# THE FEASIBILITY OF ESTABLISHING A PROGRAM TO TRAIN COMPUTER PROGRAMMERS UTILIZING A TIME-SHARING SYSTEM AND REMOTE DATA-COMMUNICATIONS TRANSMISSION TERMINALS


By

ARTHUR LEE HARDWICK

Bachelor of Science
Kansas State College
Pittsburg, Kansas
1958

Master of Education
Kansas State College
Pittsburg, Kansas
1960

Education Specialist
Kansas State College
Pittsburg, Kansas
1961



Submitted to the faculty of the Graduate School
of the Oklahoma State University
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THE FEASIBILITY OF ESTABLISHING A PROGRAM TO TRAIN COMPUTER PROGRAMMERS UTILIZING A TIME-SHARING SYSTEM AND REMOTE DATA-COMMUNICATIONS TRANSMISSION TERMINALS

THESIS APPROVED:

J. Paschal Twyman

Dr. J. P. Twyman - Chairman

D D Grosvenor

Dr. D. D. Grosvenor - Thesis Adviser

Solomon Sutker

Dr. Solomon Sutker

R P Jungers

Dr. R. P. Jungers

N N Durham

Dean of the Graduate School

## Preface

The tremendous advancements that have occurred in the field of computer science technology in the past decade have resulted in a staggering shortage of qualified data processing personnel. This shortage will continue to increase until capable educators in this country become aware of the problem and initiate techniques by which the problem can be solved. Little research has been carried on to identify specific techniques to best meet the objective of adequately training the necessary level of qualified data processing personnel. For this reason the technique of data-communications and, more specifically, that time-sharing techniques were studied as means to solve a portion of the problem.

Many qualified persons and organizations displayed interest and rendered assistance in the conduct and completion of the study. I am especially grateful for the valuable guidance and diligent assistance of my friend and committee chairman, Dr. Paschal Twyman, Assistant to the Chancellor, University of Missouri, St. Louis, Missouri. I am also grateful for the technical assistance of Dr. Dale Grosvenor, Director of the Computer Center, Oklahoma State University. Gratitude also is expressed to the members of my doctoral committee, Dr. Solomon Sutker, Dr. M. W. Roney, and Dr. R. P. Jungers. I hold the highest regard and gratitude to an outstanding individual who encouraged and counseled me throughout the study, Dr. James Boggs, Vice President for Academic Affairs, Oklahoma State University.

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# THE RESEARCH PROBLEM

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## The Problem

The scientific and technological development of recent years and the advent of the space age have required rapid changes in the manpower needs of both industry and business, particularly in the fields of science. One of the crucial shortages has been that of adequately trained technicians to fill positions as computer programmers and systems analysts. The shortage of this type of technician is becoming increasingly more severe due to the continuous development of more complex and advanced data processing equipment and techniques.

The education and preparation of technical manpower is generally conceded to be a functional responsibility of educational institutions, and an increasing demand is being placed on two year post-secondary institutions such as technical institutes, junior colleges, and area vocational-technical schools to expand their offerings to include data processing programs.

Although there has been general acceptance of the principle of training data processing personnel in a two year post-secondary program for a number of years, there has been, and still is, some disagreement as to the qualifications necessary to provide adequately trained programmers for the industry of today. In fact differences of opinion have existed since the development of the first two year post-secondary programmers curriculum. Even before the development of modern electronic data processing equipment of today, educators attempted to provide training in only a few highly specialized aspects of data processing.

Serious questions have arisen from differences of opinion as to the curriculum needed to train programmers and the requirements of equipment so that the student can attain the necessary qualifications. For this reason the technique of data communications is being considered as a method of providing the qualifications needed by programmers at a more economical cost. This technique is also being utilized to provide knowledge and experience of data communications itself. This should provide the trainee with skills that will greatly enhance his position as a programmer. This study, therefore, is concerned with the problem of whether and to what extent it is feasible to establish a program to train computer programmers utilizing a time-sharing system and remote data-communications transmission terminals. The terminals would be located at the local schools where the majority of the training would be completed.

A survey was made of potential employers of the trainees from such a system to determine: present and anticipated needs including frequency and volume, number of data processing personnel presently employed, the number of data processing personnel needed in 1966-67, 1968-69, and 1970-71, and the qualifications needed by graduates of an educational program to be recognized as qualified programmers. More specifically, the U. S. Office of Education curriculum guide for electronic data processing will be analyzed as it relates to data communications in the five following areas:

1. What general data processing qualifications are needed

by adequately trained programmers for the industry of today and the future?

2. What specialized knowledge of data communications and experience with data communications equipment would be required to enhance the position of programmers?

3. What hardware or equipment requirements are needed to support the necessary curriculum?

4. What economic factors are involved in hardware or equipment configurations and program implementation?

5. What data communications techniques can be utilized in a data processing curriculum and how can they extend the programmers qualifications?

The basic method proposed to help alleviate the problem would be a two year post-secondary data processing program. The program comprises a succession of courses designed to provide an understanding of the concepts, principles, and techniques involved in processing data.

The method proposed is intended to produce as output a programmer. This programmer will be a candidate for a position in the business world and will be qualified to:

Apply current available programming techniques to a defined problem with minimum supervision;

Be capable of being retrained for a particular machine in two weeks or less;

Understand and master special techniques as the "point of need" occurs;

Communicate his programming decisions to personnel involved through proper documentation.

## Existing Need for Data Processing Personnel

The need for qualified data processing personnel is becoming a matter of national concern, and many educational institutions are developing programs in an attempt to meet this need. However, before making any definite decisions regarding the appropriate manner in which to establish such an educational program, it is imperative to obtain pertinent information regarding the existing and anticipated need for data processing personnel for the nation. This information is needed to properly establish trends of the data processing industry.

Specifically, then, the purpose of this study on existing needs for data processing personnel was to identify and assemble important statistical, descriptive and comparative data related to these manpower needs.

The computer or electronic data processing industry has grown from an infant employing a relatively handful of people to a giant needing the services of one and one-half million people in less than two decades. The U. S. Department of Labor estimates a growth to eight million employees by 1970.[1]

The need for trained data processing personnel, particularly for business use, will rise sharply during the next few years. Programmers especially, will be in demand. A mad scramble for programmers and, to a lesser extent for other trained data processing people will take place. "Companies want programmers so badly," says one educator, "they'll take anyone with a little bit of knowledge. The current corps of 100,000 programmers is about 25,000 fewer than needed to efficiently handle the

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[1]Darnowski, Vincent S. A Teacher's Guide to Computers--Theory and Use. Washington: National Science Teachers Association, 1964, p. 3.

nation's 23,000 computers."[2] The shortage of programmers could be a threat to future sales of computers, which currently are growing 15 to 20 per cent yearly. The United States can consider itself lucky if many trained data processing persons are not lured to other countries.

One of the crucial shortages has been that of adequately trained technicians to fill positions as programmers and systems analysts. The shortage of programmers and systems analysts is becoming increasingly more severe due to the continuous development of more complex and advanced data processing equipment and techniques. The recent requirements of industry and science have created a tremendous demand for people skilled in the technical field of data processing. Many new industries in engineering, electronics, missiles, and manufacturing are requiring data processing technicians who can work side by side with an engineer or scientist to help analyze the specific problem at hand and devise a way to instruct the computer to achieve the desired results. As a direct consequence, the educational requirements for many business occupations have changed considerably. This is especially true of those occupations which require training beyond that provided by the general high school curriculum.

During World War II, electronics became an industry. The application of electronics to business accounting and data processing machinery led to the development of computers and computer systems. These electronic tools and systems have been refined and improved since the 1950's.

Their use in business and industry has mushroomed at a rapid rate. So has their use in government and defense projects.

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[2] Alemansky, Burt. "Lack of Programmers Hurts Computer Uses; Training Is Stepped Up." The Wall Street Journal (September 21, 1965).

Forms, receipts, bills, orders, tax blanks, checks, and other pieces of business paper have grown rapidly in number in the past two decades. It would be possible for men to keep and work from these written records, but the labor and time used would be fantastic. An estimate has been made that by 1980, if all records were handwritten and hand-processed, an army of workers equal in number to the present population of the United States would be needed to process the records produced by the Federal Government alone.[3]

A variety of estimates are available concerning the market for computers in the 1970's. A consensus of the most reliable of these indicates that by 1970 the number of computer systems installed will approximate 52,000 with another 10,000 on order. Based on the number of projected installations, actual personnel requirements are staggering--the number of technical people required is 104,000 analysts, 240,000 programmers, and 132,000 operators. This grand total of 470,000 computer specialists is almost twice the number of doctors in the United States today.[4]

Technological changes in the industry will help reduce the number of personnel required. These changes are expected to reduce the number of personnel to approximately 92,000 systems analysts, 145,000 programmers and 80,000 operators, but this is still a grand total of 318,000 people.[5]

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[3] Gibson, Dr. E. Dana. International Data Processing. Elmhurst: The Business Press, 1965, pp. 119-121.

[4] Brandon, Richard H. "The Computer Personnel Revolution," Computers and Automation (August, 1964), pp. 22-25.

[5] Ibid.

It is far-fetched to imagine that in the three years remaining before 1970, the number of people in the computer field can be tripled unless something is done immediately. The education facilities for this kind of undertaking are not presently available nor is the economic capability for absorbing a training program of this magnitude.

There exist shortages within the schools with reference to computers. There is a shortage of competent, educated personnel to operate and teach about computers. There is a shortage of basic knowledge on the part of all school personnel about computers and the associated field of data processing. The general education of most Americans at all levels still contains little if any mention of these machines.

In view of these shortages and the acute need already expressed by users of data processing equipment, a practical solution is needed to the problem of educating people in the field of data processing. How does the high school or college student obtain the education he needs in order to become proficient as a data processing technician? (Data processing technician refers to the business programmer, scientific programmer and systems analyst.)

Many academic institutions are developing courses for programming. Miami-Dade Junior College in Florida says it is doubling its programmer training plans because it has been unable to fill the standing requests from companies for programmers.[6]

Industries in the United States are rapidly expanding their data processing facilities in the area of data communications. Data

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[6] Alemansky, Burt. "Lack of Programmers Hurts Computer Uses, Training is Stepped Up." The Wall Street Journal (September 21, 1965).

communications as the term is used in this study refers to transmission of data over communications medium from computer to computer or computer to terminal. This technique is also referred to as tele-processing, tele-communications, on-line computing systems and occasionally time-sharing; even though time-sharing is only one aspect of the total data communications technique. A recent research program conducted at the University of California in Los Angeles with the participation of 638 major companies and universities throughout the United States showed that in 1965 one per cent of all computer activities were on-line data communications computing systems. By 1970, it was estimated in this research that 50 per cent of all computing activities would be on-line computing systems, and, by 1975, 90+ percent of all computing activities would be on-line computing systems.[7]

From the interest of American industry in this new and rapidly expanding area of data processing and the trends of these companies to expand in this area, the idea was considered to develop an educational system along these lines. The technique of data communications was considered to provide this level of program. The student's knowledge of data communications would be a definite asset to him if he can enter any data processing installation with very little, if any, training within the data processing installation in which he secures employment.

## The Need for the Study

Differences in opinion about the requirements to train data processing programmers do exist among professional educators throughout the

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[7] Burgess, Eric. On-Line Computing Systems. Detroit: American Data Processing, Inc., 1965, p. 14.

country. Serious questions have been raised by industrial and educational personnel as to the need for, and desirability of, certain knowledge and experience requirements of data processing programmers. These questions have great bearing on whether the purposes of training data processing programmers are being carried out adequately at the two year post-secondary level (based on the USOE suggested electronic data processing curriculum guide), and subsequently, as to whether all the necessary training requirements are included in the curriculum. Should the present methods, techniques and requirements be continued? Should the curriculum be updated with additional requirements? Should newly developed techniques be considered to provide more knowledge and experiences in the training program? Also, should techniques be considered to provide more economical approaches to program implementation?

