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ABSTRACT

In 1980 1,455,000 persons worked in computer occupations. Two in five were systems analysts or programmers; one in five was a keypunch operator; one in 20 was a computer service technician; and more than one in three were computer and peripheral equipment operators. Employment was concentrated in major urban centers in four major industry divisions--manufacturing; services; finance, insurance, and real estate; and wholesale and retail trades. Between 1970 and 1980, employment of computer workers more than doubled. Educational requirements ranged from high school graduates to those with a college degree and beyond. The shortage of qualified computer workers is due to the relative newness of the field, its rapidly changing technology, and lack of qualified teachers. Overall employment is expected to increase by nearly one-half from 1980 to 1990. New technologies that will affect employment are in three major areas: hardware, software, and applications. Employment of computer and peripheral equipment operators and computer service technicians is expected to increase, while the demand for keypunch operators will decrease. The shortage of computer personnel is expected to continue, resulting in higher wages, more job mobility, increased job security, and greater opportunities. (Appendixes include data tables and a glossary.) (YLB)

Employment Trends in Computer Occupations

U.S. Department of Labor
Raymond J. Donovan, Secretary

Bureau of Labor Statistics
Janet L. Norwood, Commissioner
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Preface

This bulletin presents the results of a Bureau of Labor Statistics study of employment of workers in five computer-related occupations. It includes information on education and training for computer occupations, the impact of advancing technology on employment and education, and projected employment requirements through the 1980's. The study was conducted as part of the Bureau's program to provide information about occupations for use in career counseling and education planning.

The bulletin was prepared in the Division of Occupational Outlook under the direction of Michael Pilot. Patrick Wash supervised its preparation. H. Philip Howard and Debra E. Rothstein conducted the research, analyzed the data, and wrote the report. Vidella H. Hubbard prepared the manuscript. The Bureau is grateful to the many individuals who provided information for the study and who reviewed and commented on the draft report.

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Highlights

The use of computers has become widespread in our society.

- The number of computer systems has risen dramatically in the last decade. In 1980, more than 600,000 computer systems were in use, compared with only about 100,000 in 1970. The number is expected to continue to increase rapidly through the 1980's.
- At first limited to only a few industry applications, computers are now used in many industries. New applications are expected in the years ahead as rapid access to information becomes increasingly important.

The computer occupations are expected to be the most rapidly growing in the economy over the next decade.

- Employment in computer occupations is expected to rise from 1,455,000 in 1980 to 2,140,000 in 1990, an increase of 47 percent (chart 1). This is nearly three times as fast as the expected rate of growth for all occupations in the economy.
- Systems analysts are expected to increase from 243,000 to 400,000, or by 65 percent.
- Programmers are expected to increase from 341,000 to 500,000, or by 47 percent.
- Computer and peripheral equipment operators are expected to increase from 522,000 to 850,000, or by 63 percent.
- Keypunch operators are expected to decline from 266,000 to 230,000, a decrease of 14 percent.
- Computer service technicians are expected to increase from 83,000 to 160,000, or by 93 percent.

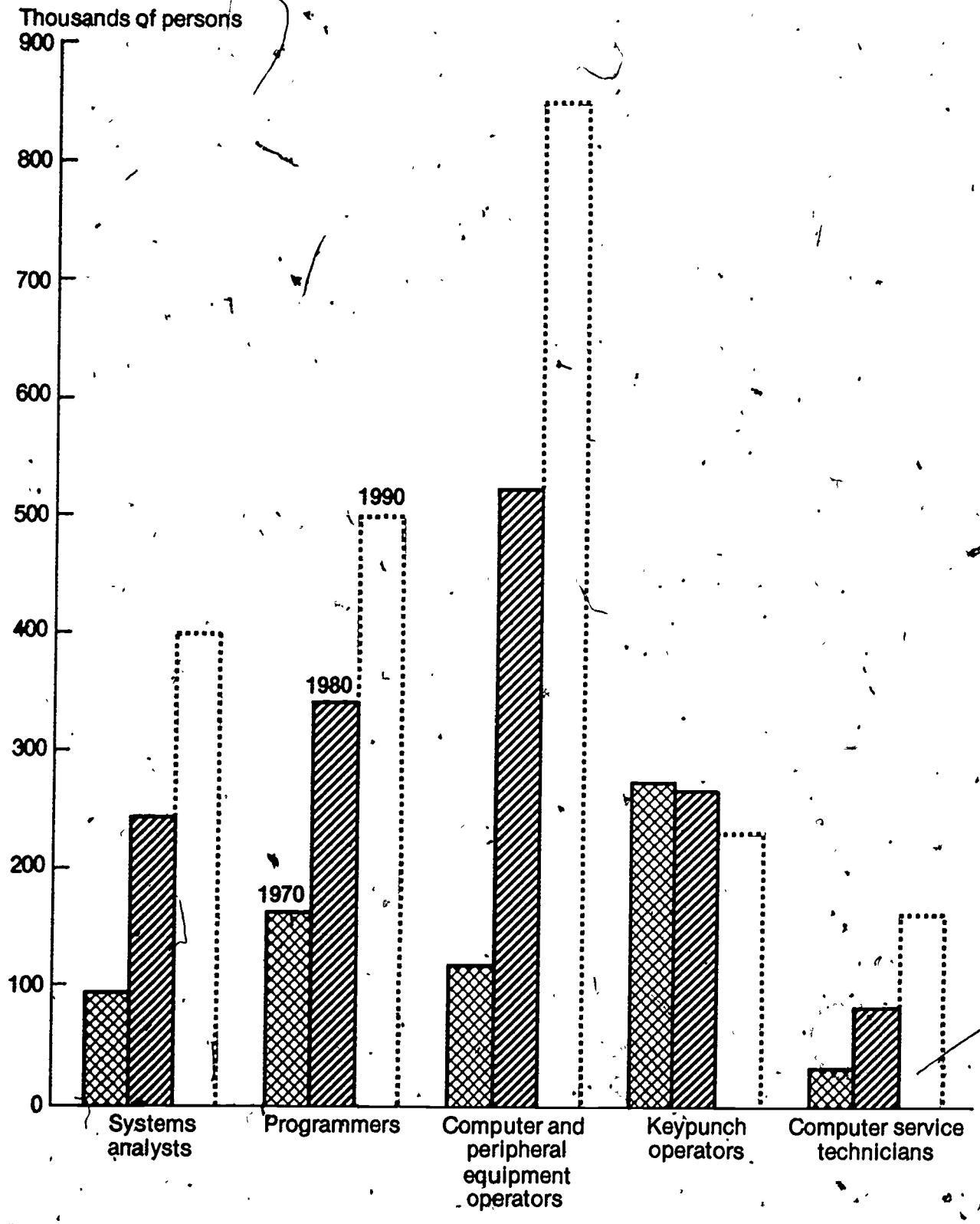
The increasing sophistication and complexity of computer operations will require workers with more and better training.

- Education and training for computer occupations have not kept up with needs.
- If future needs for trained computer personnel are to be met, major improvements are required in at least two areas— attracting qualified teachers and standardizing program content.
- Despite current shortcomings in education and training, improvements have been made. The number of computer degree programs is increasing rapidly, and there is a strong trend toward infusing computer training into curricula besides computer science

Advances in all major areas of computer technology will supply the user with more computer capability per investment dollar.

- Hardware—Advances in microprocessor technology have stimulated the development of smaller, more efficient, and less costly computer equipment. Newer hardware is expected to have a significant impact on computer employment.
- Software—The development of easier-to-use programming languages and packaged programs is expected to continue. These developments, along with the trend toward incorporating systems programming functions into hardware, will permit more direct interaction between the user and the computer, and in some cases may simplify programmer job duties.
- Applications—The number of applications made practical by hardware and software advances will make the computer accessible to more users. This increased use due to new applications will be the most significant factor causing rapid growth in computer employment over the next decade.

Chart 1. Employment in computer occupations, 1970, 1980, and projected 1990



Source: Bureau of Labor Statistics.

Chapter 1. Employment

This study discusses employment in five computer occupations: Systems analysts, programmers, computer and peripheral equipment operators, keypunch operators, and computer service technicians.[1] Although a wide variety of other workers, from engineers to sales clerks, routinely use the computer in their daily tasks, this report focuses only on those occupations whose very existence depends on computers. Table 1 presents a brief description of the major job duties for each of the occupations studied.

In 1980, 1,455,000 persons worked in computer occupations. Two out of five worked with computer software, either in systems analysis or programming. Nearly 1 in 5 entered data as a keypunch operator while 1 in 20 maintained and repaired computer hardware. By far the largest single occupation was computer and peripheral equipment operator, which accounted for more than 1 of every 3 computer workers in 1980 (table 2).

Geographic distribution

Employment in computer occupations is concentrated in the major urban centers where the majority of companies owning general-purpose computer systems are located. The 25 metropolitan areas with the largest concentrations of general-purpose computers accounted for about 56 percent of the total value of these systems in 1978, and the top 100 metropolitan areas constituted 84 percent of this total.

However, as the use of minicomputers increases and as distributed data processing (DDP) networks become more widespread, computer systems will become less concentrated. This trend is expected to result in increased opportunities for computer employment outside metropolitan areas.

[1] Fifty-five different occupational titles, shown in appendix C, were subsumed by the Bureau of the Census in the 1970 Census and in the Current Population Survey from 1971 to 1980 under six occupational categories: Computer programmer, computer systems analyst, computer specialist not elsewhere classified, computer and peripheral equipment operator, keypunch operator, and data processing machine repairer. The BLS 1970 industry-occupational matrix paralleled the Census classifications. This study, however, combines two of these classifications, systems analyst and computer specialist not elsewhere classified, because of the similiarity of the work. This study also uses the term "computer service technician" in place of the Census title "data processing machine repairer" in order to better reflect the job duties these workers perform.

Industries of concentration

Although computer workers are found throughout the economy, 8 of every 10 are in four major industry divisions (chart 2).[2] In 1978, the greatest concentration, about 30 percent, was in the services division—primarily in computer programming services, colleges and universities, and accounting and auditing services The second largest concentration, about 28 percent, was in manufacturing, predominantly in firms manufacturing durable goods. About 13 percent of all computer workers were in finance, insurance, and real estate, the great majority of whom worked in banks and insurance companies—organizations that have become heavily computerized in order to handle the large volume of transactions. Another 12 percent of all persons in computer occupations worked in wholesale and retail trade establishments. Most of these were concentrated in wholesale trade, where firms generally are large and where computers have been used for years for inventory and distribution functions.

The remaining five major industry divisions accounted for less than 20 percent of computer employment in 1978. Transportation, communications, public utilities, and government employed most of these workers, only 2 percent of all computer workers were found in mining, construction, or agriculture, forestry, and fisheries.

Industry trends, 1970-78

Employment of computer workers increased dramatically over the 1970-78 period, about two and one-half times as fast as the rate of growth of employment for the economy as a whole (chart 3) Computer employment grew rapidly in all industries, even in those that experienced little or no overall employment growth in the 1970's. In manufacturing, for example, total employment rose only 5 percent between 1970 and 1978, but computer employment rose 34 percent.

The growth of computer occupations is unlike the usual pattern of occupational growth whereby employment increases as a result of growth in the industries in which the occupations are concentrated Employment of secretaries, for example, has grown rapidly in recent years, due in large part to the rapid growth of the

[2] Data on the industry division of computer workers are based on the 1978 industry-occupational matrix, the most current matrix available when this study was prepared.

Table 1. Description of duties of computer workers

Occupation	Duties
Systems analysts	Analyze business, scientific, and engineering problems for application to electronic data processing systems. These workers are classified according to their specialty. *In business,* they analyze business procedures and problems such as development of integrated production, inventory control, and cost analysis systems, to refine data and convert them to programmable form for electronic data processing. *In scientific and technical areas,* they perform logical analyses of scientific, engineering, and other technical problems, and formulate mathematical models of these problems for computer solution. *Systems engineers* analyze electronic data processing projects to determine equipment requirements. After determining equipment requirements, they may plan the layout and implementation of computer systems to achieve efficient operation.
Computer programmers	Convert business, scientific, and engineering problems to logical flow charts for coding into computer language. These workers are classified according to their specialty. They analyze all or part of a workflow chart or diagram to develop a sequence of program steps. To do this, programmers must apply their knowledge of computer capabilities, subject matter, mathematics, and symbolic logic. They then convert the steps to language that can be processed by the computer.
Computer and peripheral equipment operators	*Computer (console) operators* monitor and operate the control console of a computer to process data according to operating instructions. They set control switches on the equipment, select and load the input and output units with materials—such as tapes and printout forms—and then clear the system and start the equipment. During the run, they observe the machines and control panel for error signals. *Peripheral equipment operators* operate on-line or off-line peripheral machines, according to instructions, to transfer data from one form to another, print output, and read data into and out of the computer.
Keypunch operators	Operate alphabetic and numeric keypunch machines to transcribe data from source material onto punchcards, paper or magnetic tape, or cards.
Computer service technicians	Install, repair, and periodically service computer equipment, following blueprints and manufacturers' specifications. These workers test faulty equipment and apply their knowledge of electronics to diagnose defects. They replace or repair defective components. On occasion, they consult with customers when planning the layout for installation or in diagnosing system malfunctions.

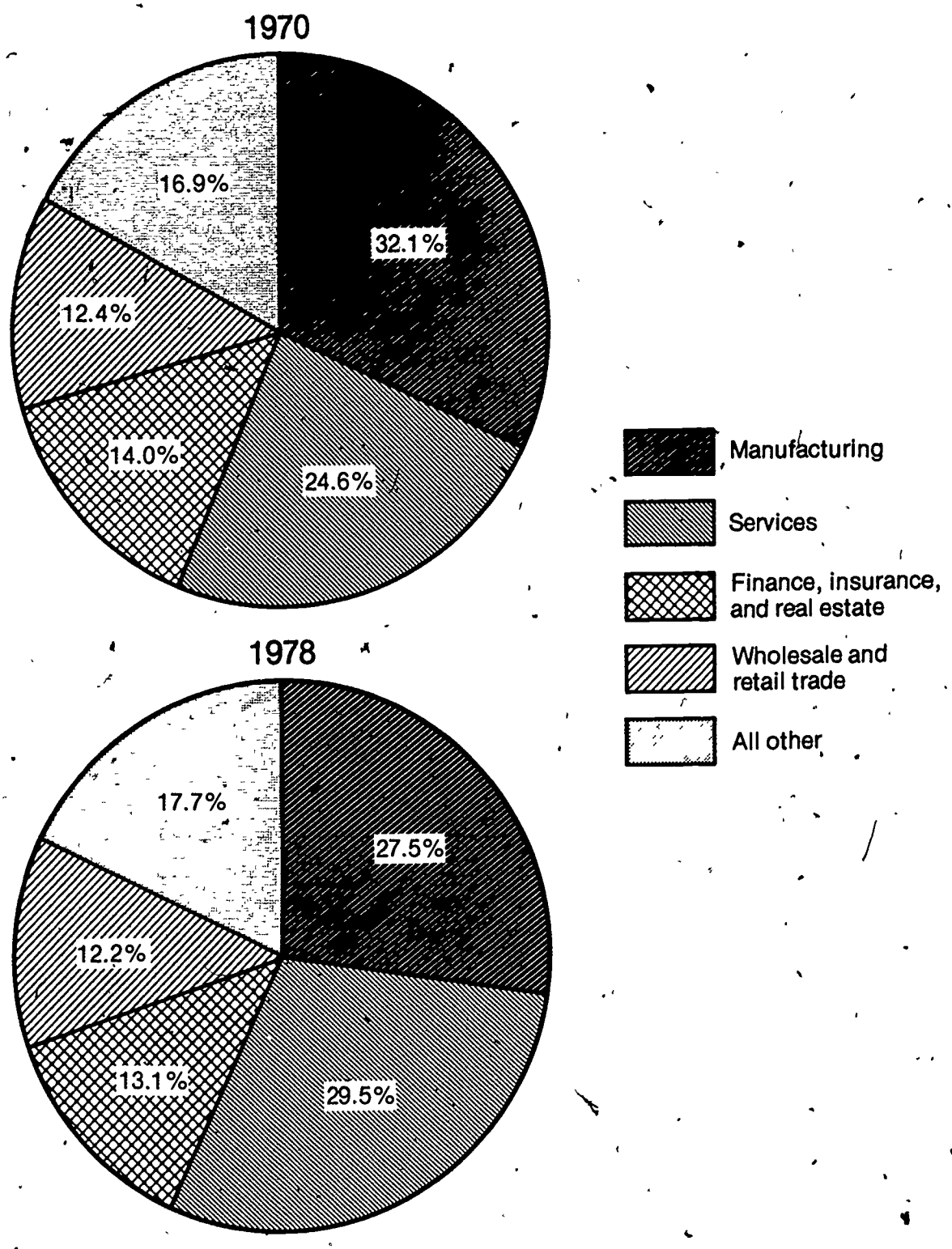
Source: Bureau of Labor Statistics.

Table 2. Employment in computer occupations, 1970-80

Year	Total	Systems analysts	Programmers	Computer and peripheral equipment operators	Keypunch operators	Computer service technicians
1970	676,037	93,200	161,337	117,222	272,570	31,708
1971	709,000	75,000	158,000	156,000	290,000	30,000
1972	798,000	88,000	186,000	196,000	283,000	45,000
1973	803,000	100,000	187,000	216,000	253,000	47,000
1974	857,000	113,000	199,000	246,000	249,000	50,000
1975	985,000	140,000	223,000	295,000	250,000	57,000
1976	1,000,000	158,000	229,000	287,000	276,000	50,000
1977	1,003,000	150,000	221,000	302,000	280,000	50,000
1978	1,158,000	182,000	247,000	393,000	273,000	63,000
1979	1,352,000	213,000	321,000	453,000	274,000	91,000
1980	1,455,000	243,000	341,000	522,000	266,000	83,000

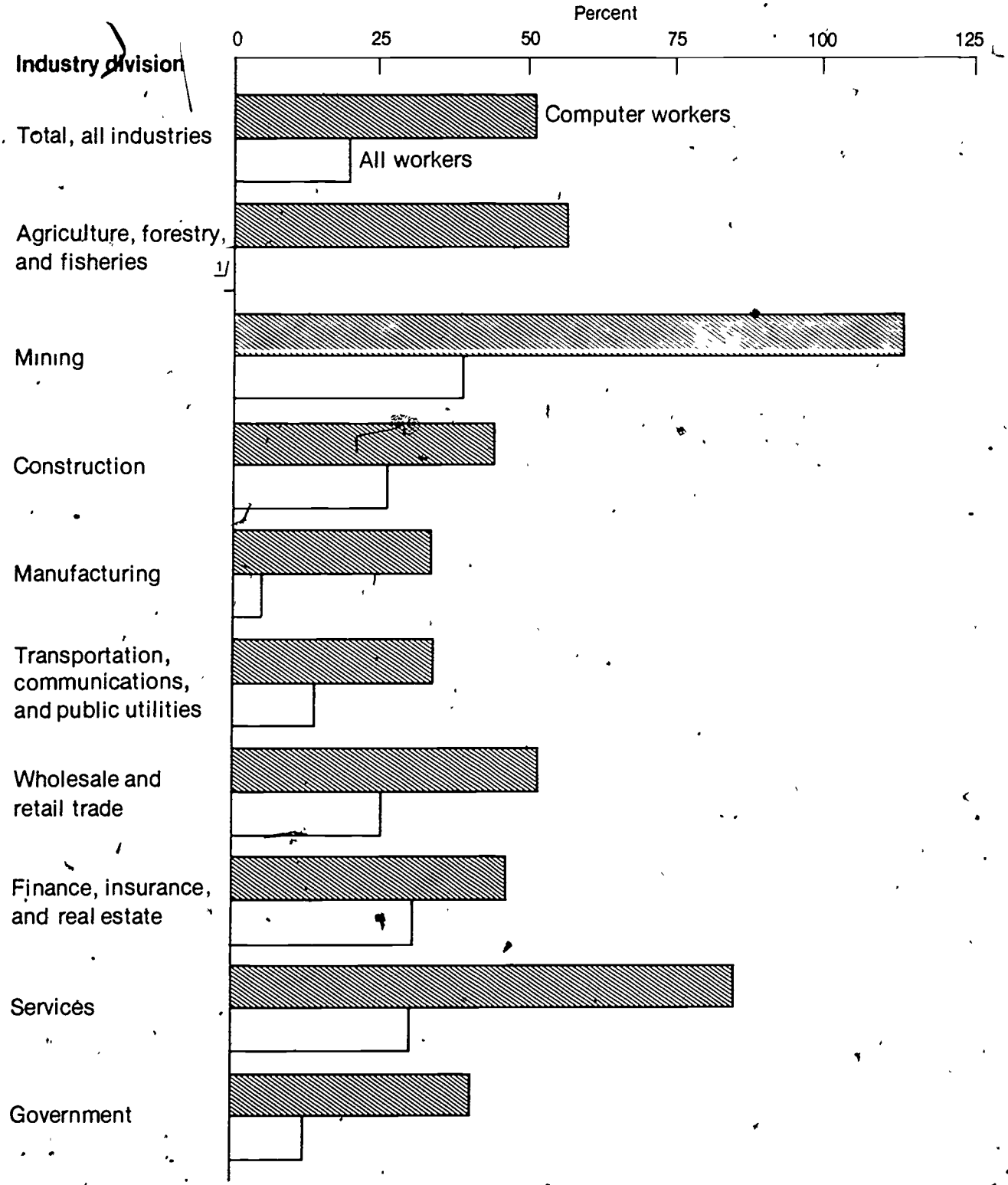
SOURCE: Bureau of Labor Statistics.

Chart 2. Employment of computer workers by industry division, 1970 and 1978



Source. Bureau of Labor Statistics.

Chart 3. Percent change in employment of computer workers and all workers by industry division, 1970-78



1/ Decrease of less than 0.05 percent

Source Bureau of Labor Statistics.

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finance, insurance, and real estate sector and the services sector, which together employ almost one-half of all secretaries. As output of firms in these sectors expanded, more secretaries were needed to handle the greater number of support functions. Employment of computer workers, however, reflects an industry's capital expenditures for technology as employers install computers to increase efficiency and productivity, whether or not their output is expanding.

Not all industry sectors have computerized their operations at the same pace. These investment decisions are based on price and the adaptability of computer hardware and software to the needs of potential users. Prior to 1970, computers were generally limited to organizations whose size would justify the cost of a central mainframe. Many manufacturing firms, banks and insurance companies, wholesalers and large retailers, and colleges and universities maintained their own computer for batch processing of personnel records, payroll, inventory, and records of student enrollment, to list just a few standard applications. In addition, process control computers were applied to industrial processes that already had a high degree of control, such as steelmaking, petroleum refining, chemical production, and electric power generation. Organizations that could not afford to operate their own computer systems contracted with computer services firms to meet their data processing needs. Many others stayed completely out of the computer market.

Technological advances during the 1970's presented potential users with an array of more efficient and more flexible hardware and software at steadily falling prices that made it cost effective for a growing number of organizations to install a computer. More affordable mainframes, highly efficient minicomputers, small business computers, and a greater variety of software packages all contributed to the explosion in computer employment during the 1970's.

As previously noted, employment of computer workers in manufacturing firms grew almost seven times as fast as overall industry employment as smaller manufacturers installed less expensive mainframes and many others adapted computers directly to the production process. One technique that developed over the period was the utilization of minicomputers in distributed data processing networks throughout a plant to enable workers to better control operations such as the flow of raw materials and the precision measurement of manufactured items.

