COMPUTER MANPOWER OUTLOOK

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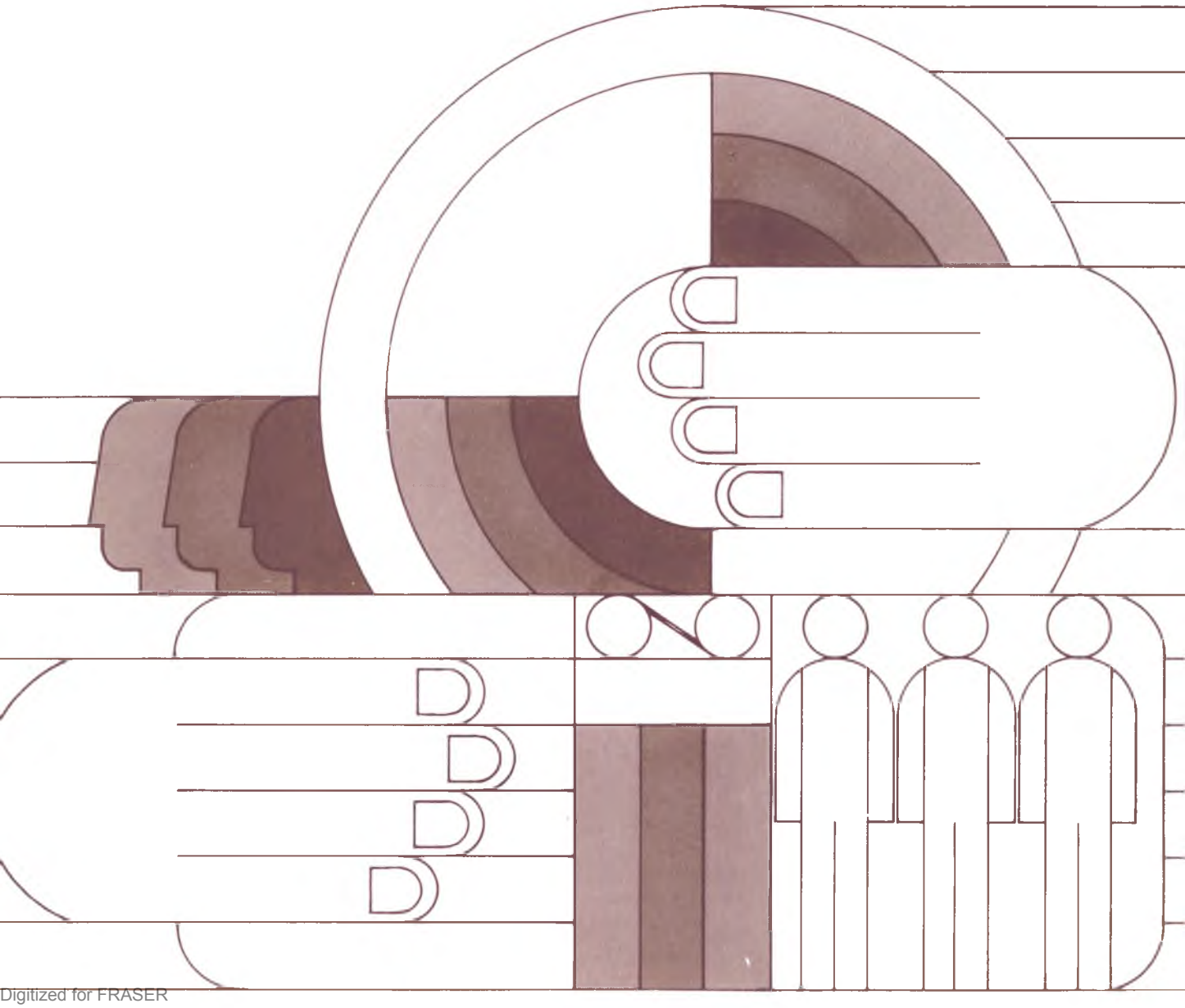

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U.S. Department of Labor
Peter J. Brennan,
Secretary

Bureau of Labor Statistics
Julius Shiskin,
Commissioner

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Preface

With the increasing use of electronic computers in U.S. business and industry, the need for reliable information about the manpower required to develop, program, operate, and manage computer systems is becoming more urgent. Recognizing this need, the National Science Foundation financed a Bureau of Labor Statistics study of computer manpower which could guide organizations—public and private—in planning computer staffing and education and training.

This bulletin presents the results of that study. It includes information on the current employment and education and training characteristics of computer occupations; explores the impact of advancing computer technology on computer manpower and education; and projects computer occupational requirements and their implications for training. Findings are based on field visits by BLS staff to major computer manufacturers and firms in all major industries using computers for a wide range of applications; study of published reports and trade and technical publications; and interviews with Government and industry experts.

The study was undertaken jointly by the Bureau's Division of Manpower and Occupational Outlook and Division of Technological Studies. Neal H. Rosenthal and John J. Macut had overall direction of the study while Morton Levine and Richard W. Riche provided major supervision of it. Robert V. Critchlow, Constance B. DiCesare, Joseph J. Rooney, and James D. York prepared the report. Edgar Weinberg, formerly Deputy Assistant Commissioner for Productivity and Technology, originated the study and contributed to the planning in the early stages.

The Bureau is grateful to the National Science Foundation for their financial support and to the many individuals who provided information for the study and who reviewed and commented on the draft report.

Contents

Introduction

Background

The sharp growth in the use of computers has had a dramatic effect on the way data processing operations are handled in organizations throughout the economy. First introduced in 1946, the number of electronic computers grew rapidly during the 1950's and 1960's, and today they number more than 100,000.[1] Accompanying the growth of computers have been continuing advances in computer technology—many resulting from new developments in electronics—which have resulted in a widening variety of contemporary computer systems that are smaller, faster, and of greater capacity than earlier models.

Experts forecast continued expansion in computer use and further advances in computer technology. These developments will have a major impact on manpower with thousands of additional computer personnel—many with changing job skills—required to effectively use the capabilities of computer systems over the next several years.

Despite the computer success story, however, little data are available regarding trends in employment or education characteristics of computer manpower. The major reason for this lack of information is the field's very rapid growth in a short period of time. Only recently have computer occupations been included in the schedules of any significant data collection surveys, and in-depth studies of employment and training requirements for computer personnel are very limited.

Study objective

The objective of this study, financed by the National Science Foundation, was to develop estimates of current employment and future requirements and training needs for major computer occupations—systems analysts, programmers, data processing machine repairers,, computer and peripheral equipment operators, and keypunch operators. Such information is needed to guide organizations, public and private, in planning staffing and education and training programs in the computer field. It could be useful, for example, in designing programs for government support of higher education in the computer sciences. The information now available for these purposes is fragmentary and uncertain, and there has been no systematic examination of economywide needs for computer manpower.

Methods

The first step in the project was to consult officials of the National Science Foundation, American Federation of Information Processing Societies (AFIPS), Business Equipment Manufacturer's Association (BEMA), Bureau of Standards, Office of Management and Budget (OMB), and others for advice in setting the course of the study, and for subject matter information.

Next, a detailed search of existing literature was made to obtain all available information on the employment and training of computer manpower and any relationships to computer use by industry, types of computer applications, and developments in computer technology.

Thereafter, officials of seven leading computer manufacturers were interviewed concerning prospective developments in their industry and subsequent implications for computer manpower employment and training.

The last step of the study's research efforts involved the collection of information through in-depth interviews with computer users. These interviews constituted a sample drawn from a file of approximately 20,000 computer sites developed by the International Data Corporation (IDC), Newtonville, Massachusetts.[2]

Study conclusions were based on data obtained in the forementioned steps, supplemented by various BLS and Bureau of the Census employment data, especially the BLS national industry-occupational matrix which provides detailed information on the distribution of employment in computer occupations by industry. Projections of computer occupational employment developed using the industry-occupational matrix are described in appendix E.

[1]International Data Corporation, *FDP Industry Report:* Review and Forecast Issue, March 1972.

[2]A detailed description of the procedure used to select computer user firms is included in appendix A.

Limitations

In assessing the study's results, it is necessary to consider its limitations. First, judgments about the future direction and pace of technological change and its impact on manpower are difficult. Consequently, the realization of study conclusions regarding computer technology depend on factors that cannot be fully anticipated. Another study constraint involved resources, which limited the number of computer user interviews conducted, in-depth research on computer productivity or output measures, and information from educational institutions treating the role and direction of computers as a new discipline in our educational system. Finally, conclusions drawn in this study are limited to the national picture. Therefore, regional differences in computer staffing, training, equipment, applications, and so forth, may exist.

Chapter 1. Highlights

Employment in computer occupations is expected to grow more slowly over the 1970-80 period than during the past decade, and the distribution of workers among computer jobs is expected to change. Although substantial computer occupational employment increases are expected during the 1970's as computers are put to new uses, a slow-down in the rate of growth of computer occupations is expected because of advances in both hardware and software. Although the number of workers in computer jobs more than quadrupled during the sixties to number 765,000 in 1970, the number is projected to increase to almost 1 million by 1980, a growth of only 30 percent during the decade. However, this rate of increase is faster than the approximately 20 percent rate projected for total employment during the same period. (See chart 1.)

Data processing machine repairers are expected to have the fastest growth among the computer occupations analyzed in this report, expanding from 36,000 in 1970 to double that number by 1980. Systems analysts and programmers also should continue to be among the most rapidly growing professional and technical occupations in the economy. The strong demand for trained systems analysts that marked recent years will continue. Approximately 100,000 workers were employed as systems analysts in 1970; the occupation is expected to grow by about 60 percent to number over 160,000 by the end of the decade. Programmer employment is expected to increase by about 40 percent from 176,000 employed in 1970 to 250,000 in 1980.

The impact of advancing data entry technology is expected to cause the employment of keypunch operators to fall from 300,000 in 1970 to 235,000 in 1980—a decline of about 20 percent. In contrast, the employment of computer and peripheral equipment operators is projected to increase to 275,000 by 1980 from 150,000 workers in 1970.

Major industries will experience different rates of growth in computer manpower requirements to 1980. The most rapid employment increases are expected in hospital, education, and data processing services. In contrast, relatively slow growth is projected for manufacturing, finance, and insurance, and the transportation, communications, and electric, gas, and sanitary services sector where computer usage already is extensive.

The thrust of future technological change will be toward supplying the user with more computer capability for his investment dollar.

Hardware. While the costs of computer manpower are rising, hardware prices have decreased and are expected to continue to fall over the 1970-80 period. Because costs of computer manpower are a major part of computer user costs, manufacturers have a strong incentive to reduce the manpower needed to use their equipment by incorporating functions that currently are being performed by computer personnel into the hardware. Also, technological innovations that enable workers in other occupations to interact directly with computers and thus eliminate costly data processing specialists are expected to be stressed.

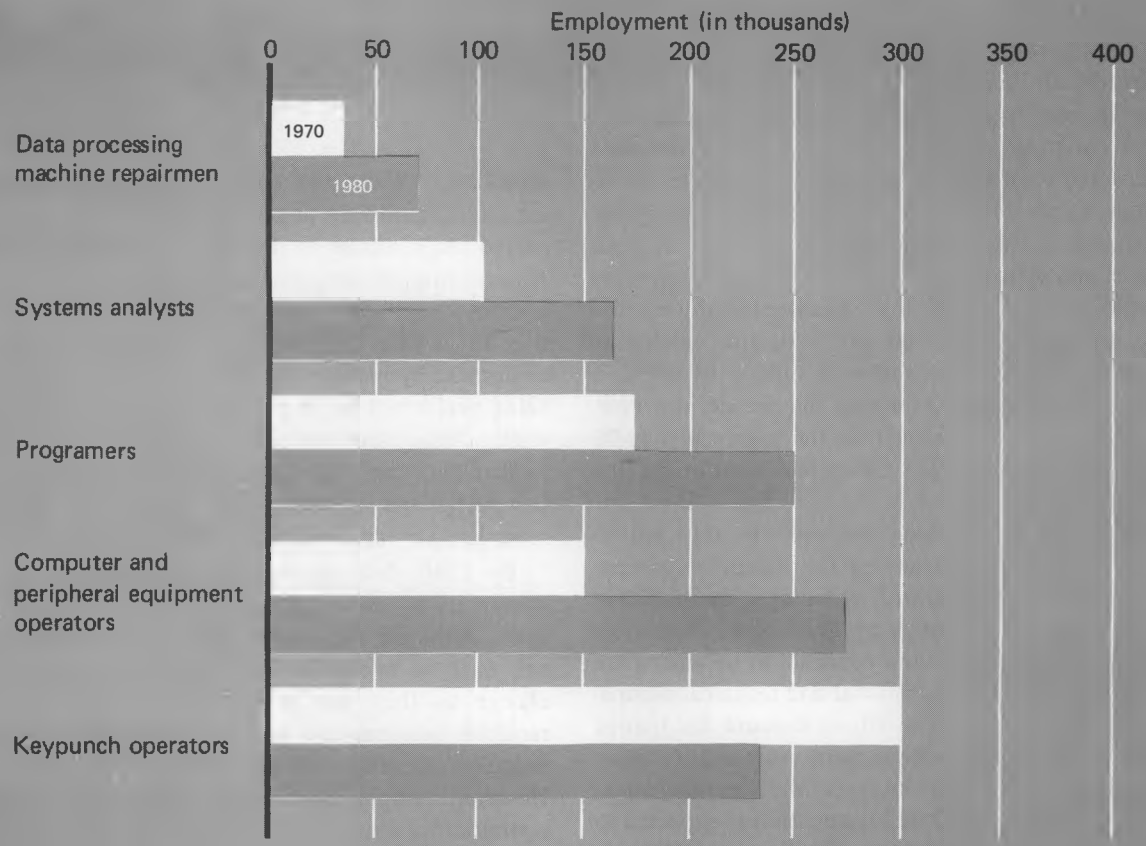
By 1980, data communications terminals and minicomputers are expected to be extended to many more users. Although the jobs of some noncomputer personnel, such as salesclerks and airline ticket agents, will change as they use computers for tasks that once required personal attention, the impact of these technologies on most computer workers should be small. However, employment requirements for keypunch operators are expected to decline as data entry terminals grow in importance.

Most banks and utilities now use magnetic ink (MICR) or optical character recognition (OCR) equipment but further extension of this technology in these industries is likely to be limited. In addition, OCR is not expected to grow significantly throughout other industry sectors by 1980 unless major changes occur in the equipment available that make it less expensive and applicable to more uses.

Software. Easier-to-use programming languages are expected to be available by the end of the decade, and packaged programs are likely to be extended to a greater variety of applications. These developments should facilitate a more direct interaction between the user and his computer and, at the same time, moderate the employment demand for programmers.

Chart 1.

Employment in Computer Occupations, 1970 and Projected 1980 Requirements



Source: Bureau of Labor Statistics.

Increasing sophistication and complexity of computer personnel functions will require workers with more and better training than in the past. Computer personnel vary widely in the amount and type of education and training they bring to the job. Workers in a single occupational specialty, such as programming, currently range from those having no education beyond high school to some with advanced degrees. This wide diversity in preparation for computer jobs is expected to diminish over the next decade, however, as more educational institutions offer computer related courses. Many users now furnish some type of in-house training for computer personnel, and expansion of these programs is expected over the 1970-80 period. In addition, computer science courses and related data processing subjects have varied greatly in quality. As a result, employers find computer science and data processing capabilities the most lacking qualifications in the backgrounds of their computer personnel, regardless of their educational levels. Computer users further indicate that

advances in hardware and software and the growing variety and complexity of applications will necessitate even better educated personnel.

Major improvements to computer education and training needed to facilitate the availability of better qualified computer personnel include:

- –a larger number of qualified teachers
- –consistency of subject matter in similar course offerings
- –more rapid dissemination of information on computer technological advances by educational institutions
- –techniques for determining in advance the performance capabilities of systems for specific applications
- –techniques for determining the ability of computer products from different companies to work in the same system.

Chapter 2. Current Status of Employment, Education, and Training

Employment

Computer occupations employed about 765,000 persons in 1970.[3] The greatest concentration, about 32 percent, was in manufacturing, and the second largest concentration, about 25 percent, was in service industries. Sizable numbers of workers also were found in finance, insurance, and real estate (14 percent); wholesale and retail trade (12 percent); government (8 percent); and transportation, communications, electric, gas, and sanitary services (7 percent). In terms of regional concentration, the States of New York and California each employed about 12 percent of the persons in computer occupations. Sizable concentrations also were found in Illinois (7 percent), Pennsylvania (6 percent), and Ohio, Texas, and New Jersey (each with about 5 percent). The distribution of computer-related employment by major industry group is shown in table 1, and the distribution of employment by State in table 2.

[3] Data for computer-related employment are available for 1971 and 1972 from the Current Population Survey, and from various BLS Area Wage Surveys. Uses and limitations of these and other supplementary data used for analysis are discussed in appendix E.

The distribution of computers by industry and by regional location parallels the distribution of computer-related employment described in the preceding paragraph. This shows the direct relationship of employment in computer occupations and computers in use.

Occupations

For this study, computer personnel are divided into five occupational categories: programmer, systems analyst, computer and peripheral equipment operator, keypunch operator, and data processing machine repairers.[4] Two out of every five computer employees

[4] Fifty-five different occupational titles, shown in appendix B, were subsumed by the Bureau of the Census under six occupational categories: computer programmer, computer systems analyst, computer specialist n.e.c., computer and peripheral equipment operator, keypunch operator, and data processing machine repairers. The BLS Occupational Matrix coverage parallels the census classifications. This study, however, combines two of these classifications, systems analyst and computer specialist n.e.c., on the basis that the occupational titles listed under computer specialist n.e.c., would have been included in this study under the occupational category of systems analyst.

Table 1. Distribution of computers and employment in computer occupations by industry, 1970

Industry	Employment		Computers	
	Number	Percent	Number	Percent
Total	765,200	100.0	33,985	100.0
Agriculture, forestry, and fisheries	710	0.1	66	0.2
Mining	6,400	.8	616	1.8
Construction	7,335	1.0	236	.7
Manufacturing	245,550	32.1	11,662	34.3
Transportation, communications, electric, gas and sanitary services	51,645	6.8	2,090	6.1
Wholesale and retail trade	94,970	12.4	2,388	7.0
Finance, insurance, and real estate	107,460	14.0	5,073	14.9
Services	188,500	24.6	7,448	21.9
Government	62,630	8.2	4,401	12.9
Not classified			5	

SOURCE: Employment: Bureau of Labor Statistics; Computers: International Data Corporation.