## Specific Assumptions and Resulting Hypotheses

From the standpoint of most technical educators involved in data processing, it is generally recognized that students in the field must, in order to have a background to meet the employment needs, have familiarity with and knowledge of the overall field of data processing, have operational knowledge of one or more basic computing systems, and an understanding of the total systems concept of data processing as it has progressed and the trends with which it is developing. General national trends can easily be established from the large volume of literature available from the many national publications. However, these trends are general in nature and do not identify the specific qualifications needed by data processing programmers. The lack of adequate information on the state level concerning the needed training requirements made it advisable to investigate the data processing requirements of the state.

It was assumed that the majority of the industrial concerns in the state would not completely understand what was meant by the two year post-secondary technical education data processing program. For this reason, each of the industrial concerns was provided a U. S. Office of Education Suggested Curriculum Guide to assist them with definitions and explanations of general program requirements, content and organization. It is also decided that to properly survey all the data processing installations in the state would be impractical and not necessarily required to secure adequate estimates. The cooperation of certain installations that were randomly sampled would reveal the required information. A complete list of all the data processing installations was secured and divided into four groups according to the number of programmers employed at each installation. From each of the four size groups a sample was randomly selected using a sampling ratio recommended by members of the committee. The sampling ratio provided that 100% of the installations employing 20 or more programmers be surveyed, 75% of those employing 10 to 19 programmers be surveyed, 50% of those employing 5 to 9 programmers be surveyed, and 25% of those employing 0 to 4 programmers be surveyed. The large number of smaller installations would have given them an undue representation if the sampling ratio was not varied in the collection of data.

The data was collected to test seven hypotheses. Hypothesis numbers 1, 2, 3, 5, 6 and 7 were tested as single hypotheses; however, hypothesis number 4 was tested as ten subhypotheses. These ten subhypotheses were based on the following size classifications, application classifications, and location classifications:

Size Classifications

S-A 20 or more programmers employed in the data processing installation

S-B 10 to 19 programmers employed in the data processing installation

S-C 5 to 9 programmers employed in the data processing installation

S-D 0 to 4 programmers employed in the data processing installation

Application Classifications

A-A Business application utilized in the data processing installation

A-B Scientific application utilized in the data processing installation

Location Classification

L-A Data processing installation in area with 75,000 population or more in a ten mile radius

L-B Same as above with change to 50,000 to 74,999 population in a ten mile radius

L-C Same as above with change to 25,000 to 49,999 population in a ten mile radius

L-D Same as above with change to 0 to 24,999 population in a ten mile radius

Hypothesis number one was that the installations employing a larger number of programmers require more qualifications of their programmers than installations with a fewer number of programmers employed. This hypothesis was designed to test if there would be a difference in the level of requirements needed by programmers among all size groups.

Hypothesis number two was that the installations utilizing scientific data processing applications require more qualifications of their programmers than the installations utilizing business data processing applications. This hypothesis was designed to test if there would be a difference in the level of requirements needed by programmers between the scientific and the business applications.

Hypothesis number three was that installations located in larger population areas require more qualifications of their programmers than the installations located in less populated areas. This hypothesis was designed to test if there would be a difference in the level of requirements needed by programmers in relation to the location of the installations by population. The installations will be divided into four major location groups.

Hypothesis number four was that the installations of specific combinations of size, application and location require different levels of qualifications of their programmers than the installations of other combinations of size, application or location. This hypothesis is that installations in a remote location, with a less scientific based application and employing fewer programmers, would generally have less ability to properly evaluate the qualification requirements of an adequately trained programmer than an installation employing a large number of programmers, with a more scientific based application, and serving a more populated area. This lack of ability to properly evaluate the qualifications required is mainly due to their lack of familiarity with the newly developing techniques and concepts relating to the requirements for programmers.

It was considered of great importance to examine this hypothesis to properly understand various stages of systems development in the individual installations and to reveal if differences existed in the acceptance of requirements because of various installations' lack of familiarity in certain areas. Hypothesis number four was designed to test if there would be an alternative difference in the understanding of one group in a more populated area, with a more scientific based application and larger number of programming personnel employed, than other groups of fewer programming personnel, less population, and less scientific application. In this hypothesis, subhypothesis[8] number $IV^1$ compares group I (size A, application A, and location A) with group II (size A, application A, location B); subhypothesis number $IV^2$ compares group I with group III (size A, application A, location C); subhypothesis number $IV^3$ compares group I with group IV (size A, application A, location D); subhypothesis number $IV^4$ compares group I with group V (size D, application A, location D); subhypothesis number $IV^5$ compares group II with III; subhypothesis number $IV^6$ compares group II with group IV; subhypothesis number $IV^7$ compares group II with group V; subhypothesis number $IV^8$ compares group III with group IV; subhypothesis number $IV^9$ compares group III with group V; subhypothesis number $IV^{10}$ compares group IV with group V.

Hypothesis number five was that installations utilizing scientific programming applications are more able to evaluate the requirements needed by programmers in a data-communications system than installations utilizing business programming applications. This can be directly attributed to the fact that more scientific installations are utilizing or contemplating the utilization of certain newly developing specialized techniques or concepts such as monitor systems, process control, data communications, etc. For this reason a comparison of the installations using mainly business programming applications was made with the installations using mainly scientific programming applications. Hypothesis

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[8] Symbols $IV^1$, $IV^2$, $IV^3$, $IV^4$, $IV^5$, $IV^6$, $IV^7$, $IV^8$, $IV^9$, $IV^{10}$, are used to identify the ten subhypotheses which combine to make hypothesis number IV.

number five was designed to test if there would be alternative difference in the ability of group A-B (installations utilizing or contemplating the utilization of certain newly developed specialized techniques or concepts of the data processing industry) to evaluate the requirements needed by programmers to adequately function in the data processing industry of today and the near future, over group A-A (installations not utilizing or contemplating the utilization of these techniques or concepts). One major difference exists between this hypothesis and hypothesis number two, which also relates to the two types of applications. The basic difference is that in hypothesis number two the objective is to consider all the business applications as one group and all the scientific applications as the other group, while in hypothesis number five the objective is to consider a group of installations of a certain size utilizing the scientific application compared to a group of installations of the same size utilizing the business application.

Hypothesis number six was that the training requirements needed by programmers in the present time period are up-graded in the 1970-71 time period. It was assumed that almost all the installations would require more qualifications of their programmers over an established time period. For this reason a hypothesis was established to evaluate the requirements in the present time period and compare these requirements with the requirements established in the 1970-71 time period. Hypothesis number six was designed to test if there would be a difference in the qualifications required by all installations in the present time period compared to the 1970-71 time period.

Hypothesis number seven was that the data communications training requirement needed by programmers in the present time period are up-graded in each of the following time periods. The technique of data communications is an extremely new and highly specialized aspect of data processing. It has been established as the technique being utilized in only a few installations in the state. However, it is anticipated that this technique will be utilized more in each time period. For this reason a hypothesis was developed to evaluate the data communications requirements needed in the present time period and the 1966-67 time period, 1968-69 time period, and 1970-71 time period. Hypothesis number seven was designed to establish that there would be an alternative difference between the data communications technique requirement needed in the present time period and each of the following three time periods.

# CHAPTER II

## REVIEW OF SCIENTIFIC INFORMATION

### Review of Literature

Information concerning data communications and its relation to computerized instruction is elusive. Generally this information exists on paper or in notebooks. Printouts of the instructions to the computer and of characteristic student-computer interaction are sometimes available, but not through customary publication channels in the manner of a textbook or programmed instruction text. To overcome this problem, a review of literature relating to data communications was developed.

However, to adequately consider the literature that is available in the area of data communications it should be considered in the four basic areas of: general literature, time-sharing literature, systems literature, and computer assisted instruction literature. The majority of the available literature is in the computer assisted instruction area, which has very little if any relationship to the proposed system; however, it is being discussed to assist those who may have potential utilization in conjunction with a system similar to the proposed system.

#### General Literature

"The Development and Current Status of Computer Based Instruction and Equipment Research," by W. Dick, describes the development and current status of computer-based instruction, including: (1) learning principles, (2) current computer-instruction projects, (3) typical computer-instruction equipment, (4) programs and programmed texts, (5) research with computer instruction, (6) programming and equipment improvements, (7) current problems, and (8) future prospects.

"Individual Instruction and the Computer-Potential for Mass Education," by R. T. Filep, lists the unique characteristics of computerized instruction and the potential high-priority applications, and compares the impersonal nature of computerized instruction with "live" instruction. The author also comments on several possible system configurations and describes a current project to use computerized instruction for in-service teacher education. He concludes with a list of six research objectives.

Several authors have discussed the developing potential of computer assisted instruction in a more general vein. "An Overview of Potentials of Computer Assisted Instruction," by R. H. Bolt, sees computer assisted instruction as a useful partner of book- and teacher-aided instruction. He points out that a system which accommodates both computer assisted instruction and educational management could evolve into an information environment of extraordinary power for educational research.

"The Computer As an Instructional Tool," by D. D. Bushnell, not only reviews the development of computer-based teaching machines, but also describes (1) the potential use of rapid information retrieval systems in instruction and (2) the possibilities for computer-aided diagnosis of student learning needs.

The availability of computer assisted instruction will also have an important effect on contemporary research on learning and stresses. "Computer Based Systems--the New Research Aid," by D. J. Davis and L. M. Stolurow, points out that computer assisted instruction equipment makes possible the study of response contingency variables which cannot be investigated in any other way. They draw illustrations from research studies.

A broadly based paper on the technology of training, "Current Status of the Technology of Training," by G. A. Eckstand, holds that the psychology of learning is at last bridging the gap between basic science and a practical technology. He sees the individualization of training, including computer assisted instruction, as a promising research area.

There have been some considerations of the role of computers, not just in the computer assisted instruction, but in educational processing generally. "The Role of Computers in Education," by N. McDonald, while emphasizing adaptability of computer assisted instruction lessons to individual needs, also considers the use of computers for automated class scheduling. "Computers in Education" by R. E. Packer, lists seven categories in discussing the application of computers to automated education: educational administration, military training, reference and research automation, school counseling, sports, teaching, and training in computer technology.

Time-Sharing Literature

It is undoubtedly the increased availability of computer time-sharing software and hardware which has sparked the widespread interest in computerized instruction in the past year. Many reports contain a reference to time-sharing, although most systems have reached a point of development when the non-technical user can take the time-sharing capability for granted. Several companies now offer on-line, time-shared computer service adaptable for instruction.

Project MAC (Multiple-Access Computer) has pioneered the utilization of time-shared equipment. The article "Communications Implications of the Project MAC Multiple-Access Computer System," by R. C. Mills, suggests some new transmission and terminal equipment requirements, including a general purpose terminal, perhaps with keyboard input and visual display output. He believes transmission requirements for time-shared multiple-access systems probably cannot be met by straightforward extensions of services now available through common carriers.

"Teaching Mathematics Through the Use of a Time-Shared Computer," by J. C. Richardson, has established a project to answer three questions about time-sharing: (1) How can a time-shared computer be programmed to act as a useful tool for teaching mathematics? (2) How can teachers be taught the necessary techniques to use it? (3) How can a time-sharing system be made economically feasible? The study is being conducted in several schools in suburban Boston. Students in grades 6, 9 and 11 use a time-shared computer at Bolt, Beranek and Newman as a mathematical laboratory. The investigators anticipated several benefits from a time-sharing system: (1) The student will have the feeling of working on his own computer. (2) Having a computer on an "always ready" basis will encourage students to engage in extracurricular use of the computer. (3) Students will achieve a more thorough grounding in basic concepts of mathematics.

The PLATO (Programmed Logic for Automatic Teaching Operation) system at the University of Illinois Coordinated Science Laboratories was expanded to ten stations early in 1965, as revealed in the article, "Computer Assistance for Instruction--A Review of Systems and Projects," by Karl L. Zinn. In the article a corresponding improvement in software was noted, a new tutorial logic was developed which allows authors to enter parameters from any student station while other stations are in use.

Only a few papers trace the procedure by which specifications were set and computers selected for particular systems. Beginning with a consideration of the capabilities of a particular computer, "Capacity of the PLATO II System, Using the CSXL Computer as the Control Element," by H. Bobotek, analyzed the restrictions storage would impose on the number and length of lesson programs and the number of students served by the PLATO II system at the University of Illinois. The article also describes the storage problems of the PLATO II system when confronted by requirements of the flexible PLATO teaching programs. The first computer employed in PLATO II was a medium-speed digital computer with high speed memory of 1,024 words. Because of this limited memory capacity, PLATO II could be used to instruct only two students, though the program was written to handle more. To stretch the memory, textual information stored on slides was displayed to the student electronically on a television screen. The computer used as the control element may limit the capacity of the system either by the amount of available storage or by the speed of its operations. The limitations due to speed, however, do not appear to be significant for a system serving less than 1,000 students; the restrictions imposed by storage seem most important.