Computer employment in the services sector grew almost three times as fast as total industry employment as computer equipment became more affordable. Employment of computer workers grew rapidly in the types of establishments that already were computerized by the beginning of the decade—colleges and universities as well as firms providing accounting, auditing, and computer programming services. Even more rapid employment growth occurred in hospitals and other health services and in miscellaneous business services. Computer employment in health services increased as more flexible computer systems were increasingly adapted to medical diagnosis and patient care. Firms providing business management services, those doing commercial research and development, and private employment agencies were three of the more significant sources of growth in computer employment during the 1970's. These and other types of relatively small service firms were able to successfully incorporate small business computers into their operation.

Computer employment in wholesale and retail trade grew more than twice as fast as total industry employment as wholesalers installed distributed data processing networks to give themselves better control over their inventory and distribution functions. Employment in retail firms increased even faster as single-store operations installed a small business computer to handle their inventory and other business records and retail chains installed point-of-sale terminals linked to a central computer. Finance, insurance, and real estate experienced relatively moderate gains in computer employment between 1970 and 1978. This reflected the relatively slow growth of the insurance industry, which accounts for about one-third of total employment in this industry division, and the fact that operations in the insurance industry already had been largely computerized prior to 1970. This left only modest gains to be made in the 1970's.

Computer employment in government grew more than twice as fast as total government employment throughout the 1970's. This reflected the slower than average growth in government during this period, and the increasing use of computers to manage the enormous amount of recordkeeping that government programs require. Growth of computer occupations was strongest in State and local governments, where government employment growth was concentrated.

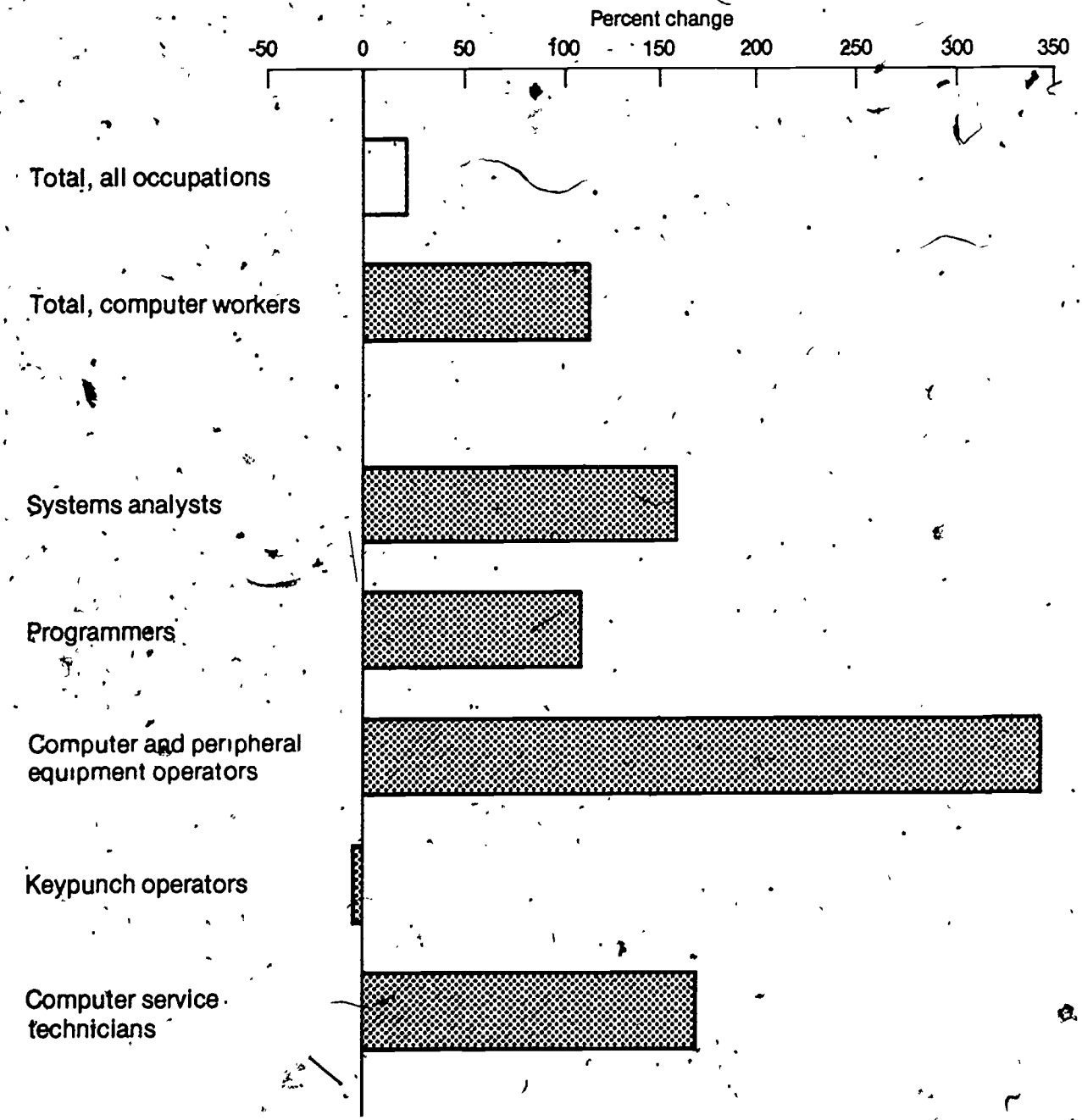
The smallest increase in computer employment occurred in transportation, communications, and public utilities. These are large, centralized industries that could afford the larger, more expensive computer systems available prior to 1970. It should be noted, however, that even this relatively modest increase exceeded the average growth rate for all occupations.

Computer employment in agriculture, forestry, and fisheries; mining; and construction combined increased faster than in any other sectors as the relatively small firms in these industries made substantial use of smaller, less expensive computer systems.

Occupational trends, 1970-80

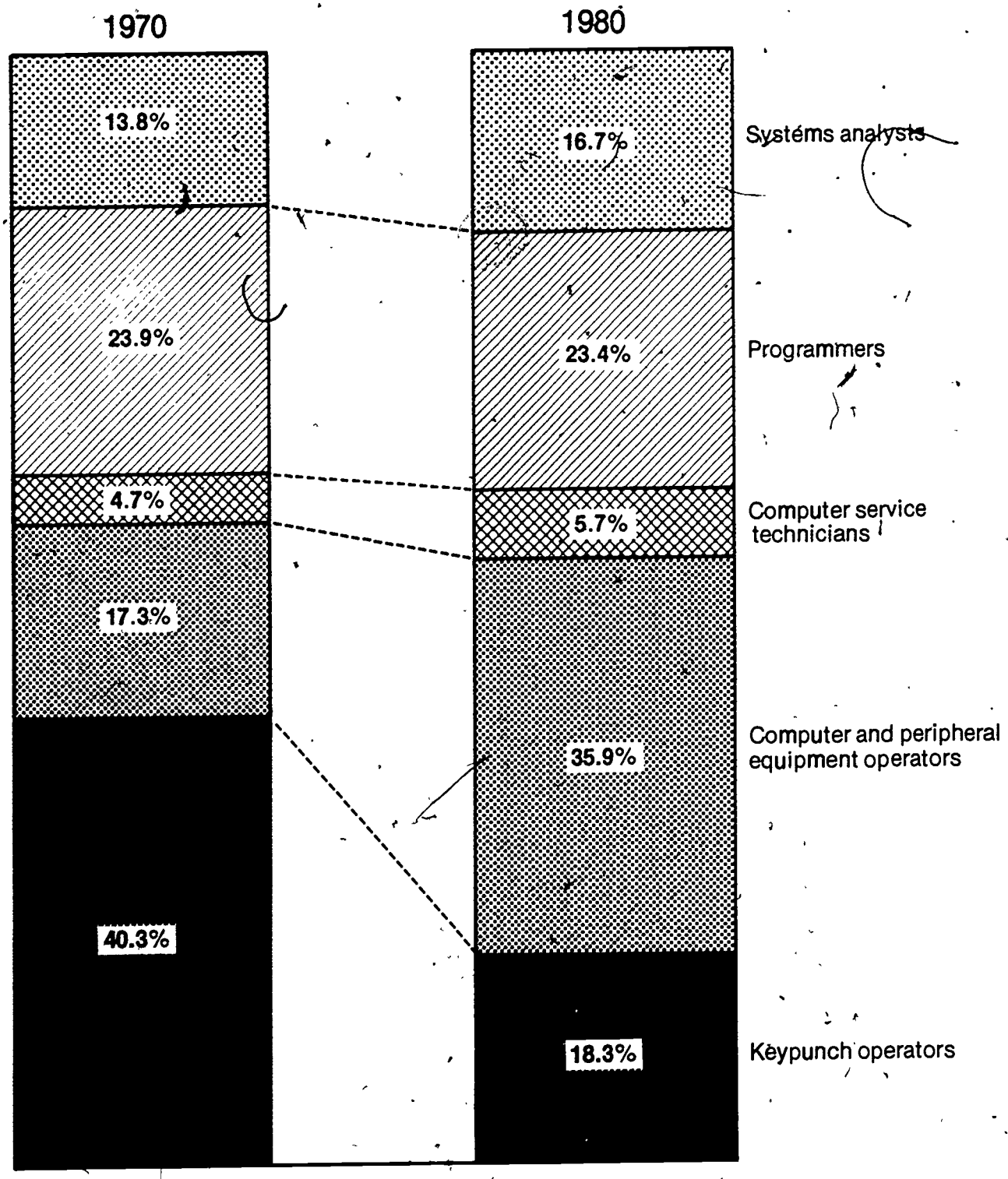
Employment of computer workers more than doubled between 1970 and 1980, growing from 676,000 in

Chart 4. Percent change in employment of computer workers by occupation, 1970-80



Source: Bureau of Labor Statistics.

Chart 5. Distribution of computer workers by occupation, 1970 and 1980



Source: Bureau of Labor Statistics.

1970 to 1,455,000 in 1980. This was nearly five times the average rate of growth for all occupations in the economy.

Technological advances and changes in methods of operation have resulted in vastly different rates of growth among the individual computer occupations (chart 4). All of the computer occupations except keypunch operators grew much faster than the average for all occupations. Programming employment, for example, increased by about 111 percent, and employment of systems analysts increased by 161 percent, as industries in all sectors sought to develop and refine software for an increasing number of applications. Decreasing hardware costs and the resultant rise in the amount of computer equipment in use contributed to a 162-percent increase in the number of computer service technicians. The largest increase, however, was for computer and peripheral equipment operators, whose employment grew three and one-half times in response to the rapid increase in the number of computer systems in use. Employment of keypunch operators declined 2 percent as more efficient forms of data entry were developed.

The differing rates of growth experienced by the individual computer occupations signficantly changed the distribution of computer employment by 1980 (chart 5). Keypunch operator, for example, was the largest computer occupation in 1970, with about two-fifths of total computer employment. As technological innovations made their functions less important, their proportion of employment fell to less than one-fifth in 1980. By contrast, computer and peripheral equipment operators—who constituted less than one-fifth of computer employment in 1970—grew to become the largest of these occupations in 1980, representing over one-third of all computer personnel.

Chapter 2. Education and Training

Current requirements

Educational requirements for computer workers range from high school to a college degree and beyond. The most professional computer work, which involves systems design and analysis and systems programming, generally is done by persons having 4 years or more of college training. The middle range of computer work, involving scientific and complex business applications programming as well as equipment maintenance, is typically performed by those with training from a 2- or 4-year college or from a program operated by a computer vendor. The work requiring the least formal education involves basic applications programming, equipment operation, and keying functions. This work is usually carried out by high school graduates, many of whom have received some formal training from a public or private school or on-the-job training from a computer manufacturer or other source.

Regardless of educational level, however, the most desirable qualifications for programming and systems personnel are a background in computer science and data-processing-related subjects and a knowledge of the business the computer operation is serving. Educational requirements for the individual computer occupations are as follows:

Systems analysts. A bachelor's degree—including courses in computer science—generally is the minimum educational requirement. However, the type of degree employers prefer depends on the type of work done in the organization. For a job with a bank, insurance company, or business firm, a college degree in accounting, business, economics, or information systems is appropriate. For work in a scientific or technical organization, applicants need a degree in the physical sciences, mathematics, engineering, or computer science. In addition to the bachelor's degree in a suitable field, some employers prefer applicants to have related work experience.

Some employers require systems analysts to have a graduate degree. A growing number of employers seek applicants who have a degree in computer science or information systems. Regardless of college major, most employers look for people who are familiar with programming languages. Courses in computer concepts, systems analysis, and data base management systems offer good preparation for a job in this field.

In addition, most employers prefer applicants who have some experience in computer programming. Because of the importance of programming experience, many who begin as programmers are promoted to analyst trainees. Employers, computer manufacturers, and colleges and universities offer formal training in systems analysis.

Because technological advances occur so rapidly in the computer field, continuous study is required to keep skills up to date. Usually employers and "software" vendors offer 1- and 2-week courses. Additional training may come from professional development seminars offered by professional computing societies.

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

Programmers. There are no universal training requirements for programmers because employers' needs vary. Most programmers are college graduates; others have taken courses in programming to supplement their experience. Firms that use computers for scientific or engineering applications usually require programmers to have a bachelor's degree with a major in computer science and a minor in a physical science. Some of these jobs require a graduate degree. Although some employers who use computers for business applications do not require a college degree, they prefer applicants who have had courses in data processing, accounting, and business administration.

Public and private vocational schools, community and junior colleges, and universities teach computer programming and data processing. Instruction ranges from introductory courses to advanced courses at the graduate level. High schools in many parts of the country also offer courses in computer programming.

An indication of experience and professional competence at the senior programmer level is the Certificate in Computer Programming (CCP), conferred by the Institute for Certification of Computer Professionals upon candidates who have passed a 5-part examination.

Computer service technicians. Employers usually re-

quire applicants to have 1 to 2 years of post-high school training in basic electronics or electrical engineering from a computer school, technical institute, junior college, or 4-year college. A few technicians are trained through apprenticeship programs. Electronics training in the Armed Forces also is excellent preparation. Generally, 6 months to 2 years of on-the-job experience are required before newly hired technicians are considered competent to work independently on more complex systems. High school courses in mathematics, chemistry, and physics are considered good preparation. Communication skills also are important.

Computer operating personnel. High school graduation is the minimum educational requirement for computer operating jobs such as keypunch operator, auxiliary equipment operator, and console operator. Many employers prefer console operators who have some community or junior college education. Beginners usually are trained on the job, the length of training varies. Auxiliary equipment operators can learn their jobs in a few weeks, but console operators require several months of training before they are sufficiently familiar with the equipment to be able to trace the causes of breakdowns.

Formal computer training is desirable because most employers look for applicants who already are skilled in operating data entry equipment or computer consoles. High schools, vocational schools, computer and business schools, and community and junior colleges offer this type of computer training. Computer vendors also offer structured training programs for many of these workers.

Post-employment training

With the rapid changes in computer equipment and technology, there is a great need for continuing education programs for computer personnel. The extent of job-related supplementary training varies widely. Some employers have regularly scheduled, in-depth training programs in areas such as computer languages or data processing operations. Others provide this type of training only when changes are made in computer procedures or equipment. Many companies also maintain a tuition refund plan or pay for employee attendance at professional seminars. Regardless of the type or length of training, it is usually paid for by the employer.

The most common types of supplementary training include computer vendors' course offerings, in-house training programs, on-the-job training, professional seminars, and reimbursement for college, correspondence, and vocational school courses. The length of post-employment training ranges from a few hours to more than 1 year, but training usually is completed in 1 to 12 weeks—with the higher level computer jobs generally requiring the more lengthy training.

Among computer occupations, systems analysts most frequently take computer science courses as well as systems, programming, and management training. Programmers usually train in programming languages and techniques and, to a lesser extent, in systems analysis and design. Training for computer service technicians often involves computer electronics and related courses. Console, peripheral equipment, and keypunch operators train in data preparation, production control, computer equipment operation techniques and, occasionally, programming.

Current status of education and training

As described in the previous sections, various types of computer education and training currently are available. Because of the relative newness of the computer occupations and the shortage of skilled computer workers, however, some problems exist in training computer personnel.

One major problem that has persisted from the beginning of the computer era is a shortage of qualified teachers in this field. Educational institutions find it very difficult to keep their experienced teachers or to attract qualified teachers because salaries and research facilities often are not comparable with those offered by private industry. Many institutions are unable to offer more computer science courses because there are not enough instructors.

As a result of the shortage of qualified teachers and programs, the number of people receiving college degrees in computer science, although rising rapidly, is falling short of employers' needs. Graduates of programs in computer science are only filling 1 out of 4 jobs at the bachelor's level, 1 out of 10 jobs at the master's level, and 1 out of 4 jobs at the doctorate level.[1]

Due to the unique nature of the computer field—technological advances and applications are increasing at a very rapid rate—educational institutions find it difficult to design and implement courses that disseminate the latest developments in a timely manner. Thus, the subject matter in similar course offerings from different schools is not always consistent.

Despite the shortcomings of computer education and training in its current form, a number of positive developments have occurred in the past few years.

One development in computer education is the trend toward infusing computer training at the college and university level into other curricula besides computer science. For example, most schools now offer computer courses in their business and engineering programs. Furthermore, one college administrator has estimated that 1 out of 3 undergraduates and 1 out of 2 graduates now use a computer in their coursework.

In order to make programs more relevant and to

[1] John W. Hamblen, *Computer Manpower—Supply and Demand—by States, 1981* (Information Systems Consultants)

encourage consistency among computer curricula, the Association for Computing Machinery has issued revised recommendations for computer education programs. These guidelines include detailed course descriptions as well as recommendations on program organization and implementation.

Steps also have been taken by colleges and universities to meet the needs of those already in the labor force. Many schools now offer night courses in computer science, most of which are tailored to meet specific job requirements.

Computer vendors and others have refined their "canned" learning programs to meet employers' needs. These courses now cover a variety of computer concepts and practical applications. The programs, which utilize a number of learning techniques, are especially useful for occupations with high turnover because they are self-paced and relatively inexpensive.

As the computer becomes more prevalent in all aspects of our economy, it is increasingly important for people to become familiar with this tool. Towards this end, a growing number of high schools are offering computer education courses. These provide the student with some programming knowledge as well as an understanding of the logic of computing, and are excellent preparation for use of the computer in any career.

In summary, educating and training enough computer personnel to meet employer's needs still present a number of problems. The relative newness of the field, its rapidly changing technology, and the inability of educational institutions to compete for skilled teachers have all been contributing factors to the shortage of qualified computer workers in computer occupations. For a better understanding of the current situation, a brief look at the evolution of computer education and training is provided below.

Evolution of education and training

The dramatic rise in computer use during the 1950's outstripped the availability of personnel with data processing skills. As opportunities in the computer field expanded rapidly and the demand for skilled computer workers increased, many people sought training in this field. But schools were not yet providing courses in data processing. The educational system, of course, required a certain amount of time to develop programs to meet the specific needs of employers. Additionally, the implementation of educational programs was delayed by two factors. First, computers were needed to provide practical experience for the student, and this equipment was prohibitively expensive during the 1950's. Secondly, the relatively few people who were qualified to teach at that time could earn considerably more money in the business world.

As equipment costs gradually declined and as more instructors became available through the 1950's and 1960's, a growing number of public and private colleges, universities, and vocational schools began to include data processing in their curriculums. Nevertheless, the number of graduates with specific training for computer jobs continued to fall further behind the rapidly growing demand. To fill this widening gap, a large number of private vocational schools were established that offered computer training. Some of these schools, however, were criticized for providing poorly qualified teachers, limited subject matter, and obsolete computing equipment.

Thus, the major sources of training in the 1950's and 1960's became the computer manufacturers. Many persons trained in this way acquired only limited skills because their training usually focused on the operating procedures for their company's computer system. Employees trained in this manner, therefore, found it difficult to transfer or advance to jobs requiring knowledge of different types of computers and related equipment.

Computer manufacturers continued to provide training as part of the overall computer sales package until the early 1970's. As a result of antitrust settlements, manufacturers thereafter considered training a separate service that required a separate charge. Thus, the growing awareness of computer education costs led many

Table 3. Enlisted strength in Department of Defense computer specialties, 1971-79

Year	Total, computer specialties	ADP repairers	ADP support and administration[1]
1971	31,780	9,168	22,612
1972	29,591	8,516	21,075
1973	28,326	8,525	19,801
1974	26,736	7,860	18,876
1975	26,238	8,184	18,054
1976	22,843	7,683	15,160
1977	20,760	7,284	13,476
1978	20,433	7,353	13,080
1979	20,509	7,419	13,090

1 Includes computer operators, analysts, programmers, and electric accounting machine operators.

SOURCE: U.S. Department of Defense, Defense Manpower Data Center.

computer users to look for and closely evaluate alternative training methods in order to get the most for their computer education dollar

One alternative for computer users was to train their own computer personnel These "in-house" training programs generally took place at the user's site and were tailored to meet the specific needs of the company's computer operations The programs were usually administered by company personnel or an educational services firm, and included instructional tools such as videotapes, cassettes, and self-paced computer manuals.

Another source of training for computer personnel was the Armed Forces Although occupation-specific data are not available for years prior to 1971, the Armed Forces are believed to have been a major source of computer training during the 1950's and 1960's. As may be seen in table 3, however, the number of military personnel in computer-related job specialties declined sharply over the 1970's.

Computer education and training continued to evolve throughout the decade. In addition to the growing number of in-house training programs, the number of formal degree programs offered by colleges and universities increased dramatically in response to rising student interest and to requests from employers for graduates with a higher level of specific computer skills. The number of computer and information science programs offered at every degree level more than doubled over the period 1966-67 to 1978-79 (chart 6). Bachelor's degree programs experienced the most spectacular growth—554 percent. Associate degree programs in the computer fields grew 225 percent for the period. Growth in master's and Ph.D. programs was not as rapid as at the undergraduate levels—reflecting the strong demand for computer workers and the rising wages—but the number of programs still increased 162 percent and 117 percent, respectively.

Along with the growth in degree programs, the number of persons receiving degrees in the computer sciences also increased sharply From 1970-71 to 1977-78, the total number of bachelor's, master's, and doctoral degrees in these fields grew from 4,104 to 12,06[illegible]—a 194-percent increase (chart 7). Historical data by degree level for six computer curricula are presented in table 4.

