced computer equipment, the remainder in plants that produced conventional office machines and scales and other weighing devices.

Computer equipment manufacturing plants employed about 195,000 workers in 1976. These plants manufacture general purpose computers as well as those used for special applications, such as space exploration and missile guidance. They also manufacture related equipment such as machines that read magnetic numbers on bank checks. In addition to computers and related equipment, plants may furnish "software" (computer programs and operating systems that control the operation of the computer). Thousands of people whose employment is not included in this chapter are employed outside manufacturing plants by firms that specialize in software or that rent or lease computers and provide related services.

In 1976, about 95,000 people were employed in factories that produced conventional office machines and scales. Of this total, nearly half produced desk calculators, cash registers, coin and ticket counters, and adding, accounting, and voting machines; the rest produced typewriters, industrial and household scales and miscellaneous office machines, including items as diverse as postage meters and dictating machines.

Large plants account for most of the employment in office machine and computer manufacturing. About 65 percent of the industry's employees work in plants that have 1,000 or more employees; several computer plants have more than 5,000 employees.

Six of every 10 persons employed in computer manufacturing work in California, New York, and Minnesota, and the following States employ most of the remainder: Massachusetts, Pennsylvania, Colorado, Florida, Texas, Arizona and North Carolina. In New York, the lower Hudson River Valley area has many important computer manufacturing centers: Poughkeepsie, East Fish Kill, and Kingston. Large manufacturing plants also are located in Utica, N.Y., and in the Boston, Mass., and Philadelphia, Pa. areas. The leading center in the Midwest is Minneapolis-St. Paul. The Los Angeles and San Diego industrial areas are the most important computer manufacturing centers in the West, followed by Phoenix, Ariz.; and San Jose, Calif.

Most of the conventional business machine manufacturing employment is located in eight States: Ohio, Kentucky, New York, Michigan, California, Illinois, New Jersey, and Connecticut. Some of the important manufacturing centers are: Dayton, Toledo, and Euclid, Ohio; the New York-Northeastern New Jersey industrial area; Hartford and Stamford, Conn.; Chicago, Ill.; Detroit, Mich.; and Lexington, Ky.

## Occupations in the Industry

A variety of occupations, requiring a broad range of training and skills, are found in plants that make office machines and computers. More than half of the industry's workers are in white-collar jobs (engineering, scientific, technical, administrative, sales, and clerical); the others are in plant jobs (assembly, inspection, maintenance, transportation and service).

White-collar workers represent a significantly larger proportion of total employment in the computer industry than in most other manufacturing industries because of the highly complex nature of computer manufacturing.

Some of the key occupations in the office machine and computer industry are described briefly in the following section. (Detailed discussions of professional, technical, skilled, and other occupations found in this industry, as well as in many others, are presented elsewhere in the *Handbook*, in sections covering individual occupations.)

*Engineering and Scientific Occupations.* Nearly 1 out of every 10 workers in the office machine and computer industry is an engineer or scientist. Most of them work at computer plants.

The largest group of engineers work with electricity or electronics. Most are engaged in research and development, although many work in production. The industry also employs large numbers of mechanical and industrial engineers. Some mechanical engineers are engaged in product development and tool and equipment design. Others are concerned with the maintenance, layout, and operation of plant equipment. Industrial engineers determine the most effective means of using the basic factors of production—labor, machines, and materials.

Chemists make up the largest group of scientists in office machine and computer manufacturing. Their work is primarily in chemical processing of printed circuits used in computers. Mathematicians make up another large group of scientists. Their work on complex mathematical problems is important in designing computers. Physicists are employed in research and development to work on items such as miniaturized components and circuits. Statisticians work in fields such as quality control and production scheduling.

The industry also employs systems analysts and computer programmers, many of whom have scientific or engineering backgrounds. Systems analysts primarily devise new information processing techniques and improve existing techniques. Programmers design and test computer programs. Some analysts and programmers specialize in scientific and engineering problems, while others process accounting, inventory, sales, and other business data. In addition, systems analysts and programmers may assist sales personnel in determining data processing needs of customers.

*Technical Occupations.* More than 1 out of every 20 workers in the industry is a technician. Most specialize in electronics and assist engineers and scientists in research and development, testing and inspecting electronic components, and doing complex assembly work. Some electronics technicians specialize in repairing computers. Chemical con-

trol technicians prepare solutions used in the etching of circuit boards. Photographic technicians set up cameras and other equipment used in the tracing process to create copper etchings on circuit boards. Drafters prepare drawings from sketches or specifications furnished by engineers. Engineering aides assist engineers by making calculations, sketches, and drawings, and by conducting performance tests on components.