Table 2. Percent distribution of computers and employment in computer occupations by State, 1970

State	Computers	Employment	State	Computers	Employment
Total	100	100	South Atlantic—Continued		
			Virginia	1.9	2.6
Northeast			West Virginia	0.4	0.4
New England			North Carolina	1.8	1.6
Maine	0.3	0.2	South Carolina	.8	.6
New Hampshire	.4	.3	Georgia	2.2	1.8
Vermont	.2	.2	Florida	2.5	2.3
Massachusetts	4.4	3.9	East South Central		
Rhode Island	.5	.4	Kentucky	.8	.9
Connecticut	2.2	1.9	Tennessee	1.4	1.3
Middle Atlantic			Alabama	1.2	1.1
New York	10.5	12.1	Mississippi	.5	.3
New Jersey	4.5	4.9	West South Central		
Pennsylvania	6.1	6.0	Arkansas	.5	.3
North Central			Louisiana	1.1	.9
East North Central			Oklahoma	1.2	1.1
Ohio	5.6	5.2	Texas	5.5	5.3
Indiana	2.4	2.0	West		
Illinois	6.6	6.9	Mountain		
Michigan	3.6	4.0	Montana	.2	.1
Wisconsin	2.1	1.8	Idaho	.3	.1
West North Central			Wyoming	.1	.1
Minnesota	1.8	2.2	Colorado	1.2	1.2
Iowa	1.1	.9	New Mexico	.5	.4
Missouri	2.5	2.4	Arizona	.9	.8
North Dakota	.2	.1	Utah	.5	.7
South Dakota	.1	.1	Nevada	.2	.2
Nebraska	.8	.5	Pacific		
Kansas	.8	.8	Washington	1.5	1.4
South			Oregon	.8	.7
South Atlantic			California	10.8	11.9
Delaware	.4	.3	Alaska	.1	.1
Maryland	2.5	3.5	Hawaii	.4	.4
District of Columbia	1.2	.7			

SOURCE: 1971 International Data Corporation file; 1970 Census of Population.

are keypunch operators, while more than one out of five are programmers and one out of five are computer and peripheral equipment operators. Systems analysts and repairers make up the balance. (See table 3.)

Not included among computer occupations were thousands of workers in a variety of computer-related jobs, such as salesworkers and production workers employed by computer manufacturers, as well as engineers, sales clerks, and many other people who use computers as a tool in their work. The principal criterion for including workers in computer occupations was whether their jobs resulted from the presence of the computer itself.

Table 4 provides a breakdown of total employment and employment in each occupation by major industry group in 1970. The largest number of keypunch operators—the occupation that currently employs the most workers—is found in manufacturing with 28 percent of the total, followed by services with 21 percent of the total, and the industry group of finance, insurance, and real estate with about 17 percent of the total. Computer programmers, the second largest occupational category, are also concentrated in these three industries—manufacturing with 36 percent, services with 29 percent, and finance, insurance, and real estate with 12 percent. The industry employment distribution of computer and peripheral equipment operators like the keypunch operators to whom they are occupationally related, was concentrated in manufacturing (30 percent), services (21 percent) and finance, insurance, and real estate (18 percent). Almost 90 percent of all systems analysts were employed in four industries. Manufacturing included 40 percent of their total employment; services 28 percent; wholesale and retail trade 11 percent; and finance, insurance and real estate 9 percent. The smallest computer occupation in this study, data processing machine repairers were almost totally employed in three industries—36 percent in services, 30 percent in manufacturing, and 29 percent in wholesale and retail trade.

Table 5, provides a brief description of the major job duties for each of the computer occupations.

Table 3. Employment in computer occupations, 1970

Occupational group	Employment	
	Number	Percent
Total	765,200	100.0
Systems analysts	102,700	13.4
Programmers	176,500	23.1
Data processing machine repairers	36,000	4.7
Computer and peripheral equipment operators	150,000	19.6
Keypunch operators	300,000	39.2

SOURCE: Bureau of Labor Statistics.

Staffing patterns

The survey of 136 [5] computer users provided information on the staffing patterns that exist at computer sites. The occupational mix, as well as the absolute number of workers on the computer staff, appears to depend more on the size of the site than on the type of industry or the computer application.

For purposes of the computer manpower study a small site was defined as having a monthly rental value of 0-$5,000; a medium site, $5,001-$40,000 and a large site, over $40,000. Monthly rental values were selected as the proxy for measuring size of site against which staffing patterns would be evaluated. An effort was made to determine the extent to which staffing patterns varied according to size of site.

Generally, small sites have a greater overlap in job duties than large ones and each job position is consequently more multi-functional. As a result, job titles are generally less definitive at small sites than at large ones. At a number of relatively small sites visited in the BLS survey, for example, the EDP manager performed both the programming and the systems analysis functions. Such a site would have one EDP manager and no programmers or systems analysts. Programming and systems analysis were being carried out, but one would not know this by analyzing the list of the computer occupations at the site because this work is being done by the manager. Larger sites have more functional specialization and an employee is less likely to be doing more than his job title would indicate.

A specialized, technical job such as systems analyst tends to increase as a relative percentage of all staff positions as the size of the site increases. This may well be the result of the fact that persons such as EDP managers and programmers are able to be multi-functional at many small sites and handle any systems analysis, unlike at larger sites where greater specilization is necessary. At the small sites visited, systems

[5] Information from 4 of the 136 user sites visited was too incomplete to warrant inclusion in this chapter.

Table 4. Employment in computer occupations by major industry division, 1970

Industry	Total		Systems analysts		programmers		Data processing machine repairers		Computer and peripheral equipment operators		Keypunch operators	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total, all industries[1]	765,200	100.0	102,700	100.0	176,500	100.0	36,000	100.0	150,000	100.0	300,000	100.0
Agriculture, forestry and fisheries	713	(2)	20	(2)	157	(2)	5	(2)	123	(2)	408	0.1
Mining	6,403	0.8	1,081	1.1	1,854	1.1	41	0.1	1,642	1.1	1,785	.6
Contract construction	7,335	1.0	921	0.9	1,969	1.1	95	.3	1,432	1.0	2,918	1.0
Manufacturing	245,550	32.1	41,472	40.4	63,131	35.8	10,736	29.8	45,455	30.3	84,756	28.3
Transportation, communication, electric gas, and sanitary services	51,648	6.8	5,383	5.2	10,015	5.7	535	1.5	11,072	7.4	24,643	8.2
Wholesale and retail trade	94,970	12.4	10,812	10.5	4,080	8.0	10,464	29.1	16,345	10.9	43,269	14.4
Finance, insurance, and real estate	107,464	14.0	9,275	9.0	21,557	12.2	291	.8	26,284	17.5	50,057	16.7
Services	188,502	24.6	28,384	27.6	51,819	29.4	12,808	35.6	31,709	21.1	63,782	21.3
Government	62,637	8.2	5,356	5.2	11,924	6.8	1,026	2.9	15,943	10.6	28,388	9.5

[1] Totals may not add due to rounding.

[2] Less than .1 percent.

SOURCE: Bureau of Labor Statistics.

Table 5. Description of duties of computer manpower

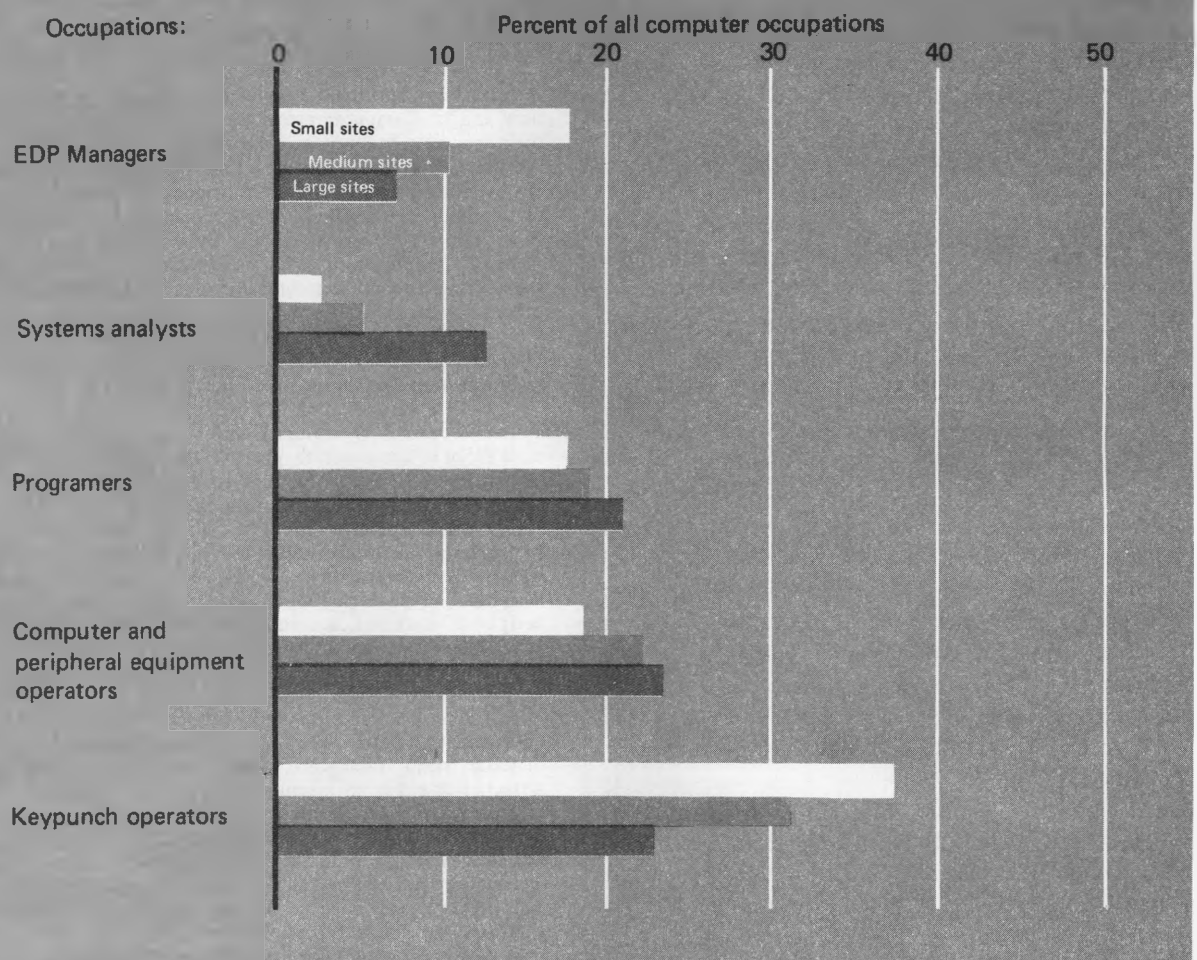
Job title	Description of major duties
Systems analysts	Analyze business, scientific, and engineering problems for application to electronic data processing system. Systems Analysts are classified according to their specialty. In business (nonmanagerial) analyzes business problems; such as development of integrated production, inventory control and cost analysis system, to refine its formulation and convert it to programmable form for application to electronic data processing system. In scientific and technical areas (nonmanagerial) performs logical analyses of scientific, engineering, and other technical problems and formulates mathematical models of problems for solution by digital computer. Those employed as systems engineers analyze electronic data processing projects to determine equipment requirements. Analyze capabilities and limitation of computers and peripheral equipment and plan layout of computer and peripheral equipment to achieve efficient operation. Usually employed by consulting firm or equipment manufacturer.
Computer programmers	Convert business, scientific, engineering problems to detailed logical flow charts. Computer programmers are classified according to their specialty. In business applications (nonmanagerial) converts symbolic statement of business problems to detailed logical flow charts for coding into computer language and solution by means of automatic data processing equipment. May convert detailed flow chart to language processable by computer. In scientific and technical applications (nonmanagerial) converts scientific, engineering, and other technical problem formulation to format processable by computer.
Data processing machine repairers	Install and periodically service computer systems. Experience or technical training in electronics often is necessary.
Computer and peripheral equipment operators	Computer (console) Operators-Monitor and operate the control console of a computer to process data according to operating instructions. Study instructions to determine equipment setup and operation; switch necessary auxiliary equipment into circuit and start and operate computer; make adjustments to computer to correct operating problems; review errors made during operation to determine cause; and maintain operating records. 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 electronic computer.
Keypunch operator	Operates alphabetic and numeric keypunch machine, similar in operation to electric typewriter, to transcribe data from source material onto punchcards and produce prepunched data: Attaches skip bar to machine and previously punched program card around machine drum to control duplication and spacing of constant data. Loads machine with decks of punchcards. Moves switches and depresses keys to select automatic or manual duplication and spacing, select alphabetic or numeric punching, and transfer cards through machine stations. Depresses keys to transcribe new data in prescribed sequence from source material into perforations on card. Inserts previously punched card into card gage to verify registration of punches.

analysts made up only 2.4 percent of the total for all EDP staff; at medium sites they were 5.7 percent of the total, and at large sites they jumped to 12.9 percent of all EDP staff. (See chart 2.)

Keypunchers showed the opposite trend. They made up 37.1 percent of the EDP staff at small sites, 31.1 percent at medium sites, and only 23.0 percent at large sites. There are several possible reasons for the reversal in trends. There is more overlap between programming and systems analysis work than between keypunch work and other EDP functions. Thus, at small sites a programmer might perform any necessary systems analysis work in the course of carrying out his job, but it would be less likely that anyone other than a keypuncher would do

Chart 2.

Relative Proportions of Computer Occupations by Size of Site



Source: Bureau of Labor Statistics.

punch work. Another possible explanation is that larger sites can afford more sophisticated data input equipment, which is more productive and thus requires fewer keypunchers. Also, the nature of work at many large sites is more complex and sophisticated. Consequently as the size of the computer site increases, the need for systems analysts increases more rapidly than the need for less technical people, such as keypunchers.

Programmers represented 17.6 percent of the total EDP staff at the small sites, 19.1 percent at the medium size sites, and 21.2 percent at the large sites. For computer and peripheral equipment operators, the figures were 18.4 percent at the small sites, 22.2 percent at the medium ones, and 23.2 percent at the large ones. The EDP managers were 17.6 percent of the total EDP personnel at small sites, to 10.7 percent at medium size sites, and 7.2 percent at large sites.

The occupational title, "programmer-analyst" was used at 14 of the sites included in the survey. Programmer-analysts perform both programming operations and systems analysis work, and consisted of approximately 10 percent of all the people at survey sites who were performing such operations. They were found in small, medium, and large sites in five of the major industry divisions. This may indicate a trend in the merging of two closely related occupations.

Education and training

Computer education and training is evolving, but beset with problems of quality, professionalism, and leadership, the study found. Much of this is the result of the computer field's very rapid growth. A brief look at this growth from an education viewpoint provides a good background to the current situation.

The very rapid growth of computer use during the 1950's far outstripped the availability of personnel with data processing skills. Computer jobs were growing rapidly and many people sought training in the field, but schools were not yet offering data processing subjects. The generally slow reaction of the educational system to occupational needs was compounded in this instance because expensive computer equipment was needed for student interaction in the instructional process, and because the relatively few people who were qualified to teach attracted higher salaries in the business world.

The major source of developmental stage computer education and training was the computer manufacturers who, in addition to producing new computers and illustrating new uses for computers, provided instruction to employees of their customers. Many persons trained in this way, however, acquired only limited skills since their training usually concentrated on the operating procedures for their company's computer system. This procedure, therefore, restricted transfers or advances to jobs requiring knowledge of different types of computers and related equipment.

During the 1960's more post high school educational institutions, both public and private, included data processing in their curriculums, but the number of graduates with specific training for computer jobs fell further behind the burgeoning growth of computer jobs. To fill the widening gap between the demand for and the availability of computer personnel, a large number of private computer schools were established. Some of these schools, however, have been criticized for exploiting the computer manpower situation for financial gain, providing substandard teachers, limited subject matter, and obsolete computing equipment.[6]

In the late 1960's, computer manufacturers added a new dimension to the education issue by declaring that educational services would no longer be included in the pricing of computer systems and constituted a separate charge.[7] Subsequent awareness of computer education costs led many computer users to evaluate and seek alternative ways to train workers (private EDP school or private and public educational institutions) in order to get the most for their computer education dollar.

The economic downturn, coupled with rising computer education costs at the beginning of the 1970's, led computer users to consider another possibility—training their own computer personnel. These "in-house" training programs, usually administered at the user's site by company personnel or an education services company, sometimes include videotape education packages and are tailored to the needs of the company's computer operations.

As a result of these EDP educational developments over the past two decades, various types and levels of computer training are currently offered by several different sources, most of which are growing in number. Nevertheless, the discipline still lacks:

- —A sufficient number of qualified teachers.
- —Consistency of subject matter in similar course offerings.
- —Rapid dissemination of data on computer technological advances through educational institutions.
- —Techniques for determining in advance the performance capabilities of systems set up for specific applications.

[6]Tirney, Thomas R. "Education for Data Processing: Yesterday, Today, Tomorrow" *Computers and Automation*, July 1972. Vogeding, Lorin C. "Training For Computer Programmers" *Computers and Automation*, July 1970.

[7]"The Company Classroom Comes of Age," *Business Automation*, July 1970.

Techniques for determining the ability of computer products from different companies to work in the same system.

Despite the shortcomings of computer education and training in its current state, training and education are generally thought to be necessary for optimum utilization of computer systems. It is noteworthy, however, that some employers consider on-the-job training sufficient except for the top jobs (systems and management work) in a computer operation. They argue that the greater availability of college graduates in recent years enables them to hire persons with higher educational levels than is really required for the work. They further maintain that most formal course work goes unused in computer operation functions, and that the only really necessary qualifications for success in computer work are intelligence and the ability to think logically. This de-emphasis on computer education and training may pertain for some systems performing basic, repetitive and unchanging tasks, but the study's findings indicate that an increasingly large number of computer users either anticipate changes in their computer functions or plan improvements in the efficiency of their computer operations. For these users, experienced personnel trained in computer and information science are needed to facilitate such changes or improvements. In addition, many of the new uses to which computer systems are being adapted are more complex and sophisticated, which in turn requires more educated and experienced computer manpower.

Education characteristics of computer occupations

This study found the educational characteristics of computer workers ranged from high school to college degree and beyond. (See table 6.) The most professional computer work, which involves EDP management, systems design and analysis, and systems programming, is performed by persons typically having 4 years or more of college training. The middle range of computer work, involving scientific applications and complex business applications programming, and equipment maintenance, is typically done by persons having college, junior college, or computer manufacturer school backgrounds. 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 some computer manufacturer or private computer school training.

Regardless of education level, however, the desired ingredients most lacking in computer staff backgrounds are computer science and data processing related subjects and a knowledge of the business their computer operation is serving. The data in table 7 indicates the relatively small number of persons receiving degrees in computer subject fields in 1970.

No significant differences in computer education characteristics were found by industry, although larger numbers of more educated workers were employed by the industries with the greatest computer penetration. Computer education characteristics by occupation among the respondents interviewed during the survey phase of this study are as follows:

EDP managers. Most EDP managers had taken some college courses. About half held bachelor's degrees, nearly a third also had an advanced degree. A small number were junior college graduates. Few attended private computer schools or manufacturer schools.