The number of associate degrees awarded in data processing technologies fluctuated considerably in the 1970's (table 5). The number of associate degrees in all data processing technologies fell over the first half of the decade, then increased steadily over the remainder

Table 4 Number of college degrees conferred in the computer sciences by degree level and curriculum, 1970-71 through 1978-79

Degree level and year	Total, computer and information sciences	Computer information sciences, general	Information sciences and systems	Data processing	Computer programming	Systems analysis	Computer and information sciences, other
Bachelor's:							
1970-71	2,388	1,624	177	409	32	88	58
1971-72	3,402	2,451	268	504	8	72	99
1972-73	4,304	3,278	234	566	14	97	115
1973-74	4,756	3,761	338	539	15	54	49
1974-75	5,033	4,127	308	410	5	138	45
1975-76	5,652	4,530	493	483	3	89	54
1976-77	6,407	5,229	553	465	20	105	35
1977-78	7,201	5,940	742	395	24	61	39
1978-79	8,769	7,350	840	442	56	48	33
Master's:							
1970-71	1,688	1,131	143	171	5	88	50
1971-72	1,977	1,572	142	131	7	110	15
1972-73	2,113	1,627	115	144	0	153	74
1973-74	2,276	1,801	198	113	8	124	32
1974-75	2,299	1,921	147	114	0	79	38
1975-76	2,603	2,349	166	1	0	87	0
1976-77	2,798	2,580	149	6	0	60	3
1977-78	3,038	2,713	234	53	0	30	8
1978-79	3,055	2,773	183	51	0	23	25
Doctorate:							
1970-71	126	110	11	0	0	6	1
1971-72	167	145	16	0	0	6	0
1972-73	196	165	17	0	0	0	14
1973-74	198	178	13	0	0	0	7
1974-75	213	196	17	0	0	0	0
1975-76	244	221	20	0	0	3	0
1976-77	216	195	20	0	0	1	0
1977-78	196	183	13	0	0	0	0
1978-79	236	227	9	0	0	0	0

SOURCE U.S. Department of Education, National Center for Education Statistics.

of the decade. Only two courses, computer programming and data processing equipment maintenance, registered any net growth over this period. This reflects the higher training requirements for programmer trainees and computer service technician trainees—some formal training generally is required—than for console and peripheral equipmemt operators, keypunch operators, and related workers. The decline in the number of degrees in these latter areas reflects the ability of many jobseekers to take entry level positions without any formal training. Some of those who chose to take formal training may have opted for public or private vocational programs that generally can be completed in less time than an associate degree and at a lower cost

Public and private vocational schools provide another source of training. Because historical data are not available, it is difficult to determine whether vocational schools are growing in importance as a source of trained computer workers Nevertheless, over 235,000 students were enrolled in these schools in 1978, with 9 of 10 enrolled in public vocational education programs (table 6). The number of persons —58,000—who completed these programs in 1978 was about 6 times the number of associate degrees awarded that year, greatly expanding the pool of jobseekers with at least some formal training.

Table 5. Associate degrees conferred in data processing technologies, 1971-72 through 1978-79

Curriculum	HEGIS code[1]	Associate degrees awarded							
		1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79
Total, data processing technologies	5100	8,971	7,640	6,998	6,821	7,176	7,993	9,339	10,833
Data processing technology, general	5101	5,669	4,584	4,360	3,921	3,981	4,671	5,095	5,974
Keypunch operator and other input preparation technology	5102	402	327	133	237	202	131	264	230
Computer programmer technology	5103	2,198	2,118	2,018	2,199	2,547	2,618	3,368	3,797
Computer operator and peripheral equipment operation technology	5104	431	249	205	240	229	304	263	475
Data processing equipment maintenance technology	5105	104	103	226	179	188	241	319	299
Other	5199	167	259	56	54	21	28	30	58

[1]HEGIS codes are from the Higher Education General Information Survey, see *A Taxonomy of Instructional Programs in Higher Education* (U.S. Department of Health, Education, and Welfare, 1970).

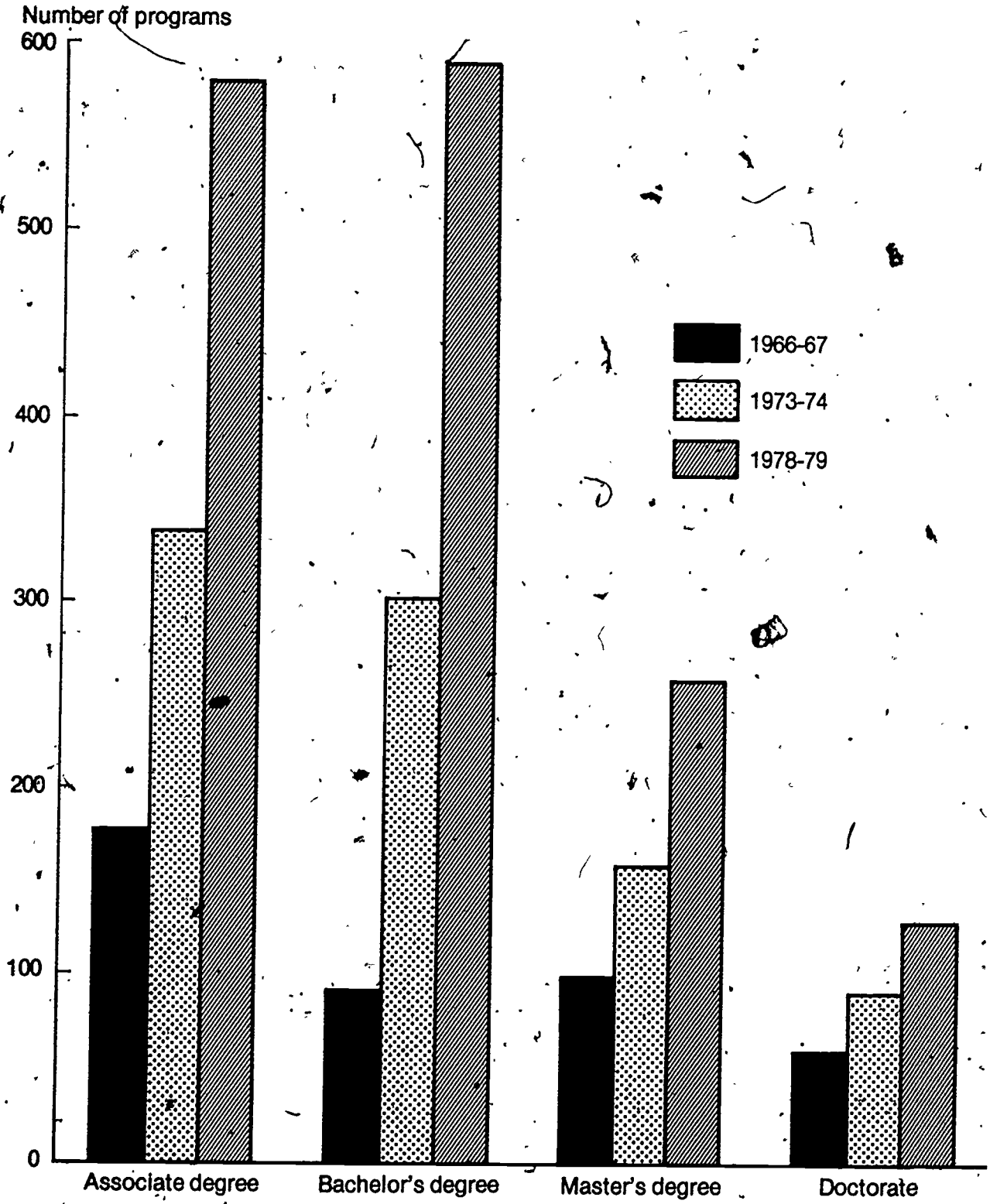
SOURCE. U.S. Department of Education, National Center for Education Statistics.

Table 6. Total enrollments and completions in public and private vocational programs, 1977-78

O.E instructional code and title	Public vocational education		Private vocational education	
	Enrollments	Completions	Enrollments	Completions
Total	218,160	45,599	18,737	12,188
14.0201 Computer and console operator	50,666	11,519	785	627
14.0202 Keypunch operator	—	—	7,674	5,171
14.0203 Computer programmer	83,479	11,165	6,913	4,776
14.0299 Other business data processing	84,015	22,915	3,365	1,614

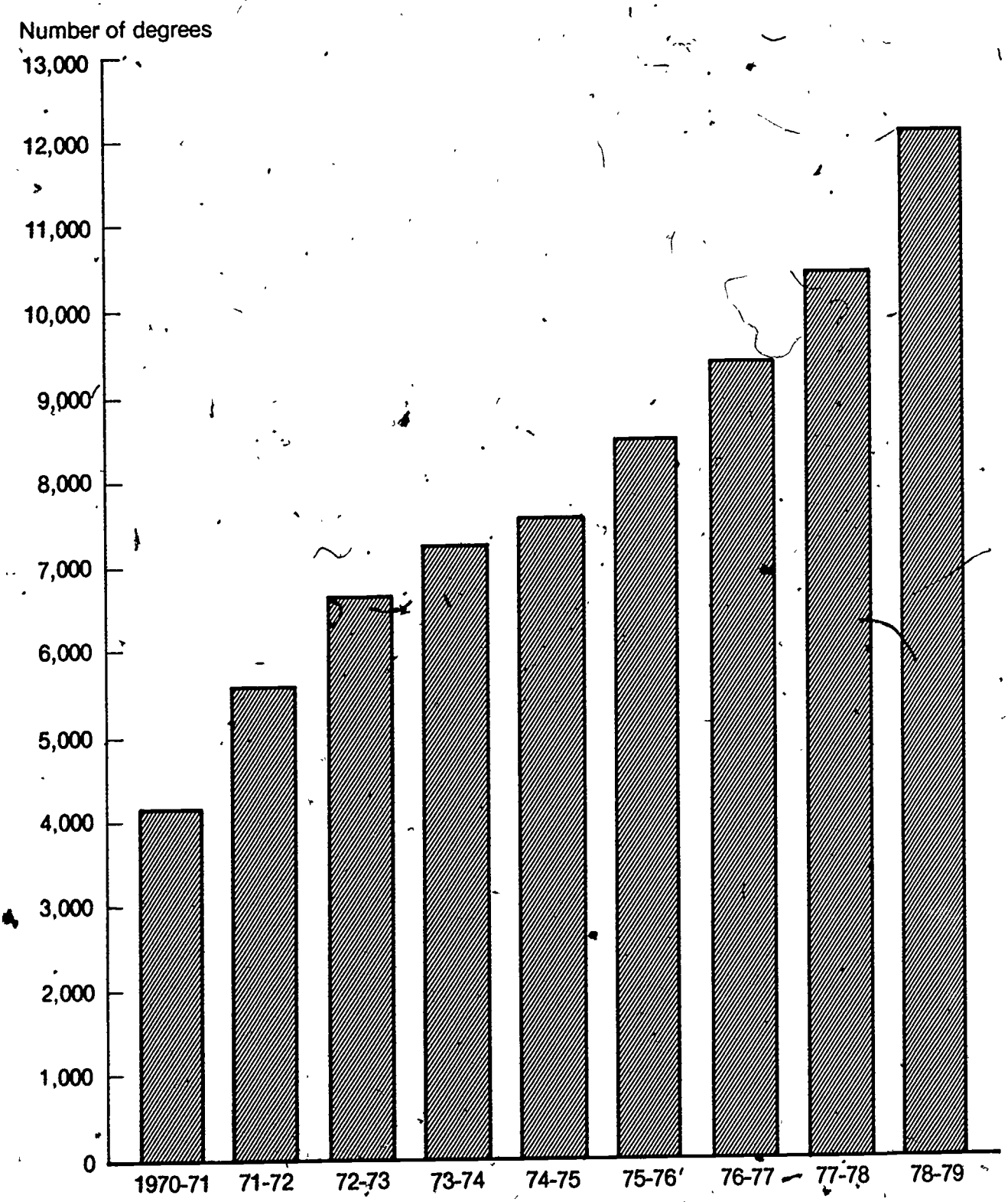
SOURCE U.S. Department of Education, National Center for Education Statistics

Chart 6. Number of college programs in the computer sciences by degree level, 1966-67, 1973-74, and 1978-79



Source: John W. Hamblen, *Computer Manpower—Supply and Demand—by States*, Table 1.

Chart 7. Number of bachelor's, master's, and doctoral degrees in the computer sciences, 1970-71 through 1978-79



Source: U.S. Department of Education, National Center for Education Statistics.

Chapter 3. Projected Employment Requirements

Even after the spectacular gains registered in the 1970's, overall employment in the computer occupations is expected to increase by nearly one-half from 1980 to 1990 (chart 8).

Technological factors affecting growth

Rapid technological progress is expected to continue over the next decade—affecting the types of computers available, computer applications, and the size and composition of computer occupations. New technologies that will affect employment can be divided into three major areas: Hardware (computer mainframe and peripheral equipment), software (computer programs and languages), and applications. These areas are all interrelated; advances in any one area generally have major implications for the others. The development of more efficient hardware, for example, can generate a whole spectrum of new applications. Elements in each of these three areas that are expected to have a significant impact on employment in the computer field are discussed in the following sections.

Hardware. Recent advances in semiconductor technology have spurred the development of computer components that are smaller in size but have greater memory and more available functions. In addition, prices have declined to the point where hardware costs are less than computer personnel costs in most data processing department budgets. These technological advances have led to new types of computer hardware as well as major improvements to existing hardware. Three major technologies that are expected to have a significant impact on computer employment are discussed in this section: Computer terminals, optical character recognition equipment, and minicomputers.

Improvements in the efficiency of computer terminals have resulted in a rising utilization of this type of equipment. The number of installed terminals is expected to increase from just over 2 million at the end of 1978 to almost 5 million by the end of 1983.[4] Terminals can be applied to many present computer systems, improving present applications or making possible new applications involving the transfer of data from one location to another for processing.

[4] International Data Corporation, *Special Report. Computer Industry Review and Forecast 1974-1983* (Waltham, Mass.).

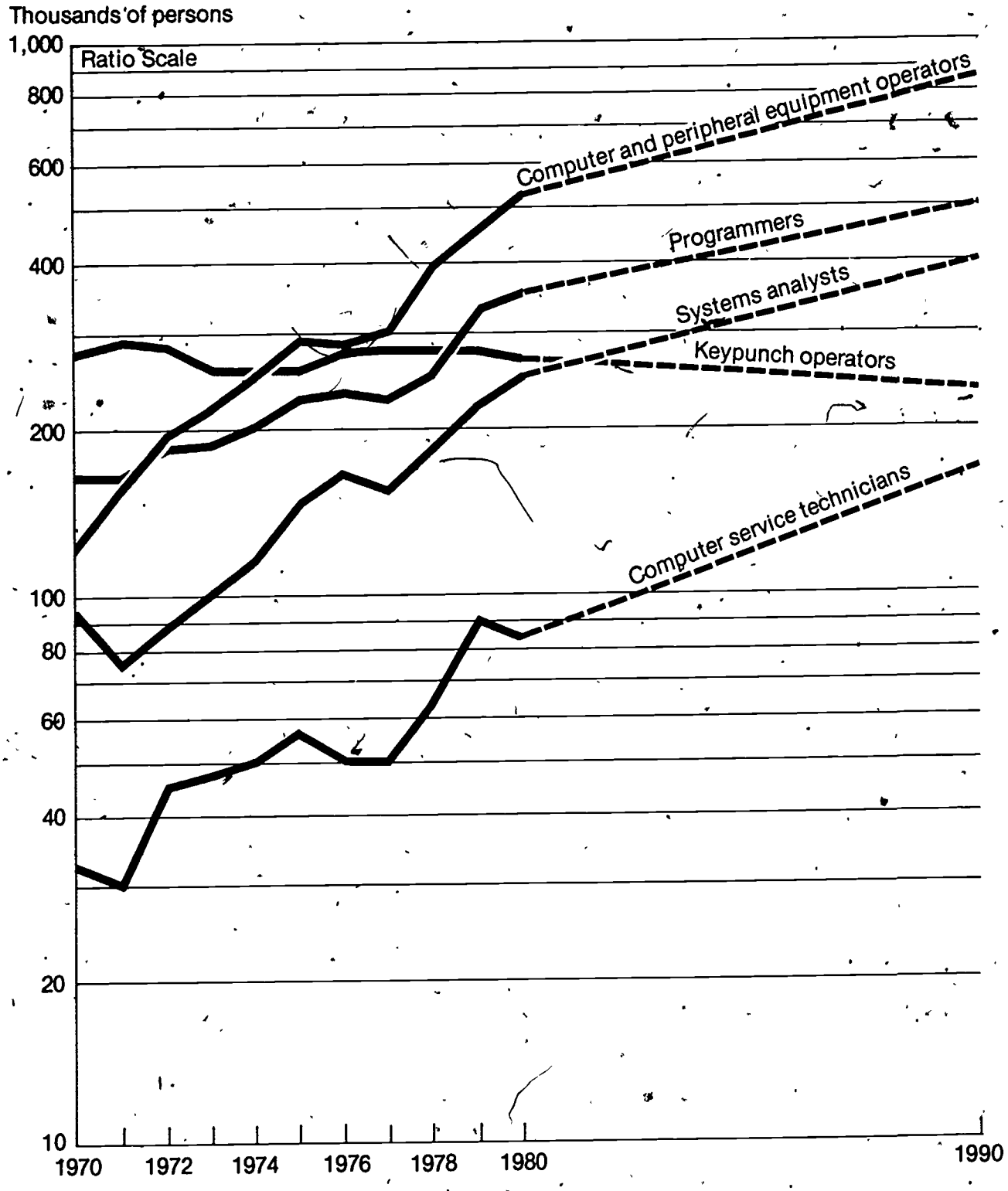
Among the computer occupations, increased terminal use will have its greatest impact on keypunch operators. Fewer of these workers will be needed, as data entry operations continue to move from card punch to more efficient on-line data entry systems. Airlines, for example, routinely use terminals at their ticket sales locations that are linked by data communications systems to a central computer. Data are entered directly into the central computer by reservation and ticket agents instead of keypunch operators who traditionally have worked at the central computer site. This example illustrates another important facet of computer terminal usage—terminals are expected to have a greater impact on noncomputer occupations than on computer occupations. As new applications are developed for terminals, more and more workers in noncomputer jobs will have to adapt to using terminals. Bank tellers and loan officers, for example, increasingly will operate terminals connected to the bank's central data base, and newspaper reporters and editors will use terminals in their work as well.

Optical character recognition equipment (OCR) provides another form of computer data entry. OCR equipment "reads" printed information in various forms and translates that information into computer input form. These machines can enter data into a computer system at a very high speed. This equipment, however, was slow in gaining acceptance due to its high cost and the limited number of typefaces it could recognize. Recent advances in microprocessor technology have reduced the cost of this equipment. Additionally, OCR equipment gained greater acceptance in the marketplace with the introduction of hand-held scanners, which have exposed more users to the accuracy and ease of use of this data entry technique.

Although applications for this equipment are still somewhat limited, an expanded product line that now includes three types of OCR equipment has contributed to the development and acceptance of a growing number of new applications. Each type of equipment, of course, has applications for which it is best suited.

- Page readers can identify characters at various locations on a sheet of paper. Page readers originally were used in the printing and publishing industries, but applications now have been developed for other businesses, such as insurance, where forms are sent in for processing to a

Chart 8. Employment of computer workers by occupation, 1970-80 and projected 1990



Source: Bureau of Labor Statistics.

central location from points all over the country.

- Document readers can recognize a few lines of information on a single pass. The major application of document readers is for billing purposes. Major users include credit card companies and public utilities.
- Hand-held scanners, which are mainly used in department stores in conjunction with point-of-sale terminals, are passed over an item manually to pick up pricing and inventory information. Other users include libraries, where these scanners are used to check out books, and businesses, for inventory and production control.

Although not technically considered OCR equipment, other forms of character recognition equipment have gained increased acceptance in recent years.

- Bar code readers recognize printed vertical bars of varied sizes. This equipment is mainly used in grocery stores to read the Universal Product Code.
- Optical mark readers (OMR) detect the presence or absence of marks at specific locations on a document. Their most common application is in educational testing. Utilities also use this technique for reading meters.
- Magnetic ink character recognition equipment (MICR) senses characters printed in a magnetic ink. The best example is found in banks, which use MICR for check clearing.

In general, the widespread use of these character recognition technologies will not have a major effect on the overall employment of computer workers. The impact on keypunch operators, however, almost certainly will be negative as these data entry techniques increasingly replace card punching.

Minicomputers (minis) are yet another rapidly growing technology in the computer field. The value of minicomputer shipments by U.S. manufacturers is expected to more than triple between 1978 and 1983—increasing from $3.1 billion to $10.3 billion (chart 9). These machines, once defined as inexpensive, single-purpose computers, now encompass a wide range of capabilities and functions.

Small businesses—relative newcomers to the computer market—will increasingly use minicomputers as hardware costs continue to decline and more applications are developed. Small businesses use minis for general applications such as personnel administration, inventory control, payroll, and general business planning, as well as for industry-specific applications such as optimizing fertilizer and other crop input requirements and projecting insect activity in agricultural production.

Large businesses, especially those with widely scattered field offices, such as insurance companies, also will utilize more minis—often in conjunction with their central computer. These distributed data processing systems give processing capabilities to data users who can immediately use the information. They permit data entry and manipulation by workers at different locations, thus increasing the efficiency and flexibility of field operations.

Increased minicomputer utilization will have employment implications for all the computer occupations. A greater amount of equipment in operation can be expected to spur demand for computer and peripheral equipment operators and computer service technicians. More systems analysts and programmers also will be needed to design systems using this equipment and to develop programs for the ever-increasing number of applications. Keypunch operator employment, however, will be negatively affected as minis increasingly are used for on-line data entry.

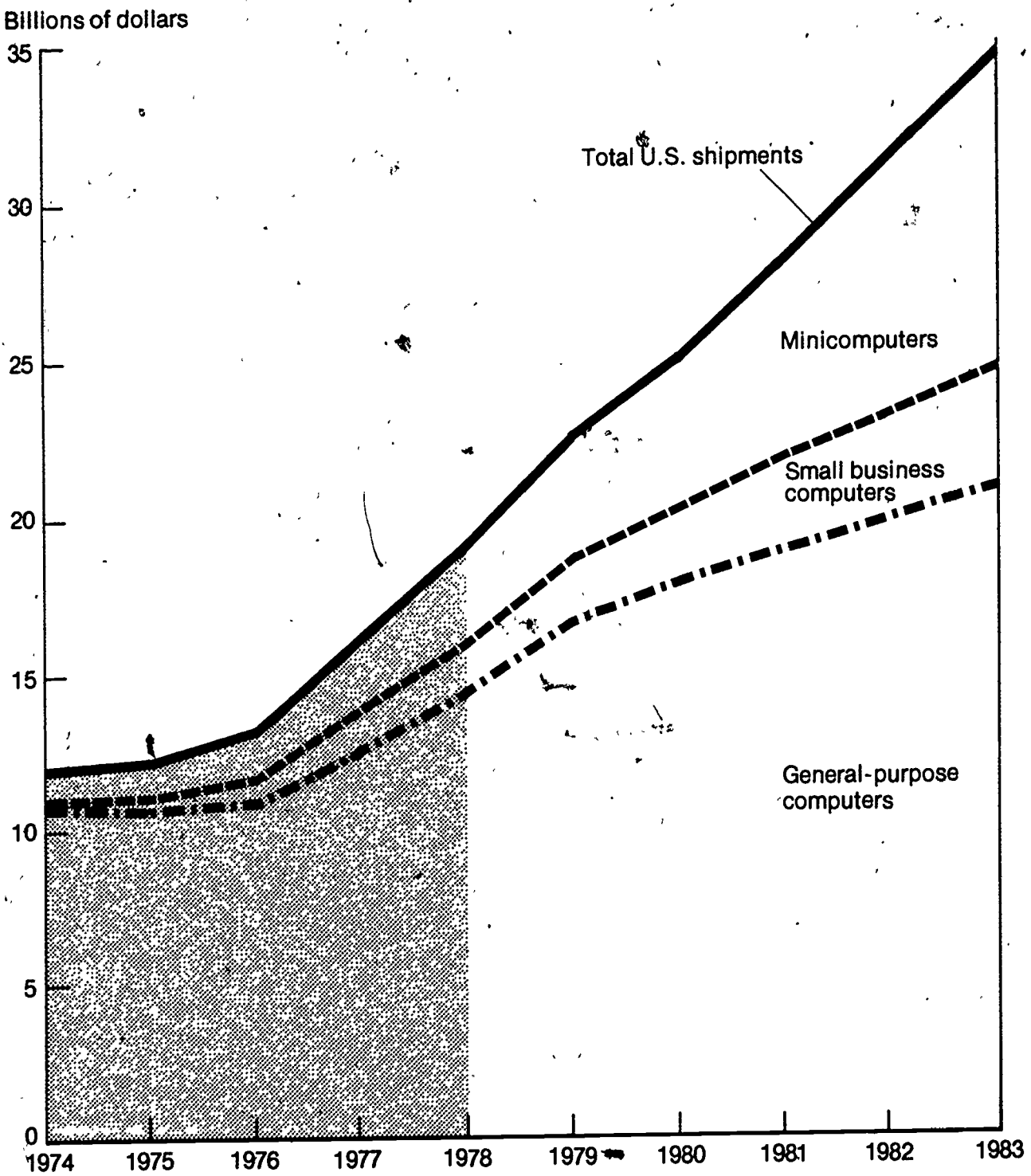
Software. Computer software will continue to evolve rapidly in a number of areas, resulting in increased productivity for many computer users. These software advances also will affect specific computer occupations, especially programmers and systems analysts. While there will be continued strong demand for these workers, their specific job duties may be affected. Software developments also will continue to make the computer more accessible to workers in such fields as publishing and medicine.