*Administrative and Sales Occupations.* About 1 out of every 13 workers is an administrator. Included are top executives who manage companies and determine policy decisions and middle managers who direct departments such as advertising and industrial relations. Other administrative employees in staff positions include accountants, lawyers, and market researchers.

Sales personnel hold about 1 out of every 25 jobs in the industry. Those who sell conventional office machines usually work on their own. Computer sales personnel, on the other hand, are assisted by a host of technical experts, such as engineers and systems analysts. Because computers are complex and expensive, computer sales representatives may have to spend several months to complete a sale.

*Clerical Occupations.* Nearly 1 out of every 6 workers in the industry is in a clerical job. Included in this group are secretaries, clerk typists, file clerks, bookkeepers, and business machine operators, as well as computer personnel such as keypunch and computer operators.

*Plant Occupations.* Nearly half of this industry's employees are plant (blue-collar) workers. Most plant workers are engaged directly in making computers and office machines. They include assemblers, inspectors or testers, machinists, machine tool operators, and their supervisors. Truckdrivers, material handlers, power truck operators, guards, and janitors move materials and perform custodial duties, and plumbers and pipefitters, electricians, carpenters, and other workers maintain production machinery and building facilities.

*Assembly Occupations.* (D.O.T. 706.884, 726.781 and .884) Workers who assemble computers and office machines have many different skills, and make up the largest group of plant workers.

Assemblers may put together small parts to make components or components to make sub-assemblies or the finished product. Much of their work is done by hand. Some assemblers do a single operation as components move down the assembly line. The assembly of typewriters, for example, is divided into many simple operations. Each assembler does one job as the typwriter passes the work station. Some assembly jobs are difficult and require great skill, while others are relatively simple. Skilled electronics assemblers, for example, use diagrams as guides to wire complex memory and logic panels for computers.

Machines are used for many assembly operations. Automatic wire-wrapping machines, for example, wire panels and plug-in-boards. Operators feed these machines and remove and inspect finished items.

Electronic technicians usually do the most difficult hand assembly work. In research laboratories, they put together experimental equipment. In plants, they put together complex items that require a knowledge of electronics theory.

Assemblers commonly use screwdrivers, pliers, snippers, and soldering irons and they use special devices to position and hold parts during assembly. Some assemblers use precision equipment to weld connections in circuit assemblies.

*Machining Occupations.* Most office machine and computer manufacturing plants employ machining workers who operate power-driven machine tools to produce plastic and metal parts for computers, typewriters, accounting machines, calculators, and other products. Numerical control machine operators tend machines that have been programmed to perform machining operations automatically. Toolmakers construct and repair equipment used to make and assemble parts. Diemakers specialize in metal forms (dies) used in punch and power presses that shape metal parts.

*Inspection and Testing Operations.* These operations begin when raw materials enter the plant and continue throughout the assembly process. Finished parts and products are tested and inspected thoroughly.

Some inspectors examine individual parts; others inspect components during subassembly; still others inspect completed office machines and computers. Many inspecting jobs require highly skilled workers. On the other hand, relatively unskilled people can run some automatic test equipment. Workers who feed or monitor this equipment are called test-set operators or testing machine operators.

Job titles indicate the work many inspectors do. *Machined parts inspectors* (D.O.T. 609.381) use precision testing instruments to determine whether parts have been machined properly. *Type inspectors* (D.O.T. 706.687) use a magnifying glass to examine typewriter type for defects. *Electronic subassembly inspectors* (D.O.T. 726.384) use microscopes, meters, and various measuring devices to examine circuits and other electronic subassemblies. *Electronic assembly inspectors* (D.O.T. 722.281) use special instruments to test electronic systems such as computer memory units.

In plants that manufacture conventional office machines, final inspection is relatively simple. Inspectors operate the machines, look for defects, and refer malfunctioning machines to repairers. The final inspection or "debugging" of computers, on the other hand, is very complex. Electronic technicians inspect new computers under the supervision of electronic engineers. They use complex equipment to run tests and detailed drawings and instructions to find causes of malfunctions.

*Maintenance Occupations.* Many maintenance workers with different types of training take care of the industry's production machinery and equipment. Skilled electricians are responsible for the maintenance of

electrical equipment. Machine and equipment repairers make mechanical repairs. Maintenance machinists and welders build and repair equipment. Air-conditioning and refrigeration mechanics are employed in plants that are air-conditioned and have special refrigerated and dust-free rooms in order to maintain the equipment. Painters, plumbers, pipefitters, carpenters, and sheet-metal workers, and other building maintenance craft workers also are employed in this industry.

*Other Plant Occupations.* Many truckdrivers are employed to make deliveries to various parts of plants. Laborers load and unload trucks and boxcars and do general clean-up work. Some other plant occupations are boiler operator, stationary engineer, guard, and janitor.