Table 6. Educational characteristics of persons in computer occupations at BLS computer survey sites

Computer occupation	Education level (percent)[1]						
	High school	Some college		College graduate		Private computer school graduate	Other[2]
		Junior college graduate	Other	Bachelor's degree	Graduate degree		
EDP manager	100.0	5.0	16.8	44.1	15.9	5.0	6.0
Systems analyst	100.0	3.9	19.7	57.8	11.8	4.3	4.6
Programmer	100.0	10.4	24.1	36.6	5.8	8.2	2.5
Console operator	99.4	5.9	18.9	2.9	.2	12.7	4.9
Peripheral equipment operator[3]	98.6	1.7	5.0	1.1	---	8.9	8.9

[1]Occupational percent totals are not additive because of the possibility of multiple education entries. For example, programers who are high school graduates, completed some college, and are graduates of a private computer school are included in those columns.

[2]Includes military, correspondence, manufacturer school courses, etc.

[3]Includes keypunch operators.

SOURCE: Bureau of Labor Statistics.

Table 7. Computer related degrees conferred by institutions of higher education in the United States, 1970-71.

Field of study	Total	Bachelor's degrees (requiring 40 or 5 years)	Master's degrees	Doctor's degrees
Total computer and information sciences	4,104	2,388	1,588	128
Computer and information sciences, general	2,865	1,624	1,131	110
Information sciences and systems	331	177	143	11
Data processing	580	409	171	------
Computer programming	37	32	5	------
Systems analysis	182	88	88	6
Computer and information sciences, other	109	58	50	1

SOURCE: U.S. Department of Health, Education and Welfare, Office of Education.

The major field of study found among EDP managers was business administration. Mathematics and accounting made up the next largest area of concentration. Some EDP managers majored in engineering specialties and data processing or computer science. A few majored in economics, physics, English, or law.

Systems analysts. Among the computer occupations, systems analysts had the highest reported education level. Practically all had completed some college training. About two-thirds held bachelor's degrees, one-fifth of whom had advanced degrees. Small numbers of systems analysts attended private computer schools or manufacturer's schools, and very few were junior college graduates.

The field most studied by systems analysts was business administration. Mathematics, accounting, engineering, and computer sciences were the next most commonly studied disciplines. A few majored in economics or statistics.

Programmers. Programmers had a somewhat lower education level and more varied educational backgrounds than systems analysts or EDP managers. Most programmers pursued some type of post high school education. However, only slightly more than a third were bachelor's degree holders, about one-eighth of whom received advanced degrees. More programmers graduated from junior colleges and private computer schools than EDP managers or systems analysts.

The major fields of study for programmers were business administration, mathematics, and data processing. Large numbers of programmers also majored in accounting; some studied engineering, economics, or English.

Computer operators. Practically all computer console operators were high school graduates. Nearly half had some post high school education or training. The dominant post high school pursuit was college, but few received degrees. Many console operators graduated from junior colleges and an even larger number from private computer schools. Substantial numbers of console operators also attended computer manufacturer schools.

Aside from on-the-job computer training, console operators most frequently took high school commercial courses, general business courses or computer operation and related data processing courses. Some also had computer science, accounting, or mathematics courses in their backgrounds.

Peripheral equipment operators. Although most peripheral equipment operators were high school graduates, nearly three-fourths of them had no schooling beyond that level. Of those who did, most attended computer manufacturer schools or graduated from private computer schools. Some took college courses, and a few were junior college or college graduates.

The studies of peripheral equipment operators who had some training besides on-the-job, included high school commercial courses, keypunch and related data processing courses, and general business courses.

Supplementary post employment training

The extent of job related supplementary training varies widely, with few employers having formal in-depth programs. Some companies have no supplementary training provisions for their computer employees; others provide this type of training only when changes in computer procedures or equipment are made; and still others have regular supplementary training programs of varying type and degree. Some companies also maintain a tuition refund plan or pay for their computer employees attendance at professional seminars.

The frequency and variety of supplementary training is much greater among computer jobs involving management, systems analysis, and programming than for computer operating personnel. There appears to be no significant variation in the extent of training by industry, and regardless of the type or length of training, it is usually paid for by the employer.

The most commonly mentioned type of supplementary training includes manufacturer's schools, in-house training programs, and on-the-job training; college, correspondence, and vocational school courses and professional seminars are used less frequently. The length of supplementary training ranges from less than a day to a year or more; but the bulk of this training usually is completed in 1 to 12 weeks with the higher level computer jobs usually requiring the more lengthy training.

Among computer occupations, EDP manager supplementary training most frequently involves computer operations and programming, accounting, and general business management. Systems analysts most frequently take computer science courses; and systems, programming, and management training. Programmers most frequently train in programming languages and techniques; and to a lesser extent, systems analysis and design training. Console, peripheral equipment and keypunch operators usually train in data preparation, production control, and computer equipment operation techniques, and occasionally programming. Data processing machine repairer training usually involves computer electronics related courses.

Chapter 3. Technological Factors Affecting Projected Manpower Requirements

Technology is advancing at a rapid pace in the computer field. This will affect the types of computers being manufactured, the uses to which computers are applied, and the size and composition of computer occupations. New technologies that have manpower implications can be divided into three areas: hardware (computer mainframe and peripheral equipment), software (computer programs and languages), and applications.

Impact of hardware technology on computer manpower

Technological developments in computer hardware range from improvements in existing equipment to predictions of a new "fourth generation" of computers. However, not all hardware related technological developments have an equal impact on computer manpower. This report discusses only those innovations judged to have significant implications for computer-oriented occupations. The judgment as to whether or not a new technology will have a major impact on manpower was based largely on the opinions and expectations of officials interviewed at seven computer manufacturers and 132 of the 136 computer users who were contacted for information during the survey phase of this study.[8]

The four major technologies examined in this section are optical character recognition equipment, computer terminals, minicomputers, and data communication systems. As indicated in table 8, user sites surveyed were using these technologies on a limited basis with the rate of diffusion highest for computer terminals (installed at 16 percent of total sites), and lowest for data communications (installed at 6 percent of total sites). A substantial number of survey sites, however, report plans to install these hardware devices in the future, so further manpower impact can be anticipated.

Optical character recognition equipment (OCR) provides a form of computer data entry. OCR machines "read" printed information in various forms and translate the information into computer input form. Where these machines can be used, they can enter data into a computer system at a very high speed. Their usefulness, however, is limited by two factors: currently most OCR readers are designed to read only one or, at most, a small number of type fonts; and, OCR readers are expensive.

OCR equipment is now widely used only by firms that use "turnaround" documents (printed forms that a firm can send out and receive back), such as the

[8]Information from 4 of the 136 user-sites visited was too incomplete to warrant inclusion in this chapter.

Table 8. Status of major hardware technology at computer user sites

Technology	Number of sites where computer hardware was—					
	Installed at time of visit		Planned for future installation		Not installed or planned at time of visit	
	Number	Percent of total	Number	Percent of total	Number	Percent total
Character recognition equipment[1]	11	8.3	16	12.1	105	79.5
Computer terminals	21	15.9	27	20.5	84	63.6
Minicomputers	17	12.9	30	22.7	85	64.4
Data communications	8[2]	6.1	42	31.8	82	62.1

[1]Includes optical character recognition and magnetic ink character recognition equipment.

[2]The number of sites sresently utilizing data communications equipment may be understated as indicated in the text, page 46.

SOURCE: Bureau of Labor Statistics.

customer billing forms used by electric power, telephone, and credit card companies. The form includes the customer's name, address, account number, and balance due. When the form is returned with the customer's remittance, it is "read" by the OCR equipment. Banks use a similar technology-magnetic ink character recognition (MICR) on bank checks. In applications where "turnaround" documents cannot be used, OCR is not expected to grow rapidly between now and 1980.

Views of computer manufacturers. Among the seven computer mainframe manufacturers surveyed, there was divergence of opinion over the importance of OCR as an emerging technology, and over its effect on the employment of keypunch operators.

Several officials interviewed forecast a relatively minor impact:

- OCR is growing slowly and will not have much effect for some years. High cost limits its introduction, and there is no breakthrough in sight that will substantially reduce OCR cost. However, within 20 years, OCR may be used extensively enough to eliminate some keypunch operators, but operators will be needed for the OCR equipment.
- OCR will have a slightly negative effect on keypunch operators; but the equipment is expensive, and at present, customers are not demanding control processors that will interface with OCR machines.
- OCR is not expected to significantly decrease keypunch operator employment. It is already in limited use in banks and other firms where highly repetitive operations are involved.
- OCR is not expected to have a significant impact on keypunch operator employment. Only a few thousand OCR machines are currently in use, and their introduction has not affected keypunch operator employment.

Other officials interviewed anticipated a more extensive impact.

- OCR will decrease keypunch operator employment. A sophisticated OCR unit could replace approximately 10 keypunch operators; and by 1980, OCR equipment may cause total keypunch employment to decline by up to 10 percent.
- OCR will cause a decline in keypunch operators.
- OCR will greatly reduce keypunch operators.

Experiences at computer user sites surveyed. Character recognition equipment was being used in 11 survey sites, or 9 percent of the total 132 contacted for information. Five of these survey sites were using OCR readers and six survey sites were using magnetic ink character recognition (MICR) systems, an older, but similar technology. Based on experiences at firms surveyed, further diffusion of OCR equipment will likely bring about displacement of keypunch staff. The impact of MICR on employment, however, is uncertain.

Three of the five sites using OCR reported a decrease in keypunch operators (one of the sites had converted 90 percent of its data entry operations from cardpunch and key/tape to OCR, and decreased its keypunch staff by 20 percent). One site reported that the size of its keypunch staff remained unchanged, but it was handling a larger flow of data. The fifth site was experimenting with OCR, and had not changed its data entry staff. All five sites were in the "large" monthly rental category.

None of the six sites using MICR systems reported a change in data entry staff-possibly because all of the MICR systems had been installed more than 5 years ago, and thus were excluded in the survey questions relating to staff changes. Four of these sites were in the medium-size class, and two were larger sites.

Fifteen sites reported that they either would or might install OCR readers in the future and one site stated that it would possibly install a MICR system. Small, medium, and large sites are all represented in this group. Only four of the sites made any prediction about the effect of OCR on their staff, and in all four instances, the number of keypunch operators was expected to decline.

Only two of the 44 industries covered in the survey showed a consistent pattern in the use of character recognition equipment. Four of six banks surveyed were using MICR systems, a technology quite common in the industry. All three public utility companies surveyed either have installed (one firm) or plan to install (two firms) OCR equipment for use in customer billings. The remaining character recognition systems-both installed and planned-are so widely dispersed among industries that there is no apparent industry pattern.

Computer terminals are probably the fastest growing technology in the area of computer hardware and their use is expected to increase significantly. Terminals can be applied to many present computer systems, improving present applications or making possible new applications involving transfer of data from one location to another for processing.

Computer terminals are expected to bring about some decline in the need for data entry people. On-line terminals at locations remote from central computer sites can handle–via data communications systems–data entry operations heretofore performed by keypunch operations at the central site. For example, airline reservation systems use terminals at their ticket sales offices-terminals that are linked by data communications systems to a central computer. Data entry for ticket sales is performed by the people who work in the sales offices, not by keypunch operators who work at the computer site.

The example of airline reservation systems illustrates another important factor about computer terminal usage: terminals will probably have a greater impact on non-computer occupations than on computer-related occupations. Airline ticket agents, for example, have had to learn how to use terminals once the terminals were applied to ticket sales operations. As terminals are applied to new non-computerized operations, the people involved in carrying out those operations will likewise have to adapt to using terminals.

Views of computer manufacturers showed general agreement that computer terminals and on-line data entry will be used more extensively over the next decade. However, forecasts of the future extent of terminal use by the experts interviewed varied considerably. Significant changes in the number and content of keypunch operator positions are expected. Some specific comments by officials of computer manufacturers are presented below.

- The growth rate for terminals is greater (18 percent annually) than for CPU mainframe installations (10-12 percent annually). On-line terminals will have a large negative impact on keypunch operators with the number of programmers relatively unchanged—increasing in some applications decreasing in others.
- By 1980, there may be 2½ million computer terminal facilities, of which two-thirds will likely use keying for input. The use of terminal keyboards requires persons who have other skills in addition to key entry. Keypunch/tape operators will need retraining to qualify for terminal-oriented jobs that encompass more than card-punch operations.
- Data preparation may change dramatically in the near future, especially in switching from keypunch to on-line data entry. Large establishments are the most susceptible to this trend. There may be a 20 percent reduction in requirements for computer data entry employees.
- On-line data entry will become increasingly important, but this will not mean the demise of keying. Keying operators will still be needed to use some type of device, although not cards or tape, in order to key data into a computer.
- Computer market growth lies mainly with terminal growth. But much of the employment effect will be on non-computer personnel. Computer terminals at point-of-sale checkout facilities in retail supermarkets, for example, may improve cashier item handling by 50 percent, decrease employment of stock clerks by the same percent and create more jobs for applications programmers and computer maintenance technicians. Bank tellers increasingly will operate terminals on-line to the bank's central data base and newspaper reporters and editors will increasingly use CRT terminals. All of these applications are expected to occur in the next 5-6 years. Ninety percent of all terminal operations will be performed by non-computer people.
- By 1980, the present number of terminals (185,000) may grow to 800,000; and the existing number of CRT terminals (65,000) may total 325,000.

Experiences at computer user sites surveyed. Computer terminals were being used at 21 sites, or 16 percent of total sites surveyed. All of these sites were in the medium or large categories. Seven sites reported a decrease in card punchers resulting from terminal use, five sites reported no change in staff, and eight sites did not provide information about their staffs. One site was using a CRT terminal and reported an increase in its data entry staff as the terminal operated at a slower speed than the keypunch equipment that it replaced.

Twenty-seven sites plan to install terminals over the next 10 years. These sites were fairly evenly divided among the small, medium, and large size categories. Ten sites expected terminals to cause a decrease in keypunch staff, three sites predicted little or no change in keypunch staff, one site expected an increase in its staff, and twelve sites offered no opinion on the future impact.

The 48 survey sites that use or plan to use terminals constitute slightly over one-third of all survey sites.

Six of the 44 industries covered by the survey show a possible industry trend in terminal usage. In each of the six industries, at least one-half of the sites visited use or plan to use terminals. The industries are: rubber products (SIC 30), instruments (SIC 38), retail trade (SIC 53), educational services (SIC 82), and Federal and State governments (SIC 91-97).

Minicomputers are defined in this study as computers (logic system and memory cores) that cost less than $25,000. Defining minicomputers in monetary terms was judged to be the most useful method for the study.

Minicomputers (mini's) generally are applied to one or a very restricted number of operations at a time. As "dedicated" single purpose computers, mini's can be used as independent computer systems programmed to perform single, specific jobs ("stand-alone" operations). Minicomputers also are used as integrated parts of larger computer systems-though still applied to single, specific operations within the larger system.

Programming requirements for mini's are minimal and operations are fairly simple. Because of this, mini's used in "stand-alone" operations frequently can be operated by non-computer specialists such as engineers, accountants and production workers. For this group, the computer is only one of a number of tools used in their work. This is a trait that minicomputers share with terminals. When used as a part of a larger computer

system operated by computer specialists, mini's require only a relatively small amount of attention from the staff.

Views of computer manufacturers. Officials of computer manufacturers forecast a sharp growth in minicomputer use which is expected to complement rather than supplant larger computer systems. The greatest impact may be on non-computer clerical occupations as indicated in the specific comments provided below.

- Estimated growth in minicomputer systems is projected to be at least 20 percent annually. Minicomputers used as free-standing units frequently use "canned" programs which will cut into clerical rather than computer jobs, since they will be applied to work which is not done by large computers.
- Minicomputers are the fastest growing segment of the computer industry. They are expected to complement large computers rather than replace them, since mini's are usually programmed to perform one function indefinitely. The implication is for a depressing effect on computer occupations. However, even though only one-tenth as many workers in computer occupations will be needed per minicomputer as per large computers, the tremendous growth in mini's will more than offset any adverse employment impact.
- Minicomputers should increase greatly in usage, but should not interfere with the growth in larger computers. The two types sell to different markets, and thus are non-competing. Mini's do not generally require a special computer staff.
- As the applications for minicomputers grow, much of their employment impact will be on non-computer occupations. Mini's will not replace larger computers; rather, a mini would be used in a factory floor and be tied into a large central computer. Mini's therefore will create some additional employment for programmers and analysts.
- The outlook for mini's is very bright. There will be an increasing number of applications for mini's, and to some extent they will replace large computers.

Experiences at computer user sites surveyed. Seventeen sites in the survey—13 percent of the total—have installed minicomputers: two small sites, nine medium sites, and six large sites. Thirteen of the sites reported no change in their computer staffs resulting from installing mini's, with two sites specifying that their mini's were being operated by people who were not part of the regular computer staff. The remaining four sites stated that their computer staffs had increased in size.

Thirty sites stated that they planned to install minicomputers in the future; 7 small sites, 16 medium sites and 7 large sites.

The expected manpower impact of this change is mixed. Seven sites stated that their computer staff would not be affected because the mini's would be used in other parts of the company by non-computer specialists. Six sites simply reported no expected change in their staffs. Four sites expected an increase in the size of their computer staff. Six sites expected an increase in specific occupations: programmer (two sites), systems analyst (one site), programmer and systems analyst (one site), operator (one site), and maintenance technician (one site). Four sites expected a decrease in staff, with one specifying a reduction in keypunch operators. Three sites did not provide information on staff changes.

In each of eight industries, at least half of the firms surveyed were using, or planned to use, minicomputers. These industries are: Transportation equipment (SIC 37), instruments (SIC 38), utilities (SIC 49), retail trade (SIC 53), insurance carriers (SIC 63), miscellaneous business services (SIC 73), medical services (SIC 80), and educational services (SIC 82).

Data communications, which involves the transmission of information from one location to another for computer input, is a growing technology. Communications networks often will involve the use of on-line terminals and/or minicomputers. Through use of this technology, computers can be put to new applications, and people who previously had little or no access to computers will use them as a valuable aid.

Several occupations will be affected by data communications. Keypunch operators may decline in number while more peripheral equipment operators may be needed. More programmers may also be required, although the increase should be smaller than that for peripheral equipment operators. Whether or not the number of peripheral equipment operators and programmers increase, there will be a demand for people in these two occupations who can handle data communications equipment.

At a conference on computer usage, some enlightening forecasts on the future of data communications were provided.[9] The growth trend in data communications was estimated by one conference participant to be 50 percent annually;[10] and by 1975, 60 percent of all minicomputers may be used in communications functions. Nearly all computers installed in 1972 reportedly had data communication capabilities.

A number of factors were cited as contributing to the growth of data communications: greater information requirements by users; reduced costs of communications equipment; improved data communications services: and

[9]Systems of Computers: The Dispersal of Computing Power. Conference sponsored by the American Management Association, New York City, March 1972.