One trend in software technology has been the incorporation of systems programming functions into computer hardware. If this trend continues over the next decade, it may curb the demand for some systems programmers. Overall demand for programmers, however, will remain strong—allowing these workers to shift to other types of programming.

Packaged programs are another software option available to computer users. These programs, which are being developed for an ever-increasing number of applications, simplify programming operations, reduce programmer skill requirements, and may require fewer programmers at a computer site. In some instances, certain programming operations may be simplified to the point where they could be performed by computer operators. These packaged programs also will permit programming to be done by noncomputer personnel in many cases.

Another promising area for software improvement is in the development of user-oriented, high-level computer languages. Thus far, research in this area has not produced all of the desired results. COBOL, for example, was a language developed for use by managers in business applications, but in practice it has proved to be too complex for this purpose. Advances have been made in this area, however, that allow noncomputer personnel to bypass programmers and have direct access to the computer. Table Producing Language (TPL), for example, now allows noncomputer workers such as social scientists to use computers in their daily work. Improved hardware and further advances in

Chart 9. Value of computer systems produced by U.S. manufacturers by type of computer, 1974-78 and projected 1979-83



Source: International Data Corporation.

software technology may lead to the development of even more high-level languages.

Applications. Increases in the number of applications will be the main stimulus to computer employment growth over the next decade Although progress in hardware and software technology may temper the demand for computer workers at some computer sites, these same technological advances are expected to bring the computer within reach of an increasing number of users.

Some new applications will be made possible with the continued development and refinement of new computer hardware For example, computers can be applied to point-of-sale operations in supermarkets or department stores through the use of computer terminals, character recognition equipment, and other types of data communications equipment Data communications networks also will permit traditional computer users to develop and, implement new computer applications. Banks, for example, will increasingly use terminals for electronic funds transfer systems (EFTS).

Along with the introduction of new hardware, the cost of computer equipment has dropped dramatically in recent years. These reductions in hardware costs are expected to continue, allowing more relatively small organizations to utilize computers. These newcomers will use the computer for traditional functions, such as accounting and inventory control. Additonally, they will have new, industry-specific applications, creating more jobs for computer personnel over the next decade. Small oil and gas exploration firms, for example, are increasingly using computers for such specialized applications as production statistics, land lease data, and geologic and engineering applications.

New software developments, such as higher level, easy-to-use languages, will continue to make the computer more accessible This will increase the number of potential computer users, especially small businesses. Also, more industries will become computerized as packaged programs are developed for their specific applications.

As may be seen from the above, hardware, software, and applications are all interrelated. While hardware and software developments may appear to curb the demand for some computer workers due to increased productivity, this is only a small part of the overall story. Far more important in terms of employment impact will be the expanding number of applications made practical by these hardware and software advances. As the computer is made accessible to more users through these developments, many more computer workers will be needed.

Expected employment growth by occupation

In general, a greater variety of applications, advancing software technology, and more efficient computer hardware all lead to a greater utilization of computer equipment, which will result in a growing demand for computer personnel over the next decade. Table 7 presents employment projections for each of the computer occupations. Increasing applications and greater amounts of hardware, for example, are expected to spur the employment of computer and peripheral equipment operators and computer service technicians. At the same time, changes in data entry methods will reduce the demand for keypunch operators. A summary of the employment outlook for each computer occupation follows

Systems analysts. Employment of systems analysts is expected to increase from 243,000 in 1980 to 400,000 in 1990, or by 65 percent.

The history of computers has been marked by many unsuccessful attempts to solve problems, reduce costs, and increase productivity. A major cause of such failures has been the lack of adequate systems analysis and design to take full advantage of computer capabilities. As the requirements of computer users continue to escalate, they will demand greater efficiency and increased performance from their computer systems. Similarly, computer hardware and software advances will increase computer application possibilities and the compatibility of equipment from different sources. These advances also will permit "networking" or other equipment interrelationships, such as distributed data processing, in new and existing computer systems. As a result, systems analysts, who have always been in great demand, will continue to be sought to reduce computer systems

Table 7. Employment in computer occupations, 1980 and projected 1990

Occupation	1980 employment	Projected 1990 requirements	Percent change, 1980-90
Total, all occupations	1,455,000	2,140,000	47.1
Systems analysts	243,000	400,000	64.6
Programmers	341,000	500,000	46.6
Computer and peripheral equipment operators	522,000	850,000	62.8
Keypunch operators	266,000	230,000	-13.5
Computer service technicians	83,000	160,000	92.8

SOURCE: Bureau of Labor Statistics.

problems and develop more sophisticated and complex computer operations.

Programmers. Computer programmer employment is expected to grow from 341,000 in 1980 to 500,000 in 1990, an increase of 47 percent. The overall demand for programmers will increase as less expensive and more sophisticated computer hardware and software attract new computer users and increase the number and type of computer applications among existing users

More systems programmers will be needed to develop the complex operating programs made necessary by higher level languages and complicated computer configurations, as well as to link or coordinate the output of different programs from different systems. As increasing applications expand the computer market, the need for applications programmers also will increase, although not quite as rapidly as in the past as more people use "canned" programs to process data without the direct assistance of a programmer. Continuing development of programming instructions built into computer hardware, user-oriented languages, terminal programming by non-EDP personnel, and more standardized software packages are expected to simplify some job duties of applications programmers.

Computer and peripheral equipment operators. Employment of computer and peripheral equipment operators is expected to increase from 522,000 in 1980 to 850,000 in 1990, or by 63 percent. The major cause of this growth is the increasing use of computer hardware. The increased utilization of distributed data processing systems, and the concomitant rise in the number of minicomputers and other types of peripheral equipment, also will require increasingly large numbers of computer operating personnel.

Similarly, recent advances in miniaturizing circuits have enabled manufacturers to reduce both the size and cost of computer components. As the technology is further developed, a continued expansion in the use of computers is expected, especially by small businesses. As small business applications increase, many of these organizations are expected to install their own computer systems, thus generating additional demand for workers to operate the equipment.

Keypunch operators. Employment of keypunch operators is expected to decline from 266,000 in 1980 to 230,000 by 1990. This 14-percent decrease is the only projected employment decline among the computer occupations studied.

Data entry has long been considered a bottleneck in data processing operations. Cardpunch-oriented data entry systems in the past have produced slow, error prone, and increasingly costly performance in many computer operations. Further, the gap between machine speed and the time required for manual card input has widened due to advances in internal data processing capabilities of computers. These problems, along with expected increases in the volume of data to be processed, have spurred technological advances in alternative methods of data entry. These methods include computer terminals and other forms of direct keying, along with other data communications input systems Users are expected to continue to employ these more efficient data entry methods, thus diminishing the need for keypunch operators.

Computer service technicians. Employment of computer service technicians is expected to show the largest increase of all the computer occupations—growing from 83,000 in 1980 to 160,000 in 1990, or by 93 percent.

The rising demand for computer service technicians is related to the growing number of computers in use 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, further intensifying the demand for these workers.

Expected employment growth by major industry division

Although computer employment is expected to grow substantially in all industries over the next decade, considerable variation is expected. Table 8 presents 1978 and projected 1990 computer employment by major industry division. The following sections describe the factors underlying computer employment growth in each of these industry groups.

Manufacturing. Computer employment in manufacturing is expected to increase rapidly - by about 70 percent—over the period 1978 to 1990. Because computers are readily adaptable to manufacturing processes, this industry division had already made extensive use of computers by the early 1970's. Over the next decade, the manufacturing sector will continue to apply computers to process control, quality control, business forecasting, and management information functions such as accounting and personnel management. In addition, more intensive use will be made of existing systems; many of these will require additional computer personnel. Also, minicomputer systems will continue to be developed for specific manufacturing functions, such as product design and precision measurement. Some of

[1] As indicated earlier, the latest industry-occupational matrix available when this report was prepared presented employment of computer workers by industry for 1978 This section, therefore, describes employment change between 1978 and 1990

Table 8. Employment in computer occupations by industry division, 1978 and projected 1990

Industry division	Total, all occupations			Systems analysts			Computer programmers		
	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90
Total, all industries	1,157,983	2,140,000	84.8	181,998	400,000	119.8	246,998	500,000	102.4
Agriculture, forestry, and fisheries	1,079	1,785	65.4	45	200	344.0	269	600	123.0
Mining	13,107	24,860	89.7	2,354	5,000	112.4	3,176	6,300	98.4
Construction	10,213	17,525	71.6	1,423	3,000	110.8	2,481	4,500	81.4
Manufacturing	320,270	552,400	72.5	61,915	119,500	93.0	73,830	129,000	74.7
Transportation, communication, and public utilities	66,505	107,130	63.5	8,215	17,700	115.5	12,445	23,000	84.8
Wholesale and retail trade	141,665	242,000	70.8	18,782	35,000	86.3	19,409	35,000	80.3
Finance, insurance, and real estate	152,498	266,900	75.0	14,358	30,100	109.6	26,300	51,000	93.9
Services	343,759	719,900	109.4	59,800	147,500	146.7	84,366	204,000	141.8
Government	116,695	207,500	77.8	21,914	42,000	91.7	24,722	46,600	88.5

	Computer service technicians			Computer and peripheral equipment operators			Keypunch operators		
	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90
Total, all industries	63,001	160,000	154.0	392,993	850,000	116.3	272,993	230,000	-15.8
Agriculture, forestry, and fisheries	5	10	100.0	337	625	85.5	423	350	-17.3
Mining	87	210	141.4	5,397	11,650	115.9	2,093	1,700	-18.8
Construction	95	200	110.5	3,641	7,725	112.2	2,573	2,100	-18.4
Manufacturing	15,914	44,000	157.6	103,093	215,000	108.5	65,518	47,900	-26.9
Transportation, communication, and public utilities	816	1,580	93.6	26,057	52,300	100.7	17,972	12,550	-30.2
Wholesale and retail trade	18,737	46,000	145.5	44,455	90,000	102.5	40,282	36,000	-10.6
Finance, insurance, and real estate	527	1,300	146.7	69,026	147,500	113.7	42,287	37,000	-12.5
Services	25,132	66,000	162.6	103,647	236,000	127.7	70,814	66,400	-6.2
Government	1,683	3,700	119.2	37,340	89,200	138.9	31,031	26,000	-16.2

SOURCE: Bureau of Labor Statistics.

the job functions traditionally carried out by computer personnel will be performed in the future by engineers, machinists, and other personnel using minicomputers.

Finally, computer terminals will be used more extensively but will have a mixed impact on computer employment. For example, terminals are used in warehouse inventory control and in research and development. Some data input will be handled by warehouse personnel and research scientists or engineers, decreasing the demand for keypunch operators. Greater terminal use, however, should increase the demand for systems analysts and programmers. Also, the larger amounts of computer equipment in use will further spur the need for additional computer service technicians.

Transportation, communications, and other public utilities. This industry division has been intensively computerized since the late 1960's. Consequently, it is expected to experience the smallest increase in computer employment through the 1980's, about 65 percent. Installing new computers and upgrading present computer systems—especially in the communications sector—will result in sharp employment increases for computer service technicians, systems analysts, and computer programmers. The demand for computer and peripheral equipment operators also is expected to increase with the greater utilization of computer terminals. The number of keypunch operators, however, is expected to decline, partially offsetting the gains registered in other occupations.

Wholesale and retail trade. Computer employment in wholesale and retail trade is expected to increase by about 70 percent, less than the average for all industries through the next decade. During the 1970's, both retailers and wholesalers increasingly adopted such practices as computerized ordering and inventory systems, as well as integrated point-of-sale credit authorization systems. These applications will gradually extend to the smaller establishments in the industry division, creating additional demand for computer workers.

Employment of systems analysts, programmers, and computer and peripheral equipment operators will all increase as small retailers and wholesalers increasingly computerize their operations. The largest percentage increase, however, is projected for computer service technicians due to the expected growth in the number of data processing terminals and associated communications devices. Employment of keypunch operators will decline as new data are captured at the source by noncomputer personnel such as sales clerks, or keyed in via terminals connecting branch outlets to the organization's main data base.

Finance, insurance, and real estate. Computer employment in this major industry sector will increase

sharply through the 1980's—by 75 percent—as more small and medium-sized companies adopt computer techniques already widely used by larger firms in the industry. Most of this employment increase will occur in the finance sector. More banks are expected to automate their teller operations, participate in automated check clearing facilities, and offer 24-hour banking services through the use of on-line terminals. In addition, rapidly emerging banking applications such as electronic funds transfer systems (EFTS) will generate expansion of computer staffs in financial institutions. Increased participation in centralized credit checking and authorization systems will spur the demand for computer workers in credit agencies. Within finance, the group expected to show the smallest employment gains are securities firms. These firms were extensively computerized in the 1970's, with the implementation of fully automated stock quotation facilities and a national system for clearing securities transactions.

Although overall employment in finance, insurance, and real estate is expected to increase rapidly, growth rates for the individual occupations will vary. Employment of computer service technicians will increase the most rapidly, due to the large numbers of terminals, minicomputers, and other data communications equipment in operation. The demand for systems analysts, programmers, and computer and peripheral equipment operators also will remain very strong as the industry continues to increase the number and types of applications as well as the volume of computer equipment. Keypunch operator employment will decline as more efficient methods of data entry are adopted.

Services. Services, the fastest growing industry division in the economy, are expected to show the greatest increase in computer employment through the 1980's, employment is expected to more than double over the period. An expanding market for data processing in hospitals, educational institutions, and, especially, computer service organizations will account for most of the increase. Demand for programmers and systems analysts will be strong as hospitals continue to computerize their medical information and communications systems, as well as automating the services they provide to patients. Employment requirements of these systems and of those for medical diagnosis and instruction will assure the need for computer specialists in hospitals.

Similar growth is expected in educational services as more computer-assisted instructional systems are developed, library operations such as acquisitions and cataloging continue to be automated, and administrative tasks including class scheduling and maintenance of student records are handled by computers. Because many medical and educational applications are expected to feature direct data entry by users, such as hospital record clerks or students, employment requirements for keypunch operators should decline.

The growth of computer service organizations also will contribute heavily to the overall increase for computer workers in this industry. Service firms will continue to need large numbers of computer and peripheral equipment operators as well as more systems analysts and programmers to design and implement systems for the growing number of applications for small businesses and other organizations. At the same time, computer maintenance companies will need many more computer service technicians to service the increasing stock of computer equipment. Several factors will contribute to a growing need for contract data processing services and the resulting demand by service firms for trained computer personnel. These sources of demand include a growing number of applications featuring computer-to-terminal interfacing or minicomputers, and the growing popularity of franchised data processing services that are expected to enlarge the market.

Several other sectors within this broad industry division will experience growth in computer employment. Hotels, for example, will continue to install computerized reservation systems; and business services such as accounting, credit reporting, and research will become increasingly computerized.

Government. Computer employment requirements in government will increase by about 80 percent through the 1980's, as new information systems are installed and existing ones expand their capabilities. State and local government agencies will experience the greatest growth in computer personnel as their potential for new computer applications is realized. Growth in Federal computer employment will be somewhat slower, but steady nevertheless, as data processing requirements continue to expand.

Currently, most State and local computer systems have been developed around a single functional area such as revenue collection and disbursement, payroll, or medical and insurance information processing. In the future, however, consolidated systems serving a greater variety of information processing needs and using terminal networks and other data communications technology will be developed.

Within government, employment of computer service technicians will grow dramatically—keeping pace with hardware sales and installations. Larger amounts of equipment in use will also spur the demand for computer and peripheral equipment operators. Requirements for programmers and systems analysts, especially at the State and local level, will also rise rapidly as law enforcement, voter registration, and traffic-oriented applications continue to be computerized. Keypunch operator employment, however, will decline as more efficient methods of data entry continue to be utilized

Agriculture, forestry, and fisheries, mining, and construction. The number of people employed in the computer occupations in these industry divisions is so small that accurate employment projections cannot be made. It is expected, however, that computer employment in these industries will exhibit the same trends as in the overall economy.

Job openings

In addition to openings resulting from growth in the demand for computer workers, many jobs will become available each year as workers retire, die, leave the labor force for other reasons, or transfer to other occupations. Data on estimated annual job openings between 1980 and 1990 are presented in table 9. Total openings for each occupation consist of those resulting from employment change in that occupation and those stemming from the need to replace workers who leave the labor force for a variety of reasons. Although keypunch operator employment is expected to decline, for example, there will be many job openings in this large occupation as workers die or retire.

Sufficient data are not available to develop estimates of openings resulting from transfers of workers to other occupations. The limited data that are available, however, indicate significant mobility both within the computer field and for computer workers who transfer to other kinds of jobs. Programmers, for example, often advance to systems analyst jobs and many systems analysts become managers. To a lesser extent, a career ladder exists for computer operating personnel, with some of these workers advancing to programmer positions.

Implications of employment projections

The extremely rapid employment growth projected for the computer occupations will have a significant impact on education and training, wages, and other aspects of the labor market for computer workers. Some foreseeable trends are:

- The educational system will need to develop more programs to meet the continually rising demand for computer workers. Additionally, as computer use becomes more widespread, the trend toward infusing computer-related training into more curricula will accelerate.
- Shortages of computer workers are expected to become increasingly pronounced in the years ahead. As more and more workers are required to bring new computer applications on-line, competition among employers for skilled computer personnel will become increasingly intense. Thus, firms are likely to continue using aggressive recruiting techniques to fill their computer staffing requirements.
- The shortage of trained computer personnel is likely to result in a continued escalation of wages for these workers. Not only will entry salaries be driven up, but also the salaries of experienced workers in order to maintain an organization's internal salary structure.
- The great demand for computer personnel will make it more difficult to hire and retain workers in occupations requiring similar aptitudes. Math teachers, for example, are being lured away from public schools by the higher salaries in computer specialties. Colleges and universities also are finding it difficult to compete with business and government organizations to attract and retain computer science professors who may earn less than a beginning programmer. As the continuing upward pay spiral further discourages graduate study, schools will find it increasingly difficult to alleviate the teacher shortage.
- As electronic data processing operations grow in importance across all industries, the importance of and opportunities for skilled computer workers also will increase. Many companies, for example, now include data processing managers on their executive boards, a practice almost unheard of a decade ago. As data processing budgets expand and the coordination of computer operations becomes more complex, opportunities of this type are expected to become more prevalent.

In summary, the shortage of computer personnel is expected to continue, resulting in higher wages, more job mobility, increased job security, and generally greater opportunities for these workers. At the same time, this labor market imbalance will result in serious problems for employers as they attempt to maintain a stable computer staff.

Table 9. Projected average annual job openings in computer occupations, 1980-90

Occupation	Total average annual openings, 1980-90	Employment change	Replacement needs[1]
Total	93,700	68,500	25,200
Systems analysts	19,000	15,700	3,300
Programmers	20,550	15,900	4,650
Computer and peripheral equipment operators	41,800	32,800	9,000
Keypunch operators	3,900	-3,600	7,500
Computer service technicians	8,450	7,700	750

[1] Separations from the labor force due to deaths and retirements.
SOURCE: Bureau of Labor Statistics.

Appendix A. Methods

Sources of data

Data for this study were obtained from several sources. First, interviews were conducted with officials of the American Federation of Information Processing Societies, the International Data Corporation, and others. Various experts, including educators and government officials, also were interviewed.

Next, a search of existing literature was made to obtain available information on the employment and training of computer personnel. In addition, information was sought on computer use by specific industry, types of computer applications, and advances in computer technology.

These sources were supplemented by data from the Bureau of the Census and BLS, especially the BLS national industry-occupational matrix that provides detailed information on the distribution of occupational employment by industry. The employment projections presented in this report represent an interim revision of portions of that matrix to reflect the results of the study.

Framework for projections

Projections of employment for the economy as a whole and by industry were prepared by BLS and described in *Employment Projections for the 1980's*, BLS Bulletin 2030. A brief description of the assumptions that underlie these projections is presented in *Occupational Projections and Training Data*, BLS Bulletin 2052.

Computer employment projections presented in this study were developed within the framework of the latest BLS industry-occupational matrix. The most recently developed matrix presents data on occupational composition of all industry sectors for 1970, 1978, and 1990. Matrix staffing patterns reflect the 1970 Census industry-occupational employment estimates, updated by the Bureau's Current Population Survey that provides census-based occupational estimates for the years between the decennial censuses.

In-depth analysis of the computer occupations and evaluation of trends in the computer field led to an upward revision of the 1990 matrix employment projections for each of the computer occupations. These revised projections were then applied to the 1990 estimates of total employment for each of the 200 industries included in the matrix to yield new ratios showing the concentration of each computer occupation in each industry. The total number of computer workers per industry was obtained by summing across all of the computer occupations.

Change in matrix data base

The BLS is in the process of converting from an industry-occupational matrix based on census data to one based on the Occupational Employment Statistics (OES) survey.[1] These two data sources differ in several major respects:

Respondents. The census-based Current Population Survey (CPS) is a household survey, completed by an individual who responds for all members of the household. Persons who hold two or more jobs are only counted once, based on where they work the most hours each week. The OES survey is an establishment survey in which an official of the responding firm completes a questionnaire based on company records. Data from the OES survey count all jobs in each surveyed industry.

Time frame. Industry staffing patterns are available from the Census only every 10 years. The OES surveys are updated on a 3-year cycle, with staffing patterns benchmarked to the third year of the cycle.

Occupations. The CPS collects employment data for approximately 400 occupations. The data are categorized according to job titles that were used in the 1970 Census. The OES survey collects data for more than 1,800 occupations. Each occupation to be surveyed in a particular industry is defined on the questionnaire for that industry.