### Training, Other Qualifications, and Advancement

A bachelor's degree in engineering or one of the sciences is usually required for engineering and scientific jobs. For research and development work, applicants with advanced degrees generally are preferred. Some companies have training programs designed to give newly hired college graduates a broad picture of manufacturing operations before they are assigned to a particular department. Because of the highly technical nature of computers, many of the industry's executives have backgrounds in engineering or science.

Engineers and scientists, as well as persons with a degree in computer science, are employed as sales workers, programmers, and systems analysts. Most business and liberal arts graduates are employed in accounting, personnel, and other administrative activities.

Technicians qualify for their jobs in a number of ways. Some obtain training in either public, private, or Armed Forces technical schools. Others have one or more years of scientific or engineering training, but have not completed all of the requirements for a degree. Still other technicians are promoted from lower grade jobs in the plant and some well-qualified technicians may advance to engineering jobs after completing courses in mathematics, engineering, and related subjects.

People who complete commercial courses in high school or business school are preferred in clerical jobs such as secretary or office machine operator. For computer operators, most firms prefer applicants who have some college or technical training in data processing. With additional training, some computer operators and clerical workers advance to programmer jobs.

In selecting workers for plant jobs, firms generally prefer high school or vocational school graduates, who are then trained through on-the-job instruction and experience that varies from a few days to years. Some plants also conduct classroom training of short duration. Skilled craft workers, such as machinists and tool and die makers, may spend 3 to 4 years in learning their jobs and some firms have formal apprenticeship programs, which include both on-the-job training and classroom instruction related to the particular craft. Frequently, openings for skilled jobs are filled by workers already in the plant.

Workers who have little or no previous experience or training are hired for less skilled inspection, assembly, and machining jobs. Applicants may have to pass aptitude tests and demonstrate ability for particular types of work. Most assembly and inspection jobs require good eyesight and color perception, manual dexterity, and patience.

Experienced plant workers have opportunities to advance to jobs with higher pay. Assemblers, for example, can become semiskilled inspectors, and eventually skilled inspectors. Machine tool operators can move to skilled machinist jobs. Craft workers and skilled inspectors can become technicians, after completing courses in company-operated schools, junior colleges, or technical schools. Supervisory jobs are open to experienced plant workers who have leadership ability.

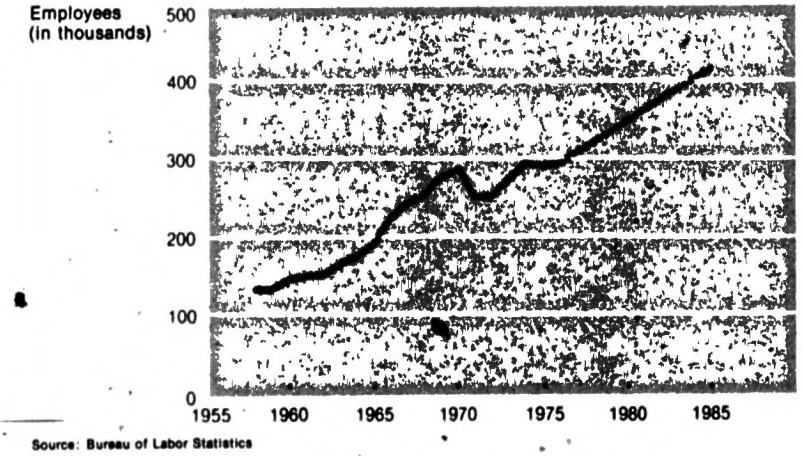
### Employment Outlook

Employment in this industry is expected to increase faster than the average for all industries through the mid-1980's. This growth is projected to occur principally in plants that produce electronic computer equiment; little growth is forseen among manufacturers of conventional office equipment. In addition to the job openings that result from employment growth, many openings will arise as experienced workers retire, die, or transfer to jobs in other industries.

The demand for computers and related equipment is expected to in-

**Very rapid employment growth is expected in plants that produce electronic computer equipment**

Wage and salary workers in office and computing machine manufacturing, 1958-76 and projected 1985




Source: Bureau of Labor Statistics



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crease rapidly as computers are used to solve an increasing array of problems in business, industry, and government. Using computers to control the flow of automobile traffic, to aid physicians make a medical diagnosis, and to help students learn more quickly are just a few of the new computer applications that are likely to come into widespread use over the next few years. In addition to growth generated by new applications, demand will rise as further price reductions bring a computer system within reach of more and more small organizations. Growth in the number of computers will be accompanied by a need for additional computer-related equipment—input and output, storage, and communication devices—as well as software designed specifically to meet the needs of certain types of organizations.