[10]Ibid.

growing user confidence. Also of importance is the trend, mentioned in the above paragraph, of using minicomputers for communications functions, thus freeing a general-purpose computer for other tasks. When a computer user does install a mini for communication purposes, he may hire an additional programmer with communications experience. This type of specialist might be employed for several months when the user first installs his communications network, then might move on to another job once the network is operational.

Views of computer manufacturers. Computer manufacturers generally expect that data communications will continue to gain importance and will create some new peripheral equipment operator positions. However, several officials interviewed suggested that the greatest impact would be on non-computer personnel. Some specific comments are provided below.

- Data communications are not expected to have any significant manpower effects. Where a central computer with terminals is used, there may be an increase in console operating personnel at the central site.
- Data communications allows a decrease in tape and card handling, thus decreasing manpower requirements. However, the present limiting factor for data communications use is cost, which is not decreasing. Therefore, not much impact is expected before 1980.
- New data transmission devices will significantly, though perhaps indirectly increase employment for peripheral equipment operators. This increase will be closely tied to an expected increase in the use of remote terminals connected to a central computer by data communications networks.
- Data communications should lead to an increase in the overall employment of peripheral equipment operators, and in the replacement of accounting machine operators.
- Data communications will increase decentralization of computer operations; this will stimulate employment growth to the extent that a decentralized operation derives less benefit from economies of scale. The greatest employment impact will be on occupations outisde the computer industry.
- Development in data communications will be very gradual. New engineering positions involving a specialization in data communications equipment are evolving.
- Data communications will create many new jobs for peripheral equipment operators, as there will be a large increase in computer operations performed on a remote on-line basis. But much of the employment impact will be on non-computer personnel.

Experiences at computer user sites surveyed. Among the computer sites surveyed only eight sites–6 percent of total–specifically reported using data communications, the lowest rate of diffusion of the four technologies shown in table 8. This may understate considerably the extent to which data communications is currently being used, however. Any computer installation using remote terminals tied into a central computer system is using data communications (an example of this is the computerized reservations systems used by airlines and hotels). Therefore some survey sites using terminals probably also utilize data communications equipment.

Four sites reported that introducing data communications equipment had an impact on their data entry staffs. At three sites, the number of employees in data entry tasks declined in number, and at the fourth site, where staff size remained unchanged, productivity increased.

Forty-two sites reported plans to install data communications facilities in the future. These sites were distributed among 27 of the 44 industries included in the survey. Possible industry trends (at least one-half of the sites in an industry) occurred in food products (SIC 34), instruments (SIC 38), communications services (SIC 48), banks (SIC 60), stock brokers (SIC 62), and insurance (SIC 63). The 42 sites include 4 small sites, 22 medium sites, and 16 large sites.

Twenty-seven sites gave information about manpower expectations. Six sites expected no change in their computer staff, 11 sites expected a decline only in data entry employees, eight sites expected an increase in programmers or data communication specialists or computer staffs at remote locations, and two sites expected a decline in data entry people and no increase in other occupations.

Impact of software technology on computer manpower

Major improvements are underway in computer languages and programs–the software component of the computer industry. These major developments likely will lessen the growth in demand for programmers since they all make possible fewer programmer man-hours per computer application.

Highly sophisticated languages will increase the degree of training and specialization required of programmers and others who use them. Where these languages are used, and their uses may be somewhat limited, they may reduce the number of programmers.

At the opposite extreme, languages simple enough to be used by noncomputer persons also are being developed. Research on such languages is still in its early stages; but if successful, these less complex languages would allow non-computer people to by-pass programmers and have direct access to computers.

Packaged programs are another development available to computer users. Although presently limited to relatively routine operations, packaged programs simplify programming operations, reduce programmer skill requirements, and probably make possible fewer programmers at a computer site. In the future, some programming operations may be simplified to the point they could be performed by console operators.

Although user-oriented languages and packaged programs will have no adverse impact on employment of programmers, this trend may be partially offset by an increase in demand for a small specialized group of high level programmers employed by companies that supply software to computer users and for in-house systems programmers employed at sites characterized by complex computer use.

Views of computer manufacturers. Computer manufacturers generally forecast that advances in software technology will bring about a reduction in the demand for programmers and a simplification of the programming function. Generally, computer manufacturers agree that some degree of standardization in program packages is possible and already exists. But most manufacturers stated that presently there is only a limited demand for standard program packages as many computer-using companies believe that their programming requirements are so specialized that standardized programs are not suitable. Some specific comments are provided below.

- Management-oriented languages may have a negative impact on high level programmers, as non-computer people will be doing more of this work. Otherwise no major manpower effect is anticipated.
- Programming can be simplified by using more complex hardware to perform some programming operations. There is a trade-off between using hardware and software to do this job. Software has been stressed in the past, but the rapid increase in software costs will cause more emphasis to be placed on hardware. This will lower programmer skill requirements and the number of programmers needed.
- High level programs that can write more simple programs (software that can write software) are being developed. This will stabilize the number of programmers and will lower programmer skill requirements to some extent.
- Computer growth will be in applications and their attendant software. Hardware could be built for specific applications, but if the application changed, the hardware would have to be replaced and this is much more expensive than replacing a particular software package. As software technology gains, "systems" oriented occupations (designers, engineers, and analysts) will increase in number, while fewer programmers will likely be needed.
- Management-oriented languages should slow the rate of growth in programmer occupations.
- The incorporation of common programming functions into the hardware should have no major impact over the next 5 years, but by 1985 the effect could be dramatic. Computers are constantly being made simpler to operate, however, so that the programming job is becoming easier.
- User-oriented languages will not displace programmers, who still will be needed to design the overall system. Similarly, programmers still will be needed to develop the hardware that can generate its own programs—a capability presently useful only in a few specialized fields. Hence, programmer displacement at firms manufacturing computers is not expected to be significant.
- Some programming functions already are being built into computer hardware thereby slowing growth in computer manpower. The decline in demand for computer manpower resulting from the innovation will continue throughout this decade.

Experiences at survey sites. Among the computer-user sites surveyed, only a few changes based strictly on software technology were reported. A software concept known as management information systems was most frequently mentioned as coming into wider usage. Five survey sites reported that they would be introducing or expanding their use of management information systems. Other comments are as follows:

- Software changes are going to be significant in affecting the functions of computer personnel. The new software de-emphasizes coding operations, thus reducing the time spent on routine work and increasing the proportion of time spent on the more complex analysis tasks.
- The emergence of an abundance of one-time programs has had the effect of reducing the amount of specialization of computer personnel. With so many one-time programs, it has proven cost effective for all personnel to have programming knowledge.
- Higher level languages will have an important two-fold effect on computer personnel. The first effect will be to improve the productivity of programmer-analysts. The second effect will be on the vertical mobility of employees. With the greater complexity of the higher level languages, even fewer operators will be able to advance to programmer-analyst positions.

Impact of applications technology on computer manpower

The BLS computer users survey also attempted to ascertain the impact of computer applications changes on staffing patterns. Computer users were asked what changes they anticipated in applications and what effects those changes would have on manpower. Any antici-

pated relative increase in a present application or introduction of a new application was recorded to determine if any relationship exists between computer applications and staffing patterns.

The application which was most frequently mentioned was business forecasting. Out of 132 sites queried, 12 expected to add or increase the business forecasting application. Of these, eight anticipated no impact on their staffs. The four sites which anticipated staff changes felt that these changes would involve more programmers and systems analysts.

The only other application which was mentioned with any frequency was inventory control. Of the three sites that mentioned inventory control, two anticipated a need for more systems analysts and programmers and the third forecast a need for more operators.

Four additional sites expect to introduce or increase both business forecasting and inventory control applications. Two sites indicated no effect on staff was expected, one predicted more keypunch and data control personnel would be needed, and the fourth expected to add systems analysts.

Some new applications are made possible by the development of new hardware. For instance, computers can be applied to point-of-sale operations in supermarkets or department stores through the use of computer terminals. Such applications may create jobs for applications programmers, and perhaps also for peripheral equipment operators and maintenance technicians.

Chapter 4. Projected Manpower Requirements

Employment growth

Continued employment growth characterizes the outlook for computer jobs through 1980. The major factors contributing to this growth include:

- growth in the number and types of computers and peripheral equipment manufactured.
- growth in the number and types of organizations using computers or computer services.
- continuing development of new computer uses.
- increasing dependence on computers to increase efficiency and productivity.
- increasing emphasis on computers as a management information tool.

The rate of computer employment growth however, will be slower than during the past two decades. Also within the framework of this projected growth, an interplay of several factors will result in different rates of employment increase among specific computer occupations. (See table 9 for 1970 employment and projected 1980 requirements for computer occupations.)

The expectation of slower growth was hinted at in 1970, when the computer field was found to be susceptible to the economic slowdown, and extensive computer penetrations up to this point had greatly reduced the untapped new customer base. The economic slowdown also prompted computer users to begin or intensify efforts to increase their own computer capabilities, rather than to rely almost totally on computer manufacturers for equipment configurations and technical advice. Users increasingly choose computer systems that perform the functions they want computerized, instead of installing a computer system and then trying to tailor their needs to accommodate the capabilities of that system. This user sophistication is expected to continue in the years ahead, and temper rising computer manpower expenditures.

Table 9. Projected growth of employment requirements for computer occupations, 1970 to 1980

Occupation	1970 employment	Projected 1980 requirements	Percent change
Total	765,200	997,600	30.4
Data processing machine repairers	36,000	72,600	101.7
Systems analysts	102,700	165,000	60.7
Programmers	176,500	250,000	41.6
Computer and peripheral equipment operators	150,000	275,000	83.3
Keypunch operators	300,000	235,000	−21.7

SOURCE: Bureau of Labor Statistics.

A slowing of overall computer employment growth also can be foreseen in the widening range of user oriented hardware and software refinements whose greater simplification and cost reduction is expected to continue through the 1970's. Although products of advancing technology are especially evident in the data entry and software areas, options featuring increased speed, capacity, simplicity, and compatability are also available for the memory, processing, and output components of computer systems.

Closely related to the increased use of these system refinements, is the expectation that an increasing number of new and existing computer systems will use minicomputers, have on line applications, or include terminals or some similar form of data communications. However, none of these increasingly attractive computer devices create employment opportunities for large numbers of computer workers. The most significant manpower impact of their increased acceptance is for non-computer personnel who will use computer equipment and therefore perform added job functions, or for existing computer personnel who will face some job redesign.

Finally, a slowing of computer employment growth also should be occasioned as the use of timesharing and other computer services becomes more widespread among organizations whose computer functions do not justify establishing or continuing their own systems. Economies of scale indicate that fewer computer workers will be needed by computer service companies to do the work of many prospective computer users than if those prospective users maintained their own computer systems.

Job separations

In addition to employment growth, many job openings will become available each year as workers leave existing jobs because of death, retirement, other labor force separations, or to work in other occupations. Table 10 summarizes openings expected from employment growth and separations from the labor force between 1970 and 1980. Sufficient data are not available to develop estimates of employment openings resulting from workers who transfer to other occupations. However, data available in Occupation and Residence in 1965, –C(2)7E, U.S. Bureau of the Census, sheds some light on this subject.

Although keypunch operator employment is expected to decline, large numbers of job openings for these workers will nonetheless occur because they are currently the largest computer occupation and the one with the greatest proportion of women, many of whom leave the labor force each year for family responsibilities.

Table 10. Estimated job openings in computer occupations caused by employemnt growth and separations from the labor force, 1970 to 1980

Occupation	Total openings	Employment growth	Separations from the labor force
Total	520,630	232,400	288,230
Data processing machine repairers	39,800	36,000	3,200
Systems analysts	80,500	62,300	18,200
Programmers	116,360	73,500	42,860
Computer and peripheral equipment operators .	174,300	125,000	49,300
Keypunch operators . . .	109,670	–65,000	174,670

SOURCE: Bureau of Labor Statistics.

Expected employment growth in computer occupations

Many of the factors that affect the overall direction of computer growth also are expected to influence employment among occupations in the computer field. In general, continually advancing hardware and software technology is expected to result in a greater demand for computer and peripheral equipment operators and data processing machine repairmen. To a lesser extent computer technology coupled with user maturity, will increase the demand for the more sophisticated computer occupations such as systems analysts and systems programmers. At the same time continuing data entry advances will decrease the use of punch cards resulting in an employment decline for keypunch operators.

Keypunch operators. Employment of keypunch operators is expected to decline to 235,000 in 1980 from 300,000 in 1970. This decrease (22 percent) represents a reversal of the employment trend that prevailed for these workers during the past two decades. Despite expected large increases in the volume of data to be entered in computer systems in the years ahead, the extensive penetration of the computer market by card punch oriented systems in the past coupled with their exhibited slow, error prone, and increasingly costly performance in many computer operations, will decrease the use of the card punch form of data entry.

The smaller untapped computer user market in the years ahead will be characterized by more new users who choose alternatives to card punch because of advances in other data entry techniques and equipment, especially terminals or other forms of direct keying, or other data communications related input systems.

Further, advances in computer technology have greatly increased the internal data processing capabilities of computers with a resultant widening of the speed differential between manual card input and computer processing. Since the use of cards permits the computer to work only as fast as the people who code the data, this restriction in the throughput of high speed systems can increasingly be expected to cause attrition in card punch among some large users.

Computer and peripheral equipment operators. Employment of computer and peripheral equipment operators is expected to increase very rapidly, to 275,000 in 1980 from 150,000 in 1970. This employment growth (83 percent) is a faster increase than in previous years. The major cause of the expected employment growth is the widening use of more computer hardware products, especially terminals and data entry keying other than punch cards, which will require increasingly large numbers of computer operating personnel.

Similarly, new models of existing computers and peripheral equipment having greater speeds, memories, and capacities will occasion more computer throughput and require increases in operating personnel.

Furthermore, advancing technology is continually making computers more sophisticated. As a result, an increasing number of people presently classified as operating personnel will be required to perform technical or coding and control functions.

Programmers. Computer programmer employment is expected to increase to 250,000 in 1980 from 176,500 in 1970. This growth rate (42 percent) reflects the

emergence of counter trends within the occupation as technological advances alter programming skill requirements.

The demand for some programmers will increase as more sophisticated computer hardware and software attracts new computer users and increases the number and type of computer applications among existing users. However, this same sophistication is resulting in the development of standardized software packages and enabling programming capabilities to be built into the computer equipment itself, decreasing the demand for other programmers.

The net effects of these trends are expected to be slower programmer employment growth than in the past, and changes in the distribution of programmers by type, and the functions they perform. Larger numbers of systems programmers will be needed to develop the complex operating programs made necessary by more high powered language and complicated computer configurations and to link or coordinate the output of different programs from different systems. On the other hand, continuing development of software to write new software, computers operating in the language of the user, terminal programming by non EDP persons and more standardized software packages are expected to simplify or eliminate some functions of applications programmers and lessen the growth in demand for this type of programming in the years ahead. In some computer systems, applications programmer functions such as coding, may eventually accrue to other computer jobs.

Systems analysts. Employment of systems analysts is expected to increase to 165,000 in 1980 from 105,700 in 1970. This projected increase (61 percent) through the 1970's continues the rapid rate of employment growth these workers experienced during previous years.

The history of computer usage has been marked by many unsuccessful attempts at problem solving, cost reduction, and productivity increase. A major ingredient of such failures has been the lack of adequate systems analysis and design in taking advantage of computer capabilities. As computer users continue to mature, they will expect greater efficiency and increased performance from their computer systems. Similarly, computer hardware and software advances will increase computer application possibilities, the compatability of equipment from different sources, and computer networking or other equipment interrelationships in new and existing computer systems. As a result, systems analysts, who have always been in great demand, will be even more intensely sought to reduce computer system problems and develop more sophisticated and complex computer operations.

Data processing machine repairers. Employment of data processing machine repairers is expected to increase dramatically to 72,600 in 1980 from 36,000 in 1970. This very rapid increase (102 percent) accelerates the employment growth that prevailed for these workers in previous years.

The burgeoning number and types of computers and computer related equipment in use since the mid-1950's, has created a tremendous demand for data processing service technicians to install, maintain, and repair computer and peripheral equipment.

This demand is expected to further intensify during the 1970's not only because of continuing high levels of computer equipment production and prolifiration, but also because of more complex computer equipment configurations and greater geographic dispersion.

Expected employment growth by major industry division

Manufacturing. Computer manpower requirements in manufacturing are expected to grow moderately between 1970 and 1980. Growth will occur, to varying degrees, in most occupations. The number of computer and peripheral equipment operators and data processing machine repairers will grow very rapidly while growth will be moderate for programmers, and system analysts. Keypunch operator employment is expected to decline moderately. (See table 11.)

The growth in manpower obviously reflects a growth in computer usage among manufacturers. More specifically, the manufacturing sector of the economy is expected increasingly to apply computers to process control, quality control, business forecasting, and management information functions. This will be accomplished through more intensive use of existing computer systems, frequently in the form of additional shifts at sites where only one or two shifts are currently in operation. Further, new minicomputer systems are expected to be adopted to specific manufacturing functions, and many existing computer systems will be upgraded, with a resulting expansion in computing capacity and an increase in computer staffs.

Finally, computer terminals, often coupled to data transmission equipment, will be used more extensively but will have a mixed impact on computer-related employment. Terminals can be used, for instance, in warehouse inventory control and in research and development. Data input will be handled by warehouse personnel and research scientists or engineers, accounting for the decline in keypunch operators. However,

Table 11. Employment in computer occupations by major industry division, 1970 and projected 1980

Industry division	Total all occupations			Systems analysts			Computer programmers		
	1970	1980	Percent change	1970	1980	Percent change	1970	1980	Percent change
Total all industry[1] divisions	765,200	997,600	30.4	102,700	165,000	60.7	176,500	250,000	41.6
Agriculture, forestry, and fisheries	713	656	−8.0	20	15	−25.0	157	114	−27.4
Mining	6,403	6,290	−1.8	1,081	1,151	6.5	1,854	1,876	1.2
Contract construction	7,335	9,674	31.9	921	1,337	45.2	1,969	2,823	43.4
Manufacturing	245,550	308,513	25.6	41,472	64,386	55.3	63,131	85,141	34.9
Transportation, communication, electric, gas, and sanitary services	51,648	48,951	−5.2	5,383	6,634	23.2	10,015	11,700	16.8
Wholesale and retail trade	94,970	107,213	12.9	10,812	12,960	19.9	14,080	16,843	19.6
Finance, insurance, and real estate	107,464	138,915	29.3	9,275	14,524	56.6	21,557	28,243	31.0
Services	188,502	313,858	66.5	28,384	56,388	98.7	51,819	87,880	69.6
Government	62,637	63,470	1.3	5,356	7,599	41.9	11,924	15,376	29.0

	Data processing machine repairers			Computer and peripheral equipment operators			Keypunch operators		
	1970	1980	Percent change	1970	1980	Percent change	1970	1980	Percent change
Total all industry[1] divisions	36,000	72,600	101.7	150,000	275,000	83.3	300,000	235,000	−21.7
Agriculture, forestry, forestry, and fisheries	5	0		123	76	−38.2	408	451	10.5
Mining	41	59	43.9	1,642	2,094	27.5	1,785	1,110	−37.8
Contract construction	95	0		1,432	2,779	94.1	2,918	2,735	−6.3
Manufacturing	10,736	22,175	106.5	45,455	76,109	67.4	84,756	60,702	−28.4
Transportation, communication, electric, gas, and sanitary services	535	762	42.4	11,072	16,477	48.8	24,643	13,378	−45.7
Wholesale and retail trade	10,464	16,888	61.4	16,345	27,927	70.9	43,269	32,595	−24.7
Finance, insurance, and real estate	291	685	235.4	26,284	54,932	109.0	50,057	40,531	−19.0
Services	12,808	30,083	134.4	31,709	70,772	123.2	63,782	68,735	7.2
Government	1,026	1,946	89.7	15,943	23,732	48.9	28,388	14,817	−47.8

[1]Totals may not add due to rounding.