Industries. The CPS does not collect occupational employment by detailed industry. Staffing patterns from the latest decennial Census are updated based on estimates of occupational employment from the CPS and on estimates of industry employment from the Industry Employment Statistics (IES) survey. This produces occupational employment data for 200 industries. The OES survey collects occupational employment by detailed industry. Data are not collected in the agricultural or

[1] A background discussion of the OES survey may be found in the *BLS Handbook of Methods*, Bulletin 1910 (1976), pp 57-59

private household industries—these are estimated. This procedure generates occupational employment data for 378 industries.

Preliminary findings indicate that the two surveys reported comparable levels of employment in 1978 for all of the computer occuptions except computer and peripheral equipment operators. Preliminary OES survey results show substantially fewer of these workers than were reported in the 1978 CPS. Differences in occupational classification are the most likely explanation for the different employment estimates. The 1970 Census lists general job titles (some of which are now outdated) that the respondent has to fit to job duties, whereas the OES survey has a specific definition included on each questionnaire that probably eliminated a number of workers from this category.

Appendix B. Industry Distribution of Computer Employment by Occupation, 1970, 1978, and Projected 1990

Table B-1. Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Total, all computer occupations						Computer programmers					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Total, all industries	765,183	0.97	1,164,791	1.23	2,140,000	1.88	176,496	0 22	248,998	0 26	500,000	0 44
Agriculture, forestry, fisheries	687	.02	1,079	.03	1,785	.06	149	–	269	.01	600	.02
Agriculture	419	.01	564	.02	865	03	47	–	72	–	200	01
Agricultural production	154	–	161	.01	230	.01	–	–	–	–	20	–
Services, except horticulture	225	.13	327	.14	500	16	39	02	52	02	130	04
Horticultural services	40	.03	76	.03	135	.06	8	.01	20	01	50	.02
Forestry	149	.28	473	.59	775	1 09	90	17	179	.23	350	.49
Fisheries	19	.04	25	.04	145	.23	12	.03	18	03	50	08
Mining	6,114	.97	13,107	1.48	24,860	2.35	1,752	28	3,176	36	6,300	59
Metal mining	500	.53	646	.68	1,125	1 00	132	14	159	17	300	.27
Coal mining	179	.12	391	.18	700	.21	31	02	55	03	100	.03
Crude petroleum and natural gas	5,037	1.80	11,479	2.53	21,935	4.47	1,494	54	2,847	63	5,700	1 16
Nonmetallic mining, quarrying	398	.34	581	.48	1,100	.95	95	08	115	09	200	17
Construction	7,045	.15	10,213	.17	17,525	.25	1,864	04	2,481	.04	4,500	07
General building contractors	852	.07	1,269	09	2,425	14	202	.02	312	02	600	03
General contractors, exc. building	5,274	.38	7,332	47	12,385	64	1,497	11	1,855	12	3,250	17
Special trade contractors	919	04	1,612	.06	2,715	08	165	01	314	01	650	02
Manufacturing	238,399	1.21	320,270	1 56	552,400	2 34	60,615	31	73,830	36	129,000	55
Durable goods	169,644	1.49	235,027	1 90	421,700	2 90	47,474	.42	58,043	47	104,500	68
Ordnance	8,612	2.91	6,923	4.02	10,400	6.02	3,221	1 09	2,143	1 24	4,000	2 31
Lumber and wood products	1,439	23	1,841	.27	2,850	.39	294	05	381	06	490	07
Logging	71	06	99	08	140	13	25	02	36	03	40	04
Sawmills, planing mills	951	.24	1,136	27	1,580	34	195	05	254	06	290	06
Misc. wood products	417	.34	606	.46	1,130	.67	74	06	91	.07	160	09
Furniture and fixtures	2,237	.48	3,011	58	4,550	67	388	08	529	.10	820	12
Stone, clay, and glass products	3,732	.58	4,983	71	8,120	1 14	719	.11	895	.13	1,450	20
Glass and glass products	1,214	.66	1,488	.74	2,460	1 11	254	.14	311	.15	560	25
Cement, concrete, plaster	1,252	.56	1,727	.70	2,770	1 06	307	14	385	.16	590	23
Structural clay products	193	33	188	.37	230	72	37	06	37	.07	40	13
Pottery and related products	190	.43	272	.58	500	1.18	21	.05	27	06	30	07
Misc. nonmetallic stone	883	66	1,308	.86	2,160	1 40	100	07	135	09	230	15
Primary metal industries	11,043	.85	13,515	1 08	20,900	1 55	2,202	17	2,549	20	4,100	30
Blast furnaces, steel works	5,402	.97	6,028	1 25	8,620	1.80	1,048	19	1,129	23	1,620	34
Other primary steel	1,982	.54	2,499	68	4,040	.95	404	11	478	.13	840	20
Primary aluminum	1,519	.97	2,275	1.27	3,690	2.04	324	.21	426	24	730	.40
Other primary nonferrous	2,140	.96	2,713	1 19	4,550	1 76	426	.19	516	23	910	.35
Fabricated metal products	9,989	.72	13,874	.90	22,670	1.21	1,960	.14	2,589	17	4,550	24
Cutlery, other hardware	1,664	1 10	2,209	1.23	3,510	1.54	267	.18	367	20	690	30
Fabricated metal products	2,799	.65	3,949	79	6,780	.98	610	.14	825	16	1,670	24
Screw machine products	865	.83	1,075	.99	1,530	1 35	120	11	147	.14	220	19
Metal stamping	1,446	.62	2,142	.87	3,690	1.27	321	14	407	17	670	23
Misc. metal products	3,215	.69	4,499	88	7,160	1 32	642	14	843	16	1,300	24
Machinery, except electrical	56,319	2 85	90,982	3 93	199,680	6 70	17,098	86	24,318	1 05	51,190	1 72
Engines and turbines	1,551	1.41	2,354	1 78	4,190	2.93	394	.36	560	42	890	.62
Farm machinery, equipment	2,004	1.56	2,747	1 84	4,680	2 60	429	33	572	38	920	51
Construction machinery	3,847	1 31	6116	1.65	10,240	2.19	851	29	1,253	34	1,950	42
Metalworking machinery	3,041	.96	4,488	1.29	7,820	1 79	759	24	1,011	.29	1,900	44
Office, accounting machinery	4,849	5.33	4,980	6 91	6,670	10 13	1,304	1 43	1,156	1 60	1,600	2 43
Electronic computing equipment	33,025	17.57	58,322	21 72	145,420	30 94	11,626	6 19	17,388	6 49	39,960	8 50
Machinery, n e c	7,922	.93	11,975	1.23	20,660	1 67	1,735	20	2,378	24	3,970	32
Electrical machinery	35,815	1 87	47,031	2 29	78,670	3 15	10,751	56	12,002	58	19,900	80
Household appliances	1,958	1.06	2,370	1 30	3,940	1 85	407	22	464	25	620	29
Radio, TV, communications equipment	15,891	2.52	18,763	3 14	27,100	4 12	5,062	80	5,128	86	7,300	1 11
Electrical machinery, n.e.c.	17,966	1.63	25,898	2.03	47,630	2 92	5,282	48	6,410	50	11,980	73
Transportation equipment	28,727	1.50	35,814	1 73	50,650	2 14	8,172	43	8,982	43	12,200	51
Motor vehicle equipment	9,111	1.13	13,827	1 41	22,400	1 96	1,999	25	2,855	.29	5,180	45
Aircraft and parts	16,706	2.51	18,213	3 10	22,540	4.39	5,448	82	5,316	91	5,990	1 17
Ship, boat building, repair	2,196	.80	2,592	.92	3,680	1 17	586	21	594	.21	680	22
Railroad equipment	445	88	661	1.08	990	1.55	94	19	125	20	150	23
Mobile dwellings	105	12	195	18	430	.16	8	.01	15	01	40	01
Cycles, misc. transportation equipment	163	.65	326	77	610	92	37	–	77	18	160	24
Professional and scientific instruments	8,180	1.80	12,558	2.22	19,980	2 92	2,092	46	2,958	52	4,870	71
Scientific instruments	3,168	1.79	4,454	2 27	6,330	3.23	816	46	1,051	54	1,430	73
Optical, health service supplies	1,876	1.38	3,428	1.66	5,710	2 14	451	.33	791	38	1,550	58
Photo equipment and supplies	2,831	2 60	4,377	3 34	7,460	4.05	756	69	1,040	79	1,780	.97
Watches and clock devices	305	.97	299	.99	380	1.05	69	.22	74	.24	110	30
Misc. manufacturing	3,552	.82	4,495	.97	5,930	1 18	577	.13	699	15	930	18
Nondurable goods	68,755	.84	85,783	1.04	131,700	1 45	13,141	.16	15,787	19	25,500	28
Food and kindred products	11,169	.63	13,569	.79	20,020	1.15	1,903	.11	2,157	13	3,390	20
Meat products	1,841	.53	2,280	65	3,300	.93	266	.08	308	.09	540	15
Dairy products	1,639	67	1,586	.85	1,750	1 27	239	.10	218	.12	240	17
Canning and preserving	1,741	.61	2,318	.77	3,840	1.06	384	14	479	16	820	23
Grainmill products	913	.66	1,246	.85	1,880	1.20	155	.11	189	13	290	.19
Bakery products	1,018	.37	1,190	.51	1,250	61	156	06	165	.07	230	11
Confectionery products	643	.78	674	.87	860	1 07	111	13	118	.15	140	17
Beverages	1,588	.67	1,966	.86	2,900	1.24	273	.12	296	13	350	.15
Misc. food preparations	1,786	.99	2,309	1.24	3,380	1.66	319	.18	384	.21	580	.28
Tobacco manufacturing	788	.96	817	1.21	860	1.49	204	.25	192	.29	200	35
Textile mill products	6,421	66	7,134	.79	10,370	.98	1,143	.12	1,262	14	1,960	.19
Knitting mills	1,472	.60	1,554	.66	2,220	.66	208	.08	237	10	360	.11
Dyeing, finishing textiles	652	.78	783	.99	1,155	1.50	118	.14	131	17	190	.25
Floor coverings	861	1.51	1,134	1.85	2,080	2 01	151	.26	184	.30	360	.35
Yarn, fabric mills	2,962	.57	3,211	71	4,345	.95	561	.11	599	.13	890	.19
Misc. textile mill products	456	.61	454	65	570	.69	105	.14	111	.16	160	19
Apparel, textile products	6,206	.45	7,093	.53	10,750	.69	894	.06	1,058	08	2,000	13
Apparel and accessories	5,482	.45	6,203	.54	9,360	.71	805	.07	946	08	1,780	13
Misc. fabricated products	724	.43	890	.46	1,390	59	89	.05	112	06	220	09
Paper and allied products	5,885	.83	6,899	.99	11,250	1.42	1,036	.15	1,149	17	2,100	.27
Pulp, paper, paperboard mills	2,944	1.01	2,320	1.25	5,130	2 01	582	.20	599	.23	1,010	39
Paperboard containers, boxes	1,033	.46	1,040	.49	1,540	58	183	08	191	09	380	14
Misc. paper and pulp products	1,908	1.01	2,539	1.16	4,580	1.71	271	.14	359	16	710	26

See notes at end of table

Table B-1 Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Total, all computer occupations						Computer programmers					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Printing and publishing	12,220	1.05	15,921	1.26	25,740	1.92	2,199	0 19	3,101	0 25	5,590	0 42
Newspaper publishing, printing	2,281	55	3,223	.70	5,570	1.05	440	11	552	12	1,050	20
Printing, publishing, exc. newspaper	9,939	1.34	12,698	1.58	20,170	2.48	1,759	24	2,549	32	4,540	.56
Chemical and allied products	13,734	1.33	18,144	1.68	31,020	2.33	3,193	.31	3,851	36	6,400	48
Industrial chemicals	4,389	1.38	6,526	1.70	10,010	2.54	1,317	41	1,493	46	2,700	69
Plastics, synthetics	1,042	1.02	1,361	1.41	2,370	2.18	272	27	298	.31	410	38
Synthetic fibers	1,128	1.04	1,425	1.22	2,530	1.40	226	.21	271	.23	520	29
Drugs and medicines	2,778	1.94	4,436	2.39	7,880	3.57	614	34	912	49	1,550	.70
Soaps and cosmetics	2,034	1 63	2,577	1.92	4,040	2.43	345	28	416	31	590	35
Paints and varnishes	1,018	1.49	1,278	1.77	2,000	2.17	127	.19	161	22	230	25
Agricultural chemicals	557	1 01	777	1.27	1,220	2.14	124	.23	156	26	190	33
Misc. chemicals	798	.72	764	.89	970	.85	168	15	144	17	210	18
Petroleum and coal products	5,141	2.70	6,883	3.30	9,750	5.48	1,280	.67	1,503	72	1,950	1 10
Petroleum refining	4,807	3 13	6,449	3.92	9,090	7 48	1,250	81	1,464	.89	1,890	1 56
Misc. petroleum, coal products	334	.91	434	99	660	1 17	30	08	39	.09	60	11
Rubber, misc. plastic products	5,294	.92	6,957	.93	10,760	1 34	1,000	17	1,231	16	1,800	22
Rubber products	3,674	1.28	4,162	1.41	5,750	1.70	760	26	822	28	1,010	30
Misc. plastic products	1,620	.56	2,795	.62	5,010	1 08	240	.08	409	09	790	17
Leather products	1,897	.59	1,826	.71	2,040	.95	289	09	283	11	310	14
Leather tanning, finishing	109	.42	108	47	140	1 02	7	.03	7	03	10	07
Footwear, except rubber	1,319	.58	1,217	71	1,200	.91	223	10	211	12	220	17
All other leather products	469	.68	503	79	700	1 02	59	09	65	10	80	12
Transportation, other public utilities	48,606	.97	65,505	1 13	107,130	1.69	9,345	19	12,445	22	23,000	36
Transportation, total	20,130	.70	23,966	.73	32,780	93	3,095	.11	3,894	12	5,500	16
Railroads, railway express	8,186	1 33	6,937	1.36	6,225	1.45	768	12	689	13	650	15
Local, interurban transit	540	14	595	.13	880	.16	60	02	73	02	100	02
Street railways, bus lines	516	18	558	.16	845	.20	56	.02	65	02	90	02
Taxicab service	24	03	37	03	35	03	4	—	8	.01	10	01
Trucking and warehousing	4,343	37	5,739	39	8,035	52	554	05	814	.06	1,300	08
Trucking services	3,829	.36	5,129	.38	7,195	.50	490	05	730	05	1,160	08
Warehousing and storage	514	58	610	.65	840	.81	64	.07	84	09	140	14
Water transportation	1,106	.47	1,293	.53	1,720	.81	258	11	368	.15	450	21
Air transportation	4,522	3 31	6,822	1.63	11,080	2 10	1,155	.34	1,486	.36	2,100	40
Pipelines	367	2.17	537	2 81	850	5 32	113	.67	147	77	160	1 00
Transportation services	1,066	1.00	2,043	1.20	3,990	1 57	187	17	317	19	740	29
Communications, utilities, sanitary services	28,475	1 32	41,539	1.69	74,350	2.65	6,250	29	8,551	35	17,500	62
Communications	16,286	1.51	23,992	1.99	48,525	3 50	3,300	31	4,628	.38	10,400	75
Telephone (wire and radio)	14,660	1.62	21,097	2.19	43,450	4 02	2,887	32	3,985	41	9,100	84
Telegraph, misc. comm. services	1,004	2.11	1,931	3.05	3,160	5.17	276	58	445	70	850	1.39
Radio broadcasting, TV	622	.48	964	.54	1,825	.75	137	11	198	.11	450	18
Utilities, sanitary services	12,190	1.13	17,547	1 39	25,825	1.82	2,950	.27	3,923	.31	7,100	50
Electric light and power	4,343	1.33	7,080	1 61	10,505	2.54	1,069	33	1,710	.39	3,400	81
Electric—gas utilities	3,994	2.04	4,847	2.36	7,210	3.08	832	42	989	48	1,700	73
Gas, steam supply systems	2,854	1.72	3,507	2.11	4,725	2.83	858	52	975	.59	1,500	.90
Water supply	758	57	1,060	.69	1,600	.85	141	11	185	12	300	16
Sanitary services	152	.06	950	33	1,460	.36	28	.01	37	01	110	03
Other utilities, n.e.c.	84	1.25	103	1.45	225	2 21	22	33	27	.38	90	88
Wholesale and retail trade	93,137	57	141,665	.69	242,000	95	13,550	08	19,409	09	35,000	.14
Wholesale trade	62,738	1.59	94,614	1.96	164,640	3.08	9,695	25	13,663	28	24,000	.45
Wholesale, except misc. wholesale	50,254	1.90	78,236	2.35	140,950	3.77	7,955	30	11,347	.34	20,100	54
Motor vehicles and equipment	4,309	1.30	6,441	1.50	9,180	1.76	543	.16	810	19	1,450	.28
Drugs, chemicals allied products	5,006	2.15	6,250	2 32	8,220	2.82	670	.29	832	31	1,250	43
Dry goods and apparel	2,041	1 30	2,444	1 46	3,370	1 75	300	19	369	22	450	23
Food and related products	5,927	1.02	7,767	1.16	10,680	1.49	865	.15	1 155	17	1,550	22
Farm products—raw materials	633	.60	1,138	73	1,620	1.61	118	11	208	13	300	30
Electrical goods	4,766	1.50	6,671	1.78	10,120	2 20	664	21	908	.24	1,400	.30
Hardware, plumbing	1,762	1.03	2,131	1.02	2,760	1.23	267	.16	378	18	500	22
Machinery, equipment, supplies	25,810	3.46	45,394	4.28	98,190	7.99	4,528	.61	6,687	63	13,200	1.07
Misc wholesale trade	12,484	97	16,378	1.10	24,150	1.50	1,740	.13	2,316	.16	3,900	24
Metals and minerals, n e c	1,362	1.01	1,673	1.19	2,415	1.48	170	.13	200	.14	350	21
Petroleum products	2,336	1.17	2,527	1.08	3,015	1.26	458	23	622	27	1,100	46
Scrap and waste material	82	.08	155	.12	315	27	15	.01	26	.02	60	04
Alcoholic beverages	1,352	1 37	2,042	1.56	2,760	2 22	118	12	183	.14	250	20
Paper and its products	1,343	1.01	1,601	1.22	2,270	1 40	146	.11	168	13	200	12
Lumber, construction materials	708	.44	955	54	1,440	67	92	06	110	06	150	07
Wholesale trade, n.e c	5,299	1.14	7,425	1 37	11,940	2.01	741	16	1,007	19	1,800	30
Retail trade	30,399	.24	47,051	.30	77,360	38	3,855	03	5,746	.04	1,000	05
Building materials	937	16	1,311	.18	1,940	.24	149	.03	215	03	300	04
Lumber, building materials	549	.15	921	.19	1,450	.30	87	.02	139	03	200	04
Hardware and farm equipment	388	17	390	.16	490	.15	62	.03	76	03	100	03
General merchandise, total	15,537	.61	22,727	.77	37,420	87	1,956	.08	2,819	10	6,200	14
Department, mail order	11,845	76	18,570	.96	31,615	1 06	1,498	.10	2,327	12	5,550	19
Limited price stores	1,001	32	1,065	.38	1,490	45	95	.03	106	.04	150	.05
Vending machine operators	273	.40	324	.43	505	39	25	.04	25	03	50	04
Direct selling	724	.22	782	.22	850	.25	168	.05	165	05	200	06
Misc. merchandise stores	1,694	.56	1,984	.66	2,960	.60	170	.06	196	07	250	05
Food and dairy stores	3,996	20	6,553	.28	11,500	.39	476	.02	733	.03	1,350	05
Grocery stores	3,676	.22	5,975	.30	10,400	40	452	.03	698	.03	1,290	05
Dairy product stores	124	.34	219	.49	350	.84	12	03	19	04	30	07
Retail bakeries	115	.10	231	.17	530	.35	8	01	13	.01	20	01
Food stores, n e c.	81	.07	128	.09	220	.15	4	—	3	—	10	01
Auto dealers, gas stations	1,306	07	2,034	.10	3,100	14	103	.01	155	.01	200	.01
Motor vehicle dealers	752	10	1,064	12	1,585	16	72	.01	100	.01	125	01
Tire, battery, accessory stores	515	.28	915	.35	1,460	40	31	.02	55	.02	75	02
Apparel and accessories	2,220	.29	3,303	.36	5,080	.45	208	.03	292	.03	450	.04
Apparel, accessory stores	1,643	27	2,481	33	3,840	.43	135	.02	181	02	300	03
Shoe stores	577	38	822	.47	1,240	.53	73	.05	111	.06	160	06
Furniture and appliances	1,421	.26	2,237	33	3,940	.49	254	.05	401	08	750	09
Home furnishing stores	658	19	943	23	1,620	.32	86	.02	123	.03	240	.05
Appliances, TV, radio stores	763	.36	1,294	.48	2,320	76	168	.08	278	.10	510	.17
Eating and drinking places	1,108	.04	2,736	.06	4,310	08	103	—	166	—	250	—