Research in the development of memory units has tended towards qualitative changes in memory. Several developments, both in hardware and software, seem promising for time-sharing. These include vocabulary compressions, slave memories, special storage languages, and associative networks. "Slave Memories and Dynamic Storage Allocations," by M. V.

Wilkes, proposes a fast core memory of, say, 32,000 words as a slave to a slower core memory of, say, one million words in such a way that in practical cases the effective access time is nearer that of the fast memory than that of the slow memory.

In an information retrieval system, the Magnacard system can be used to store large files of inventory information. It consists of a bank of filing cabinet drawers containing oxide coated cards, each one inch by three inches, which can be read from or written onto by magnetic heads similar to those found in tape recorders. Access to the stored information is provided through a mechanism which can remove a drawer from the bank, read from or write onto the cards in that drawer, and return the drawer to the bank. "A Statistical Optimization of Search Time in an Information Retrieval System," by P. L. Leifer, discusses the organization of the inventory file within the drawers in order to optimize the retrieval time for a given number of interrogations of the file in a time-sharing environment.

"Human Factor Problems in Computer Generated Graphic Displays," by J. Barmack, reviews current practices in computer-generated graphic displays from the point of view of engineering psychology. Input devices which are integral with computer assisted instruction systems are also considered. Theories of cognition are examined with respect to their applicability to computer-graphics.

Much of the research on computer-assisted information retrieval is on a natural language capability to facilitate interaction between student and computer during the search. "Automatic Message Retrieval--Studies for the Design of an English Command and Control Language Systems" by Arthur D. Little, Inc., has reported on an associative searching technique which (1) permits the user to employ his own vocabulary in formulating a typewritten request, and (2) allows the machine to find relevant information even when there is no direct matching of vocabulary items. The answers made by the computer are based on the network of associations implicit in the stored message data, and the item output is in order of decreasing relevance to the question.

"The Massachusetts Institute of Technology Technical Information Project," by M. M. Kessler, has described a working model of a technical information retrieval system in use at MIT. It involves the literature of 21 journals in the field of physics. Remote consoles give the student access to a time-sharing computer facility. Programs have been developed for a variety of search techniques based on key words, citation index, bibliographic coupling, author, location, or combinations of these. The computer responses may be in real time or delayed. A teaching program in the computer teaches the student how to use the system.

## Systems Literature

As in other applications of computer technology, there is an understandable tendency on the part of educators and manufacturers to build instructional systems around available hardware and software. "State-of-the-art" systems, however, often distract investigators from a proper search for an optimum learning environment or instruction system configuration. The systems literature presented in this section of the review of literature will be oriented toward the development and implementation of hardware in existing systems.

"The Use of PLATO--A Computer Controlled Teaching System," by D. L. Bitzer, Elisabeth R. Lyman, and J. A. Easley, compares the merits of a large central system, such as PLATO, with a smaller local system, such as the McGraw-Edison Responsive Environment. The use of a high-speed digital computer as a central control element provides a great flexibility in an automatic teaching system. Using a computer-based system permits versatility in teaching logics since changing the type of teacher merely requires changing the computer program, not the hardware. In addition, having access to the decision-making capacity of a large computer located as one unit permits complicated decisions to be made for each student. Such capacity would be prohibitively expensive to provide by means of decision-making equipment located at each student station. The results of exploratory queuing studies show that a large system could teach as many as a thousand students simultaneously without incurring noticeable delay for any student's request.

In a monograph on an information system approach to education, "An Information Approach to Education," D. C. Ryans has described a teaching model which emphasizes three characteristics of teaching-learning: (1) the interdependence and interrelatedness of conditions influencing teaching-learning, (2) the importance of information processing in the description of teaching behavior and pupil learning behavior, and (3) the basic information-conveying nature of instruction. Some aspects of the model are illustrated with the system at the System Development Corporation.

"The Computer As an Educator," by W. Fuerzeig, considers the computer as it relates to educators. The article classifies computer-based instruction in four categories: computer-controlled systems, student-controlled systems. He cites specific examples of systems that fall into each category.

The student, like the instructor, the central processing unit, the terminal, and the software, is a component in the instructional system. Consequently, system studies should take into consideration student variables ranging from motivation to perception. In the article "Modern Learning Theory and the Elementary-School Curriculum," by P. Suppes, case studies relating to these student variables are given; for example, he is emphatic about the importance of careful attention to individual difference variables in planning computer assisted instruction systems. He reports that, when freed from a lock-step instructional procedure, the fastest child in a first grade mathematics program achieved 50 per cent more than the slowest; the fastest child in a kindergarten required 196 trials on a reading experiment, the slowest 2506 trials; and rate was not strongly correlated with I. Q.

For those who are mainly interested in designing systems as a training system and not as answering-processor, G. A. Eckstrand's article, "Current Status of the Technology of Training," has identified three steps in the design of a training system: (1) setting training requirements, (2) designing the training environment, and (3) designing evaluation techniques. He describes each step in helpful detail.

IBM publications from Poughkeepsie deal with the Coursewriter program for the IBM 1401, 1440, and 1460-1448 data processing systems, "IBM 1401 or IBM 1440 Operating Systems-Computer Assisted Instruction," and the IBM 1800 data acquisition and control system, "IBM Data Acquisition and Control System--Systems Summary."

From the IBM Poughkeepsie computer, a pilot study by the American Society for Training and Development, was initiated in the industrial training of employees at IBM offices in Philadelphia, Los Angeles, San Francisco and Washington, D. C.; the students were IBM customer engineers.

"IBM Begins Coast to Coast Test of Computer Assisted Instruction."

Computer Assisted Instruction

"Computer Assistance for Instruction--A Review of Systems and Projects," by Karl L. Zinn, lists 89 computer assisted instruction programs, including data on subject-matter, author, system, language, terminal characteristics and availability. Of the 89 programs in Zinn's list, 65 are an hour or more long and not specifically designated as demonstration programs. Of these 65 programs, 57 have been run on a CAI system and 26 are listed as having received some form of empirical evaluation. The availability of the program in Zinn's list is uncertain as he did not request this information in his survey.

"A descriptive list of PLATO Programs," by Elisabeth Lyman, provides a comprehensive index of programs developed at the University of Illinois for use on the PLATO system. The programs are classified by the type of teaching logic used, or by their research use.

Catalogs and lists are not the only source of data on CAI programs. Many programs are described in greater detail in research reports. Notable among such reports is "Computer Based Laboratory for Learning and Teaching," by P. Suppes, D. Hansen, and M. Jerman. They outline 320 sessions, 160 each for spelling and arithmetic, developed at the Stanford Computer-Based Laboratory for Learning and Teaching and now in use at the Brentwood Elementary School, East Palo Alto. Each session is of 30 minutes duration, the student engaging in two sessions per day, one each in spelling and arithmetic.

"Computer-Based Mathematics Instruction by P. Suppes, and "Those Wonderful Teaching Machines--or Are They?" by P. Suppes, M. Jerman, and

Groen, describe the Stanford mathematics programs for grades 1, 4, and 6. Six concepts are taught by computer in grade 1: (1) use of light pen, (2) concrete objects to show sets, (3) set notation to show sets, (4) empty set, (5) equal sets (2-answer choices), and (6) equal sets (3-answer choices).

"Computer Assisted Instruction in Initial Reading at Stanford," by Atkinson and Hansen describes the Stanford Computer Assisted Instruction curriculum for teaching initial reading. The article includes a description of the Stanford Computer Assisted Instruction IBM/System 1500, the nature of reading lesson preparation and software example, the nature of the initial reading curriculum and some tentative empirical results by five-year-olds utilizing this material. A brief description is given of certain optimal quantitative models for instruction in the reading area.

Near the other end of the educational spectrum, "Application of a Computer Controlled Automatic Teaching System to Network Synthesis," by R. Backman, describes two computer assisted instructions lessons on the synthesis of two-terminal reactive networks programmed for the PLATO II teaching system and used in the electrical engineering curriculum at the University of Illinois.

"The Use of Programmed Learning and Computer Based Instruction Techniques to Teach Electrical Engineering Network Analysis," by Roger Johnson, also used the PLATO system to teach electrical network analysis (EE322, University of Illinois). Two groups of students were selected to use each of the two types of instruction logic, inquiry and tutorial. Both the instruction sequences were to achieve the same performance objectives. The desired performance objectives were obtained satisfactorily in both cases, although in certain aspects the inquiry teaching program exhibited some advantages.

IBM's Watson Research Center in Yorktown has been conducting experimentation with Computer Assisted Instruction. Programs will be developed for students ranging from kindergarten through graduate school. In the Florida State University publication, "Study of Computer Potential in Helping Pupils Learn," Pennsylvania State University publication, "Experimental Computer Assisted Instruction System," and J. J. Schurdak's article on Columbia University participation, "An Approach to the Use of Computer in the Instructional Process and an Evaluation," are among the institutions that have been linked to IBM computers at Yorktown. At the American Management Association conference on educational technology IBM presented "IBM Uses Computer to Train Employees in Four Scattered Locations," where segments of courses in statistics, American History, English, bridge, number squaring and cubing, spelling, and reading were present daily.

E. N. Adams of IBM Yorktown has discussed the "Roles of the Electronic Computer in University Instruction," A research report on a computer-controlled language laboratory.

Other research reports from the IBM Yorktown staff include H. W. Morrison's paper on "Computer Processing of Responses in Verbal Training" and E. M. Quinn's classification of content independent Course-writer programs which are economical in terms of preparation and computer storage.

Computer Assisted Instruction is being explored at the new Irvine campus of the University of California, which, under a joint research agreement with IBM, will become a computer laboratory for investigating all the ways in which the computer can aid educational institutions. The University of California was the site of a conference on the uses of the computer in Undergraduate Physics Instruction, which included discussion of curricular-administrative problems, pedagogical techniques, systems, and equipment. University of California at Santa Barbara is the center of the Culler-Fried "Computer-Based Blackboard" system, connected also with the Harvard Computation Center. The display is a CRT with a memory. Using a keyboard in the classroom, the instructor can cause the computer to generate a graphic display on the CRT of simple or complex functions, as well as symbols.

The presentation by J. M. Newton at the ONR Conference in Newberyport, Massachusetts, on "Computer Assisted Instruction Languages," explains this system.

Dartmouth College is the site of an evolving time-sharing system which has been in operation for over two years. It is explained in the article by C. M. Louhner, "The Evolving Time-Sharing System at Dartmouth College," GE 235 and now 635 computers with the Data-Net are used. Terminals are 20 teletypes installed in dormitories and at other locations. When the system was first put into operation, only one algebraic compiler, BASIC, was available. Subsequent additions have included the following: TEACH, a system which allows an instructor to code BASIC programs to analyze the results of a student program while the student's progress is running; a fairly complete version of ALGOL 60; a machine-language interpretive program called DIP; a program maintenance system called EDIT.

Numerous New England schools have accessed the Dartmouth time-shared computer, among them Phillips Exeter Academy. An article by Edward C. Berkeley, "The Romance of Good Teaching--and the Time-Shared Computer," explains the relation with this Institution and Dartmouth College.

A central library of useful programs has been established; it now contains 16 categories. In each category, there are a dozen to two dozen routines.

One of the early projects of MIT's Project MAC was a computer program for semantic information retrieval, "SIR, a Computer for Semantic Information Retrieval," by B. Raphael, discusses this system. Further experience with MAC (Multiple-Access Computer) suggested some significant new transmission and terminal equipment requirements. MIT's Project MAC is wide in scope; research has been done on slave memories and dynamic storage allocation and the findings are presented in "Slave Memories and Dynamic Storage Allocations," by M. V. Wilkes.

Systems Development Corporation has a broad program in computer-assisted education. Specific projects include an author language, PLANIT, and computer-assisted counselling. The entire program is summarized in the proceedings of an ONR-sponsored meeting of the CAI interest group at SDC in September 1966.