SOURCE: Bureau of Labor Statistics.

increased terminal use should increase the demand for systems analysts and programmers.

Transportation, communications, electric, gas, and sanitary services. This industry division was intensively computerized by 1970. Consequently, no overall growth in computer-related employment is expected during the 1970's. (See table 11.) A small growth in computer installations and possible upgrading of present computer systems may result in a small increase in the number of systems analysts and programmers. Some growth in the number of computer and peripheral

equipment operators also is expected to occur as the use of computer terminals, data communications, and optical character recognition equipment increases. Terminal and data communications operators, however, frequently allow data input operations to be performed by people who are not specifically in computer-related occupations. This, combined with OCR equipment, will cause a decline in the number of keypunch operators large enough to offset the growth in all other computer occupations.

Finance, insurance, and real estate. Employment of computer manpower in this major industry sector will grow moderately during the 1970's (see table 11) as more small and medium sized companies adopt computer techniques widely used by larger firms in the industry. More banks are expected to automate their teller operations, and a growing number of small insurers will computerize policy writing and billing functions. Occupational employment growth in this industry division should parallel the basic trends noted earlier for computer personnel throughout the economy. Keypunch operator employment decline may be more prominent in this sector as more insurance data entry is done directly by policy clerks or agents. Employment requirements for data processing machine repairmen will continue to grow very rapidly as their skills are needed to service and repair extensive data processing equipment. For example, more banks will participate in automated central check clearing facilities and offer 24-hour banking services through the use of on-line terminals. Increasing use of terminal networks also will characterize the insurance sector of the industry with agents having access to telecommunications equipment linking field locations to the home office. Growing use of data communications equipment will contribute to the demand for computer personnel in securities firms; many sources predict fully automated stock quotation facilities and a national system for clearing securities transactions by 1980.

Services. An expanding market for data processing services in hospitals, educational institutions, and computer service bureaus will result in very rapid employment growth of computer manpower in this industry sector. (See table 11.) Programmers and systems analysts will be in particularly strong demand as an increasing number of hospitals automate their food service and computerize patient records. Although medical information and communications systems currently are in the early development stages, they are expected to grow substantially by 1980. The manpower requirements of these systems and of those for medical diagnosis and instruction will assure the need for computer specialists in hospitals. Similarly, the expected increase in the volume of data processing contracted to computer service firms should add greatly to the demand for computer and peripheral equipment operators in this sector.

Similar growth is expected in educational services as more computer-assisted instructional systems are developed, library operations such as acquisitions and cataloging are automated, and administrative tasks including class scheduling, student record maintenance, and enrollment forecasting are handled by computers. Educational institutions will stress on-line, time shared computing; substantial growth of terminal networks connecting different administrative units also is expected. Because many medical and educational applications will feature direct keying of data by users such as hospital records clerks or students, employment requirements for keypunch operators will slow drastically; nevertheless, some growth in their number is predicted in the services sector.

Manpower requirements in computer service bureaus and computer maintenance firms also will contribute heavily to the overall growth of computer occupations in this industry division. Service bureaus will continue to demand large numbers of computer and peripheral equipment operators and a growing number of systems analysts and programmers to design and implement systems for data acquisition and control. At the same time, computer maintenance companies will need a growing number of data processing machine repairers to service the increasing stock of computer equipment. Several factors will contribute to an expanded need for contract data processing services and the resulting demand by service bureaus and computer maintenance firms for trained computer personnel. These include growth in applications featuring computer-to-terminal interfacing or minicomputers, and the growing popularity of franchised data processing services that are expected to enlarge the scope of the market.

Several other sectors within this broad industry division should experience somewhat lesser growth in computer manpower requirements. They include limited expansion of computer usage in legal services, notably legal research applications; continued growth of computer installations dedicated to hotel reservation systems; and business services such as credit reporting.

Wholesale and retail trade. Growth of computer manpower requirements in wholesale and retail trade will be closely tied to the spread of automated point-of-sale equipment in retailing and the use of computerized ordering and inventory systems by

wholesalers. Currently only the largest department and food retailers have adopted integrated point-of-sale and credit authorization systems, but these technologies should spread to variety stores and smaller retail establishments by the end of the 1970's. Two factors likely to increase the market penetration of these retailing systems are expected improvements in software and the industry's development of a standardized code for retail groceries.

Although overall computer manpower employment will grow slowly in this industry, growth among the different computer occupations in the industry should closely parallel national trends discussed earlier (see table 11). The largest increases in employment are projected for data processing machine repairers and computer and peripheral equipment operators due to expected growth in the number of data processing terminals and associated communications devices. Demand for systems analysts and programmers also will show some growth, especially for applications programmers needed by retailers automating point-of-sale or inventory operations. Keypunch operator employment is expected to decline moderately as more data is captured at the source by noncomputer personnel or keyed in via terminals connecting branch outlets to a retailer's main data base. Although existing business application systems for accounting and payroll will continue to process large volumes of work, demand for keypunch operators is not expected to keep pace. Many firms have or plan to improve keying efficiency by switching from keypunch data entry to key-to-tape or key-to-disc, thus achieving some savings in manpower costs.

Automated ordering and inventory systems will extend gradually to more establishments in the wholesale sector of the industry but resulting effects on computer manpower will not be significant. Smaller wholesalers are likely to contract out these services to data processing service bureaus rather than install their own systems.

Government. Computer manpower requirements in government will increase over the decade as new information systems are installed and existing ones expand their capabilities (see table 11). State and local governmental agencies will experience the greatest growth in computer manpower as their untapped potential for new applications of hardware is realized. Growth in Federal computer manpower needs will be slower but nevertheless steady as government programs and resulting 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. However, the future should see the development of consolidated systems serving a greater variety of information processing needs and using terminal networks and other data communications technology in their operation.

Within government, growth of the various computer occupations is not expected to deviate from the overall national pattern described earlier. Data processing machine repairer and computer and peripheral equipment operator employment will expand at a very rapid rate, keeping pace with hardware sales and installations. Requirements for programmers and systems analysts, especially at the State and local level, also will rise rapidly as law enforcement, voter registration, and traffic oriented applications are introduced to their computer systems. Keypunch operators, however, will decline substantially, in part due to the effects of direct data entry.

Agriculture, forestry, and fisheries; mining; and contract construction. The number of people employed in computer occupations in these industry divisions is so small that reasonably accurate employment projections cannot be made.

Implications for training

The implications that projected manpower requirements have for computer related training programs is not clear. Information on the type of training received by computer personnel presented earlier in the report indicates that there is no one source or type of training for any of the computer occupations. Furthermore, data has only recently become available on the number of individuals completing training directly related to a few computer occupations. Thus, it is impossible to determine any numerical increases in training that will be required to meet manpower needs as projected in this study.

Nevertheless, it appears likely that computer occupations will continue to grow, and the increasing sophistication and complexity of computer personnel functions will require workers with greater amounts of specific computer related training than in the past. This is especially true of the occupations that are high on the computer education spectrum, programmers and systems analysts. At the same time, expected increases in simplified computer functions performed by noncomputer personnel will erode the need for some types of specific lower level computer training.

The field, however, must be watched very closely to assure that supply and demand do not get out of balance. With the economic slowdown in the 1970's, employment growth slowed, and concern about computer personnel shortages dissipated. Also, our educational system is likely to turn out larger numbers of persons trained in computer occupations. Young persons are very aware of this field through improved vocational guidance literature and an increased number of schools offering data processing courses. Possible surpluses in some non-computer jobs requiring college training also may result in many young persons seeking college training in the computer field, which is currently advertised as one with good job prospects.

Appendix A. Sample Design

This appendix presents the procedures used in selecting the sample for the computer user survey part of this study. Appendix F contains a copy of the Computer Manpower Interview Guide used in the survey visits.

Selection of respondents

A sample of interview respondents was selected from a detailed list of computer users compiled by the International Data Corporation, Newtonville, Massachusetts, in June 1971. This "IDC Data File" listed approximately 20,000 computer user locations, or sites, having about 35,000 installed computer systems.[1] In addition to the name and address of the firm using the computer, each user entry contained detailed information on the central processing units, peripheral equipment, and software at that site. Two information elements from the available data on each site were used to group entries for purposes of a sample design: average monthly rental value and 2-digit Standard Industrial Classification (SIC) designation.[2]

The National Bureau of Standards Office of Computer Information prepared a computer printout that listed the IDC File's computer site entries by the 77 active 2-digit industries of the economy and, within each 2-digit industry, allocated all sites to 1 of 3 monthly rental categories: small, medium, or large.[3] The small rental class was comprised of sites that paid less than $5,001 in average monthly rental for all equipment components of their systems; the medium rental class consisted of sites that paid from $5,001 to $40,000 in average monthly rental; and the large class included sites that averaged $40,001 or more in monthly rental payments.

The following general methodology for selecting a sample from the computer listing was used:

1. A median rental value was computed for each user rental size class (small, medium, and large) and multiplied by the number of sites within that class to yield total rental costs for the class by industry. Each rental class then was summed across all industries and the percent it comprised of total rental for all three classes was computed. These percents were multiplied by visits of 140[4] to derive a first approximation of the number of interviews that should be allocated to each of three sizes of users throughout the economy.

2. In an effort to consider number as well as rental paid by sites in a given rental size class, a similar distribution was computed using the number of sites in each rental class, i.e., the number of user sites in each of the three size classes was summed across all industries and the percent each group of sites comprised of all industry sites was computed. These percents also were multiplied by total visits (140) to yield a second approximation of the number of interviews that should be allocated to each size class of user throughout the economy.

3. Both approximations were weighted equally in the final selection of the number of visits to be made in each size category (i.e., the number of visits computed by each method was averaged). Allocation of visits within each of the three size categories of users by industry was made according to the value of the respective industry rental class as a percent of total rental value for that class summed across all industries.

[1]The International Data Corporation conducts a continuing series of checks on the percentage of total existing U.S. computer installations covered by the IDC Data File. These checks include an evaluation of the percentage coverage of the File by geographic area, user industry, computer price class, and manufacturer. IDC judged the June 1971 File to have no significant geographic bias or basic deviation in completeness of coverage by industry. According to IDC, this edition of the File contained about three-fourths of all U.S. general purpose digital computer sites, and approximately 65 percent of all U.S. general purpose digital computer systems.

[2]*Standard Industrial Classification Manual,* Executive Office of the President, Bureau of the Budget, 1967.

[3]The rental value of equipment owned by users was estimated by International Data Corporation in the development of the IDC Data File.

[4]Funds available to conduct the study limited the visits to 140.

Appendix table A-1. Distribution of scheduled computer user interviews by industry

SIC Code [1]	SIC Title	User visits by monthly rental			
		Total	Small	Medium	Large
10	Metal mining	2	1	1	
13	Crude petroleum and natural gas	2		1	1
15	Building construction-general contractors	2	1	1	
19	Ordance and accessories	1			1
20	Food and kindred products	4	1	2	1
22	Textile mill products	2	1	1	
23	Apparel and other finished products	2	1	1	
26	Paper and allied products	2	1	1	
27	Printing, publishing, and allied industries	3	1	1	1
28	Chemicals and allied products	4	1	2	1
30	Rubber and miscellaneous plastics products	4	1	1	2
32	Stone, clay, glass, and concrete products	2	1	1	
33	Primary metal industries	3	1	1	1
34	Fabricated metal products, except ordance, machinery, and transportation equipment	3	1	1	1
35	Machinery, except electrical	10	2	3	5
36	Electrical machinery, equipment, and supplies	3	1	2	
37	Transportation equipment	5	1	2	2
38	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks	3	1	1	1
40	Railroad transportation	1			1
42	Motor freight transportation and warehousing	1	1		
45	Transportation by air	2			2
46	Pipe line transportation	1			1
48	Communication	3		1	2
49	Electric, gas, and sanitary services	3	1	1	1
50	Wholesale trade	5	3	2	
53	Retail trade-general merchandise	2		1	1
54	Food stores	4	1	2	1
60	Banking	6	1	3	2
61	Credit agencies other than banks	1		1	
62	Security and commodity brokers, dealers, exchanges, and services	2			
63	Insurance carriers	6	1	3	2
66	Combinations of real estate, insurance, loans, law offices	2	1	1	
70	Hotels, rooming houses, camps, and other lodging places	3	2	1	
73	Miscellaneous business services	3	1	1	1
80	Medical and other health services	6	2	3	1
81	Legal services	2	2		
82	Educational services	9	2	4	3
86	Nonprofit membership organizations	1		1	
89	Mescellaneous services	11	2	5	4
91	Federal government	6	1	2	3
92	State government	3		2	1
93	Local government	3	1	1	1

[1] *Standard Industrial Classification Manual,* Executive Office of the President, Bureau of the Budget, 1967.

After selection of the user sample as described above, 12 industries[5] had situations believed to be unfavorable to the study. These situations characterized industries of two types: Some that had an unusually high concentration of users, but a great amount of available secondary source data, drew many visits. On the other hand, some that were characterized by few computer sites and little secondary source data, but which showed indications of rapid growth in the near future, drew too few interviews to develop sufficient information for the study. To develop a better sample for analytical purposes for these 12 industries, the total number of visits allocated to them in the sample selection as described above was reallocated judgementally by the staff working on the study. After reallocation. total visits to each of the 12 industries were distributed among the size classes in each industry according to the same procedures used in the overall sample selection.

The final step was to choose the names of

[5] These industries were metal mining (SIC 10), building construction (SIC 15), air transportation (SIC 45); pipeline transportation (SIC 46), retail trade-food (SIC 54); banking (SIC 60); insurance carriers (SIC 63), real estate (SIC 65); hotels, rooming houses, and other lodging places (SIC 70), medical and other health services (SIC 80); legal services (SIC 81); and Federal Government (SIC 91).

respondents through random selection in each size class in each industry where interviews were to be conducted.

Of the original 140 allocated interviews, 133 were conducted. Uncooperative respondents and scheduling problems resulted in the inability to conduct seven interviews. An additional three user interviews were conducted with computer manufacturers during the course of the study. In total 136 computer users were interviewed. A distribution of scheduled visits bv industry and size class if provided in appendix table A-l.

Approximately 7,700 people were employed at the computer sites visited by BLS staff. The occupational distribution of these people differs somewhat from the national distribution. (See appendix tables A-2 and 3.) At least part of the difference between the two distribution figures is due to a combination of several factors.

The BLS computer user survey consisted of visits to an equal number of small, medium, and large computer sites. The variation in staffing patterns due to the size of computer sites affects the occupational distribution. For instance, the percent of the total in the "programmer and programmer analyst" and "systems analysts" categories are approximately the same as in the national categories, although slightly lower in both instances; and survey results show that at small sites, the data processing manager frequently performs some or all of the programming and systems analysis work, which understates the proportion of programmers and analysts in the survey. The same situation exists in regard to repairers since few, if any, small and medium-sized sites employ their own repairers. As small and medium sites constitute two-thirds of the sites in the survey, there would be a considerable understatement of employment in this occupation.

There are some differences between the occupational categories used for the national figures and those used in the BLS survey of computer sites. The occupational category of "EDP Manager" was not included in the national category, although it was found in the computer user visits that these people are involved in computer operations in many small sites. However, one

Appendix table A-2. Distribution of employment in computer occupational at BLS computer user survey sites

Occupation	Number	Percent distribution
Total	7,722	100.0
EDP managers	633	8.2
Systems analysts	873	11.3
Programmers and programmer analyst[1]	1,606	20.9
Data processing machine repairers	21	0.3
Computer and peripheral equipment operators	1,718	22.3
Keypunch operators	1,932	25.1
Other	939	11.9

[1]The occupation of programmer analyst has been defined on page 14.

SOURCE: Bureau of Labor Statistics.

of the job titles in the national category included under "Computer System Analysts" is "Manager, Computer Programming"—but since there is no description of this job category nor an employment figure, there is no way of determining to what extent it corresponds (or does not correspond) to the computer survey category of "EDP Manager."

The greatest disparity in the distribution of employment is found in the category of "keypunch operator," the proportion being considerably smaller in the BLS computer survey than in the national data. One reason for this disparity may have been the rapid adoption of new data entry technology (described earlier in the section on technological developments), which reduced requirements for keypunch operators between 1970 (when the national figures were collected) and 1972 (when the visits to computer sites were conducted). Another possible reason is that in the national figures, "IBM Operators" are included in the category of "keypunch operators" rather than in the category of "computer and peripheral equipment operators."

Appendix B. 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 Programmers, Computer Systems Analysts, Computer Specialists, n.e.c., Computer and 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
- digital-computer systems analyst
- engineer, systems
- health-systems analyst, computer
- manager, computer programming

Computer Specialist, 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
- encoding clerk
- encoding machine operator
- 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
- Computing-systems maintenance workers
- Customer's service man-data processing machine rental
- Data-processing-machine servicers
- Engineer customer's
- IBM installer
- Mechanic
  - Computing systems
  - Data processing
  - Electronics computer
  - IBM machine

Appendix C. Industry Distribution of Computer Manpower

Information concerning employment of computer personnel by industry was obtained for 1970 and 1980 (projected) from the BLS industry occupational matrix. Employment totals are presented, according to Matrix detailed industry levels, in the following table.