Although the demand for conventional office machines is expected to remain strong through the mid-1980's, employment in plants that produce this type of equipment will grow slowly. Most job openings will result from the need to replace experienced workers who retire, die, or transfer to other industries. The demand for office equipment should continue to rise as business and government organizations grow and the volume of paperwork increases. However, technological improvements in production methods are expected to increase output per worker. For example, increasing mechanization of operations formerly done by hand will tend to reduce labor requirements, particularly in plants where products are mass-produced, such as typewriters and calculators.

Some occupational groups in the office machine and computer manufacturing industry are expected to grow faster than others. For example, the number of professional and administrative workers, particularly engineers, scientists, and technicians, is expected to increase more rapidly than the number of plant workers. Demand for these workers will be spurred by continued high levels of research and development expenditures to improve machine capabilities, design more efficient software, and develop new applications for computers.

Semiskilled workers, such as assemblers and inspectors, will continue to account for most of the work force in production occupations, despite the growing use of automated and mechanized assembly line equipment.

## Earnings and Working Conditions

In 1976, plant workers in the office machine and computer industry had average earnings of $5.29 an hour. Wages in computer manufacturing plants are slight higher than in the industry as a whole, averaging $5.46 an hour in 1976.

National wage data are not available for individual occupations in the office machine and computer industry. However, the following tabulation, based on data obtained from a small number of union contracts, provides an example of the range in hourly wage rates for selected occupations in 1976:

| | *Hourly rate ranges* |
|---|---|
| Assemblers | $3.00–4.50 |
| Machinists | 4.38–5.82 |
| Tool-and-die makers | 5.50–6.50 |
| Electricians | 5.50–6.50 |

Some employees work night shifts and weekends because many plants operate around the clock. Employees working second or third shifts, or more than 8 hours a day or 40 hours a week generally receive extra pay. Paid vacations and holidays are almost universal in this industry. Most employees receive 1 to 4 weeks of vacation, depending on length of service. They also receive insurance and pension benefits at least partially financed by the employer. Employee stock purchase plans are available in many firms.

In general, the work surroundings in office machine and computer plants are more favorable than those in most other types of factories. Work stations usually are well-lighted and clean, and free from dust, fumes, and loud noises. Many computer factories are relatively new and are located in suburban areas.

Some plant jobs are repetitious, but very few require great physical effort. Fewer and less severe injuries take place in office machine and computer manufacturing than the average for all manufacturing.

Many plant workers are covered by union contracts. The principal unions in this industry are the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the International Union of Electrical, Radio and Machine Workers; and the International Brotherhood of Electrical Workers.

## Sources of Additional Information

For general information on jobs in the industry, write to:

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



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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 supervise others
- work with all types of people
- work with things—you need good coordination and manual dexterity
- work independently—you need initiative and self-discipline
- work as part of a team
- work with details, perhaps numbers or laboratory reports
- help people
- use creative talents and ideas
- work in a confined area
- do physically hard or dangerous work
- work outside in all types of weather

A counselor can help you find out more about your interests and abilities so you can judge whether a job's characteristics suit you.

The EMPLOYMENT OUTLOOK section tells whether or not the job market is likely to be favorable. Usually an occupation's expected growth is compared to the average projected growth rate for all occupations (20.1 percent between 1976 and 1985). The following phrases are used:

| | |
|---|---|
| Much faster | 50% or more |
| Faster | 25.0 to 49.9% |
| About as fast | 15.0 to 24.9% |
| Slower | 4.0 to 14.9% |
| Little change | 3.9 to -3.9% |
| Decline | -4.0% or more |

Generally, job opportunities are favorable if employment is growing at least as fast as for the economy as a whole.

But, you would have to know the number of people competing with you to be sure of your prospects. Unfortunately, this 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 |

Competition or few job openings should not stop your pursuing 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 1976.

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, such as paid vacations, holidays, and sick leave.

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

Despite difficulties in determining exactly what people earn on 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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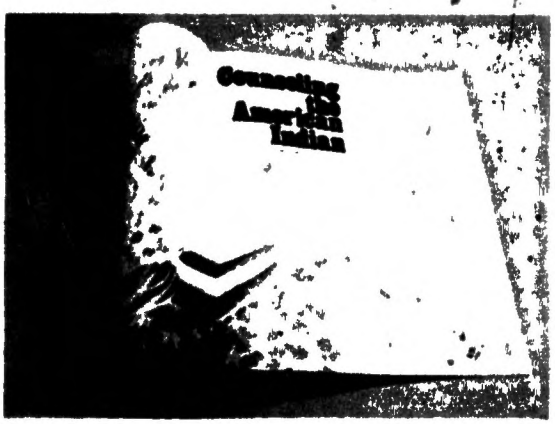


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