COBIS (Computer-Based Instruction System) at the Electronic Systems Division, Hanscom Air Force Base, Bedford, Massachusetts, has three principal features: (1) a light-pencil is used in a multiple-choice format, (2) the student indicates his degree of certainty on a CRT screen, (3) the computer considers both the student's answers and his degrees of certainty when branching to remedial sequences or further steps. A description by J. D. Baker of a special scoring system developed for this purpose is found in "COBIS Computer Based Instruction System."

Florida State University is linked to IBM's Watson Research Center in Yorktown, New York. Subject matter being developed includes: solution of trigonometric identities, educational measurement, non-matric geometry, learning paired-associates, test validity, and stress and strain tensions.

The relationship between Florida State University to the Yorktown Research Center is explained in the University's publication, "Study of Computer Potential in Helping Pupils Learn."

The Laboratory for Computer-Assisted Instruction at the University of Texas opened in September, 1965. An IBM 1401-1026 system became operational in February, 1966. There are 33 course development projects underway, and statistics on system utilization are available in "Quarterly Progress Report--June 30, 1966."

This project evolved from work between IBM (Advanced Systems Development Division) and schools in Northern Westchester County. Remote access to IBM 7090 and 1401 computer systems was made via 1050 terminals. The project is oriented mainly toward simulation as a method of providing individualized instruction in economics, although other programs are in development for other subject matters. The description of this project by R. L. Wing is found in "Status Report, Project 2841, June, 1966."

The Learning Research and Development Center at the University of Pittsburgh is described in a general report, "The Learning R-D Center," covering the five major projects (Individually Prescribed Instruction, Computer-Assisted Instruction, Curriculum Design, SUCEED, Responsive Environments) and the exploratory research areas: Learning Laboratories, Measurement and Decision Processes, and Educational Sociology.

Westinghouse Electric Corporation is developing a computer-based educational system, centered about six areas of effort: hardware development, computer programming, educational materials preparation, student motivation planning, teacher role determination, and administrative implementation development. The heart of the system is the control computer and the student consoles, designated as SLATE. The Behavioral Technology Department, located in Albuquerque, N. M., is particularly concerned with development of computer-based educational material, student motivation planning, and teacher role determination. This system is described in the publication "An Introduction to the Behavioral Technology Department."

### Background of Data-Communications

A dozen years ago the Bell System did not consider data transmission important enough to include it in a discussion of their future plans - ten characters per second teleprinters and associated equipment were satisfying all existing needs. Now, talking about on-line data processing and clamoring for faster, more sophisticated remote terminal equipment is common. The computer manufacturers are all announcing on-line and real time capabilities. Recently the Bell System estimated that by 1970 sixty per cent of their revenue would come from the transmission of data.[9]

High-speed communications devices, linked to satellites in space, will transmit data to and from virtually any point on earth with the ease of a dial system. Students, businessmen, scientists, government officials, and housewives will converse with computers as readily as they now talk by telephone.[10]

Some of the most profound changes wrought by the computer will be in education. Here, the machine will do more than assist students to

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[9] Computer/Communications Terminal Equipment, Honeywell Electronic Data Processing, Wellesley Hills, Massachusetts, 1965. pp II-1.

[10] Sarnoff, David. "No Life Untouched," Saturday Review, July 23, 1966.

solve problems and to locate up-to-date information. It will fundamentally improve and enrich the entire learning process. The student's educational experience will be analyzed by the computer from the primary grades through university. Computer-based teaching machines, programmed and operated by teachers thoroughly trained in electronic data processing techniques, will instruct students at the rate best suited to each individual. The concept of mass education will give way to the concept of personal tutoring, with the teacher and the computer working as a team. Computers will bring many new learning dimensions to the classroom. For example, they will simulate nuclear reactors and other complex, dangerous, or remote systems, enabling students to learn through a form of experience that could formerly be taught only in theory.

In just ten years, the typical electronic data processor has become ten times smaller, 100 times faster and 1,000 times less expensive to operate. These trends will continue, and our national computing power, which is doubling every year, will soon be sufficient to make the computer a genuinely universal tool.

In 1956, there were fewer than 1,000 computers in the United States. Today, there are 30,000 or more than $11 billion worth; and by 1976 the machine population may reach 100,000. And these figures will, of course, be greatly increased through the growth of data processing in other nations.

A decade ago, our machines were capable of 12 billion computations per hour; today, they can do more than 20 trillion, and by 1976--a decade from now--they will attain 400 trillion - or about two billion computations per hour for every man, woman and child. Quite evidently, the threshold of the computer has barely been crossed.[11]

Dr. Jerome B. Wiesner, Dean of Science at the Massachusetts Institute of Technology and former science advisor to President Kennedy, wrote recently in The New York Times:

> The computer, with its promise of a million-fold increase in man's capacity to handle information, will undoubtedly have the most far-reaching social consequences of any contemporary technical development. The potential for good in the computer and the danger inherent in its misuse, exceed our ability to imagine. . . .We have actually entered a new era of evolutionary history, one in which rapid change is a dominant consequence. Our only hope is to understand the forces at work and to take advantage of the knowledge we find to guide the evolutionary process.[12]

Advances in this evolutionary process are coming so quickly that educators are all hard pressed to keep up with them. Today, card processors, tape handling devices, computer to computer processing, etc., can digest mountains of information. This type of equipment is capable of much more than computer users are doing with them. For this reason the equipment manufacturer and using organizations are devoting more and more effort toward developing more sophisticated systems.

From the first basic method of data transmission known as the telegraph to the development of the first basic computerized data transmission system was an approximate 120-year span of time. The computer itself can be taken back by historians to the origin of the ten digits. Much has been written about notched sticks, counting stones, and the persistence of the abacus with its 800 year record of efficiency. The chronological progress carries through the 1600's and the efforts of

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[11] Sarnoff, David. "No Life Untouched," Saturday Review, July 23, 1966.

[12] "The New Computerized Age": A Special Section of Saturday Review July 23, 1966.

Pascal, Grillet, Leibnitz, and others; then to Jacquard of the late 1700's and his punched cards, the first basic form of mechanical programming.[13]

These early efforts to remove drudgery from the accounting operation can be said to be automatic, if, in its connection with data processing, automation can be taken to mean the mechanization of arithmetic process. However, this chapter is not planned to be concerned with the basic developments of the computer, or data transmission in the broad sense. This study will concentrate on computerized data transmission as an integral part of a total data communication system.

Within the United States the Bell Telephone System has approximately 70 million miles of long distance circuits. When these lines are all tied together with switching centers and central information offices, it becomes the world's largest and oldest fixed-program computer. The major question that confronts computer users when considering data communications applications is what would be the limitations for their company and what costs factors will arise?

The June, 1966, issue of "Datamation" presents an item in the "Look Ahead" section that will have a great impact on these questions and the future of data communications. It was pointed out that reductions in data transmission rates could offset such efforts of integrated circuit breakthroughs. It's conceivable, says the hardware expert, that with your own satellite, you might be able to achieve coast-to-coast transmission rates of 5¢ per hour.[14] This compares (assuming voice grade lines) to approximately $8.10/hour.

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[13] Lytel, Allen. <u>ABC's of Computer Programming</u>, Indianapolis: Bobb-Merrill, 1962.

[14] <u>Datamation</u>, F.D.T. Thompson Publication, Inc., Chicago, Illinois, June, 1966, pp. 19.

However, without trying to predict the future in the next three to five years we must consider data communications as they presently exist if we plan to utilize such a system as an educational tool for today's education program.

The basic elements involved in data communications may be divided into four general areas: circuits and networks, modulating-demodulating equipment for converting recorded digital or analog information to signal suitable for transmission over telephone lines, the computing and terminal equipment, and communications package control routines.

The first general area of circuits and networks must consider the sources available for data-transmission by type of line circuits and the type of companies providing the line service. These factors must be considered in any data transmission system; however, the planners of such a system must also consider three other parameters within which they must work. They are the information rate (speed of communications), the accuracy required, and the band width used. Each of these items places restrictions on the planning of such a system. As an example, there is a terrific amount of redundancy in the English language. One can garble up a written or spoken message badly and still determine what's intended. This is not the case with figures, however. A digit 2 that comes out a digit 7, or even an alphabetic character, is of no value because missing digit cannot generally be recreated from context as can sometimes be done in a sentence. This gets into the subject of error detection and control which must be considered in the design of an effective system.

To adequately utilize these parameters the types of communication lines much be understood. These lines can be categorized as simplex, half-duplex, and duplex, depending upon its ability to handle communications. The simplex line refers to a line that has the ability to communicate one way only, the half-duplex line refers to a line that has the ability to communicate either way but not simultaneously, and the duplex line refers to a line that has the ability to communicate both ways simultaneously. After understanding the three basic categories of communication lines, one must then consider the types of lines or channels.

At present the most commonly used data communications line or channel is the narrow-band channel with speed capabilities of approximately 150 bits per second. This is the channel commonly used for handling teletype and some typewriter terminals. The voice grade is the communication line or channel that has been used much more widely in the past few years. The voice-grade is capable of handling speeds at approximately 2,400 bits per second. This channel is becoming widely used on a lease or toll basis for computer-terminal communications and in specialized areas of computer to computer communications. It usually is used for computer to computer communications when transmission speed is not necessarily the prime consideration. For example, in a teaching situation where a computing terminal configuration of equipment is required at a remote terminal location and the speed of the transmission could be held to approximately 2,400 bits per second. However, the most efficient computer to computer communications where production is involved would require wide-band facilities which are capable of handling data at speeds of greater than 2,400 bits per second. Some examples of wide-band channels are telpak A (40,800 bits per second), telpac B (62,500 bits per second, telpac C (105,000 bits per second), telpak D ( 437,500 bits per second, microwave, and coaxial angle.

Following this discussion of types of communications lines or channels used in data communications, it is necessary to discuss other factors on voice-grade channels, mainly because these would be the types of channels used in the designed educational system. The basic reason for the use of the voice-grade channel would be cost. In a strictly educational system, the cost must be a prime consideration. However, if the system can justify a large number of administrative or production programs, a higher speed channel should also be considered. For the purposes of this study, we will consider only the voice-grade channel.

The voice-grade channel presents five basic physical restriction factors from the laws of electricity that limit the ability of companies providing data communications line service to transmit data. They are as follows:

1. Net Loss
2. Band width
3. Distortion
4. Distraction
5. Interference

If something about these basic physical restrictions are understood, it can be seen that, while a system can transmit phenomenal amounts of information, it cannot violate the laws nor exceed their limitations. To better understand these limitations each physical restriction must be examined; the first will be net loss.

Quite simply a signal gets weaker the farther it travels. It is similar to whispering in a long hallway. The farther apart the sending and the receiving are, the harder it is to hear. In data transmission, this means that it becomes exceedingly difficult to distinguish one character from another. Direct current pulses are not suitable for long distance transmission for this reason. In 1920, a long distance call was the equivalent of two people speaking to each other at a distance of about 35 feet. Today it is something like from 4 to 12 feet. This is a big improvement, but it is still not good enough. The way that net loss is overcome in long distance transmission is by first converting the DC pulses to tones or frequencies and then amplifying and transmitting these frequencies over the line where they are then reconverted to the DC pulses. This builds in what is called "gain" which can preserve the clarity of the signal. This, in turn, allows the receiving device to distinguish between characters.

The second physical restriction to be examined will be band width. The normal range of audible sound is somewhere between 20 and 20,000 cycles. These are the sounds that most people can hear. Normal voice sound, however, comes somewhere in between 300 and 3,000 cycles. If we chop off a little at each end of this voice grade line, we don't lose too much. It may tend to distort the voice of the speaker a little, but if we don't chop too much, one can still recognize the voice.

In the case of digital transmission of data, there is another problem. The speed at which we can transfer information in digital form is restricted by the band width. Theoretically we can transfer information at 1 bit per cycle of band width per second, i.e.: 2700 cycle band width= 2700 bits/second.

The practical upper limit of the switched network voice has been thought to be about 2000 bits per second and, on a private line 2400 bits per second. As you can see, if the volume of data to be transferred within a given time exceeds the "speed limit" of the line, other means must be found. One way is to simply expand the band width. This is called broad band.