Appendix table C-1. Employment in selected computer occupations by detailed industry

Industry	Total all occupations		Computer programmers		Computer systems analysts	
	1970	1980	1970	1980	1970	1980
Total all industries	765,222	997,641	176,506	249,996	102,704	164,994
Agriculture, forestry, fisheries	713	656	157	114	20	15
Agriculture	431	447	49	28	9	
Agriculture production	157	328				
Services, except horticulture	233	103	41	20	9	
Horticultural services	41	15	8	8		
Forestry	263	194	96	78	11	15
Fisheries	19	16	12	8		
Mining	6,403	6,290	1,854	1,876	1,081	1,151
Metal mining	527	591	140	169	90	125
Coal mining	185	199	32	45	15	25
Crude petroleum and natural gas	5,273	5,064	1,581	1,560	935	949
Nonmetallic mining, quarrying	418	431	101	101	41	52
Construction	7,335	9,674	1,969	2,823	921	1,337
General building contractors	878	1,057	211	314	88	183
General contractors, except building	5,509	7,360	1,586	2,172	714	1,154
Special trade contractors	948	1,258	172	337	119	
Manufacturing	245,550	308,513	63,131	85,141	41,472	64,386
Durable goods	175,405	234,783	49,485	67,248	33,941	53,489
Ordnance	8,982	8,408	3,370	3,153	2,340	2,242
Lumber and wood products	1,487	1,533	301	390	200	258
logging	73	78	26	33		
Sawmill planning, mill workers	994	971	205	256	145	187
Miscellaneous wood products	426	483	76	101	55	71
Furniture and fixtures	2,292	2,755	405	631	158	260
Stone, clay, glass products	3,872	4,438	757	1,024	488	690
Glass and glass products	1,252	1,388	264	372	175	248
Cement, concrete, plaster	1,316	1,568	328	433	169	240
Structural clay products	200	157	39	39	11	14
Pottery and related products	192	175	22	24	12	16
Miscellaneous nometallic, stone	902	1,150	104	156	111	172
Primary metal industries	11,478	11,415	2,325	2,848	1,340	1,654
Blast furnaces, steel works	5,649	5,292	1,115	1,363	655	752
Other primary steel	2,057	2,072	426	523	152	226
Primary aluminum industry	1,574	1,733	338	410	303	394
Other primary nonferrous	2,203	2,319	446	552	230	282
Fabricated metal products	10,404	13,179	2,069	3,057	1,004	1,590
Cutlery, other hardware	1,863	1,869	302	405	213	293
Fabricated metal products	2,861	3,347	632	892	294	456
Screw machine products	896	984	127	184	85	132
Metal stamping	1,477	2,275	335	549	96	185
Miscellaneous metal products	3,307	4,704	673	1,027	316	524
Machinery, except electrical	58,204	106,216	17,739	31,673	14,275	29,299
Engines and turbines	1,607	2,414	412	666	269	455
Farm machinery, equipment	2,066	2,127	449	570	236	318
Construction machines	3,987	4,977	890	1,217	740	1,036
Metalworking machinery	3,139	4,064	798	1,121	328	438
Office, accounting machines	5,093	5,732	1,358	1,492	1,188	1,385
Electronic computing equipment	34,108	76,183	12,005	24,082	10,680	24,451
Machinery n.e.c.	8,204	10,721	1,827	2,525	834	1,216
Electrical machinery	36,939	43,387	11,208	11,725	6,522	9,047
Household appliances	2,011	2,286	423	552	300	399
Radio, TV, communication equipment	16,392	16,149	5,278	4,817	2,931	3,510
Electrical machinery, n.e.c.	18,536	25,027	5,507	6,356	3,291	5,138
Transportation equipment	29,709	28,210	8,531	8,752	5,765	5,755
Motor vehicle equipment	9,429	11,909	2,096	3,087	1,333	2,023
Aircraft and parts	17,263	11,885	5,673	4,423	3,982	2,953
Ship, boat building, repair	2,282	3,525	617	1,027	361	637
Railroad equipment	460	460	98	123	69	92
Mobile dwelling	107	172	8	18	14	39
Cycles, miscellaneous transportation equipment	168	258	39	74	6	11
Professional, scientific instrument	8,424	11,667	2,177	3,286	1,535	2,343
Scientific instruments	3,269	4,676	849	1,266	679	1,033

Appendix table C-1. Employment in selected computer occupations by detailed industry—Continued

Industry	Computer and peripheral equipment operators		Keypunch operators		Data processing machine repairers	
	1970	1980	1970	1980	1970	1980
Total all industries	150,005	274,998	300,006	235,000	36,001	72,598
Agriculture, forestry, fisheries	123	76	408	451	5	
Agriculture	89	30	279	389	5	
Agricultural production	35		122	328		
Services, except horticulture	47	30	136	54		
Horticultural services	7		21	7	5	
Forestry	27	38	129	63		
Fisheries	7	8				
Mining	1,642	2,094	1,785	1,110	41	59
Metal mining	84	131	207	157	6	11
Coal mining	60	79	78	52		
Crude petroleum and natural gas	1,367	1,702	1,355	805	35	48
Nonmetallic mining, quarrying	131	182	145	96		
Construction	1,432	2,779	2,918	2,735	95	
General building contractors	153	235	409	325	17	
General contractors, except building	1,124	2,043	2,062	1,991	23	
Special trade contractors	155	502	447	419	55	
Manufacturing	45,455	76,109	84,756	60,702	10,736	22,175
Durable goods	30,002	51,605	51,665	40,906	10,312	21,535
Ordance	1,617	1,888	1,525	974	130	151
Lumber and wood products	284	475	697	410	5	
Logging	14	25	33	20		
Sawmill, planning, mill workers	136	239	503	289	5	
Miscellaneous wood products	134	211	161	100		
Furniture and fixtures	495	869	1,207	933	27	62
Stone, clay, glass products	960	1,646	1,661	1,078	6	
Glass and glass products	229	399	578	369	6	
Cement, concrete, plaster	342	585	477	310		
Structural clay products	37	46	113	58		
Pottery and related products	60	82	98	53		
Miscellaneous nometallic, stone	292	534	395	288		
Primary metal industries	2,421	3,501	5,288	3,268	104	144
Blast furnaces, steel workers	1,172	1,620	2,632	1,452	75	105
Other primary steel	485	731	972	553	22	39
Primary aluminum industry	304	464	623	465	6	
Other primary nonferrous	460	687	1,061	798	6	
Fabricated metal products	2,262	4,256	5,048	4,276	21	
Cutlery, other hardware	295	474	1,053	697		
Fabricated metal products	583	1,088	1,331	911	21	
Screw machine products	175	317	509	351		
Metal stamping	422	849	624	692		
Miscellaneous fabricated metal products	787	1,528	1,531	1,625		
Machinery, except electrical	7,580	16,806	10,588	10,601	8,022	17,837
Engines and turbines	277	554	637	708	12	31
Farm machinery, equipment	391	622	971	589	19	28
Construction machines	672	1,113	1,656	1,543	29	68
Metalworking machinery	711	1,207	1,254	1,186	48	112
Office, accounting machines	613	944	810	519	1,124	1,392
Electronic computing equipment	3,131	9,182	1,653	2,569	6,639	15,899
Machinery, n.e.c.	1,785	3,185	3,607	3,488	151	307
Electrical machinery	6,569	10,470	11,335	9,871	1,305	2,274
Household appliances	386	639	892	674	10	22
Radio, TV, communication equipment	2,940	3,582	4,627	3,290	616	950
Electrical machinery, n.e.c.	3,243	6,248	5,816	5,983	679	1,302
Transportation equipment	5,617	7,567	9,405	5,608	391	528
Motor vehicle equipment	1,926	3,558	4,028	3,136	46	105
Aircraft and parts	3,076	2,724	4,258	1,519	274	266
Ship, boat building, repair	483	1,047	750	657	71	157
Railroad equipment	75	112	218	133		
Mobile dwelling	25	50	60	65		
Cycles, miscellaneous transportation equipment	32	76	91	97		
Professional, scientific instrument	1,498	2,828	2,945	2,716	269	494
Scientific instruments	529	980	1,019	1,035	193	362

Appendix table C-1. Employment in selected computer occupations by detailed industry—Continued

Industry	Total all occupations		Computer programmers		Computer systems analysts	
	1970	1980	1970	1980	1970	1980
Manufacturing—Continued						
Durable goods—Continued						
Professional, scientific instrument—Continued						
Optical, health service supplies	1,920	2,630	468	719	227	332
Photo equipment and supplies	2,922	4,071	788	1,207	606	949
Watches and clock devices	313	291	72	94	23	29
Miscellaneous manufacturing	3,618	3,577	597	709	324	351
Nondurable goods	70,045	73,730	13,646	17,893	7,431	10,897
Food and kindred products	11,149	10,430	1,940	2,282	938	1,110
Meat products	1,859	7,627	273	323	79	94
Dairy products	1,554	1,024	231	192	157	141
Canning and preserving	1,772	1,949	398	551	156	175
Grain-mill products	928	877	163	182	80	91
Bakery products	982	1,007	153	198	29	100
Confectionery products	653	573	115	138	49	59
Beverage industries	1,569	1,558	275	323	128	146
Miscellaneous preparation	1,826	1,655	332	375	254	304
Tobacco manufacturing	801	619	210	179	74	68
Textile mill products	6,606	6,753	1,193	1,547	565	784
Knitting mills	1,506	1,441	215	272	76	98
Dyeing, finishing textiles	667	715	123	157	51	69
Floor coverings	886	985	158	213	76	108
Yarn, fabric mills	3,056	3,198	588	771	316	455
Miscellaneous textile mill products	491	415	109	134	46	54
Apparel, textile products	6,310	5,952	927	1,144	419	528
Apparel and accessories	5,577	5,298	835	1,028	374	458
Miscellaneous fabricated products	733	653	92	116	45	70
Paper and allied products	6,039	6,726	1,082	1,434	703	997
Pulp, paper, paperboard mills	3,036	2,920	610	690	396	467
Paperboard containers, boxes	1,055	1,164	190	292	74	132
Miscellaneous paper and pulp products	1,948	2,438	282	452	233	398
Printing and publishing	12,399	14,451	2,277	4,135	998	2,132
Newspaper publishing printing	2,317	2,401	459	558	118	115
Printing, publishing except news	10,082	12,050	1,818	3,577	880	2,017
Chemical and allied product	14,148	16,474	3,333	4,319	2,244	3,051
Industrial chemicals	4,544	4,968	1,379	1,625	767	932
Plastics, synthetics	1,067	1,663	283	444	150	248
Synthetic fibers	1,162	1,265	236	311	179	242
Drugs and medicines	2,875	3,625	639	918	670	990
Soaps and cosmetics	2,078	2,436	358	508	231	337
Paints, varnishes	1,040	1,070	133	170	92	127
Agricultural chemicals	575	508	130	153	54	65
Miscellaneous chemicals	807	839	175	190	101	110
Petroleum and coal products	5,350	4,161	1,345	1,042	1,018	821
Petroleum refining	5,005	3,907	1,314	1,011	980	783
Miscellaneous petroleum, coal product	345	254	31	31	38	38
Rubber, miscellaneous plastic products	5,418	5,738	1,043	1,241	439	655
Rubber products	3,768	3,547	794	777	308	374
Miscellaneous plastic products	1,650	2,191	249	464	131	281
Leather products	1,925	2,630	296	570	133	751
Leather tanning, finishing	110	79	7	6		
Footwear, except rubber	1,339	1,287	228	275	65	59
All other leather products	476	1,264	61	289	68	692
Transportation, other public utilities	51,648	49,051	10,015	11,700	5,383	6,634
Transportation, total	21,800	18,500	3,363	3,733	1,824	2,246
Railroads railway express	8,717	4,808	832	621	524	435
Local, interurban transit	562	543	62	85	39	33
Street railways, bus line	533	538	58	85	34	33
Taxicab service	29	5	4	-	5	
Trucking and warehousing	5,262	4,785	684	901	271	387
Trucking services	4,727	4,352	616	824	244	358
Warehousing and storage	535	433	68	77	27	29
Water transportation	1,150	983	271	307	133	161
Air transportation	4,627	5,925	1,201	1,476	661	990

Appendix table C-1. Employment in selected computer occupations by detailed industry—Continued

Industry	Computer and peripheral equipment operators		Keypunch operators		Data processing machine repairers	
	1970	1980	1970	1980	1970	1980
Manufacturing—Continued						
Durable goods—Continued						
Professional, scientific instrument—Continued						
Optical, health service supplies	330	611	857	896	38	72
Photo equipment and supplies	607	1,184	883	671	38	60
Watches and clock devices	32	54	186	114		
Miscellaneous manufacturing	699	1,300	1,966	1,172	32	45
Nondurable goods	15,453	24,504	33,091	19,796	424	640
Food and kindred products	2,752	4,134	5,441	2,796	78	108
Meat products	438	720	1,062	6,490	7	
Dairy products	350	376	808	315	8	
Canning and preserving	447	742	741	414	30	67
Grain-mill products	277	403	408	201		
Bakery products	264	427	536	282		
Confectionery products	134	213	355	163		
Beverage industries	450	694	699	372	17	23
Miscellaneous food preparation	392	559	832	399	16	18
Tobacco manufacturing	205	250	312	122		
Textile mill products	1,278	2,081	3,549	2,323	21	18
Knitting mills	223	375	992	696		
Dyeing, finishing textiles	181	295	305	176	7	18
Floor coverings	236	403	416	261		
Yarn, fabric mills	607	964	1,531	1,008	14	
Miscellaneous textile mill products	31	44	305	183		
Apparel, textile products	1,127	1,877	3,829	2,403	8	
Apparel and accessories	1,000	1,681	3,368	2,131		
Miscellaneous fabricated products	127	195	461	272	8	
Paper and allied products	1,322	2,223	2,771	1,807	161	265
Pulp, paper, paperboard mills	762	1,120	1,263	643	6	
Paperboard containers, boxes	197	369	594	371		
Miscellaneous paper and pulp product	363	734	914	589	156	265
Printing and publishing	2,976	4,843	6,072	3,208	76	133
Newspaper publishing printing	768	1,168	948	515	24	45
Printing, publishing except news	2,208	3,675	5,124	2,693	52	88
Chemical and allied product	3,045	5,142	5,483	3,885	43	77
Industrial chemicals	936	1,468	1,440	907	22	36
Plastics, synthetics	309	514	318	343	7	14
Synthetic fibers	208	352	539	360		
Drugs and medicines	540	1,010	1,026	707		
Soaps and cosmetics	442	771	1,039	805	8	15
Paints, varnishes	243	404	572	369		
Agriculture chemicals	156	229	229	149	6	12
miscellaneous chemicals	211	294	320	245		
Petroleum and coal products	1,143	1,384	1,829	889	15	25
Petroleum refining	1,088	1,310	1,608	778	15	25
Miscellaneous petroleum, coal product	55	74	221	111		
Rubber, miscellaneous plastic products	1,235	2,008	2,686	1,834	15	
Rubber products	862	1,155	1,799	1,241	5	
Miscellaneous plastic products	373	853	887	593	10	
Leather products	370	562	1,119	733	7	14
Leather tanning, finishing	27	38	76	35		
Footwear, except rubber	252	384	794	569		
All other leather products	91	140	249	129	7	14
Transportation, other public utilities	11,072	16,577	24,643	13,378	535	762
Transportation, total	4,397	6,230	12,114	6,148	102	143
Railroads railway express	1,676	1,632	5,651	2,080	34	40
Local, interurban transit	129	254	327	171	5	
Street railways, bus line	129	254	307	166	5	
Taxicab service			20	5		
Trucking and warehousing	938	1,538	3,364	1,950	5	9
Trucking service	823	1,377	3,044	1,793		
Warehousing and storage	115	161	320	157	5	9
Water transportation	143	216	603	299		
Air transportation	1,210	2,200	1,504	1,172	51	87

Appendix table C-1. Employment in selected computer occupations by detailed industry—Continued

Industry	Total all occupations		Computer programmers		Computer systems analysts	
	1970	1980	1970	1980	1970	1980
Transportation, other public utilities—Continued						
Transportation, total—Continued						
Pipelines	371	325	116	91	42	33
Transportation services	1,111	1,231	197	252	154	207
Communications, utilities, sanitary	29,415	29,832	6,652	7,967	3,559	4,388
Communications	17,228	17,959	3,538	4,479	2,219	2,877
Telephone (wire and radio)	15,606	16,137	3,103	3,949	1,948	2,519
Telegraph, miscellaneous communication service	1,188	1,555	291	363	205	258
Radio broadcasting, TV	746	804	144	167	66	100
Utilities, sanitary services	12,629	12,405	3,114	3,488	1,340	1,411
Electric light and power	4,526	4,711	1,127	1,305	425	519
Electric-gas utilities	4,196	3,748	879	942	522	545
Gas, steam supply systems	2,963	2,814	905	943	304	316
Water supply	936	948	149	215	42	60
Sanitary services	167	226	30	50	39	59
Other utilities, n.e.c.	89	113	24	33	8	12
Wholesale and retail trade	94,970	107,213	14,080	16,843	10,812	12,960
Wholesale trade	63,927	71,470	10,059	11,432	8,548	9,660
Wholesale except miscellaneous wholesale	51,239	58,628	8,257	9,265	7,438	8,297
Motor vehicles and equipment	4,380	5,284	565	831	205	274
Drugs, chemicals, allied products	5,095	4,673	695	811	261	352
Dry goods and apparel	2,078	1,915	310	366	165	192
Food and related products	5,847	5,091	873	1,011	290	393
Farm products raw material	652	472	123	117	49	52
Electrical goods	4,885	7,344	691	1,152	620	1,038
Hardware, plumbing	1,804	1,378	278	334	54	74
Machinery equipment supplies	26,497	32,481	4,722	4,643	5,793	5,932
Miscellaneous wholesale trade	12,688	12,633	1,802	2,167	1,110	1,353
Metals and minerals, n.e.c.	1,410	1,752	179	218	185	250
Petroleum products	2,404	1,977	473	564	358	440
Scrap and waste material	85	104	16	23		
Alcoholic beverages	1,302	1,352	115	141	35	46
Paper and its products	1,372	1,494	151	184	186	230
Lumber, construction materials	726	799	96	118	45	46
Wholesale, n.e.c.	5,389	5,571	772	919	301	341
Retail Trade	31,043	35,742	4,021	5,411	2,264	3,300
Building materials	960	714	156	156	53	46
Lumber, building materials	563	453	91	96	39	27
Hardware and farm equipment	397	261	65	60	14	19
General merchandise, total	16,041	18,601	2,064	2,914	1,278	1,928
Department, mail order	12,244	14,451	1,579	2,276	897	1,435
Limited price stores	1,020	688	99	101	105	110
Vending machine operators	251	302	23	40	21	37
Direct selling	788	831	185	215	43	34
Miscellaneous merchandise stores	1,738	2,329	178	282	212	312
Food and dairy stores	4,038	5,368	493	786	202	376
Grocery stores	3,720	4,963	468	746	186	345
Dairy product stores	124	152	13	19	5	7
Retail bakeries	112	148	8	21		
Food stores, n.e.c.	82	106	4		11	24
Auto dealers, gas stations	1,389	1,909	107	199	107	199
Motor vehicle dealers	769	996	75	144	20	
Tire, battery accessory	523	722	32	55	30	43
Gasoline service stations	5	0				
miscellaneous vehicle dealers	35	35				
Apparel and accessories	2,260	1,889	216	227	70	134
Apparel, accessories stores	1,673	1,391	140	136	44	107
Shoe stores	587	498	76	91	26	27
Furniture and appliances	1,432	1,343	261	309	92	129
Home furnishing stores	656	607	88	100	24	60
Appliance, TV, radio stores	776	736	173	209	68	69
Eating and drinking places	1,106	1,677	105		108	
Miscellaneous retail trade stores	3,874	4,396	619	820	411	644
Drug stores	999	1,031	172	243	61	93