See notes at end of table

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Total, all computer occupations						Computer programmers					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Misc. retail trade stores	3,874	0.28	6,150	0.33	10,070	0.42	606	0.04	965	0.05	1,500	0.06
Drug stores	1,028	.22	1,338	.27	2,050	31	174	04	245	05	400	.06
Liquor stores	103	.08	147	.09	210	10	12	01	21	01	40	02
Farm, garden supply stores	235	.20	447	.27	720	.39	49	04	66	05	120	.07
Jewelry stores	250	.24	401	30	680	42	27	03	47	03	90	.06
Fuel and ice dealers	577	.50	657	.60	895	.86	50	04	52	05	50	.05
Retail florists	12	.01	16	01	20	01	–	–	–	–	–	–
Misc. retail trade stores	1,669	.36	3,144	46	5,495	.62	294	06	514	07	800	09
Finance, insurance, real estate	103,868	2.72	152,498	3.03	266,900	4.11	20,430	53	26,300	52	51,000	79
Finance, total	52,796	3.27	90,813	4.23	172,890	5.66	9,039	56	13,440	63	28,300	93
Banking	39,878	4.02	69,366	5.20	135,990	7.02	6,656	67	9,915	74	22,100	1.14
Credit agencies	6,306	1.76	12,138	2.38	20,700	2.68	1,153	32	1,997	39	4,200	54
Stock brokers, investment	6,612	2.49	9,309	3.09	15,200	4.41	1,230	46	1,528	51	2,000	58
Insurance	49,211	3.64	58,871	3.66	89,780	4.58	11,078	82	12,388	77	22,000	1.12
Real estate	1,851	.22	2,814	.22	4,230	29	313	04	472	04	700	.05
Services, total	184,994	.90	343,759	1.26	719,900	2.06	50,531	24	84,366	31	204,000	58
Hotels and lodging places	688	07	1,171	09	2,220	12	99	01	152	01	270	01
Hotels and motels	586	08	1,110	.12	2,155	16	99	01	152	02	270	02
Lodging places, except hotels	102	03	61	.02	65	01	–	–	–	–	–	–
Other personal services	809	06	587	04	610	04	51	–	42	–	40	–
Laundry, cleaning	804	13	578	13	610	20	51	01	42	01	40	01
Misc. business services	90,262	5.52	169,570	6.36	376,610	9.02	26,071	1.59	44,023	1.65	112,300	2.69
Advertising	854	.66	1,063	71	1,560	1.05	214	17	258	17	360	24
Business management services	6,849	3.83	13,062	4.72	28,050	6.08	1,938	1.09	3,399	1.23	8,600	1.86
Commercial R&D	4,029	4.60	8,331	6.15	20,930	9.23	1,797	2.05	3,297	2.43	8,800	3.88
Computer programming	58,661	52.28	110,361	57.45	255,580	70.99	19,366	17.26	31,799	16.55	79,660	22.13
Detective and protective	407	29	937	.33	2,180	46	82	06	181	06	480	10
Employment, temporary help	6,725	3.12	9,412	2.44	10,410	1.66	307	14	640	17	1,600	25
Services to buildings	36	.01	68	01	150	02	–	–	–	–	–	–
Other misc. services	12,701	2.68	26,336	3.36	57,750	5.40	2,367	50	4,449	57	12,800	1.20
Automobile repair services	780	16	1,232	17	2,190	25	105	.02	151	02	310	03
Auto repair	39	01	166	.03	390	07	–	–	–	–	–	–
Auto services, except repair	741	.44	1,066	.49	1,800	60	105	06	151	07	310	10
Other repair services	2,128	.67	4,244	.94	12,700	2.57	–	–	–	–	–	–
Electrical repair shops	993	.79	1,339	1.02	4,200	2.29	–	–	–	–	–	–
Other repair services	1,135	.59	2,905	.91	8,500	2.74	–	–	–	–	–	–
Motion pictures, theaters	862	.36	827	.40	1,070	35	189	.08	181	09	210	07
Misc. entertainment	291	07	741	10	1,280	15	44	01	121	02	340	04
Medical, other health	13,554	.29	26,371	39	57,970	53	2,495	05	4,642	07	13,500	12
Hospitals	11,538	.39	21,232	.54	48,430	83	2,016	07	3,499	09	10,710	18
Convalescent institutions	156	03	501	06	1,790	08	27	01	66	01	390	02
Health services, n.e.c.	1,860	.68	4,638	.67	8,750	94	452	16	1,077	.16	2,400	26
Legal services	201	.05	365	06	690	09	30	01	64	01	160	02
Educational services	33,927	.58	58,066	77	102,840	1.28	11,785	20	17,713	24	33,000	41
Elementary, secondary	4,461	11	7,596	15	11,430	22	1,048	03	1,620	03	3,000	06
Colleges and universities	26,507	1.68	45,196	2.24	80,720	3.58	10,047	64	14,887	74	27,500	1.22
Libraries	160	20	435	42	1,270	84	54	07	124	.12	400	26
Educational services, n.e.c.	2,799	1.12	4,840	1.31	9,420	1.91	636	.25	1,082	29	2,100	43
Museums, art galleries, zoos	47	16	119	23	320	.35	16	06	30	06	70	08
Nonprofit organizations	6,372	.45	9,616	.50	15,350	62	950	07	1,495	08	2,800	11
Religious organizations	587	10	924	13	1,070	14	–	–	–	–	–	–
Welfare services	2,837	.66	4,191	.65	8,670	71	423	10	686	11	1,200	13
Nonprofit membership organizations	2,928	77	4,478	91	7,590	1.25	527	14	809	16	1,600	26
Other professional, related services	35,073	4.26	70,850	5.47	146,060	8.94	8,696	1.06	15,752	1.22	41,000	2.51
Engineering and architectural services	3,470	1.09	8,169	1.66	20,210	3.22	1,317	41	2,462	50	8,100	1.29
Misc. professional services	5,002	2.42	9,943	2.76	23,840	5.51	1,969	95	3,449	96	10,900	2.52
Government, total	82,343	1.94	116,695	2.31	207,500	3.49	18,260	43	24,722	49	46,600	78
Federal public administration	52,551	2.32	68,319	3.01	101,675	4.26	12,785	57	15,277	67	20,600	86
Postal service	712	10	1,637	.24	3,800	57	143	02	278	04	600	09
Other Federal public administration	51,869	3.35	66,682	4.19	97,875	5.68	12,642	82	14,999	94	20,000	1.16
State public administration	18,504	3.00	30,099	3.33	63,025	5.56	3,185	52	6,629	62	14,000	1.24
Local public administration	11,288	.82	18,277	.99	42,800	1.76	2,290	17	3,816	21	12,000	49

See notes at end of table

Table B-1 Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Computer systems analysts						Computer and peripheral equipment operators					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Total, all industries	102,697	0 13	181,998	0.20	400	0.35	149,995	0 19	392,993	0 42	850,000	0 75
Agriculture, forestry, fisheries	18	–	45	–	200	.01	122	–	337	01	625	02
Agriculture	8	–	17	–	75	–	89	–	216	01	380	01
Agricultural production	–	–	–	–	10	–	35	–	61	–	120	01
Services, except horticulture	8	–	17	01	50	.02	47	03	136	06	220	07
Horticultural services	–	–	–	–	15	.01	7	–	19	01	40	02
Forestry	10	.02	28	04	85	12	26	.05	97	12	190	27
Fisheries	–	–	–	–	40	06	7	02	24	.03	55	.09
Mining	969	15	2,354	.26	5,000	.47	1,634	26	5,397	61	11,650	1.10
Metal mining	80	.09	129	.14	250	.22	84	09	182	19	400	35
Coal mining	13	.01	35	02	100	.03	60	04	208	10	450	13
Crude petroleum and natural gas	840	30	2,132	47	4,500	92	1,361	49	4,707	1 04	10,150	2 07
Nonmetallic mining, quarrying	36	04	58	.05	150	13	129	11	300	.24	650	56
Construction	839	.02	1,423	03	3,000	04	1,432	03	3,641	06	7,725	.11
General building contractors	81	.01	184	.01	400	.02	155	.01	409	03	1,100	.06
General contractors, exc building	648	.05	1,106	.07	2,350	12	1,121	08	2,576	17	5,300	28
Special trade contractors	110	–	153	–	250	01	156	01	656	02	1,325	04
Manufacturing	38,002	.20	61,915	.30	119,500	.51	45,967	23	103,093	.50	215,000	91
Durable goods	31,103	.27	50,977	41	99,500	.68	30,262	27	68,915	56	145,000	1 00
Ordnance	2,138	72	1,951	1 14	3,100	1.79	1,631	55	1,995	1 16	2,700	1 56
Lumber and wood products	179	.03	293	04	550	07	286	05	658	10	1,450	20
Logging	–	–	–	–	–	–	14	01	37	03	80	08
Sawmills, planing mills	130	.03	211	05	370	08	136	04	311	07	670	14
Misc. wood products	49	.04	82	06	180	11	136	11	310	.24	700	41
Furniture and fixtures	142	.03	242	05	420	06	500	11	1,187	23	2,370	35
Stone, clay, and glass products	431	.07	705	.10	1,360	19	959	15	2,152	.31	4,400	62
Glass and glass products	158	.08	249	13	480	22	231	12	523	.26	1,150	52
Cement, concrete, plaster	150	07	238	.10	440	.17	336	.15	747	30	1,500	.58
Structural clay products	10	.02	14	.03	20	.06	37	06	68	13	120	38
Pottery and related products	11	.03	18	.04	30	07	61	14	152	.32	380	90
Misc. nonmetallic stone	102	.08	186	.12	390	.25	294	.22	662	44	1,250	81
Primary metal industries	1,214	.09	1,878	.15	2,900	22	2,417	.19	5,061	40	11,000	82
Blast furnaces, steel works	590	.11	803	.17	1,170	.24	1,165	21	2,216	.46	4,500	94
Other primary steel	137	.04	242	.07	380	09	484	.13	1,062	29	2,300	.54
Primary aluminum	276	.18	508	.29	870	48	306	20	766	43	1,600	88
Other primary nonferrous	211	.09	325	14	480	19	462	21	1,017	44	2,600	1 00
Fabricated metal products	904	06	1,620	.10	2,700	14	2,258	16	5,520	.36	12,080	65
Cutlery, other hardware	179	11	333	.19	610	.27	274	.18	686	.38	1,500	66
Fabricated metal products	270	.06	508	.10	910	.13	591	14	1,499	30	3,380	.49
Screw machine products	77	.08	124	.11	190	17	175	17	409	38	850	.75
Metal stamping	88	04	156	.06	280	.10	426	.18	1,010	.41	2,250	77
Misc. metal products	290	.06	499	09	710	.13	792	17	1,916	37	4,100	.75
Machinery, except electrical	13,131	.67	24,490	1 06	54,500	1.83	7,674	39	20,163	.87	51,500	1.73
Engines and turbines	243	.22	447	.34	630	.58	280	.25	736	56	1,900	1 33
Farm machinery, equipment	215	.17	362	24	550	.31	395	31	974	65	2,500	1 39
Construction machinery	672	.23	1,283	.35	2,500	.54	679	23	1,822	49	4,100	88
Metalworking machinery	300	.09	515	15	1,020	.23	713	22	1,764	.51	3,800	87
Office, accounting machinery	1,005	1.19	1,254	1 74	1,600	2.43	621	58	1,049	1 46	1,800	2.73
Electronic computing equipment	9,864	5.25	19,286	7 20	45,400	9.66	3,198	1 70	9,283	3.46	27,000	5 74
Machinery, n.e.c.	752	.09	1,343	14	2,600	21	1,788	21	4,535	.47	10,400	84
Electrical machinery	5,977	.31	9,362	.45	16,870	.67	6,641	35	14,525	.71	31,000	1 24
Household appliances	274	.15	411	.23	720	.34	392	.21	829	.45	2,100	99
Radio, TV, communications equipment	2,694	43	3,804	.63	6,100	.93	2,971	47	5,591	.93	9,900	1 51
Electrical machinery, n e c	3,009	.27	5,147	40	10,050	62	3,278	30	8,105	64	19,000	1 17
Transportation equipment	5,285	.28	7,504	.36	11,800	.50	5,668	.30	11,919	.58	20,800	88
Motor vehicle equipment	1,204	15	2,219	.23	4,400	.38	1 937	.24	5,054	.51	9,590	84
Aircraft and parts	3,673	.56	4,655	.80	6,380	1 24	3,115	.47	5,477	.93	9,300	1 62
Ship, boat building, repair	326	.12	452	.16	690	.22	483	.18	972	.34	1,900	60
Railroad equipment	63	.13	130	.21	210	.33	76	15	203	.33	450	.70
Mobile dwellings	13	.02	35	.03	90	.03	25	.03	88	.08	250	09
Cycles, misc. transportation equipment	5	.02	13	03	30	05	32	13	125	29	310	47
Professional and scientific instruments	1,408	.31	2,490	.44	4,510	66	1,518	.33	3,965	70	7,400	1 08
Scientific instruments	623	.35	1,031	.53	1,600	.82	536	.30	1,255	64	2,160	1 10
Optical, health service supplies	210	.15	465	.23	970	36	335	25	1,087	53	2,100	79
Photo equipment and supplies	554	.50	966	.74	1,900	1 03	615	.56	1,546	1.18	3,000	1 63
Watches and clock devices	21	.07	28	.09	40	.11	32	10	77	25	140	39
Misc. manufacturing	295	.06	442	09	790	.16	710	.16	1,770	.38	3,000	60
Nondurable goods	6,899	.08	10,938	.13	20,000	.22	15,705	.19	34,718	.41	70,000	.77
Food and kindred products	877	.05	1,279	.07	2,250	.13	2,851	16	6,177	36	11,900	.69
Meat products	72	.02	106	.03	180	.05	447	.13	1,055	.30	2,050	.58
Dairy products	158	.07	195	.11	270	.20	382	16	663	36	1,020	74
Canning and preserving	143	.05	207	.06	410	.11	455	16	1,006	.34	2,100	.58
Grainmill products	79	.05	128	.08	230	.15	279	.20	637	.44	1,200	.77
Bakery products	27	.01	54	02	90	04	281	10	599	.26	750	.37
Confectionery products	45	.06	64	.08	100	12	137	.17	276	.36	510	.64
Beverages	119	.05	163	.07	260	.11	471	.20	1,012	.44	2,040	.87
Misc. food preparations	234	.13	362	.19	580	.28	399	.22	929	.50	1,800	.88
Tobacco manufacturing	68	.08	87	.13	130	.23	209	.26	357	.53	430	.74
Textile mill products	509	.06	748	08	1,410	.13	1,284	.13	2,656	.30	5,500	.52
Knitting mills	68	.03	96	04	190	.06	226	.09	483	.20	1,250	.37
Dyeing, finishing textiles	47	.06	77	.10	130	.17	182	.22	369	.47	700	.91
Floor coverings	68	.12	104	17	220	.21	236	.41	545	.89	1,300	1.26
Yarn, fabric mills	285	.06	403	.09	740	16	609	.12	1,196	.26	2,100	.46
Misc. textile mill products	41	.05	68	.10	130	.16	31	.04	63	.09	150	.18
Apparel, textile products	386	.03	589	.04	1,090	.07	1,146	.08	2,626	.20	5,900	.38
Apparel and accessories	344	.03	509	.04	930	.07	1,016	.08	2,286	.20	5,150	.39
Misc. fabricated products	42	.02	80	.04	160	.07	130	.08	340	17	750	32
Paper and allied products	643	.09	975	.14	1,760	.22	1,335	.19	2,716	.39	5,800	.73
Pulp, paper, paperboard mills	360	.12	482	.18	780	.30	765	.26	1,443	.54	2,900	1.13
Paperboard containers, boxes	67	.03	104	.05	220	.08	200	.09	386	.18	700	.26
Misc. paper and pulp products	216	.12	389	.18	760	.28	370	.20	887	.41	2,200	.82

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Computer systems analysts						Computer and peripheral equipment operators					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Printing and publishing	918	0.08	1,694	0 13	3,350	0.25	3,029	0.26	6,756	0 54	13,900	1 04
Newspaper publishing, printing	109	.02	147	.03	280	05	778	19	1,781	39	3,600	68
Printing, publishing, exc newspaper	809	.10	1,547	19	3,070	.38	2,251	30	4,975	62	10,300	1 27
Chemical and allied products	2,053	.20	3,333	.31	6,610	50	3,076	30	6,737	62	14,900	1.12
Industrial chemicals	700	.22	1,044	.32	2,140	.54	943	30	1,934	59	4,490	1 14
Plastics, synthetics	139	14	234	.24	420	39	313	31	610	.63	1,390	1 28
Synthetic fibers	165	.16	277	.23	580	32	209	19	473	40	1,130	62
Drugs and medicines	609	.43	1,137	62	2,250	1 02	546	38	1,479	.80	3,300	1 50
Soaps and cosmetics	212	.17	320	.24	610	37	448	36	1,002	75	2,200	1 32
Paints and varnishes	85	.13	139	19	270	29	247	36	554	.77	1,200	1.30
Agricultural chemicals	49	.09	80	.13	150	.26	157	29	363	.60	740	1 30
Misc. chemicals	104	.08	102	12	190	.17	213	.19	322	37	450	40
Petroleum and coal products	919	.49	1,373	66	1,950	1.10	1,149	60	2,596	1 25	4,900	2.76
Petroleum refining	884	.57	1,312	.80	1,830	1.51	1,094	71	2,444	1 49	4,520	3 72
Misc. petroleum, coal products	35	.09	61	14	120	.21	55	15	152	35	380	68
Rubber, misc. plastic products	403	.07	704	09	1,330	.17	1,248	22	2,860	38	6,100	76
Rubber products	282	10	402	14	710	21	869	30	1,656	56	3,300	97
Misc plastic products	121	04	302	07	620	13	379	13	1,204	27	2,800	60
Leather products	123	.04	156	06	250	12	378	.12	697	.27	1,100	51
Leather tanning, finishing	–	–	–	–	–	–	28	11	57	25	100	73
Footwear, except rubber	59	02	65	03	90	07	257	11	458	27	650	49
All other leather products	64	.09	91	14	160	23	93	.13	182	28	350	51
Transportation, other public utilities	4,788	.09	8,215	14	17,700	28	10,834	22	26,057	45	52,300	83
Transportation, total	1,611	.06	2,642	.08	4,700	13	4,232	15	9,256	28	17,100	49
Railroads, railway express	457	.08	596	12	800	19	1,624	26	2,619	51	3,200	75
Local, interurban transit	35	.01	50	01	75	01	130	03	290	06	600	.11
Street railways, bus lines	31	01	41	01	60	01	130	04	290	08	600	14
Taxicab service	4	–	9	01	15	01	–	–	–	–	–	–
Trucking and warehousing	212	.01	392	02	725	05	803	07	2,143	15	4,200	27
Trucking services	188	01	365	02	685	05	688	06	1,863	14	3,700	26
Warehousing and storage	24	03	27	03	40	04	115	13	280	30	500	48
Water transportation	122	05	205	08	400	19	144	06	296	12	600	28
Air transportation	609	18	1,017	.24	1,800	34	1,228	36	2,956	71	6,000	1 14
Pipelines	39	.23	60	.31	100	63	94	56	222	1.16	500	3 13
Transportation services	137	13	322	19	800	31	209	20	730	43	2,000	79
Communications, utilities, sanitary services	3,177	15	5,573	22	13,000	46	6,602	31	16,801	68	35,200	1 25
Communications	1,970	18	3,531	29	9,000	65	3,960	37	9,936	83	24,1000	1 74
Telephone (wire and radio)	1,726	19	3,026	31	8,050	75	3,558	39	8,805	91	22,000	2 04
Telegraph, misc comm services	184	.39	379	60	700	1 15	261	55	738	1 16	1,200	1 97
Radio broadcasting, TV	60	.05	126	07	250	.10	141	11	393	22	900	37
Utilities, sanitary services	1,207	11	2,042	16	4,000	28	2,642	25	6,865	.55	11,100	78
Electric light and power	382	12	807	19	1,900	45	937	29	2,525	57	3,400	81
Electric-gas utilities	470	.24	693	34	1,300	56	785	40	1,671	82	3,300	1 42
Gas, steam supply systems	274	16	390	24	550	33	667	40	1,354	.81	2,200	1 32
Water supply	38	.03	66	04	100	05	193	15	469	31	900	48
Sanitary services	35	.01	74	02	120	03	37	01	793	28	1,200	30
Other utilities, n e c	8	.12	12	17	30	29	23	34	53	75	100	98
Wholesale and retail trade	9,942	06	18,782	09	35,000	14	16,595	10	44,455	22	90,000	.35
Wholesale trade	7,871	.20	14,789	31	27,540	51	9,666	25	24,948	52	49,000	92
Wholesale, except misc wholesale	6,856	26	13,126	40	25,600	68	7,526	28	19,926	60	38,500	1 03
Motor vehicles and equipment	190	05	345	08	580	11	1,069	32	2,792	65	4,800	92
Drugs, chemicals allied products	236	10	397	14	660	23	1,088	47	2,599	97	4,650	1 59
Dry goods and apparel	157	10	257	.16	410	21	394	25	881	53	1,700	88
Food and related products	274	05	486	.08	760	11	1,381	.24	3,314	.50	6,300	88
Farm products—raw materials	45	04	108	07	200	20	135	13	478	31	800	80
Electrical goods	568	18	992	26	1,550	.34	888	28	2,183	58	4,400	96
Hardware, plumbing	50	03	89	05	140	06	280	.16	727	.35	1,300	58
Machinery, equipment, supplies	5,336	.72	10,452	99	23,140	1 88	2,291	31	6,952	66	14,550	1 18
Misc wholesale trade	1,015	.08	1,663	11	2,400	15	2,140	17	5,022	34	10,500	65
Metals and minerals, n e c	166	13	250	18	380	23	231	.17	497	.35	950	58
Petroleum products	330	.16	565	24	770	32	8	–	11	–	15	01
Scrap and waste material	–	–	–	–	–	–	30	03	90	.07	235	20
Alcoholic beverages	33	03	62	05	90	07	270	.27	757	.58	1,500	1 21
Paper and its products	173	13	265	20	390	24	252	19	527	40	1,100	68
Lumber, construction materials	40	02	60	03	90	04	183	11	430	24	900	42
Wholesale trade, n e c	273	.06	461	08	680	.11	1,166	25	2,710	50	5,800	97
Retail trade	2,071	01	3,993	02	7,460	04	6,929	.06	19,507	.12	41,000	20
Building materials	48	01	87	01	150	02	204	03	563	08	1,100	.14
Lumber, building materials	35	01	63	01	110	.02	163	.04	474	10	910	19
Hardware and farm equipment	13	01	24	.01	40	01	41	02	89	04	190	06
General merchandise, total	1,162	05	2,138	08	4,100	.10	3,537	.14	9,363	32	19,100	45
Department, mail order	809	.06	1,628	.08	3,360	11	2,661	17	7,626	39	15,720	56
Limited price stores	98	.03	147	.05	220	70	205	07	424	15	860	26
Vending machine opefators	22	.03	35	04	50	04	34	.15	104	14	280	21
Direct selling	37	.01	41	.01	50	01	200	06	340	10	440	13
Misc merchandise stores	196	06	287	09	420	08	437	14	867	29	1,800	36
Food and dairy stores	184	01	378	02	740	03	1,099	.06	3,006	13	7,200	24
Grocery stores	169	.01	343	02	670	03	1,007	.06	2,724	.14	6,420	25
Dairy product stores	5	.01	11	.02	20	.05	26	07	75	17	210	50
Retail bakeries	–	–	–	–	–	–	50	04	161	12	460	30
Food stores, n e.c.	10	.01	24	.02	50	03	16	.01	46	03	110	07
Auto dealers, gas stations	45	–	73	–	110	–	295	.02	832	04	1,900	.08
Motor vehicle dealers	18	–	20	–	25	–	176	02	434	05	980	10
Tire, battery, accessory stores	27	.01	53	02	85	.02	119	07	398	15	920	25
Apparel and accessories	64	.01	144	01	290	.03	512	.07	1,400	.15	2,900	26
Apparel, accessory stores	40	01	98	.01	200	02	397	06	1,076	14	2,220	25
Shoe stores	24	.01	46	03	90	04	115	08	324	.19	680	.29
Furniture and appliances	85	.01	190	03	390	05	278	05	801	12	1,800	22
Home furnishing stores	22	.01	65	02	150	03	151	04	402	10	900	18
Appliance, TV, radio stores	63	.03	125	.05	240	.08	127	.06	399	15	900	.30
Eating and drinking places	100	–	171	–	220	–	286	.01	1,518	04	3,100	06