By discrete assignment of many voice channels to specific frequency bands, and by separation, many voice paths can be put on a wire. Each path is limited to about 3,000 bits but each one is separated in the frequency spectrum. One of the standard forms of carrier can carry 1800 voice messages simultaneously over one pair of copper tubes in a cable.

Now, if they do not separate the voice paths but dedicate a whole wide frequency spectrum to one data link, more data can be sent quickly; this is broad band. One of the standard offerings is now able to transmit at 40,800 bits per second, others up to 62,500 bits per second. The limit is unknown.

With these speeds it is possible to hook computers together over long distance or to connect tape to tape, tape to core, etc. However, the telephone company will be deluged with requests for this type of service in the near future. Most applications can be economically solved by transmission with the voice grade line.

The third physical restriction to be examined will be distortion, or sometimes called delay.

The voice (and many data codes) is made up of various frequencies--some low, some high. It is a peculiar property of these various frequencies that, on a given communications link, cable, radio, etc., some frequencies travel faster than others. This is called propagation time. It is like a horse race. If one signal is made up of three frequencies sent from El Paso to New York and one frequency beats the other two there by five micro seconds, it cannot distinguish just what the signal is. It may repeat the code for a comma instead of a digit 2. What must be done is condition the circuits so the frequencies all arrive together to create what is called a flat response. By conditioning the circuits it, in effect, slows the faster frequencies down to the speed of the slowest. This is one of the limitations that drops the possible transmission rate from a theoretical 2700 bits per second.

The fourth physical restriction to be examined will be distraction, or usually called echo.

You have undoubtedly heard your own voice echoing in your ears on a phone. If the time delay between the time you spoke and heard the echo was very short and, if the volume of the echo was low, it didn't bother you too much. However, if the time delay was appreciable and loud enough, it was very distracting. It may be annoying, but it doesn't ruin the call. Such is not the case with digital communication. That echo keeps going around the loop (getting weaker all the time) overriding or distorting other signals so that the receiving business machine misreads the message. It garbles the message. Devices can be installed on most LD lines called "echo suppressors". These devices are directional. They operate in the opposite direction of the source. They take a fraction of a second to "turn around".

In data transmission, some devices have answer back signals to signify receipt of the message block. In these cases a delay can be built in to allow the echo suppressor to "turn around". Under certain situations, a continuous signal can be sent out that deactivates the echo suppressor, but in most instances the "turn around" time slows it down.

The last and probably most restrictive of the limitations is interference. It is usually noise. There are two types: steady or random noise and impulse noise.

Steady noise is sometimes called "white noise" for the reason that, like light, it is made up of various frequencies. It is always present in some degree. These noises are induced by such things as heat changes, wind, sandstorms, etc. The problem is to make the intelligence signal sufficiently bigger than the noise signal. This is called the signal to noise ratio.

Impulse noise is the biggest problem in data transmission. You have probably heard it as loud pops or clicks on the line. Even though these noises can be heard, they usually don't bother a voice transmission. However, it causes great problems with data transmission. Impulse noise on the line can be caused by lightning, switches operating in the central office, by people lifting an extension, etc. In transmitting printed information it may change a legal character to another character, perhaps illegal thus garbling a data message.[15]

These five basic factors that limit data transmission over voice-band channels are factors that must be considered and understood in the design of a data communications system that utilizes voice-band channels.

The second general area, the modulating-demodulating equipment for converting recorded digital or analog information to tones suitable for transmission over telephone lines, requires a great deal of cooperative work relationships between the telephone companies and the equipment manufacturers.

The relationship requires that the common carriers companies work very closely with all of the equipment manufacturers to standardize interfaces between all equipment concerned. The interfacing equipment that connects the data transmission line and the terminal itself is known

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[15] Data Communications. Mountain State Telephone Company, El Paso, Texas, Marketing Department, September, 1965.

as the "Dataphone" data set. The most common used data set is known as a "data phone".[16] The Dataset is a device that takes the D. C. pulse, converts it to tone, modulates it, and sends it out on the line. The tone is then taken off the line at the other end. It demodulates the tone back to the business machine language. The function of the Dataset is a simple one; however, it is a necessary function of the total system.[17]

Next, we will discuss the third general area of computing and terminal equipment as it relates to data communications and time-sharing. The important technological advance that makes a computer-based teaching system practical is "time-sharing", whereby the immense capacity and speed of the computer allow many students, working independently in different locations, to use a single computer at the same time with little delay in computer response to individual commands, questions, or answers.[18]

The time-sharing technique also provides dimensional data communication, a merger of two technologies. The computer at the hub of the system provides a modular facility for processing large volumes of data at high speeds. The responsiveness of the system can be tailored to a user's on-line requirements by selecting a combination of transmission facilities and terminal devices best suited to serve the needs.

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[16] Dataphone 201-A, American Telephone and Telegraph Co. - The Bell System, March, 1963.

[17] Data Communications Services. American Telephone and Telegraph Co. The Bell System, April, 1961.

[18] Suppes, Patrick, "Plug-In Instruction," Saturday Review, July 23, 1966.

First, let us consider the computing system as the hub. Towards the end of World War II, the armed services maintained inventories of supplies on punch cards. They also maintained communication networks to link outlying points by means of teleprinters with paper-tape input and output. Shortly after the conclusion of the war, conversion equipment was developed to convert the paper-tape input to card input which provided a card input and paper-tape output conversion.

In 1954, a data transceiver was added to transmit and receive punched card data over wire or microwave circuits, eliminating the conversion step. The data receiver was the first of a long line of terminals that could be connected to existing communication circuits for data transmission.

Near the start of the 1960's a magnetic-tape terminal was developed which could transmit and receive data at the same time. This was quickly expanded to include card transmission and the ability to move data from one computer's internal core memory directly to another. Transmission speed up through these devices ranged from 75 to 300 characters per second on a voice quality line, and up to 28,000 characters per second on broad-band microwave or coaxial cable services.[19]

Approximately three years later, a typewriter-keyboard terminal to which a card or paper-tape reader can be attached was developed. This typewriter-keyboard terminal was about 50 per cent faster than other keyboard terminals at that time and operated over standard voice-grade line facilities.[20]

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[19]Data Communications Capabilities, Honeywell Electronic Data Processing, Wellesley Hills, Massachusetts.

[20]IBM Tele-Processing Equipment, International Business Machines Corp. Data Processing Division, White Plains, N. Y.

The major limitation until 1965 on the expansion of remote computer techniques was communications cost. At that time a method was developed to help cut these costs. This development was the use of line adapters that modulate and demodulate signals sent over private or leased communication lines.

These adapters make it possible for a line's relative wide band width to be divided among several terminals of narrow band width. The design of the adapter and the number of terminals that can be handled depend on the type of terminals (magnetic tape, punched cards, etc.), and on the type of line used (full - duplex voice-grade, microwave, coaxial cable or other). Until the development of the line adapter and data communications control units, the majority of all data communications utilized the batch processing technique. This is the technique of executing several programs in series or one at a time.

A newer more refined technique is time-sharing in which programs are handled in parallel. Even though a higher level of data communications has been developed in time-sharing, batch processing will never disappear. Where a time-sharing system exists, there will not always be constant demand from the remote terminals, and programs run in batch-process mode give the computer something to do in these idle intervals.

The general definition in the preceding paragraph refers to time-sharing as a system where programs are handled in parallel. The definition is extremely general. To define time-sharing in the proper manner, it must be broken down into three basic divisions. These three basic divisions are multiprogramming, multiprocessing, and on-line real time.

First, consider the multiprogramming aspect of time-sharing. This aspect refers to several programs stored in a computer memory simultaneously. In multiprogramming, only one program can run at any given time. The multiprogrammed computer immediately switches to another program after one program is completed or reaches a point where the central processor cannot proceed.[21]

The second aspect of time-sharing to be considered is multiprocessing. Multiprocessing is the simultaneous operation of two or more independent computers executing more or less independent programs, with access to each others internal memories.[22]

The third aspect of time-sharing would be that of on-line, real time. An on-line, real-time system combines two kinds of activities. One, an on-line system receives information about current activities as soon as it occurs. Secondly, a real-time system is one in which an answer to a continuing problem for the most recent set of input values is always available. The time-shared computer is on-line because the computer user interacts directly with the computer and real time for the availability of the answers.[23]

Although the achievement of practical time-sharing techniques made use of the accomplishments that have been noted, there were a number of other problems to be solved. These problems and their solutions appeared in such diverse fields as dedicated business file applications (airline reservations) and real-time military applications (range safety, fire

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[21]Riley, Wallace B., Time-Sharing: One Machine Serves Many Masters, Electronics, November 29, 1965.

[22]Riley, Wallace B., Time-Sharing: One Machine Serves Many Masters, Electronics, November 29, 1965.

[23]Riley, Wallace B., Time-Sharing: One Machine Serves Many Masters, Electronics, November 29, 1965.

control, weapon allocation, etc). Other important pieces of time-sharing achievement came from efforts to speed up batch processing and from the successful solutions to the problems of multiprogramming and multiprocessing. These resulted in time in multiplexing the work of one computer and in bringing together the arithmetic and logic capabilities of several.

There also were a few more specific problems which had to be solved before time-sharing could arrive at its present status:

1. High capacity communication. Time-sharing systems demand the efficient handling of massive communications facilities and the development of hardware capable of dealing with many different communications lines at one time with a minimum of programming overhead.
2. Interrupt orientation. Because the course of events in a general-purpose time-sharing system is not predictable, it would be most inefficient for the central computer to inquire continually concerning the needs of other parts of the system. Instead, it has proved far more efficient to orient time-sharing systems to external stimuli (i.e., the need of the users). Therefore, in time-sharing every request for service initiates a priority interrupt which is dealt with according to its priority level.
3. Memory and file protection. With many users entering the system simultaneously, the problem had to be solved of providing protection both to active memory and to the library of files. Unauthorized access to or accidental destruction of existing files could not be tolerated. Memory and file

protection has progressed from initial reliance on software, to hardware and software safeguard combinations, and from there to providing sufficient hardware to insure absolute memory and file protection for every user's data.

4. Access authorization. With each of the users isolated through memory and file protection, it then became necessary to determine if each user was, in fact, authorized to have access to the system and, in addition, to provide facilities so that one user could authorize another to have access to his program, either fully or on some restricted basis such as, "read only". Here again, hardware support was required to make the function efficient.

5. Shared programs. As the number of users in time-sharing systems increased, it became important to avoid storing duplicate copies of heavily used programs or portions thereof in the main memories. Thus, techniques had to be developed to provide for the intermixed access of many users to a single program in such a way that each did not interfere with the other. This led to the concept of program segmentation and pure procedure, the latter so designated because the program procedure is not altered by execution or partial execution.

6. Memory allocation. In a large time-sharing system, the number of users and their probable problem sizes will vastly exceed the amount of main memory available. To accommodate them, the time-sharing system must indulge in swapping programs in and out of the main memory

and must be provided with techniques for efficient allocation of memory to programs requiring service. Also, for high efficiency, the system must be given techniques which allow for the partial allocation of memory so that only the active portions of a particular program are in memory at a particular time. This allows more memory to remain available for other users. An important consequence is that the actual memory used in the solution of a user's program is not equal to the apparent memory the user believes he had occupied. Thus, the user need not be aware of the true memory size of the computer. This will have important bearing on subsequent discussions.

7. Hierarchal files. As a direct consequence of the memory allocation problem and its solution, various levels of mass storage have been developed. The higher levels provide more rapid access at a higher cost per bit and more limited total capacity. Handling of information within the hierarchy may be either by the user or as a part of the executive program of the time-sharing system.

Today, a second generation of time-sharing systems is on the horizon. The new major systems will begin practical activity some time between the middle and end of 1967.

This second generation will consist of two rather different kinds of time-sharing computer systems. The most significant, perhaps, will be those using equipment heavily modified of redesigned for the specific need of servicing hundreds rather than tens of individual users. The other, providing a much more limited service, will be improved versions of the first generation systems using more up-to-date equipment at somewhat lower cost than the presently installed machines.[24]

Almost any large computer can be time-shared, but for the most efficient operation, a specially designed computer is necessary. The newer systems designed for time-sharing contain hardware for special tasks such as program relocation and memory protection.