Appendix table C-1. Employment in selected computer occupations by detailed industry—Continued

Industry	Computer and peripheral equipment operators		Keypunch operators		Data processing machine repairers	
	1970	1980	1970	1980	1970	1980
Transportation, other public utilities—Continued						
Transportation, total—Continued						
Pipelines	91	139	115	55	7	7
Transportation services	210	351	550	421		
Communications, utilities, sanitary	6,675	10,247	12,529	7,230		
Communications	4,028	6,502	7,010	3,482	433	619
Telephone (wire and radio)	3,628	5,871	6,550	3,214	377	584
Telegraph, miscellaneous communication service	260	412	177	113	255	409
Radio broadcasting, TV	140	219	283	156	113	162
Utilities, sanitary services	2,647	3,745	5,519	3,748	9	13
Electric light and power	939	1,367	1,979	1,485	56	35
Electric-gas utilities	785	1,041	1,965	1,185	45	35
Gas, steam supply systems	667	882	1,082	673	5	
Water supply	193	338	401	335	6	
Sanitary services	39	75	59	42		
Other utilities, n.e.c.	24	41	33	27		
Wholesale and retail trade	16,345	27,927	43,269	32,595	10,464	16,888
Wholesale trade	9,490	15,394	25,774	18,736	10,056	16,248
Wholesale except miscellaneous wholesale	7,389	12,576	18,518	12,940	9,637	15,550
Motor vehicles and equipment	1,054	1,910	2,556	2,269		
Drugs, chemicals, allied products	1,073	1,747	3,058	1,763	8	
Dry goods and apparel	389	602	1,214	755		
Food and related products	1,322	1,899	3,347	1,788	15	0
Farm product raw material	134	173	346	130		
Electrical goods	880	1,812	2,416	2,751	278	591
Hardware, plumbing	278	417	1,194	553		
Machinery equipment supplies	2,259	4,017	4,387	2,930	9,336	14,959
Miscellaneous wholesale trade	2,101	2,818	7,256	5,797	419	498
Metals and minerals, n.e.c.	230	342	794	680	22	44
Petroleum products	8		1,553	951	12	22
Scrap and waste material	30	45	39	36		
Alcoholic beverages	252	386	893	768	7	11
Paper and its products	247	386	769	665	19	29
Lumber, construction materials	183	290	402	345		
Wholesale, n.e.c.	1,151	1,368	2,806	2,351	359	592
Retail Trade	6,855	12,533	17,495	13,858	408	640
Building materials	202	256	549	256		
Lumber, building materials	161	211	272	119		
Hardware and farm equipment	41	45	277	137		
General merchandise, total	3,538	6,464	9,161	7,295		
Department, mail order	2,664	5,078	7,104	5,662		
Limited price stores	202	210	614	267		
Vending machine operators	30	59	177	166		
Direct selling	210	275	350	307		
Miscellaneous merchandise stores	432	842	916	893		
Food and dairy stores	1,078	1,923	2,265	2,283		
Grocery stores	989	1,772	2,077	2,100		
Dairy product stores	25	45	81	81		
Retail bakeries	48	76	56	51		
Food stores, n.e.c.	16	31	51	51		
Auto dealers, gas stations	292	536	850	975	33	
Motor vehicle dealers	175	319	476	533	23	
Tire, battery accessory	117	217	339	407	5	
Gasoline service stations					5	
Miscellaneous vehicle dealers			35	35		
Apparel and accessories	506	714	1,468	814		
Apparel, accessories stores	393	543	1,096	605		
Shoe stores	113	171	372	209		
Furniture and appliances	270	399	744	426	65	80
Home furnishing stores	146	220	398	227		
Appliances, TV, radio stores	124	179	346	199	65	80
Eating and drinking places	279	1,077	614	600		
Miscellaneous retail trade stores	690	1,164	1,844	1,208	310	560
Drug stores	196	361	570	334		

Appendix table C-1. Employment in selected computer occupations by detailed industry—Continued

Industry	Total all occupations		Computer programmers		Computer systems analysts	
	1970	1980	1970	1980	1970	1980
Wholesale and retail trade—Continued						
Retail Trade—Continued						
Miscellaneous retail trade stores—Continued						
Liquor stores	105	103	13	21		
Farm, garden supply stores	239	308	51	70	6	20
Jewelry stores	255	193	28	33	19	29
Fuel and ice dealers	563	399	50	45	36	41
Retail florists	11					
Miscellaneous retail trade stores	1,702	2,359	305	408	289	461
Finance, insurance, real estate	107,464	138,916	21,557	28,243	9,275	14,525
Finance, total	54,816	86,052	9,601	15,544	4,409	8,662
Banking	41,479	66,808	7,088	11,387	3,283	6,749
Credit agencies	6,517	7,923	1,218	2,051	504	882
Stock brokers, investment	6,820	9,171	1,295	2,106	622	1,031
Insurance	50,750	50,734	11,627	12,235	4,696	5,594
Real Estate	1,898	2,129	329	464	170	268
Services, total	188,501	313,858	51,819	87,880	28,383	56,388
Hotels and lodging places	594	781	101	136	47	
Hotels and motels	592	781	101	136	46	
Lodging places, except hotels	2				1	
Other personal services	802	580	51	79	52	91
Laundry, cleaning	794	580	51	79	52	91
Beauty shops	8					
Barber shops						
Shoe repair shops						
Dressmaking shops						
Other personal services						
Miscellaneous business services	92,487	169,143	26,953	48,548	16,017	34,614
Advertising	873	851	221	264	85	101
Business management services	7,244	12,412	2,059	3,576	1,580	3,071
Commercial R and D	4,188	7,986	1,872	3,546	1,043	2,009
Computer programming	59,669	114,470	19,890	36,168	11,710	26,655
Detective and protective	415	744	86	169	8	24
Employment, temporary help	6,838	9,850	320	659	61	139
Services building	49	106				
Other miscellaneous services	13,211	22,724	2,505	4,166	1,530	2,615
Automobile repair services	812	1,247	109	196	120	220
Auto repair	39	56				
Auto services, except repair	773	1,191	109	196	120	220
Other repair services	2,280	3,671				
Electrical repair shop	1,012	1,631				
Other repair services	1,268	2,040				
Motion pictures, theaters	888	1,151	198	290	99	156
Miscellaneous entertainment	298	446	46	78	6	
Bowling alleys, billiards						
Miscellaneous entertainment	298	446	46	78	6	
Medical, other health	14,007	17,139	2,623	4,265	1,480	3,120
Offices of physicians						
Offices of dentists						
Offices of chiropractors						
Hospitals	11,917	16,846	2,122	3,589	1,118	2,070
Convalescent institutions	155	583	27	74	40	170
Health practitioners, n.e.c.						
Health services n.e.c	1,935	2,241	474	602	322	411
Legal services	212	121	31	36	5	
Educational services	32,797	48,048	11,518	17,242	3,695	5,948
Elementary, secondary	4,514	6,776	1,081	1,635	521	948
Colleges and universities	25,357	36,611	9,750	14,447	2,769	4,312
Libraries	163	289	55	83	25	39
Educational services, n.e.c	2,754	4,372	623	1,077	380	649
Museums, art galleries, zoos	49	78	17	27	6	11
Nonprofit organizations	6,515	8,744	988	1,663	603	940
Religious organizations	591	633				

Appendix table C-1. Employment in selected computer occupations by detailed industry--Continued

Industry	Computer and peripheral equipment operators		Keypunch operators		Data processing machine repairers	
	1970	1980	1970	1980	1970	1980
Wholesale and retail trade--Continued						
Retail Trade--Continued						
Miscellaneous retail trade stores--Continued						
Liquor stores	8	31	84	51		
Farm, garden supply stores	58	104	124	114		
Jewelry stores	44	71	164	60		
Fuel and ice dealers	170	210	301	93	6	10
Retail florists			11			
Miscellaneous retail trade stores	214	386	590	554	304	550
Finance, insurance, real estate	26,284	54,932	50,057	40,531	291	685
Finance, total	16,151	38,236	24,470	23,087	185	523
Banking	12,564	30,296	18,378	17,893	166	483
Credit agencies	1,824	4,315	2,971	2,726		
Stock brokers, investment	1,763	3,625	3,121	2,469	19	40
Insurance	9,698	16,005	24,623	16,738	106	162
Real Estate	435	690	964	707		
Services, total	31,709	70,772	63,782	68,735	12,808	30,083
Hotels and lodging places	127	306	316	339	3	
Hotels and motels	127	306	315	339	3	
Lodging places, except hotels			1			
Other personal services	104	117	590	293	5	
Laundry, cleaning	104	117	582	293	5	
Beauty shops			8			
Barber shops						
Shoe repair shops						
Dressmaking shops						
Other personal services						
Miscellaneous business services	12,962	31,451	28,112	32,727	8,443	21,803
Advertising	166	258	397	228	4	
Business management services	1,030	2,460	2,235	2,467	340	838
Commercial R and D	674	1,582	519	665	80	184
Computer programming	8,651	21,225	12,974	13,470	6,444	16,952
Detective and protective	110	281	196	243	15	27
Employment, temporary help			6,457	9,052		
Services buildings					49	106
Other miscellaneous services	2,331	5,645	5,334	6,602	1,511	3,969
Automobile repair services	156	317	427	514		
Auto repair	35	56	4			
Auto services except repair	121	261	423	514		
Other repair services					2,280	3,671
Electrical repair shop					1,012	1,631
Other repair services					1,268	2,040
Motion pictures, theaters	161	384	422	371	8	
Miscellaneous entertainment	69	174	177	194		
Bowling alleys, billiards						
Miscellaneous entertainment	69	174	177	194		
Medical, other health	3,170	6,927	6,706	5,827	28	
Offices of physicians						
Offices of dentists						
Offices of chiropractors						
Hospitals	2,865	6,313	5,784	4,874	28	
Convalescent institutions	32	217	56	122		
Health practitioners, n.e.c.						
Health services n.e.c.	273	397	866	831		
Legal services	26	54	150	31		
Educational services	7,149	13,548	10,183	10,950	252	360
Elementary, secondary	944	1,820	1,946	2,373	22	
Colleges and universities	5,702	10,615	6,959	7,019	177	218
Libraries	34	98	49	69		
Educational services, n.e.c.	469	1,015	1,229	1,489	53	142
Museums, art galleries, zoos	18	35	8	5		
Nonprofit organizations	1,148	2,350	3,723	3,682	53	109
Religious organizations	125	221	466	412		

Appendix table C-1. Employment in selected computer occupations by detailed industry—Continued

Industry	Total all occupations		Computer programmers		Computer systems analysts	
	1970	1980	1970	1980	1970	1980
Services, total—Continued						
Nonprofit organizations—Continued						
Welfare services	2,924	4,060	442	753	396	574
Residential welfare	23	20				
Nonprofit membership	2,977	4,031	546	910	207	366
Private households						
Other professional related services	36,761	59,710	9,184	15,320	6,254	11,288
Engines and architectural services	3,458	4,557	1,322	1,354	790	1,195
Accounting, auditing	28,125	48,365	5,814	11,221	4,342	8,556
Miscellaneous professional services	5,178	6,786	2,048	2,745	1,122	1,537
Government, total	62,637	63,470	11,924	15,376	5,356	7,599
Federal public administration	31,636	31,273	6,133	7,091	1,914	2,465
Postal services	427	912	81	164	60	191
Federal public administration	31,209	30,361	6,052	6,927	1,854	2,274
State public administration	19,195	20,432	3,355	5,101	2,201	3,407
Local public administration	11,806	11,765	2,436	3,184	1,241	1,727

	Computer and peripheral equipment operators		Keypunch operators		Data processing machine repairers	
Services, total—Continued						
Nonprofit organizations—Continued						
Welfare services	450	895	1,630	1,838	6	
Residential welfare			23	20		
Nonprofit membership	573	1,234	1,604	1,412	47	109
Private households						
Other professional related services	6,619	15,159	12,968	13,803	1,736	4,140
Engines and architectural services	573	1,098	656	664	117	246
Accounting, auditing	5,218	12,672	11,217	12,153	1,534	3,763
Miscellaneous professional services	828	1,388	1,095	985	85	131
Government, total	15,943	23,732	28,388	14,817	1,026	1,946
Federal public administration	10,673	13,778	11,946	5,993	970	1,946
Postal services	161	490	125	67		
Federal public administration	10,512	13,288	11,821	5,926	970	1,946
State public administration	3,157	6,164	10,470	5,760	12	
Local public administration	2,113	3,790	5,972	3,064	44	

SOURCE: Bureau of Labor Statistics

Appendix D. Employment distribution of computer occupations, by state, 1970

Region and State	Total	Programers	Systems analyst	Peripheral equip. operators	Keypunch operators	Data processing machine repairers
TOTAL 50 STATES AND D.C. .	100.0	100.0	100.0	100.0	100.00	100.0
New England						
Maine	0.2	0.1	0.1	0.2	0.3	0.2
New Hampshire	0.3	0.3	0.2	0.2	0.3	0.6
Vermont	0.1	0.1	0.2	0.2	0.1	0.1
Massachusetts	3.9	4.3	3.8	3.6	4.0	3.4
Rhode Island	0.4	0.3	0.3	0.4	0.4	0.3
Connecticut	2.0	1.8	2.5	1.7	2.0	1.5
Middle Atlantic						
New York	12.1	13.4	11.3	12.5	11.6	11.5
New Jersey	4.9	5.3	5.3	4.7	4.7	4.9
Pennsylvania	6.0	5.5	5.5	6.1	6.4	5.7
East North Central						
Ohio	5.2	4.8	5.1	5.2	5.5	4.7
Indiana	2.2	1.5	1.6	1.9	2.5	4.6
Illinois2d	6.9	6.0	6.3	6.9	7.8	6.2
Michigan	4.0	3.7	3.7	4.0	4.2	3.9
Wisconsin	1.9	1.5	1.5	2.2	2.2	1.4
West North Central						
Minnesota	2.2	2.7	2.5	1.9	1.8	2.6
Iowa	0.9	0.7	0.8	1.0	1.0	0.8
Missouri	2.4	2.1	1.9	2.2	2.8	2.0
North Dakota	0.1	0.1	[1]	[1]	0.1	0.1
South Dakota	0.1	[1]	[1]	0.1	0.1	0.1
Nebraska	0.5	0.5	0.5	0.5	0.6	0.4
Kansas	0.8	0.6	0.6	0.8	1.1	0.8
South Atlantic						
Delaware	0.3	0.3	0.3	0.3	0.3	0.3
Maryland	3.6	4.2	5.7	3.4	2.4	3.1
District of Columbia	0.7	0.7	0.9	0.7	0.6	0.3
Virginia	2.6	3.0	4.2	2.2	2.0	2.5
West Virginia	0.4	0.3	0.2	0.4	0.4	0.2
North Carolina	1.6	1.5	1.3	1.7	1.8	1.3
South Carolina	0.6	0.5	0.4	0.6	0.8	0.6
Georgia	1.8	1.5	1.2	1.7	2.1	1.8
Florida	2.4	2.3	2.2	2.7	2.3	2.7
East South Central						
Kentucky	0.9	0.6	0.6	0.9	1.2	0.6
Tennessee	1.3	1.0	1.1	1.2	1.5	1.1
Alabama	1.0	1.2	1.0	0.8	1.1	1.1
Mississippi	0.3	0.3	0.2	0.3	0.4	0.3
West South Central						
Arkansas	0.3	0.3	0.2	0.3	0.4	0.2
Louisiana	0.9	0.7	0.6	1.1	1.0	1.0
Oklahoma	1.1	1.0	1.1	1.2	1.1	1.4
Texas	5.3	5.2	5.1	5.7	5.2	5.8
Mountain						
Montana	0.1	0.1	[1]	0.1	0.2	0.1
Idaho	0.1	0.2	0.1	0.2	0.1	0.1
Wyoming	0.1	[1]	[1]	0.1	0.1	0.1
Colorado	1.2	1.4	1.4	1.3	1.1	1.1
New Mexico	0.4	0.5	0.4	0.6	0.3	0.4
Arizona	0.8	0.2	1.0	0.7	0.7	0.9
Utah	0.7	0.5	0.5	0.7	0.7	1.2
Nevada	0.2	0.2	0.1	0.2	0.1	0.1
Pacific						
Washington	1.4	1.4	1.7	1.4	1.4	1.6
Oregon	0.7	0.6	0.6	0.6	0.9	0.5
California	11.8	13.8	13.6	12.0	9.9	13.1
Alaska	0.1	0.1	0.1	0.1	0.1	0.1
Hawaii	0.4	0.4	0.4	0.3	0.3	0.4

[1] Less than .05 percent

SOURCE: 1970 Census of Population.

Appendix E. Methods and Assumptions for BLS Industry Occupational Matrix Projections of Computer Manpower Requirements

The method for projecting computer manpower requirements to 1980 used in this study is the same as that used by the Bureau of Labor Statistics in other studies of future occupational manpower needs. This procedure is summarized briefly in the section that follows. Additional detail may be found in BLS Bulletin 1737, Tomorrow's Manpower Needs, Appendix A.

Framework for developing projections

The Bureau of Labor Statistics has prepared national industry and occupational manpower projections since the mid-1950's. The most current set of projections is for 1980 and 1985. The projections of manpower requirements for five computer occupations developed in this study—programmers, systems analysts, computer and peripheral equipment operators, keypunch operators, and data processing machine repairers—have recently been included in the Bureau's systematic approach to developing projections.

Underlying the Bureau's projections, and therefore, the projections of computer manpower presented in this report, are assumptions concerning the economy in 1980. Among these are:

> Fiscal, monetary, and manpower training and educational programs will achieve a satisfactory balance between relatively low unemployment and relative price stability, permitting achievement of the long-term economic growth rate. The projections assume a 4-percent unemployment rate (of the civilian labor force) and a 3-percent annual increase in the implicit price deflator for gross national product.
>
> The institutional framework of the American economy will not change radically.
>
> Economic, social, technological, and scientific trends will continue, including values placed on work, education, income, and leisure.
>
> Efforts to solve major domestic problems such as those of air and water pollution, solid waste disposal, urban congestion, inadequate industrial safety, and energy shortages may consume more productive resources but will not have more than a marginal effect on long-term growth.

Projection methods

Briefly, ratios indicating the proportion of employment represented by each of the five computer occupations were developed for the base year, 1970, for each of the 200 industries included in the latest BLS industry-occupational matrix. Estimates of these ratios were then projected to 1980 and applied to the projected total 1980 employment requirements for each industry to yield estimates of employment for each of the computer occupations. Total national requirements for each computer occupation were obtained by summing across all industries.