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Computer systems analysts						Computer and peripheral equipment operators					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Eating and drinking places	100	—	171	—	220	—	286	001	1,518	004	3,100	006
Misc. retail trade stores	383	.02	812	.05	1,460	.06	718	.05	2,024	11	3,900	16
Drug stores	58	.01	95	.02	140	02	208	04	530	11	1,100	16
Liquor stores	—	—	—	—	—	—	8	01	40	02	80	04
Farm, garden supply stores	6	.01	18	.01	40	02	58	.05	196	12	410	22
Jewelry stores	17	.02	36	.03	70	04	44	04	170	13	380	24
Fuel and ice dealers	36	.03	51	05	75	07	180	16	352	32	640	62
Retail florists	—	—	—	—	—	—	—	—	—	—	—	—
Misc. retail trade stores	266	.06	612	.09	1,135	13	220	05	736	11	1,290	15
Finance, insurance, real estate	8,352	.22	14,358	.29	30,100	.46	26,229	69	69,026	1.37	147,500	2 27
Finance, total	3,949	.25	7,846	.36	19,100	.62	16,038	.99	46,527	2 17	103,000	3.37
Banking	2,933	.30	5,957	.40	15,600	.80	12,452	1.26	36,245	2.72	81,000	4 18
Credit agencies	454	12	990	.19	2,000	.26	1,821	.51	5,978	1 17	11,500	1.49
Stock brokers, investment	562	.21	899	.30	1,500	.43	1,765	.67	4,304	1 43	9,500	2.75
Insurance	4,251	.31	6,204	.38	10,400	.53	9,751	.72	21,374	1.33	42,500	2 17
Real estate	152	.02	308	.02	600	.04	440	.05	1,125	09	2,000	14
Services, total	26,240	.13	59,800	.22	147,500	.42	32,498	16	103,647	38	236,000	67
Hotels and lodging places	93	.01	100	.01	170	.01	130	01	540	04	1,400	07
Hotels and motels	42	—	62	—	125	.01	430	02	540	06	1,400	11
Lodging places, except hotels	51	.02	38	01	45	01	—	—	—	—	—	—
Other personal services	46	—	52	—	50	—	110	.01	153	01	190	01
Laundry, cleaning	48	.01	52	.01	50	02	110	.02	153	.03	190	06
Misc. business services	14,768	.90	33,675	1.26	89,420	2 14	13,208	81	42,133	1 58	99,560	2.39
Advertising	79	.06	131	.09	260	18	169	13	382	25	740	.50
Business management services	1,404	.77	3,166	1.14	6,900	1 50	1,024	57	3,402	1.73	8,400	1.82
Commercial R&D	958	1.10	2,211	1.63	5,200	2.29	683	.78	2,137	1 58	6,100	2 69
Computer programming	10,888	9.70	24,840	12.83	66,560	18 49	8,903	7.94	27,219	14 17	61,520	17 09
Detective and protective	7	.01	23	01	90	.02	111	08	445	16	1,300	28
Employment, temporary help	56	.02	154	04	510	08	—	—	—	—	—	—
Services to buildings	—	—	—	—	—	—	—	—	—	—	—	—
Other misc. services	1,376	.29	3,360	.43	9,900	93	2,318	.49	8,548	109	21,500	2.01
Automobile repair services	109	.02	202	.02	420	05	157	03	494	07	1,100	12
Auto repair	—	—	—	—	—	—	35	.01	162	.03	390	.07
Auto services, except repair	109	.06	202	.10	420	14	122	.07	332	15	710	24
Other repair services	—	—	—	—	—	—	—	—	—	—	—	—
Electrical repair shops	—	—	—	—	—	—	—	—	—	—	—	—
Other repair services	—	—	—	—	—	—	—	—	—	—	—	—
Motion pictures, theaters	89	.04	93	.04	150	.05	162	07	289	14	510	.17
Misc. entertainment	5	—	10	—	20	—	69	02	347	04	690	08
Medical, other health	1,345	.02	3,307	.05	8,600	08	3,174	.07	10,809	16	28,500	26
Hospitals	1,014	.04	2,518	.07	7,250	12	2,866	10	9,187	.24	24,470	42
Convalescent institutions	38	.01	124	.01	650	03	33	.01	209	.03	630	.03
Health services, n.e.c.	293	.10	665	10	1,700	18	275	.10	1,413	21	3,400	36
Legal services	5	—	10	—	20	—	26	01	134	.02	360	.05
Educational services	3,579	.06	7,292	.10	15,200	.19	7,701	13	22,147	.29	44,500	55
Elementary, secondary	478	01	1,152	02	2,600	.05	970	02	3,002	.06	4,300	08
Colleges and universities	2,720	.17	5,290	.26	10,710	.47	6,205	39	17,429	.86	35,450	1 57
Libraries	23	.03	66	.06	190	13	34	.04	205	20	650	43
Educational services, n.e.c.	358	.14	784	22	1,700	.34	492	.20	1,511	.41	4,100	83
Museums, art galleries, zoos	5	.02	14	03	50	.05	18	.06	66	.13	190	.21
Nonprofit organizations	555	.04	1,087	06	2,200	.11	1,162	.08	3,247	17	6,500	.26
Religious organizations	—	—	—	—	—	—	128	.02	375	05	510	06
Welfare services	364	.08	706	.11	1,450	.16	453	.11	1,236	19	2,450	26
Nonprofit membership organizations	191	05	381	.08	750	.12	581	.15	1,636	33	3,540	59
Other professional, related services	5,639	.68	13,958	1 07	31,200	1.91	6,581	.80	23,288	1.80	52,500	3 21
Engineering and architectural services	761	.24	2,121	43	4,500	72	602	19	2,382	.48	5,900	.94
Accounting, auditing	3,847	1.29	9,387	2 12	22,000	3 67	5,139	1.72	18,380	4 15	39,900	6 65
Misc. professional services	1,031	.50	2,450	.68	4,700	1 09	840	.41	2,526	70	6,700	1 55
Government, total	13,547	.32	21,914	43	42,000	71	14,684	34	37,340	.74	89,200	1.50
Federal public administration	10,446	46	15,094	66	23,500	.99	9,432	.42	20,664	91	42,000	1 76
Postal service	143	02	339	.05	1,000	.15	213	.03	754	.11	2,000	30
Other Federal public administration	10,333	.67	14,755	.93	22,500	1.31	9,219	.59	19,910	1 25	40,000	2.32
State public administration	1,989	.32	4,406	.49	11,000	97	3,157	51	10,135	1 12	29,000	2.56
Local public administration	1,112	.06	2,412	13	7,500	.31	2,095	.15	6,541	.35	18,200	75

See notes at end of table

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Keypunch operators						Computer service technicians					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Total, all industries	299,996	0.38	272,993	0.29	230,000	0.20	35,999	0.05	63,001	0.07	160,000	0.14
Agriculture, forestry, fisheries	393	.01	423	.01	350	.01	5	–	5	–	10	–
Agriculture	270	.01	254	.01	200	.01	5	–	5	–	10	–
Agricultural production	119	–	100	–	80	–	–	–	–	–	–	–
Services, except horticulture	131	.08	122	.05	100	.03	–	–	–	–	–	–
Horticultural services	20	.01	32	.01	20	.01	5	–	5	–	10	–
Forestry	123	.23	169	.21	150	.21	–	–	–	–	–	–
Fisheries	–	–	–	–	–	–	–	–	–	–	–	–
Mining	1,718	.27	2,083	.24	1,700	.16	41	.01	87	.01	210	.02
Metal mining	198	.21	169	.18	150	.13	6	.01	7	.01	25	.02
Coal mining	75	.05	93	.04	50	.01	–	–	–	–	–	–
Crude petroleum and natural gas	1,307	.47	1,713	.38	1,400	.29	35	.01	80	.02	185	.04
Nonmetallic mining, quarrying	138	.12	118	.10	100	.09	–	–	–	–	–	–
Construction	2,815	.08	2,573	.04	2,100	.03	95	–	95	–	200	–
General building contractors	397	.03	366	.03	300	.02	17	–	16	–	25	–
General contractors, exc. building	1,985	.14	1,775	.11	1,450	.08	23	–	20	–	35	–
Special trade contractors	443	.02	430	.01	350	.01	55	–	59	–	140	–
Manufacturing	83,019	.42	65,518	.32	47,900	.20	10,796	.05	15,914	.08	41,000	.17
Durable goods	50,435	.44	41,743	.34	33,000	.23	10,370	.09	15,349	.12	39,700	.27
Ordnance	1,492	.50	730	.42	400	.23	130	.04	104	.06	200	.12
Lumber and wood products	675	.11	505	.07	350	.05	5	–	4	–	10	–
Logging	32	.63	26	.02	20	.02	–	–	–	–	–	–
Sawmills, planing mills	485	.12	356	.08	240	.05	5	–	4	–	10	–
Misc. wood products	158	.13	123	.09	90	.05	–	–	–	–	–	–
Furniture and fixtures	1,180	.25	1,011	.19	850	.13	27	.01	42	.01	90	.01
Stone, clay, and glass products	1,617	.25	1,225	.18	900	.13	6	–	6	–	10	–
Glass and glass products	565	.31	399	.20	260	.12	6	–	6	–	10	–
Cement, concrete, plaster	459	.21	357	.15	240	.09	–	–	–	–	–	–
Structural clay products	109	.18	69	.13	50	.16	–	–	–	–	–	–
Pottery and related products	97	.22	75	.16	60	.14	–	–	–	–	–	–
Misc. nonmetallic stone	387	.29	325	.21	290	.19	–	–	–	–	–	–
Primary metal industries	5,107	.39	3,910	.31	2,700	.20	103	.01	117	.01	200	.01
Blast furnaces, steel works	2,530	.46	1,802	.37	1,200	.25	69	.01	78	.02	130	.03
Other primary steel	935	.25	687	.19	470	.11	22	.01	30	.01	50	.01
Primary aluminum	607	.39	570	.32	480	.26	6	–	5	–	10	.01
Other primary nonferrous	1,035	.46	851	.37	550	.21	6	–	4	–	10	–
Fabricated metal products	4,846	.35	4,125	.27	3,300	.18	21	–	20	–	40	–
Cutlery, other hardware	944	.62	823	.46	710	.31	–	–	–	–	–	–
Fabricated metal products	1,307	.30	1,097	.22	780	.11	21	–	20	–	40	.01
Screw machine products	493	.47	395	.36	270	.24	–	–	–	–	–	–
Metal stamping	611	.26	569	.23	490	.17	–	–	–	–	–	–
Misc. metal products	1,491	.32	1,241	.24	1,050	.19	–	–	–	–	–	–
Machinery, except electrical	10,337	.52	9,688	.42	8,600	.29	8,079	.41	12,323	.53	33,890	1.14
Engines and turbines	622	.57	592	.55	520	.36	12	.01	19	.01	50	.04
Farm machinery, equipment	946	.74	812	.54	650	.36	19	.01	27	.02	60	.03
Construction machinery	1,616	.55	1,694	.46	1,540	.33	29	.01	64	.02	150	.03
Metalworking machinery	1,221	.38	1,124	.32	960	.22	48	.02	74	.02	140	.03
Office, accounting machinery	794	.87	479	.66	320	.49	1,125	1.24	1,042	1.45	1,350	2.05
Electronic computing equipment	1,839	.87	1,523	.57	1,410	.30	6,698	3.56	10,842	4.05	31,650	6.73
Machinery, n.e.c.	3,499	.41	3,464	.36	3,200	.26	148	.02	255	.03	490	.04
Electrical machinery	11,140	.58	9,305	.45	7,300	.29	1,306	.07	1,837	.09	3,600	.14
Household appliances	875	.47	652	.36	480	.23	10	.01	14	.01	20	.01
Radio, TV, communications equipment	4,548	.72	3,458	.58	2,400	.37	616	.10	782	.13	1,400	.21
Electrical machinery, n.e.c.	5,717	.52	5,195	.41	4,420	.27	680	.06	1,041	.08	2,180	.13
Transportation equipment	9,209	.48	6,973	.34	5,100	.22	393	.02	436	.02	750	.03
Motor vehicle equipment	3,925	.49	3,623	.37	3,100	.27	46	.01	76	.01	130	.01
Aircraft and parts	4,194	.83	2,463	.42	1,350	.26	276	.04	302	.05	520	.10
Ship, boat building, repair	730	.26	516	.18	310	.10	71	.03	58	.02	100	.03
Railroad equipment	212	.42	203	.33	180	.28	–	–	–	–	–	–
Mobile dwellings	59	.07	57	.05	50	.02	–	–	–	–	–	–
Cycles, misc. transportation equipment	89	.35	111	.26	110	.17	–	–	–	–	–	–
Professional and scientific instruments	2,894	.84	2,743	.49	2,400	.35	268	.06	404	.07	800	.12
Scientific instruments	1,001	.56	849	.43	690	.35	192	.11	268	.14	550	.28
Optical, health service supplies	842	.62	1,009	.49	960	.36	38	.03	76	.04	130	.05
Photo equipment and supplies	868	.80	765	.58	660	.36	38	.03	60	.05	120	.07
Watches and clock devices	183	.58	120	.40	90	.25	–	–	–	–	–	–
Misc. manufacturing	1,938	.44	1,528	.33	1,100	.22	32	.01	56	.01	110	.02
Nondurable goods	32,584	.40	23,775	.29	14,900	.16	426	.01	565	.01	1,300	.01
Food and kindred products	5,458	.31	3,851	.23	2,240	.13	80	–	105	.01	240	.01
Meat products	1,049	.30	806	.23	520	.15	7	–	5	–	10	–
Dairy products	851	.35	505	.27	210	.15	9	–	5	–	10	.01
Canning and preserving	729	.26	572	.19	370	.10	30	.01	54	.02	140	.04
Grainmill products	400	.29	292	.20	160	.10	–	–	–	–	–	–
Bakery products	554	.20	372	.16	180	.09	–	–	–	–	–	–
Confectionery products	350	.42	216	.28	110	.14	–	–	–	–	–	–
Beverages	707	.30	473	.21	210	.09	18	.01	22	.01	40	.02
Misc. food preparations	818	.45	615	.33	380	.19	16	.01	19	.01	40	.02
Tobacco manufacturing	307	.38	181	.27	100	.17	–	–	–	–	–	–
Textile mill products	3,464	.35	2,448	.27	1,450	.14	21	–	20	–	50	–
Knitting mills	970	.39	738	.31	420	.13	–	–	–	–	–	–
Dyeing, finishing textiles	298	.36	195	.25	110	.14	7	.01	9	.01	25	.03
Floor coverings	406	.71	301	.49	200	.19	–	–	–	–	–	–
Yarn, fabric mills	1,493	.29	1,002	.22	590	.13	14	–	11	–	25	.01
Misc. textile mill products	297	.40	212	.30	130	.16	–	–	–	–	–	–
Apparel, textile products	3,772	.27	2,814	.21	1,750	.11	8	–	6	–	10	–
Apparel and accessories	3,317	.27	2,462	.21	1,500	.11	–	–	–	–	–	–
Misc. fabricated products	455	.27	352	.18	250	.11	8	–	6	–	10	–
Paper and allied products	2,711	.38	1,841	.26	1,100	.14	160	.02	218	.03	490	.08
Pulp, paper, paperboard mills	1,232	.42	793	.30	430	.17	5	–	3	–	10	–
Paperboard containers, boxes	583	.26	359	.17	240	.09	–	–	–	–	–	–
Misc. paper and pulp products	896	.47	689	.32	430	.16	155	.08	215	.10	480	.18

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Keypunch operators						Computer Service Technicians					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Printing and publishing	5,997	0.52	4,250	0.34	2,600	0.19	77	0.01	120	0.01	300	0.02
Newspaper publishing, printing	930	.22	693	15	500	.09	24	.01	50	.01	140	.03
Printing, publishing, exc. newspaper	5,067	.68	3,557	.44	2,100	.26	53	01	70	.01	160	.02
Chemical and allied products	5,389	.52	4,174	.39	3,000	.23	43	–	49	–	110	01
Industrial chemicals	1,407	.44	1,032	.32	630	.16	22	01	23	.01	50	.01
Plastics, synthetics	311	.31	211	.22	130	.12	7	.01	8	.01	20	.02
Synthetic fibers	528	.49	404	.35	300	.17	–	–	–	–	–	–
Drugs and medicines	1,009	.71	908	.49	780	.35	–	–	–	–	–	–
Soaps and cosmetics	1,021	.82	828	.62	610	.37	8	01	11	01	30	.02
Paints and varnishes	569	.82	424	.59	300	.33	–	–	–	–	–	–
Agricultural chemicals	221	.40	171	.28	130	.23	6	.01	7	01	10	.02
Misc. chemicals	313	.28	196	.23	120	.11	–	–	–	–	–	–
Petroleum and coal products	1,778	.94	1,388	.67	900	.51	15	01	23	.01	50	03
Petroleum refining	1,564	1.02	1,206	73	800	.66	15	.01	23	.01	50	04
Misc. petroleum, coal products	214	.58	182	.41	100	18	–	–	–	–	–	–
Rubber, misc. plastic products	2,628	.45	2,148	.29	1,500	.19	15	–	16	–	30	–
Rubber products	1,758	.61	1,279	43	720	.21	5	–	3	–	10	–
Misc. plastic products	870	.30	867	.19	780	17	10	–	13	–	20	–
Leather products	1,100	.34	682	.26	380	.17	7	–	8	–	20	01
Leather tanning, finishing	74	.28	42	.19	30	.22	–	–	–	–	–	–
Footwear, except rubber	780	.35	483	.28	240	18	–	–	–	–	–	–
All other leather products	246	.36	157	.25	90	.13	7	01	8	.01	20	.03
Transportation, other public utilities	23,113	46	17,972	.31	12,550	20	526	01	816	01	1,580	.02
Transportation, total	11,091	.39	8,039	.24	5,250	.15	101	–	135	–	230	01
Railroads, railway express	5,304	.86	2,993	.58	1,500	.35	33	01	40	.01	75	02
Local, interurban transit	310	.08	178	04	100	02	5	–	4	–	5	–
Street railways, bus lines	294	10	158	05	90	02	5	–	4	–	5	–
Taxicab, service	16	.02	20	.02	10	01	–	–	–	–	–	–
Trucking and warehousing	2,769	.24	2,383	16	1,800	.12	5	–	7	–	10	–
Trucking services	2,463	.23	2,171	16	1,650	.11	–	–	–	–	–	–
Warehousing and storage	306	.35	212	.23	150	14	5	01	7	01	10	.01
Water transportation	582	.25	424	17	270	.13	–	–	–	–	–	–
Air transportation	1,479	.43	1,287	.31	1,050	.20	51	01	76	02	130	.02
Pipelines	114	.67	100	.52	80	.50	7	04	8	04	10	06
Transportation services	533	.50	674	40	450	.18	–	–	–	–	–	–
Communications, utilities, sanitary services	12,022	.56	9,933	.40	7,300	.26	425	.02	681	.03	1,350	06
Communications	6,687	.82	5,284	.44	3,800	.27	369	03	613	.05	1,225	.09
Telephone (wire and radio)	6,241	.69	4,880	.51	3,440	.32	248	03	401	04	950	.08
Telegraph, misc. comm. services	171	.36	173	.27	160	.28	112	.24	196	.31	250	.41
Radio broadcasting, TV	275	.21	231	13	200	.08	9	.01	16	.01	25	.01
Utilities, sanitary services	5,335	.50	4,649	.37	3,500	.25	56	.01	68	.01	125	.01
Electric light and power	1,915	.59	1,979	.45	1,800	.43	45	.01	59	.01	105	.03
Electric—gas utilities	1,902	.97	1,490	.73	900	.39	5	–	4	–	10	–
Gas, steam supply systems	1,049	.63	783	47	465	.28	6	–	5	–	10	01
Water supply	386	.29	340	.22	300	.16	–	–	–	–	–	–
Sanitary services	52	.02	46	.02	30	.01	–	–	–	–	–	–
Other utilities, n.e.c.	31	.46	11	15	5	05	–	–	–	–	–	–
Wholesale and retail trade	42,579	.26	40,282	.20	36,000	.14	10,471	.06	18,737	09	46,000	.18
Wholesale trade	25,446	.85	23,253	48	20,000	.37	10,060	28	17,961	.37	44,100	.82
Wholesale, except misc. wholesale	18,279	.69	16,549	50	14,000	.37	9,636	36	17,288	52	42,750	1 14
Motor vehicles and equipment	2,507	.75	2,494	.58	2,350	.45	–	–	–	–	–	–
Drugs, chemicals allied products	3,004	1.29	2,415	.90	1,650	.57	8	–	7	–	10	–
Dry goods and apparel	1,190	.76	937	.56	810	.42	–	–	–	–	–	–
Food and related products	3,391	.58	2,796	.42	2,050	.29	16	–	16	–	20	–
Farm products—raw materials	335	.32	344	.22	320	.32	–	–	–	–	–	–
Electrical goods	2,368	.75	2,153	.57	1,800	.39	278	.09	435	.12	970	.21
Hardware, plumbing	1,165	.68	937	.45	820	.37	–	–	–	–	–	–
Machinery, equipment, supplies	4,319	.58	4,473	.42	4,200	.34	9,336	1 25	16,830	.159	43,100	9.51
Misc. wholesale trade	7,167	.55	6,704	.45	6,000	.37	422	03	673	.05	1,350	.08
Metals and minerals, n.e.c	773	.58	678	.48	625	.38	22	.02	48	.03	110	.07
Petroleum products	1,528	.76	1,311	.56	1,100	.46	12	.01	18	01	30	.01
Scrap and waste material	37	.04	39	.03	30	03	–	–	–	–	–	–
Alcoholic beverages	924	.94	1,028	.79	900	.72	7	.01	12	01	20	02
Paper and its products	755	.57	618	.47	550	34	19	01	23	.02	30	.02
Lumber, construction materials	393	.24	355	.20	300	14	–	–	–	–	–	–
Wholesale trade, n.e.c	2,757	.59	2,675	.49	2,500	.42	382	.08	572	.11	1,160	.19
Retail trade	17,133	.14	17,029	11	16,000	.08	411	–	776	–	1,900	.01
Building materials	536	.09	448	.08	390	05	–	–	–	–	–	–
Lumber, building materials	264	.07	245	.05	230	.05	–	–	–	–	–	–
Hardware and farm equipment	272	12	201	.08	160	.05	–	–	–	–	–	–
General merchandise, total	8,882	.35	8,407	.29	8,020	.19	–	–	–	–	–	–
Department, mail order	6,877	.44	6,989	.36	6,985	.23	–	–	–	–	–	–
Limited price stores	603	.19	388	14	260	.08	–	–	–	–	–	–
Vending machine operators	192	.28	160	.21	125	.10	–	–	–	–	–	–
Direct selling	319	.10	236	.07	160	05	–	–	–	–	–	–
Misc. merchandise stores	891	.29	634	.21	490	.10	–	–	–	–	–	–
Food and dairy stores	2,237	.11	2,436	.10	2,210	.07	–	–	–	–	–	–
Grocery stores	2,048	12	2,210	11	2,020	.08	–	–	–	–	–	–
Dairy product stores	81	.22	114	.25	90	.22	–	–	–	–	–	–
Retail bakeries	57	.05	57	.04	50	.03	–	–	–	–	–	–
Food stores, n.e.c.	51	.04	55	.04	50	03	–	–	–	–	–	–
Auto dealers, gas stations	830	.05	944	.05	850	.04	33	–	30	–	40	–
Motor vehicle dealers	463	.06	489	.06	425	.04	23	–	21	–	30	–
Tire, battery, accessory stores	333	.18	404	.15	375	.10	5	–	5	–	5	–
Apparel and accessories	1,436	19	1,467	.16	1,440	.13	–	–	–	–	–	–
Apparel, accessory stores	1,071	.17	1,126	.15	1,120	.13	–	–	–	–	–	–
Shoe stores	365	.24	341	.20	320	.14	–	–	–	–	–	–
Furniture and appliances	738	.13	724	.11	700	.09	66	.01	121	.02	300	.04
Home furnishing stores	399	.12	353	.09	330	.07	–	–	–	–	–	–
Appliance, TV, radio stores	339	.16	371	.14	370	.12	66	03	121	.04	300	.10
Eating and drinking places	619	.02	881	02	740	.01	–	–	–	–	–	–