Relocation permits a program to be loaded anywhere in the memory, at the option of the supervisory program--the program may be in a different location every time the computer resumes work on it. For time-sharing, the relocation problem is complicated enough to warrant putting the solution into hardware, rather than software as has been used for many years in standard computer practice. The supervisory program loads a constant--the address of the program's first instruction--into a hardware register and adds this constant to each address reference.

Memory protection is necessary whenever more than one program exists in the memory; it establishes bounds for instructions and data pertaining to a particular program.[25]

A time-shared computer requires a large memory, or storage--both a main memory (rapid-access core memory) and bulk back-up storage (magnetic drum, disk, etc.). A typical main memory has a capacity of several hundred thousand characters and an access time of one or two microseconds. The magnetic drum usually has a capacity of about a million characters,

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[24]Weil, John W., "The Impact of Time-Sharing on Data Processing Management," Systems and Processors Operation - General Electric Computer Division, Phoenix, Arizona.

[25]Riley, Wallace B., Time-Sharing: One Machine Serves Many Masters, Electronics, November 29, 1965.

and its average access time is in the tens of milliseconds. The magnetic file usually has a capacity of hundreds of millions of characters and a typical average access time is 200 milliseconds. The main memory usually contains the supervisory program, some frequently used subroutines, and the present user's program. The demand for large memory areas comes from the compilers and subroutines of the general-purpose system, and even more, from the large requirements of the supervisory program that directs the "traffic" of other programs.

Current users' programs are typically carried in a magnetic drum memory, so they can be swapped into main memory on short notice. Magnetic disk memory is for programs that are not being used at the moment but that are called upon frequently.[26]

These time-sharing systems handle a wide variety of remote terminals from typewriter keyboard terminals to specially designed configurations of smaller computing equipment planned for specific utilization. Large numbers of remote terminal devices are now being marketed by many companies throughout the world, and to complicate matters further, new devices are entering the market daily. With this wide variety of terminal devices available today, a major problem exists in the hardware area; this is the lack of compatibility between computer manufacturers hardware. Naturally, one company's hardware is compatible with its own equipment; however, it is doubtful if it could be interfaced with other companies equipment without some major revisions that would probably cost a

[26]Riley, Wallace B., Time-Sharing: One Machine Serves Many Masters, Electronics, November 29, 1965.

considerable amount. The mix of different types of terminals would also present problems in designing of software packages.

Remote terminal devices are generally classified into either general purpose or special purpose devices. General purpose devices are those that can be used in a variety of data transmission applications, while special purpose devices are those designed for a specific type of application. The various types of terminal equipment available allow transmission of information from punched cards, punched paper tape, magnetic tape, internal memories of computers, keyboards and magnetic disk, as well as from handwritten messages and maps, etc. Information can be received in these media or as printed copy. Some manufacturers have devised configurations of terminal equipment in which the data received do not have to be in the same media as the data transmitted. The data could be sent on magnetic tape or punched cards and received on plotters.

The five major types of terminals that would be involved with typical speeds in an educational situation would be:

1. Typewriter keyboard transmission terminals can accept data from the communications line, from the keyboard, or from the paper tape or card reader. The keyboard can send data to the communication line, to the printer, or to the paper tape or card punch.

2. Card transmission terminals send and receive punched cards. Transmission speeds are determined by the limited speed of transmission line, with typical card reading devices the serial reading device of approximately 300 columns per second, or the serial punching device of approximately 160 columns per second.

3. Magnetic tape transmission terminals can receive and write or read and transmit seven track magnetic tape. Line service determines the speed of transmission.

4. Print read punch terminal is a combination terminal combining the equivalent components of card reader, card punch, control unit and printer. The card transmission speeds are basically the same as the card transmission terminal listed above with the addition of a printer with capabilities of approximately 190 lines per minute. The terminal operates on-line as a data communications terminal or off-line as a reader and printer.

5. A data transmission processing terminal or computer terminal generally is a configuration that is equipped with a communication adapter. The terminal consists of card reader, card punch, printer, data communications control unit, and central processor. This terminal could range from a basic processing unit consisting of a card reader of approximately 190 cards per minute, card punch of approximately 160 characters per second, printer of approximately 190 lines (120 characters per line) per minute, and a processing unit of approximately 4,000 characters of core memory to a large computer tied into an even larger configuration of computing system.

This fifth type of terminal would be best suited for an educational situation devoted to the training of high level language programmers. It would provide an on-line system that would have capabilities similar to that of the larger centralized configuration of the computing system limited in speed mainly by the type of communication line itself. The smaller remote computer would be capable of utilizing the higher level compiler languages of the data center configuration, on-line. This type of time-sharing system would not only provide a hardware backup from the central computer to the remote terminal but it would also provide a personnel backup to the remote location from the central location. This aspect of providing personnel backup is a key factor in the staffing of the remote educational configuration. If an instructor or a group of instructors encountered problems in their data processing instructional programs and had additional knowledgeable personnel without data centers to help solve these problems, it would prevent the breakdown of communications and help to insure high quality instruction between the instructor and the students. This type of configuration for the remote terminal would also provide off-line capabilities for the instructor to do the more repetitious aspects of a basic instructional program. It would also provide a computing facility that could assist the institutions in their administrative functions.

The final hardware consideration that will be discussed is data transmission units and controls. This will be a key factor in the selection of a system. The data transmission unit and transmission controls are the units that permit computing hardware to be used as part of a total system. It permits equipment to be used as a transmission terminal with any of its connected input/output units available as the storage medium for the data being transmitted such as card, magnetic tape, printer, disk, etc.

A complete knowledge of the capabilities, expansion flexibilities, line capabilities, line options, channel positions, automatic polling, speed, etc., is required by the data communications user before making any decision on system configuration. The data transmission hardware can be designed with necessary options to serve the total system. Any substitutes to control the system must be analyzed from all standpoints. The control units must, above all, have the necessary capabilities for the designed systems with the adequate number of lines for simultaneous transmission of data to the central processor.

The final area to be considered in the use of data communications is the area of software. This area would be classified in data communications as the communications package control routine.

When time-sharing is being utilized, most data processing personnel are concerned with the ultimate goal of the routine computations. They generally fail to realize that these routine computations are controlled by the computer's supervisory program, also called the executive or the monitor software packages. In batch-processing systems, it supervises such recurring tasks as loading of new programs, data recovery after an error, and the mechanics of input and output. Software often includes a library of subroutines for such recurring processes as calculation of square roots, sorting of lists, and other tasks that are primarily mathematical or clerical. Usually the programmer can specify one of these subroutines with a single instruction, called a macro-instruction, in his program. The supervisory program then initiates these subroutines at the proper time.

In time-sharing systems, supervisory programs have additional housekeeping tasks. The system supervisory program must keep a record of each users time on the machine, even if this occurs in millisecond increments. As for language, one of the first inputs from each user of a general-purpose computer is a designation of the language he expects to use. The supervisory program then calls the proper processor into interval memory.

For time-shared systems, the supervisory program must be large because of the complex sequence that must be controlled.

## CHAPTER III

## THE METHODOLOGY AND PROCEDURE

The advancements made in the area of data processing which have provided rapid quality methods of data-communications for modern industry should also be utilized and developed in educational institutions. This would not only provide for more efficient data processing but would also train students to efficiently program, operate, and design such systems. This study, therefore, is concerned with the problem: Is it feasible to establish a program to train computer programmers utilizing a time-sharing system and remote data-communications transmission terminal?

### Inventory and Classification of Activities

The first step of the study was to obtain a group of activities which are, or might be, engaged in by computer programmers and systems analysts on existing systems and anticipated systems. A seventeen page preliminary proposal and inquiry form was designed to obtain a list of suggested data processing activities from a selected jury of forty leaders in industry, local, state and federal government and local, state and federal technical educators with wide varieties of background and experience. A copy of the inquiry form is in Appendix B.

The activities used were broadly based on standard data processing practices, concepts, and techniques which provided familiarity to the members on the jury. These activities were intended to serve as a frame of reference to guide them in thinking of meaningful educational data processing practices, concepts, and techniques.

Illustrations of all necessary activities were listed by the author to stimulate the jury members to suggest additional activities or revisions of the illustrated activity. Further assistance and stimulation of jury members were provided by sending an outline of the study, Appendix C, along with the transmittal letter, Appendix A. The transmittal letter includes the following: (1) the purpose of the study and a request for assistance; (2) a definition of the educational data-processing activity; (3) the broad classification of activities, as a frame of reference; and (4) specific explanation of what the jury members were asked to do to assist in the study. The outline of the study set forth the following: the problem statement, objectives, procedures, significance of study, hypotheses to be tested, assumptions of the study, and limitations of the study.

## Selection of Preliminary Jury and Pre-Test of Instruments

The pre-test of the instrument was obtained from the forty industrial and educational leaders on the preliminary jury who examined the transmittal letter, the outline of the study, and by combining their efforts to complete the inquiry form, by using the information supplied and by following the instructions, resulted in valuable constructive criticisms and suggestions. These were used by the author in refining and improving the form and the instructions. Table I on the next page lists the types of institutions and positions of the preliminary jury.

The suggestions regarding the preliminary inquiry form received from the preliminary jury were assembled exactly as submitted, considering

TABLE I

TYPES OF INSTITUTIONS AND POSITIONS OF PRELIMINARY JURY

| TYPES OF INSTITUTIONS | TYPES OF POSITIONS |
|---|---|
| Private and Public College | Director, Data Processing |
| Private and Public College | Data Processing Instructor |
| Private and Public Junior College | Director, Data Processing |
| Private and Public Junior College | Data Processing Instructor |
| Private and Public University | Director, Data Center |
| Private and Public University | Data Processing Instructor |
| Technical Institutes & Extensions of University Systems | Institute Director |
| Technical Institutes & Extensions of University Systems | Director, Data Processing |
| Technical Institutes & Extensions of University Systems | Data Processing Instructor |
| State Department of Education | Director of Statistical Services |
| State Department of Education | Director, Data Center |
| State Department of Education | Data Center Coordinator |
| U. S. Office of Education | Tech. Ed. Program Specialist |
| County Offices | Director, Data Processing |
| Private Research Corporation | Systems Analysts |
| National Education Associations | Program Specialist |
| U. S. Military | Coordinator of Data Processing Activities |
| Data Processing Equipment Manufacturers | Technical Representatives |
| Data Processing Equipment Manufacturers | Systems Engineers |

each of the activities. Each suggestion was reviewed and examined critically as to meaning and clarity of expression. The majority of the preliminary jury suggested little or no change in the preliminary inquiry form. The suggestions that were considered valid were classified and eliminated of duplication. These activities were then rephrased and rewritten when they were justified as being specifically related to the educational data processing activity.

Obviously, many suggested activities were dropped from the list entirely by including only those which met the following general criteria.

1. That the activities would have application in the area of educational data processing at a level compatible to that of programmers and data processing technicians.
2. That the activity was specific enough to be developed as an activity on the inquiry form and would be of practical value to the problem.
3. That the activities suggested by the preliminary jury member be of a nature that would not discount the overall objective of the study, and that the preliminary jury member truly understood the basic data-communication concept involved as it would relate to the educational situation. Once an activity regarding educational data processing was made by a preliminary jury member who understood the objectives of the study and the basic concepts involved, it would then be considered as having practical value to the problem.
4. That the results of the suggestion would not eliminate an area of the inquiry form that is of value to the study.

All suggestions were considered and the newly designed final inquiry form was completed. The final inquiry form and the one page transmittal letter designed to give necessary instructions briefly, without sacrificing clarity was completed. The final inquiry form and the transmittal letter are Appendix D and Appendix E.

## Selection of Final Jury

In order to gather the necessary list of educational data processing activities, a final jury of randomly selected organizations in the State of Oklahoma that employed data processing programmers and systems analysts were selected by the author. The random selections were made from a list comprising all the data processing installations as of November, 1965, in the State of Oklahoma. The total list was developed with the assistance of associates on the staff of the Oklahoma Sate Board for Vocational Education and the major computer companies in the State. The major contributor in the development of this list was made by the IBM Corporation with assistance given by Honeywell, Inc., General Electric Corporation, and Univac Division of the Sperry Rand Corporation. The major computer companies also assisted in the development of four subdivisions of this list by size of computer installation and number of programmers and systems analysts employed in each firm on the list. This assistance was of great value due to the necessity for proper sampling by size groups.