Prior to this study, data on computer occupations were not covered in the BLS industry-occupational matrix. The reason for this obvious data gap was that the then existing matrix was based on the 1960 Census occupational information system,[1] in which computer occupations were not listed separately. However, the 1970 Census greatly expanded its industry and occupational coverage, including the major computer occupations. The latest BLS matrix is based on the 1970 Census industry-occupational employment estimates refined and adjusted by BLS staff to reflect unallocated workers, seasonal employment factors, BLS industry employment estimates, and occupational estimates derived from other in-depth studies.

The Census Bureau further provided BLS with the total occupational employment estimates of 1960 for all new occupations added to the 1970 Census. BLS distributed these occupational employment estimates by industry, creating comparable and refined 1960-70 trend data. These trend data provided the basis for preliminary 1980 matrix occupation-industry employment ratio projections, which were subsequently applied to BLS

[1] See *Tomorrow's Manpower Needs,* Volume IV revised (BLS Bulletin 1737, 1971).

projections of 1980 industry employment. The resulting numbers were summed across all industries to obtain preliminary 1980 matrix total occupational employment projections. Thereafter, the preliminary ratios were evaluated and, when deemed necessary, adjusted.

Several sources provided supplementary data that were used to evaluate the preliminary 1980 ratios for computer occupations. The most significant of these sources included the following:

- The computer user survey conducted as part of this Computer Manpower Study, provided information on current and future computer employment, education and training, applications and equipment, and technological developments by industry. Similar information resulting from the computer manufacturer interview and library research segments of this study also influenced the judgment of the analysts who evaluated the preliminary 1980 ratios.
- National employment estimates for some computer occupations in selected industries from the BLS Area Wage Surveys were analyzed and weighed in appraising the preliminary ratios. These data, however, exclude certain major industries such as government and do not reflect employment in non-metropolitan areas or smaller sized establishments.
- Employment information for some computer workers employed by the Federal Government was available from an annual report published by the General Services Administration.[2] Although these data are not strictly comparable to data collected in the Decennial Census or monthly Current Population Surveys because they are measured in manhours, they were useful in evaluating the preliminary 1980 computer employment ratios. Some useful computer staffing pattern information also was available from annual salary surveys published by Business Automation magazine and unpublished information from the International Data Corp.
- In addition, data from the Current Population Survey for 1971 and 1972, which include computer occupations[3], and several prior Bureau of Labor Statistics studies of computer manpower and technology were helpful. The BLS studies include *Outlook for Computer Process Control,* Bulletin 1658, and *Outlook for Technology and Manpower in Printing and Publishing,* Bulletin 1774.
- Information concerning growth of the market for computer hardware and services also was considered in evaluating and adjusting the preliminary ratios. Projected values for computer shipments (on annual and cumulative bases) and computer installations (number of systems or CPU's) from several sources were evaluated. These included published information from the International Data Corp.'s EDP Industry Report, the U.S. Department of Commerce, the Diebold Research Program, and Quantum Sciences Corp. Regression analysis techniques were employed using some of these data as well as those from unpublished sources to further check the reliability of employment estimates projected using the preliminary 1980 Matrix.

After reevaluation of preliminary 1980 Matrix ratios based on the foregoing steps, new ratios were applied to 1980 BLS industry projections to obtain final 1980 BLS Matrix employment projections.

[2]Inventory and Summary of Federal ADP Activities for Fiscal Year 1972, General Services Administration, February 1973.

[3]The Current Population Survey in 1971 and 1972 used the 1970 census occupational classification which included the 5 computer occupations projected in this study.

Appendix F. Interview Guide for BLS Computer User Survey

A comprehensive interview guide was developed and used by BLS staff to insure that computer user information was obtained and recorded in any orderly manner. At each of the survey firms, interviews were conducted with company data processing managers, personnel staff, and others concerning the firm's experiences and plans relating to computer hardware and software, size and composition of the computer staff, and skill requirements and training programs for computer occupations. A copy of the interview guide follows.

BLS-3016

U.S. DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS
WASHINGTON, D.C. 20212

Office of Management and
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Interview Guide

Manpower Study of Computer Personnel

This interview was conducted at the _____ (company),

_____ (address), _____ (city), _____ (state),

with _____ (official's name & title). Date _____.

Phone: _____

A. Introduction

This interview is being conducted by the BLS in connection with its current manpower study of computer personnel. The study, which is being made for the National Science Foundation, will yield estimates of current employment and will serve as a base from which to estimate future employment requirements for computer personnel and provide information on their training needs. The study is designed to assist the NSF and other agencies, public and private, in planning educational and training programs in this field. It also will contribute valuable information to the BLS occupational outlook program. All sources of data and information obtained in the interview will be held strictly confidential, and the published information will not permit identification of these sources.

B. Site Information

B.

1. Verify or obtain the following information (some entries are already known from the International Data Corporation Data File):

   a. Industry and SIC code(s)

1. a.

   b. Number of central processing units (CPU's).* If any CPU's are less than fully operational (in process of conversion to

b.

*A central processing unit is a general purpose digital computer forming the core of a computer system; it excludes minicomputers and peripheral equipment that may be used to feed information to the primary or central processing unit. Where several general purpose computers are combined into a system, each should be listed and counted as an individual CPU at a given site to assure compatibility with our information file.

another application or being installed), please indicate since staffing may be affected. If you have any CPU's located elsewhere that are part of this system, indicate.

c. Average monthly site rental (or purchase value). Include rental or purchase value of peripheral equipment at the site.

d. Minicomputers

(1) How many minicomputers ($5,000 to $25,000 purchase price) now are in use at the site?

d. (1)

(2) Are these minicomputers staffed by any computer specialists (full or part-time)?

(2)

2. Data entry

a. What are the primary methods of data entry at the site? (For example, card punch equipment key-to-tape, OCR [optical character recognition].)

2. a.

b. What changes in data entry methods have occurred during the past 5 years? How have these changes altered staffing requirements for any computer occupations?

b.

c. What changes in data entry methods do you anticipate over the next decade (e.g., Telecommunications)? How will these changes alter staffing requirements for any computer occupations?

C. Applications

C.

1. What are the primary applications at this site?

	100 Percent
1. Scientific and engineering . .	
Accounting	
Inventory control	
Process control	
Production, planning, and control	
Business forecasting	
Transportation (logistics) . .	
Other (specify and describe)	

2. Is this pattern of computer applications typical of most users in your industry?

2.

3. What changes do you anticipate in the applications at this site during the next 10 years (either changes in the percentage distribution of question C. 1. or new applications)? How will these affect employment requirements for computer personnel?

3.

D. Staffing

1. a. How many EDP personnel are employed at this site (specify occupational function and title)?

b. Discuss any problems in occupational classification among computer jobs because of work similarities or overlaps. For example, programmers and systems analysts frequently perform the same job functions. (Obtain user job descriptions if available.)

c. How has this staffing pattern (distribution of employment by job titles) changed in the last 5 years and what changes do you anticipate over the next 10 years?

D.

1. a.

	Number of employees
All EDP Personnel . . . . . Total	_____
EDP Managers . . . . Sub Total	_____
Department manager	_____
Manager of computer (equipment operations	_____
Manager of systems analysis/ programing	_____
Other	_____
Programmers (non-managerial) . Sub Total	
Business applications	_____
Scientific and technical applications systems (software)	_____
Systems analysts (non-managerial) . Sub Total	
Business	_____
Scientific and technical	_____
Systems engineers . . . Sub Total	_____
Computer (console) operators . . . Sub Total	_____
Peripheral equipment operators . . . Sub Total	_____
Keypunch/Tape operators	_____
Tape librarians	_____
Other	_____
Data processing machine repairers (in house) . . Sub Total	_____
Other (specify occupational function and title) . . . . . Sub Total	_____

b.

d. Please describe any new or emerging occupations not included in (a). d.

2. How many shifts are you operating at this site? Is your pattern of shift operation typical of other sites in this industry? 2.

3. How do staffing requirements vary by shift? (Interviewer note: this question is to ascertain whether certain computer personnel are not required on second or third shifts, such as systems analysts, or if fewer personnel are needed than on he first shift.) 3.

4. Do you anticipate any changes in your pattern of shift operation over the next 10 years? If so, how will this affect staffing requirements? 4.

5. Does your staff prepare work, such as programming or data input, for use by other sites? If so, estimate the number of personnel required by this extra work, by occupation. 5.

6. Do you contract-out any functions, such as programming, systems analysis, or data preparation? If possible, estimate by occupation the personnel that would be necessary were all work to be performed by your on-site staff. 6.

7. Do you have other computer personnel in the company who contribute to the data processing functions of this site? If so, estimate the number by occupation.

8. Do you have any non-computer personnel in the company who contribute to the data processing functions of this site (for example, economists who program)? If so, estimate the number, by occupation, and indicate the data processing tasks that they perform. 8.

E. Outlook E.

1. What additional computer installations are planned at this site? 1.

2. Discuss any expected changes in job duties within computer occupations during the next 10 years. (For example, programmers may increasingly perform systems analysis duties and do less routine work such as coding.) 2.

3. What impact do you expect minicomputers to have on future staffing requirements?

3.

4. Computer Personnel Supply

4.

a. In what occupations do you currently experience difficulty obtaining qualified personnel?

a.

b. In what occupations do you currently experience no difficulty obtaining qualified personnel?

b.

c. How has this situation changed over the past 5 years?

F. Education and Training of Your Computer Staff, by Occupation

1. Enter on table the educational levels attained by your present staff. (Enter number of employees by occupation and levels of education attained.)

1. Educational levels attained*

Job title	Total number	Less than high school graduate	High school graduate	Some college		College graduate		Graduate of private computer school	Other (specify)
				Junior college graduate	Other	Bachelor's degree (4 yrs.)	Graduate degree (5 or more yrs.)		
EDP Manager									
Programmer									
Systems analyst									
Systems engineer									
Computer (console) operator									
Peripheral equipment operator									
Computer maintenance technician									
Other									

*Example: A programmer who is a high school graduate, completed some college, and is a graduate of a private computer school should be included in three columns. Thus, column totals will likely exceed the total number of computer staff in each occupation.

F. 2. For the most prevalent educational attainment level shown for each occupation in the preceding table, indicate the major fields of study, curriculum titles, etc., commonly found.

F.
2.

Fields of study

EDP Manager _____

Programmer _____

Systems analyst _____

Systems engineer _____

Computer (console) operator _____

Peripheral equipment operator _____

Data processing machine repairer _____

Other _____

3. Regarding the educational backgrounds of your employees, are there any subject areas:

3.

a. in which they lack necessary preparation for the work they do?

a.

3. b. in which their preparation is not necessary for the work they do?

3. b.

4. How have educational requirements for computer personnel changed during the past 5 years?

4.

5. Do you expect to continue hiring computer personnel having approximately the same level of education as those currently employed? If not, what future changes in educational preparation of your staff do you anticipate? (Specify by occupation.)

5. EDP Manager _____

Programmer _____

Systems analyst _____

Systems engineer _____

Computer (console) operator _____

Peripheral equipment operator

Computer maintenance technician

Other

6. Where do you obtain your computer personnel? (Specify by occupation.)

6.

	EDP Manager	Programmer	Systems analyst	Systems engineer	Computer (console) operator	Peripheral equipment operator	Data processing machine repairers	Other
a. other industries (specify)..... a.								
b. other companies in your industry ..... b.								
c. schools (indicate type)..... c.								
d. other..... d.								

7. Have any of your staff transferred from noncomputer occupations? (If yes, specify occupation.)

7.

8. Supplementary Training: Describe the type of supplementary, job-related training given your staff in addition to formal educational preparation. When possible, include the length of this training and its funding source.

8. Supplementary training (post employment)

Job title	Type of training*	Description or course title	Number or % of employees	Length of training	Who administered the training?	Who paid for the training?
EDP Manager						
Programmer						
Systems Analyst						
Systems Engineer						
Computer (console) Operator						
Peripheral Equipment Operator						
Data processing machine repairer						
Other						

*In-house–classroom or on-the-job; vocational school; manufacturer's school; college.

Appendix G. Glossary of Computer Terms

ADP (Automatic Data Processing)–Data processing largely performed by automatic means.

ALGOL–A programming language used for scientific computer applicants.

Alphanumeric–A term used to indicate a combination of letters, numbers and special symbols such as punctuation or mathematical notations.

Analog Computer–A computer which operates on data represented by measurable physical quantities (speed, temperature, voltage, etc.).

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

Assembler–A computer program that performs the assemble function.

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

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

Batch Processing–A method which utilizes one program to process accumulations (batches) of similar data.

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

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

Card Punch–A machine which encodes data into tabulating cards in patterns of round or rectangular holes. Card punches may be activated by computer or from a keyboard.

Card Reader–A machine which transcribes data from punched cards to main computer storage or auxiliary storage devices.

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

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

Character—One of a set of clements which may be arranged in ordered groups to express information. Each character has two forms: 1. A man-intelligible form, the graphic, including the decimal digits 0-9, the letters A-Z, punctuation marks, and other formatting and control symbols. 2. A computer-intelligible form, the code, consisting of a group of binary bits.

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

Coding—To prepare a set of computer instructions required to perform a given action or solve a given problem.

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

Compiler—A computer program that performs the "compile" function.

Computer—A device capable of accepting information, applying prescribed processes to the information, and supply 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.

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—Transmission of data from one point to another.

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

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 numbers to express all quantities and variables.

Downtime—The time interval during which a device is malfunctioning.

EDP—Electronic Data Processing; referring to equipment that processes data by electronic means; e.g., analog or digital computers.

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 is an invoice file.

Firmware—A hardware set of functions which would otherwise be handled by software or special purpose logic.

Fortran—Formula translation; a programming language designed for mathematical applications.

General Purpose Computer—A computer designed to solve a wide range of problems.

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

Hardware—The mechanical, magnetic, electrical, and electronic devices of which a computer is built.

High Speed Printer—Computer output printer, generally one that prints out in excess of 300 lines per minute.

Input—Intelligence 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.

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

Interface—A concept involving the specification of the interconnection between two equipments having different functions.

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.

Language—A system for representing and communicating information between people and/or machines.

Line Printer—A printing device that can print an entire line of characters at one time.

Machine Language—A language designed for use by a machine, without translation.

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

Magnetic Ink—Ink containing particles of iron oxide, which can be detected (read) by machine sensors.

Magnetic Tape—Tape with a magnetic surface upon which data can be stored.

Main Storage—The general-purpose storage area of a computer.

Memory—A device or media 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 document with magnetic ink.

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

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 vocabulary which includes only primary numbers, as contrasted to alphanumeric which has both letters and numerals.

OCR (Optical Character Recognition)—A general term referring to the technique to using machines to read characters, symbols, or marks from documents, optically.

Offline—Pertains to equipment or devices not in direct communication with the Central Processing Unit of a computer.

Online—Pertains to equipment or devices directly connected to the Central Processing Unit.

Operating System—Programming that controls execution of computer programs.

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

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

Output—Relates to devices or programs which record processed information on some type of media such as a business form or magnetic tape.

Peripheral Equipment—Any equipment other than the central processing unit of a computer, which provide outside communication to the system.

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

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

Program—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. To plan a computation or process from the asking of a question to the delivery of 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 specific positions.

Real Time—Pertains to the actual time during which a physical process transpires. Pertaining to the performance of a computation during the actual time that the related physical process transpires, in order 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.

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

Source Document—A business form from which data is taken.

Storage—Pertaining to devices capable of retaining data.

Telecommunications—Transmission of signals over long distances via telegraph, radio, etc.

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—Using a computer to process multiple requests by independent users.

Updating—Bringing data or information up to the correct time or value.

Verify—To determine whether a data processing operation has been completed accurately.

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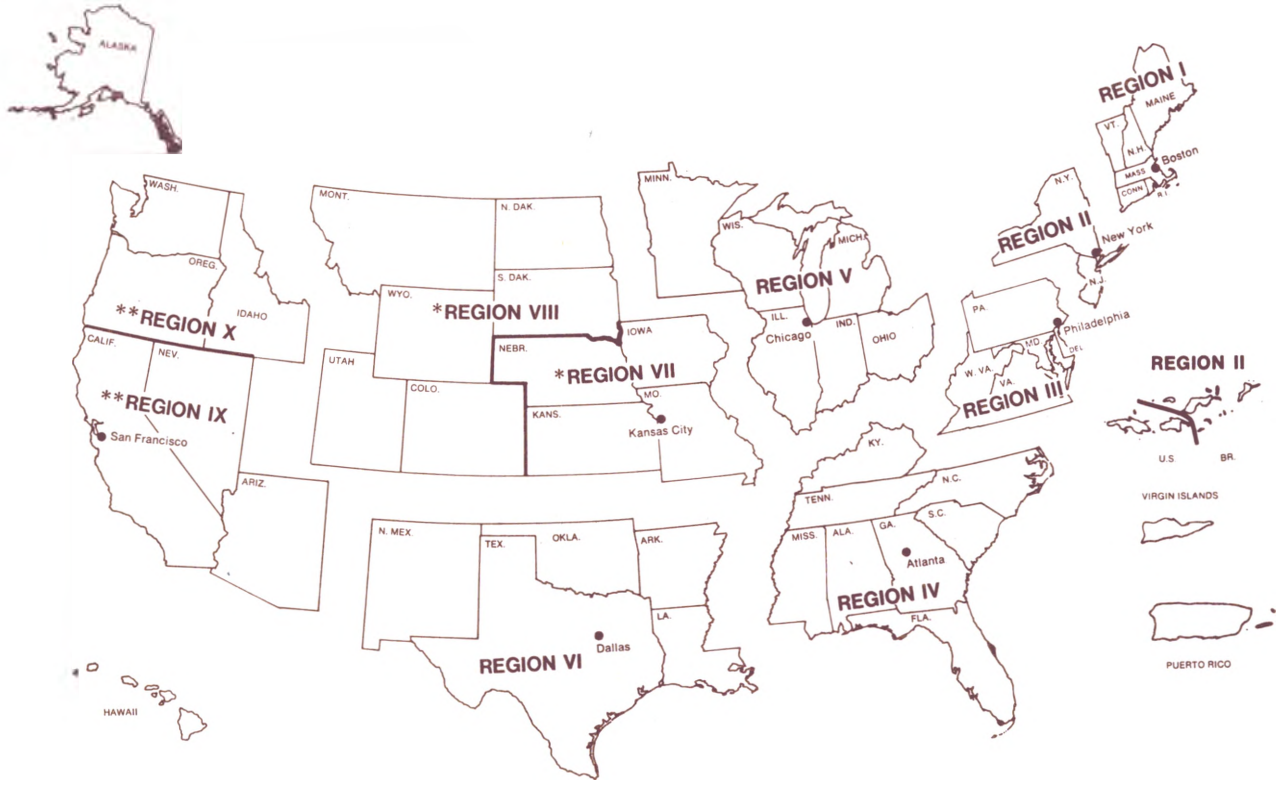

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