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Keypunch operators						Computer service technicians					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Retail Trade—Continued												
Misc. retail trade stores	1,856	0.13	1,724	0.09	1,650	0.07	312	0.02	625	0.03	1,560	0.07
Drug stores	588	13	468	.09	410	.06	–	–	–	–	–	–
Liquor stores	83	.07	86	.05	90	.04	–	–	–	–	–	–
Farm, garden supply stores	122	10	147	.09	150	.08	–	–	–	–	–	–
Jewelry stores	162	15	148	11	140	09	–	–	–	–	–	–
Fuel and ice dealers	305	.26	195	18	120	12	6	01	7	.01	10	01
Retail florists	12	.01	16	.01	20	01	–	–	–	–	–	–
Misc. retail trade stores	583	.13	664	10	720	08	306	07	618	09	1,550	18
Finance, insurance, real estate	48,564	1.27	42,287	.84	37,000	.57	283	01	527	01	1,300	02
Finance, total	23,592	1 46	22,615	1.05	21,500	70	178	01	385	02	990	03
Banking	17,678	1.78	16,908	1.27	16,400	.85	159	.02	341	03	890	05
Credit agencies	2,878	.80	3,173	.82	3,000	.39	–	–	–	–	–	–
Stock brokers, investment	3,036	1 15	2,534	.84	2,100	.61	19	01	44	.01	100	03
Insurance	24,026	1.78	18,763	1 17	14,600	74	105	01	142	01	280	01
Real estate	946	.11	909	.07	900	06	–	–	–	–	–	–
Services, total	63,038	.31	70,814	.26	66,400	19	12,687	06	25,132	09	66,000	19
Hotels and lodging places	363	.04	377	.03	370	.02	3	–	2	–	10	–
Hotels and motels	312	.04	354	.04	350	03	3	–	2	–	10	–
Lodging places, except hotels	51	.02	23	.01	20	–	–	–	–	–	–	–
Other personal services	595	.04	337	.02	320	02	5	–	3	–	10	–
Laundry, cleaning	590	10	328	07	320	10	5	–	3	–	10	–
Misc. business services	27,718	1.69	32,490	1.22	30,200	72	8,497	52	17,249	.65	45,130	1 08
Advertising	388	.30	289	19	190	13	4	–	3	–	10	01
Business management services	2,149	1.20	2,407	.87	2,350	.51	334	19	698	25	1,800	39
Commercial R&D	511	.58	538	40	470	21	80	09	148	11	360	16
Computer programming	12,963	11.55	13,852	7 21	12,900	3.58	6,541	5.83	12,851	6 69	34,940	9 71
Detective and protective	192	.14	257	09	240	06	15	01	31	01	70	01
Employment, temporary help	6,362	2 96	8,618	2 23	8,300	1 32	–	–	–	–	–	–
Services to buildings	–	–	–	–	–	–	36	01	68	01	150	02
Other misc. services	5,153	1.09	6,529	.83	5,750	54	1,487	31	3,450	44	7,800	73
Automobile repair services	409	.08	385	.05	360	04	–	–	–	–	–	–
Auto repair	4	–	4	–	–	–	–	–	–	–	–	–
Auto services, except repair	405	.24	381	18	360	12	–	–	–	–	–	–
Other repair services	–	–	–	–	–	–	2,128	67	4,244	94	12,700	2.57
Electrical repair shops	–	–	–	–	–	–	993	79	1,339	1 02	4,200	2 29
Other repair services	–	–	–	–	–	–	1,135	59	2,905	.91	8,500	2 74
Motion pictures, theaters	414	17	259	13	190	06	8	–	5	–	10	–
Misc entertainment	173	.04	263	03	230	03	–	–	–	–	–	–
Medical, other health	6,512	14	7,585	11	7,300	07	28	–	28	–	70	–
Hospitals	5,614	.19	6,000	15	5,930	10	28	–	28	–	70	–
Convalescent institutions	58	.01	102	01	120	01	–	–	–	–	–	–
Health services, n e c	840	.31	1,483	.22	1,250	.13	–	–	–	–	–	–
Legal services	140	.04	157	.03	150	.02	–	–	–	–	–	–
Educational services	10,594	.18	10,532	.14	9,620	12	268	–	382	01	520	01
Elementary, secondary	1,943	.05	1,799	04	1,510	03	22	–	23	–	20	–
Colleges and universities	7,344	.47	7,343	.36	6,780	.30	191	.01	246	01	280	01
Libraries	49	.06	40	.04	30	.02	–	–	–	–	–	–
Educational services, n e c	1,258	.50	1,350	.37	1,300	.26	55	02	113	03	220	04
Museums, art galleries, zoos	8	.03	9	02	10	.01	–	–	–	–	–	–
Nonprofit organizations	3,652	.26	3,702	19	3,700	15	53	–	85	–	150	01
Religious organizations	459	.08	549	.08	560	07	–	–	–	–	–	–
Welfare services	1,591	.37	1,555	.24	1,550	17	6	–	8	–	20	–
Nonprofit membership organizations	1,582	.41	1,575	.32	1,570	26	47	.01	77	.02	130	–
Other professional, related services	12,460	1.51	14,718	1.14	13,950	.85	1,697	21	3,134	24	7,400	45
Engineering and architectural services	669	.21	893	18	820	13	121	.04	311	.06	890	14
Accounting, auditing	10,715	3.58	12,451	2.81	11,870	1 98	1,490	.50	2,679	60	6,230	1 04
Misc. professional services	1,076	.52	1,374	.38	1,260	29	86	04	144	04	280	06
Government, total	34,757	.82	31,031	.62	26,000	44	1,095	03	1,688	03	3,700	06
Federal public administration	18,849	.83	15,860	.69	12,000	.50	1,039	.05	1,624	07	3,575	15
Postal service	213	.03	266	.04	200	.03	–	–	–	–	–	–
Other Federal public administration	18,636	1.20	15,394	.97	11,800	.68	1,039	07	1,624	.10	3,575	21
State public administration	10,161	1.65	9,912	1.10	9,000	.79	12	–	15	–	25	–
Local public administration	5,747	.42	5,459	.30	5,000	21	44	–	49	–	100	–

n.e.c. = not elsewhere classified.

NOTE A dash denotes zero or less than 0 005 percent

Appendix C. Census Occupational Titles

The 1970 Census of Population lists national totals for computer occupations in six categories. The six categories are designated as follows: Computer Programmer, Computer Systems Analysts, Computer Specialists, n.e.c., Computer Peripheral Equipment Operators, Keypunch Operators, and Data Processing Machine Repairers. The BLS industry- occupational matrix has adopted exactly these census computer occupational categories. However, for purposes of this BLS computer study, two of these common census and matrix occupational categories have been combined. Data for computer specialists, n.e.c., are combined with "systems analysts" because the occupational titles that comprise the "computer specialist, n.e.c.," category seem overwhelmingly to involve systems analysis functions. The job titles included in each of these six categories are as follows:

Computer Programmers
- computer programmer
- digital-computer programmer
- electronic data programmer
- programmer, computer
- Univac-programmer

Computer Systems Analysts
- computer analyst
- computer-systems planning
- computing-systems analyst
- data-processing-systems analyst
- digital-computer-systems analyst
- engineer, systems
- health-systems analyst, computer
- manager, computer programming
- systems analyst, computer systems
- systems analyst, data processing

Computer Specialists, n.e.c.
- computer scientist
- data-processing systems-project planner
- engineer, computer application
- methods analyst, computer
- software specialist

Computer and Peripheral Equipment Operators
- card-tape-converter operator
- computer-console operator
- computer operator
- computing-machine operator
- console operator, clerical
- digital-computer operator
- high-speed-printer operator
- K.S.T. operator
- key station terminal operator
- peripheral-equipment operator
- tape-to-card-converter operator

Keypunch Operators
- card puncher
- card-punching-machine operator
- encoder
- encoder clerk
- I.B.M. machine operator
- I.B.M. operator
- I.B.M. puncher
- I.B.M. supervisor
- I.B.M. verifier
- key puncher
- keypunch operator
- punch-card operator
- punch operator, office machine
- verifying machine operator

Data Processing Machine Repairers
- computer's service man—
  - data-processing-machine rental
- data-processing-machine serviceman
- engineer, customer's
- I.B.M. installer
- mechanic:
  - computing systems
  - data processing
  - electronic computer
  - I.B.M. machine

Appendix D. Glossary of Computer Terms

ADP—Automatic data processing.

ALGOL—A higher level programming language used for scientific applications.

Alphanumeric—A set of characters that includes letters, numbers, and special symbols such as punctuation or mathematical notations.

Analog computer—A computer that operates on data represented by measurable physical quantities (speed, temperature, voltage, etc).

Applications programming—Development of programs to meet specific user needs, such as inventory control, payroll, and reservations systems.

Assembler—A computer program that converts the user's instructions written in alphanumerics into a form that the machine can understand.

Automation—The development and application of methods of making a process self-moving or self-controlling.

Auxiliary storage—Any device that supplements the main storage area of a computer.

BASIC (Beginners All-Purpose Symbolic Instruction Code)—A programming language that is relatively easy to learn and can be used for a variety of applications.

Batch processing—A method that uses one program to process accumulations (batches) of similar data.

Binary—A numbering system based on 2's rather than 10's. Only the digits 0 and 1 are used.

Bit—A binary digit (0 or 1).

Byte—A sequence of eight binary digits usually operated upon as a unit.

Canned (packaged) programs—Programs prepared for users in machine-readable form by vendors or software firms to meet specific applications.

Card punch—A machine that encodes data onto tabulating cards in patterns of round or rectangular holes. Card punches may be activated by computer or from a keyboard.

Card reader—A machine that transcribes data from punched cards to main computer storage or auxiliary storage devices.

Centralized data processing—Data processing organization in which the user places all computing power at one site.

Character—One of a set of elements that may be arranged in ordered groups to express information. Each character has two forms: 1) A form that can be read by humans—the graphic, including the decimal digits 0-9, the letters A-Z, punctuation marks, and other formatting and control symbols; 2) a form that can be read by computers—the code, consisting of a group of binary bits.

COBOL (Common Business Oriented Language)—A higher level programming language designed for business applications.

Coding—Preparing a set of computer instructions from a detailed flow chart to perform a given action or solve a given problem.

COM (Computer Output on Microfilm)—An auxiliary computer device that produces microfilm records from computer-generated data.

Compiler—A computer program that converts a higher level language into a machine language program.

Computer—A device capable of accepting a series of logical operations, applying prescribed processes to the sequence, and supplying the results of these processes.

Computer, off-line—A computer not actively monitoring or controlling a process.

Computer, on-line—A computer actively monitoring or controlling a process.

Console—The part of a computer used for manual control and observation of the computer system.

Core storage—The main storage area of a computer containing arrays of magnetic cores, which hold instructions and/or data to be processed.

CPU (Central processing unit)—That portion of a computer containing the arithmetic, logic, control, and, in some cases, main storage devices.

CRT (Cathode ray tube)—A device similar to a television screen upon which data can be stored or displayed.

Data—Basic elements of information—facts, numbers, letters, symbols—that can be processed by a computer.

Data collection—The act of bringing data from one or more locations to a central location.

Data communications—Movement of data from one point to another by electrical transmission systems.

Data processing—A series of planned actions and operations upon data to achieve a desired result.

DDP (Distributed data processing)—Data processing organization that gives computing power to the person who can immediately and most efficiently use the information.

Debugging—The process of determining the correctness of a computer routine, locating any errors, and correcting them. Also, the detection and correction of malfunctions in the computer itself.

Digital computer—A computer that solves problems by using coded numbers to express all quantities and variables.

Downtime—The time interval during which a device is not working properly.

EDP (Electronic Data Processing)—Equipment that processes data by electronic means; e.g., analog or digital computers.

EFTS (Electronic Funds Transfer System)—Method of handling monetary transactions, such as bank deposits and bill payments, using computers and other electronic equipment instead of paper.

External memory—A storage facility or device, such as magnetic tape, which is not an integral part of a computer.

File—A collection of related records; e.g., a complete set of invoices in an invoice file.

Firmware—A set of functions built into the computer hardware that would otherwise be handled by software or special purpose logic.

FORTRAN (Formula translator)—a higher level programming language designed for mathematical, scientific, and engineering applications.

General-purpose computers—Computers that are primarily character or byte-oriented and programmed in higher level languages.

Generation—A stage of technological advance in computers. First-generation computers were characterized by their use of vacuum tubes; second generation, by transistors; and third generation, by integrated circuits.

Hard copy—Printed copy of machine output, e.g., reports, tables, listings, documents, and other business forms.

Hardware—The actual equipment used in a computer system, including peripheral equipment such as printers and tape drives, as well as the computer itself.

High speed printer—Computer output printer that prints all of the characters on a line simultaneously

Higher level language—Programming language designed for a specific range of applications and relative ease of use.

Input—Information representing data to be processed and instructions to control processing, which is moved into the internal storage of a data processing system

Instruction—A coded statement or command that causes a data processing system to carry out an operation.

Interface—The interconnection between two pieces of hardware or two systems that have different functions

Internal storage—Memory devices, such as magnetic cores, forming an integral physical part of a computer and directly controlled by the central processing unit.

Key-to-disk, key-to-tape systems—Systems for entering data directly onto a disk or tape by typing at a keyboard.

Keypunch—A keyboard-operated device that punches holes in a card to represent data.

Key verifier—A device, similar to the keypunch, used to make sure that data have been correctly punched into cards.

Line printer—A printing device that accepts information directly from a computer and prints one line at a time.

Machine language—Language that can be understood and interpreted directly by a computer.

Magnetic disk—A flat, circular plate with a surface that can be magnetized to store data.

Magnetic ink—Ink that contains particles of iron oxide, which can be detected (read) by machine sensors

Magnetic tape—Tape with a ferrous oxide surface upon which data can be stored.

Main-storage—The general-purpose storage area of a computer (same as internal storage).

Memory—A device or medium used to store information in a form that can be understood by the computer hardware.

MICR (Magnetic Ink Character Recognition)—Machine recognition of characters printed on a document with magnetic ink.

Microfiche—Sheet of film used for displaying computer output using a small amount of storage space.

Microfilm—Photographic filmstrip used for retaining records of printed document while utilizing a small amount of storage space.

Minicomputer—Small, general-purpose computers that are part of a family that has at least one product in the $2,000-$25,000 price range and comes with at least 4K

RAM. Size classes are Supermini, Traditional Mini, and Micro-mini.

Multiprocessor—A computer system incorporating multiple arithmetic and logic units for simultaneous use.

Multiprogramming—A technique for handling numerous routines or programs seemingly simultaneously by overlapping or interleaving their execution; that is, by permitting more than one program to time-share machine components.

Numeric—A machine alphabet that includes only numerals, in contrast to alphanumeric, which has both letters and numerals.

OCR (Optical Character Reader)—An information processing device that accepts prepared forms and converts data from them to computer output media via optical character recognition.

Off-line—Pertains to equipment or devices not in direct communication with the central processing unit of a computer.

On-line—Pertains to equipment or devices directly connected to the central processing unit.

Operating system—A program that controls the overall execution of computer programs. It is available to the computer at all times, either in internal storage or on auxiliary storage.

Operations research—Application of scientific principles to business management. This may involve setting up mathematical equations to depict business problems.

Original equipment manufacturer—A company that purchases computer hardware for use as components in the systems that it sells.

Output—Processed information recorded on a medium such as a business form or magnetic tape.

Peripheral equipment—Any equipment other than the central processing unit of a computer, such as a printer, card reader, terminal, or tape drive that provides outside communication to the system.

PL/1—Higher level programming language with a wide variety of features and applications.

Printer—A device for writing out computer results as numbers, words, or symbols.

Process control computer—A computer that controls a production process, such as steelmaking, petroleum refining, or electric power generation.

Processor—The hardware or software capable of performing or directing the performance of many functions.

Program (noun)—A plan for the solution of a problem. A complete program includes plans for the transcription of data, coding for the computer, and plans for the absorption of the results into the system. The list of coded instructions is called a routine.

Program (verb)—To plan a computation or process from asking a question to delivering the results, including the integration of the operation into an existing system. Thus, programming consists of planning and coding including numerical analysis, systems analysis, specification of printing formats, and any other functions necessary to the integration of a computer in a system.

Punched card—A piece of lightweight cardboard on which information is represented by holes punched in a specific positions.

Real time—The actual time during which a physical process occurs. Pertains to the performance of a computation during the actual time that the related physical process occurs, so that results of the computation can be used in guiding the physical process.

Record—A group of related facts or fields of information treated as a unit. For example, one invoice is a record in a file containing many invoices.

Run—Execute a computer program.

Scanner—That portion of a reading machine having functions of locating materials to be read and converting the optical signal to an electrical signal.

Small business computer—Small, general-purpose computer marketed by mainframers to smaller businesses and first-time users. Prices range from $10,000 to $285,000.

Software—The programs, operating instructions, and other documents that make it possible to use a computer for a specific application.

Source document—An original document from which basic data are taken.

Storage—Pertains to devices capable of retaining data and delivering them on demand at a later time.

Systems analysis—Examination of an activity, procedure, or method to determine what objective is desired, and how operations must be carried out to reach the objective.

Systems programming—Development of programs, such as compilers and operating systems, that control computer operation.

Telecommunications—Transmission of data in the form of signals over long distances via telegraph, radio, or other communications lines.

Terminal—An on-line data entry and display device, usually located away from the central processing unit. If the terminal is 'intelligent', processing devices are built into it and it also can be used for data manipulation.

Throughput—Productivity based on all facets of an operation, e.g., a computer that can read, write, and

compute simultaneously would have a high throughput rating.

Time-sharing—Use of one computer by several independent users.

Unbundling—Marketing method in which the computer vendor sells hardware, software, training, and other services separately rather than as a single package.

Universal Product Code—A standard system of marking for labels, adopted by the major supermarkets, food manufacturers, processors, and distributors for use with computerized checkout equipment

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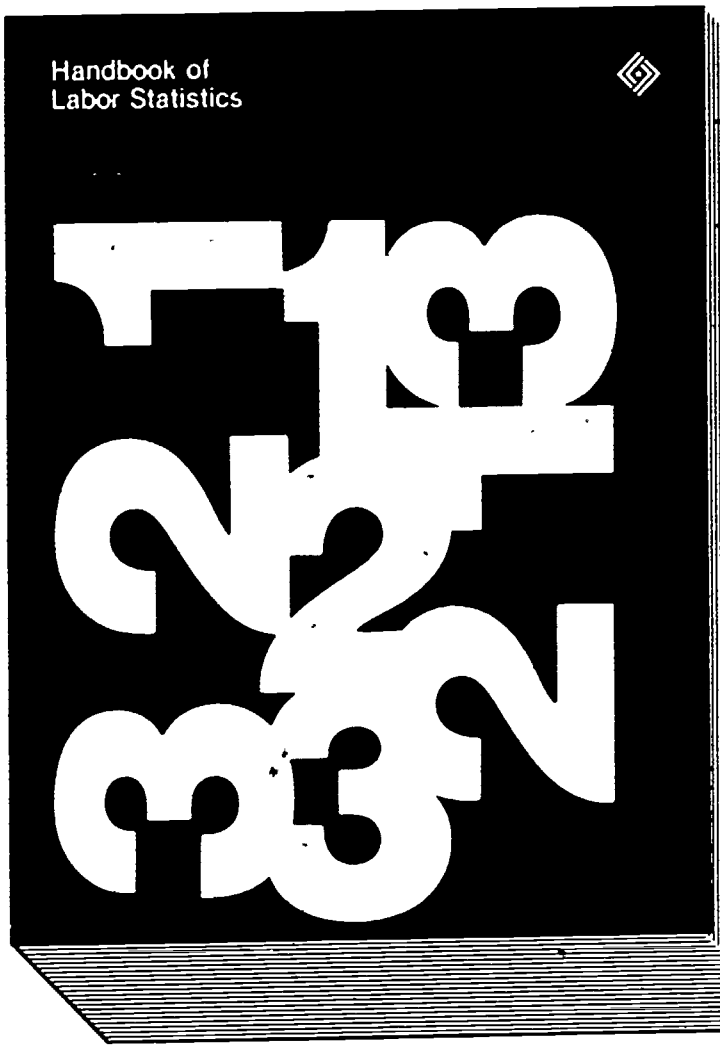

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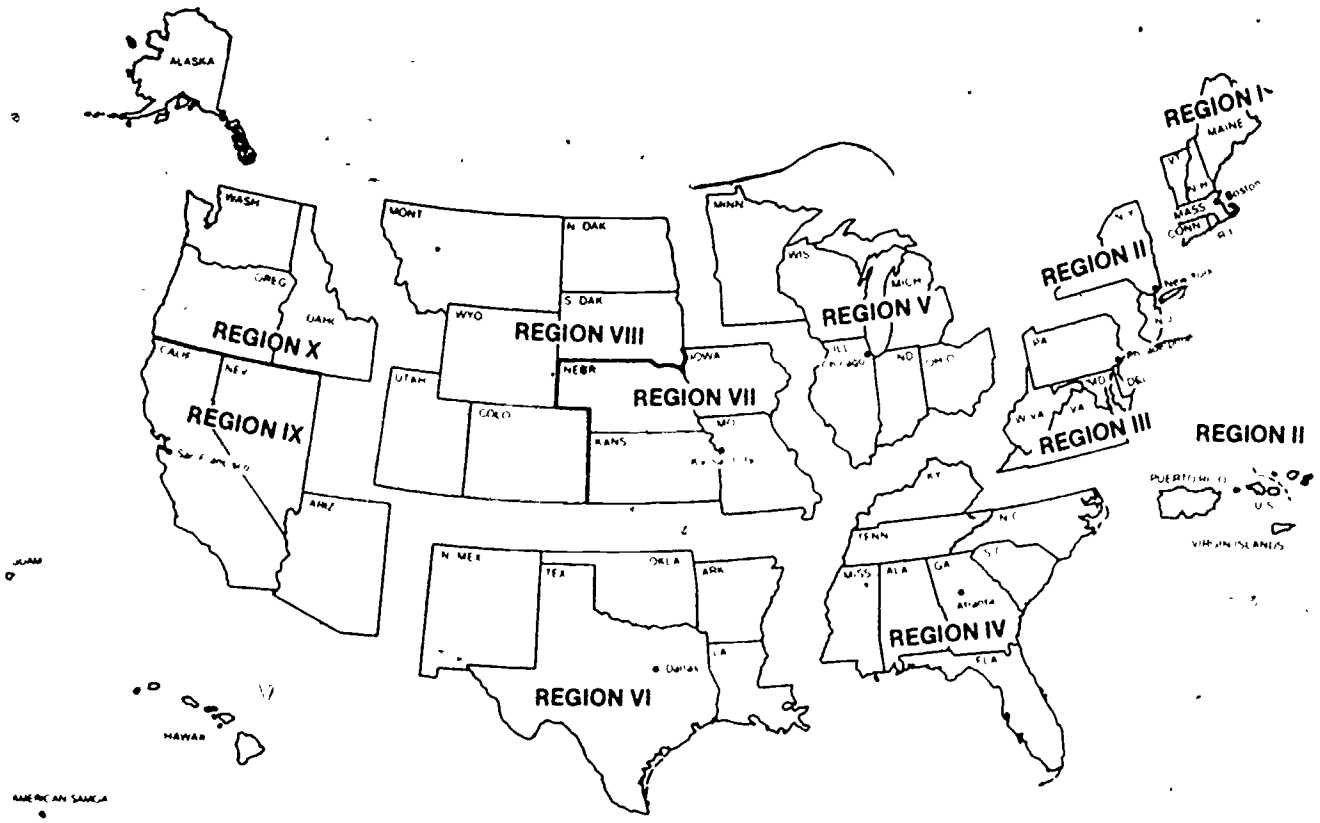

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