The 269 organizations were divided into four size groups as indicated in Chapter I. The sampling ratio, suggested by the committee, was used to determine the sample size within each size group and the samples were drawn. As can be seen in Table II, a higher sampling ratio

## TABLE II

## ORGANIZATIONS SAMPLED BY SIZE GROUPS*

| Size Group | Number of Programmers or Systems Analysts | Total Number of Organizations | Sampling Ratio | Resultant Sampling Size | Number of Organizations Returning Mail Questionnaire | Number of Organizations Interviewed | Number of Organizations not in Sample |
|---|---|---|---|---|---|---|---|
| A | 20 or more | 12 | 100 | 12 | 9 | 3 | 0 |
| B | 10-19 | 14 | 75 | 11 | 11 | 0 | 3 |
| C | 5-9 | 31 | 50 | 16 | 14 | 2 | 15 |
| D | 0-4 | 212 | 25 | 53 | 46 | 7 | 159 |

*See Appendix F for alphabetized list of organizations, locations, resource persons, and method of sampling by size groups.

was used for the size groups employing more programmers or systems analysts.

Questionnaires were mailed to the organizations in each sample. Follow-up questionnaires were sent to those who had not returned their original questionnaires at the end of the first month. If the follow-up questionnaire was not received at the end of the second month, an interview was conducted by a staff member of the division of technical education. In a few cases the interviews were required to clarify a statement or reaction to the questionnaire. Table II shows the number of organizations in each size group, the number returning mail questionnaires, the number interviewed and the number not included in the sample.

## An Examination of Tests

Actually, a random selection method was used to obtain the samples, but a sampling ratio was maintained to an overall consistency by size groups. One basic problem developed from the use of the random sample technique used in the study, that of absence of representation in some specialized area where only one or two firms existed. When these specialized areas were not represented in the random sample, it required a revision in the number of subhypotheses within hypothesis IV. This was the basic reason that the total number of 32 subhypotheses in hypothesis IV was reduced to ten. This reduction was directly attributed to the number of possible combinations of these groups.

These combination groups, as originally planned, had ten groups (4 size, 2 application, and 4 location) which offered 32 possibilities or combinations to be tested; however, after random samples were made only five groups were adequately represented by the random samples. These five groups offered ten possibilities or combinations to be tested.

Table III shows the responses by groups of size and location involved in the business application. The responses for the scientific application, according to group size and location, are shown in Table IV; however, these responses were limited to the degree that no significant difference could be established. The five adequately represented groups in the business applications are shown on Table III. These five adequately represented groups are: Group I (size A, application A, location A), Group II (size A, application A, location B), Group III (size A, application A, location C), Group IV (size A, application A, location D), and Group V (size D, application A, location D).

After an exceptionally gratifying response on the original questionnaire of 74 percent (68 out of 92), it was discovered that most of the major computer companies had informed all their sales engineers and systems engineers about our project; and they had instructed them to assist or encourage the local organizations to realistically and properly complete and return the questionnaires. This was the major factor in the rapidness and thoroughness of the completed original questionnaires. A delay of one month was given before a follow-up questionnaire was sent to the 24 organizations of the final jury who had not completed the inquiry form. The follow-up questionnaire consisted of the original transmittal letter and questionnaire. The number of follow-up questionnaires received was 13 percent of all organizations sampled.

A waiting period of one additional month was allowed to complete the follow-up questionnaire. If at the end of that time the follow-up questionnaire had not been received, an interview was then required. A total of 12 interviews were made or a total of 13 percent of all organizations sampled. The assistance given in acquiring the responses and the

TABLE III

NUMBER OF RESPONSES IN BUSINESS APPLICATION GROUPS RANDOMLY SAMPLED

| | | Location Groups | | | |
|---|---|---|---|---|---|
| | | L-A | L-B | L-C | L-D |
| SIZE GROUPS | S-A | 11 | 0 | 0 | 0 |
| | S-B | 8 | 1 | 0 | 0 |
| | S-C | 12 | 0 | 2 | 0 |
| | S-D | 38 | 0 | 3 | 6 |

BUSINESS APPLICATION - A

TABLE IV

NUMBER OF RESPONSES IN SCIENTIFIC APPLICATION GROUPS RANDOMLY SAMPLED

| | | Location Groups | | | |
|---|---|---|---|---|---|
| | | L-A | L-B | L-C | L-D |
| SIZE GROUPS | S-A | 0 | 0 | 1 | 0 |
| | S-B | 1 | 0 | 1 | 0 |
| | S-C | 1 | 0 | 1 | 0 |
| | S-D | 3 | 0 | 3 | 0 |

SCIENTIFIC APPLICATION - B

responses themselves were gratifying, and the interest in the concept far exceeded expectations.

## Treatment of Data

The 92 responses were tabulated in the computer center of the State Department of Education in Oklahoma City, Oklahoma. In twelve cases, the information on the questionnaire could not be interpreted properly so interviews were made to clarify the data. The data center coordinator and a systems analyst of the State Board for Vocational Education assisted in the planning of the final tabulation of the sampled data. The key punch staff of the office of the Department of Education punched all of the cards. The data were then run to test significant differences (chi-square) in the data for each of the hypotheses included in the research proposal and additional statistical treatment was given to the data to test significant differences in specialized items which would provide specific information that would be useful in the development of the study.

After the listing was made of the firms participating by size groups (see Table II) a tabulation was made of the responses of all ninety-two participants by size group A (see Table V), size group B (see Table VI), size group C (see Table VII), and size group D (see Table VIII). These tables were designed to record the number of responses and percentages in each of the described classifications. The basic data on Table V, VI, VII and VIII is annotated with the following symbols:

(*) Required
(X) Preferred
(O) Non-Required
(N) Cannot answer due to lack of knowledge of this aspect of the data processing system

TABLE V

TABULATION OF RESPONSES FROM SIZE GROUP A

| Organizations in Size Group A | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 1 | 17 | 13 | 60 | 40 | 0 | X | * | * | X | X | * | * | * | * | * | X | 0 | 0 |
| Present Needs | 26 | 19 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 26 | 20 | | | 0 | X | * | * | * | X | * | * | * | * | * | X | X | 0 |
| 1968-69 Needs | 30 | 22 | | | 0 | X | * | * | * | X | 0 | * | * | * | * | * | X | 0 |
| 1970-71 Needs | 35 | 25 | | | 0 | X | * | * | * | X | 0 | * | * | * | * | * | * | 0 |
| Org. # 2 | 40 | 10 | 99 | 1 | 4 | 0 | * | * | * | * | N | * | * | * | * | * | * | N |
| Present Needs | 50 | 15 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 50 | 20 | | | 4 | 0 | * | * | * | N | N | * | * | * | * | * | * | N |
| 1968-69 Needs | 55 | 25 | | | 5 | N | * | * | * | N | N | * | * | * | * | * | * | N |
| 1970-71 Needs | 55 | 25 | | | 5 | N | * | * | * | N | N | * | * | * | * | * | * | N |
| Org. # 3 | 99 | 50 | 25 | 75 | 0 | * | * | * | X | 0 | * | X | * | * | * | X | X | X |
| Present Needs | 123 | 55 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 123 | 55 | | | 0 | * | * | * | X | 0 | * | X | * | * | * | X | X | X |
| 1968-69 Needs | 123 | 55 | | | 0 | X | * | * | X | 0 | * | * | * | * | * | * | * | * |
| 1970-71 Needs | 123 | 55 | | | 0 | X | * | * | X | 0 | * | * | * | * | * | * | * | * |
| Org. # 4 | 8 | 4 | 1 | 99 | 0 | * | * | 0 | 0 | * | * | * | * | * | * | * | * | * |
| Present Needs | 10 | 6 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 10 | 11 | | | 0 | * | * | * | 0 | * | * | * | * | * | * | * | * | * |
| 1968-69 Needs | 20 | 11 | | | 0 | * | * | * | | * | * | * | * | * | * | * | * | * |
| 1970-71 Needs | 30 | 15 | | | 0 | * | * | * | | * | * | * | * | * | * | * | * | * |
| Org. # 5 | 58 | 24 | 33 | 67 | 0 | * | * | * | 0 | * | * | * | * | | | 0 | 0 | 0 |
| Present Needs | 58 | 24 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 58 | 24 | | | 0 | 0 | * | * | * | * | * | * | * | * | * | 0 | 0 | 0 |
| 1968-69 Needs | 58 | 24 | | | 0 | 0 | * | * | * | * | * | * | * | * | * | * | 0 | 0 |
| 1970-71 Needs | 58 | 24 | | | 0 | 0 | * | * | * | * | * | * | * | * | * | * | 0 | 0 |
| Org. # 6 | 20 | 10 | 20 | 80 | 5 | X | * | * | X | X | X | X | X | * | * | X | X | 0 |
| Present Needs | 20 | 15 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 25 | 15 | 30 | 70 | 7 | 0 | * | * | * | X | * | X | X | * | * | * | * | 0 |
| 1968-69 Needs | 25 | 15 | | | 7 | 0 | * | * | * | X | * | X | X | * | * | * | * | 0 |
| 1970-71 Needs | 25 | 15 | | | 7 | 0 | * | * | * | X | 0 | X | X | * | * | * | * | 0 |
| Org. # 7 | 38 | 0 | 30 | 70 | 0 | X | X | * | 0 | X | * | X | X | * | * | X | 0 | 0 |
| Present Needs | 44 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 59 | 0 | 50 | 50 | 0 | 0 | X | * | | 0 | 0 | * | * | X | * | X | 0 | 0 |
| 1968-69 Needs | 69 | 0 | 60 | 40 | 0 | 0 | 0 | * | | 0 | 0 | * | * | X | * | * | X | 0 |
| 1970-71 Needs | 79 | 0 | 70 | 30 | 0 | 0 | 0 | * | | 0 | 0 | * | * | X | * | * | X | 0 |

TABLE V (continued)

TABULATION OF RESPONSES FROM SIZE GROUP A

| Organizations in Size Group A | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 8 | 17 | 7 | 10 | 90 | 0 | * | * | * | X | * | * | X | * | * | * | * | * | * |
| Present Needs | 21 | 8 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 21 | 8 | 20 | 80 | 0 | * | * | * | * | * | * | * | * | * | * | * | * | * |
| 1968-69 Needs | 29 | 24 | | | 0 | X | * | * | * | * | * | * | * | * | * | * | * | * |
| 1970-71 Needs | 44 | 29 | | | 0 | 0 | * | * | * | * | * | * | * | * | * | * | * | * |
| Org. # 9 | 29 | 76 | 10 | 90 | 0 | X | X | * | * | X | * | 0 | X | * | X | X | X | N |
| Present Needs | 34 | 81 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 40 | 85 | 12 | 88 | 0 | X | X | * | * | X | * | 0 | * | * | X | X | X | N |
| 1968-69 Needs | 42 | 88 | | | 0 | X | 0 | * | * | X | 0 | * | * | * | X | * | X | N |
| 1970-71 Needs | 45 | 90 | | | 0 | X | 0 | * | * | X | 0 | * | * | * | X | * | X | N |
| Org. #10 | 30 | 23 | 13 | 87 | 0 | * | * | * | * | * | * | * | 0 | * | * | 0 | 0 | 0 |
| Present Needs | 30 | 23 | | | | * | * | * | * | * | * | * | 0 | * | * | 0 | 0 | 0 |
| 1966-67 Needs | 37 | 18 | 16 | 84 | 0 | 0 | X | * | * | X | * | * | * | * | X | * | 0 | 0 |
| 1968-69 Needs | 46 | 30 | 9 | 91 | 0 | 0 | X | * | * | X | 0 | * | * | * | X | * | 0 | 0 |
| 1970-71 Needs | 55 | 35 | | | 0 | 0 | X | * | * | X | 0 | * | * | * | X | * | 0 | 0 |
| Org. #11 | 13 | 10 | 10 | 90 | 0 | X | X | X | 0 | X | X | X | X | X | X | X | X | X |
| Present Needs | 14 | 11 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 16 | 12 | | | 0 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |
| 1968-69 Needs | 19 | 14 | 15 | 85 | 0 | 0 | X | X | X | X | X | X | X | X | 0 | X | X | X |
| 1970-71 Needs | 21 | 16 | 20 | 80 | 0 | 0 | X | X | X | X | X | X | X | X | 0 | X | X | X |
| Org. #12 | 45 | 20 | 40 | 60 | 0 | X | X | * | 0 | 0 | * | 0 | 0 | * | * | 0 | 0 | * |
| Present Needs | 45 | 20 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 65 | 30 | 45 | 55 | 0 | 0 | X | * | 0 | 0 | * | * | * | * | * | * | 0 | * |
| 1968-69 Needs | 65 | 30 | | | 0 | 0 | X | * | * | 0 | * | * | * | * | * | * | * | * |
| 1970-71 Needs | 65 | 30 | | | 0 | 0 | X | * | * | 0 | * | * | * | * | * | * | * | * |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |

TABLE VI

TABULATION OF RESPONSES FROM SIZE GROUP B

| Organizations in Size Group B | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 1 | 7 | 2 | 43 | 57 | 0 | * | * | * | * | * | * | * | * | * | * | * | * | * |
| Present Needs | 10 | 3 | 43 | 57 | 0 | | | | | | | | | | | | | |
| 1966-67 Needs | 10 | 3 | 50 | 50 | 0 | * | * | * | * | * | * | * | * | * | * | * | * | * |
| 1968-69 Needs | 12 | 5 | 60 | 40 | 0 | * | * | * | * | * | * | * | * | * | * | * | * | * |
| 1970-71 Needs | 15 | 5 | 70 | 30 | 0 | * | * | * | * | * | * | * | * | * | * | * | * | * |
| Org. # 2 | 5 | 7 | 10 | 90 | 3 | 0 | * | 0 | 0 | 0 | * | 0 | X | * | * | * | * | * |
| Present Needs | 6 | 7 | 10 | 90 | 3 | | | | | | | | | | | | | |
| 1966-67 Needs | 6 | 7 | 10 | 90 | 3 | 0 | * | X | * | 0 | X | X | X | X | X | X | X | 0 |
| 1968-69 Needs | 6 | 7 | 10 | 90 | 3 | 0 | X | X | * | 0 | 0 | * | * | X | X | X | X | 0 |
| 1970-71 Needs | 6 | 7 | 10 | 90 | 3 | 0 | X | X | * | 0 | 0 | * | * | X | X | X | X | 0 |
| Org. # 3 | 10 | 2 | 99 | 0 | 4 | X | * | * | * | * | * | * | * | * | * | X | 0 | 0 |
| Present Needs | 15 | 3 | 80 | 20 | 1 | | | | | | | | | | | | | |
| 1966-67 Needs | 15 | 3 | 80 | 20 | 5 | X | * | * | * | * | * | * | * | * | * | X | 0 | 0 |
| 1968-69 Needs | 20 | 3 | 80 | 20 | 5 | X | * | * | * | * | * | * | * | * | * | X | 0 | 0 |
| 1970-71 Needs | 25 | 3 | 80 | 20 | 5 | X | * | * | * | * | * | * | * | * | * | X | 0 | 0 |
| Org. # 4 | 11 | 6 | 5 | 95 | 0 | * | * | * | N | 0 | * | * | * | * | * | * | N | 0 |
| Present Needs | 17 | 8 | 5 | 95 | 0 | | | | | | | | | | | | | |
| 1966-67 Needs | 17 | 10 | 5 | 95 | 0 | 0 | * | * | | | * | * | * | * | * | * | N | 0 |
| 1968-69 Needs | 17 | 12 | 5 | 95 | 0 | 0 | * | * | | | * | * | * | * | * | * | N | 0 |
| 1970-71 Needs | 17 | 14 | 5 | 95 | 0 | 0 | * | * | | | * | * | * | * | * | * | N | 0 |
| Org. # 5 | 3 | 0 | 99 | 0 | 3 | N | 0 | * | * | 0 | * | X | 0 | * | * | X | 0 | X |
| Present Needs | 3 | 0 | 99 | 0 | 3 | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 0 | 99 | 0 | 4 | N | 0 | * | * | 0 | | X | 0 | * | * | * | 0 | X |
| 1968-69 Needs | 4 | 0 | 99 | 0 | 4 | N | 0 | * | * | 0 | | X | 0 | * | * | * | X | X |
| 1970-71 Needs | 4 | 0 | 99 | 0 | 4 | N | 0 | * | * | 0 | | X | 0 | * | * | * | * | * |
| Org. # 6 | 8 | 2 | 25 | 75 | 3 | * | * | * | * | * | * | 0 | N | * | 0 | * | 0 | 0 |
| Present Needs | 8 | 2 | 25 | 75 | 3 | | | | | | | | | | | | | |
| 1966-67 Needs | 8 | 2 | 25 | 75 | 3 | * | * | * | * | * | * | 0 | N | * | 0 | * | * | * |
| 1968-69 Needs | 8 | 2 | 25 | 75 | 3 | 0 | * | * | * | * | * | 0 | * | * | * | * | * | * |
| 1970-71 Needs | 8 | 2 | 25 | 75 | 3 | 0 | * | * | * | * | 0 | * | * | * | * | * | * | * |
| Org. # 7 | 8 | 12 | 12 | 88 | 0 | X | X | * | 0 | 0 | | X | X | * | 0 | 0 | 0 | 0 |
| Present Needs | 8 | 16 | 12 | 88 | 0 | | | | | | | | | | | | | |
| 1966-67 Needs | 10 | 16 | 16 | 84 | 0 | X | X | * | 0 | 0 | | X | X | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 12 | 20 | 20 | 80 | 0 | X | X | * | X | 0 | | X | X | * | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 12 | 20 | 20 | 80 | 0 | X | X | * | X | 0 | | X | X | * | 0 | 0 | 0 | 0 |

TABLE VI (continued)

TABULATION OF RESPONSES FROM SIZE GROUP B

| Organizations in Size Group B | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 8 | 8 | 7 | 25 | 75 | 0 | X | 0 | 0 | 0 | 0 | N | X | 0 | * | 0 | * | 0 | 0 |
| Present Needs | 9 | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 9 | 8 | 25 | 75 | 0 | X | 0 | X | 0 | 0 | N | X | 0 | * | X | * | 0 | 0 |
| 1968-69 Needs | 10 | 10 | 30 | 70 | 0 | X | 0 | X | 0 | 0 | N | X | 0 | * | X | * | 0 | 0 |
| 1970-71 Needs | 11 | 10 | 30 | 70 | 0 | X | 0 | X | 0 | 0 | N | X | 0 | * | X | * | 0 | 0 |
| Org. # 9 | 6 | 7 | 31 | 69 | 1 | * | X | * | N | 0 | * | * | 0 | * | 0 | 0 | 0 | 0 |
| Present Needs | 6 | 7 | 31 | 69 | | | | | | | | | | | | | | |
| 1966-67 Needs | 8 | 9 | 29 | 71 | 1 | * | X | * | N | 0 | | * | * | * | * | 0 | 0 | 0 |
| 1968-69 Needs | 8 | 10 | 28 | 72 | 1 | * | X | * | N | 0 | | * | * | * | * | * | * | 0 |
| 1970-71 Needs | 8 | 10 | 29 | 71 | 1 | * | X | * | N | 0 | | * | * | * | * | * | * | 0 |
| Org. #10 | 9 | 0 | 0 | 99 | 9 | * | 0 | X | 0 | X | N | N | X | X | X | X | X | X |
| Present Needs | 9 | | | | 9 | | | | | | | | | | | | | |
| 1966-67 Needs | 9 | 0 | 0 | 99 | 9 | * | 0 | X | 0 | X | N | N | X | X | X | X | X | X |
| 1968-69 Needs | 10 | 0 | 0 | 99 | 10 | * | 0 | X | 0 | X | N | N | X | X | X | X | X | X |
| 1970-71 Needs | 10 | 0 | 0 | 99 | 10 | * | 0 | X | 0 | X | N | N | X | X | X | X | X | X |
| Org. #11 | 6 | 8 | 20 | 80 | 2 | X | * | X | 0 | X | * | 0 | X | * | * | X | 0 | 0 |
| Present Needs | 6 | 9 | 20 | 80 | 0 | | | | | | | | | | | | | |
| 1966-67 Needs | 7 | 10 | 20 | 80 | 0 | X | * | * | X | X | * | * | * | * | * | * | X | X |
| 1968-69 Needs | 10 | 14 | 20 | 80 | 0 | 0 | * | * | * | X | X | * | * | * | * | * | X | X |
| 1970-71 Needs | 11 | 16 | 20 | 80 | 0 | 0 | X | * | * | X | X | * | * | * | * | * | * | X |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |

TABLE VII

TABULATION OF RESPONSES FROM SIZE GROUP C

| Organizations in Size Group C | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 1 | 5 | 0 | 0 | 99 | 0 | X | * | 0 | 0 | * | * | 0 | * | * | 0 | 0 | 0 | 0 |
| Present Needs | 5 | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 6 | 0 | 0 | 99 | | X | * | * | * | * | * | 0 | * | * | 0 | 0 | N | N |
| 1968-69 Needs | 6 | 0 | 0 | 99 | | X | X | * | * | * | | * | * | * | N | N | N | N |
| 1970-71 Needs | 6 | 0 | 0 | 99 | | X | X | * | * | * | | * | * | * | N | N | N | N |
| Org. # 2 | 8 | 1 | | 99 | 0 | 0 | X | * | 0 | X | * | X | * | * | 0 | 0 | N | N |
| Present Needs | 8 | 1 | | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 8 | 2 | | 99 | | 0 | X | * | X | * | * | * | * | * | * | * | | |
| 1968-69 Needs | 7 | 3 | | 99 | | 0 | X | * | X | * | * | * | * | * | * | * | | |
| 1970-71 Needs | 6 | 4 | 20 | 80 | | 0 | X | * | X | * | * | * | * | * | * | * | | |
| Org. # 3 | 4 | 1 | | 99 | 0 | * | * | 0 | 0 | 0 | * | * | 0 | * | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 0 | 0 | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 6 | 1 | 0 | 99 | | * | * | * | | * | | * | * | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 7 | 1 | 0 | 99 | | 0 | * | * | | * | | * | * | * | 0 | * | 0 | 0 |
| 1970-71 Needs | 8 | 1 | 0 | 99 | | 0 | * | * | | * | | * | * | * | 0 | * | 0 | 0 |
| Org. # 4 | 3 | 2 | 40 | 60 | 0 | * | * | 0 | 0 | 0 | | * | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 3 | 0 | 40 | 60 | | | | | | | | | | | | | | |
| 1966-67 Needs | 6 | 3 | 40 | 60 | | 0 | * | * | * | 0 | | * | * | * | * | 0 | 0 | 0 |
| 1968-69 Needs | 9 | 3 | 40 | 60 | | 0 | * | * | * | 0 | | * | * | * | * | 0 | 0 | 0 |
| 1970-71 Needs | 12 | 3 | 40 | 60 | | 0 | * | * | * | 0 | | 8 | 8 | 8 | 8 | 0 | 0 | 0 |
| Org. # 5 | 6 | 1 | 70 | 30 | 2 | X | | 0 | | * | * | * | 0 | * | * | 0 | 0 | 0 |
| Present Needs | 8 | 3 | 50 | 50 | | | | | | | | | | | | | | |
| 1966-67 Needs | 8 | 3 | 50 | 50 | 3 | X | | * | | * | * | * | * | * | * | * | 0 | 0 |
| 1968-69 Needs | 10 | 4 | 50 | 50 | 4 | X | | * | | * | 0 | * | * | * | * | * | * | 0 |
| 1970-71 Needs | 10 | 4 | 50 | 50 | 4 | X | | * | | * | 0 | * | * | * | * | * | * | 0 |
| Org. # 6 | 8 | 0 | 99 | 0 | 1 | 0 | * | * | 0 | * | 0 | 0 | 0 | 0 | 0 | * | * | 0 |
| Present Needs | 0 | | 99 | 0 | | | | | | | | | | | | | | |
| 1966-67 Needs | 10 | 0 | 99 | 0 | 1 | 0 | * | * | 0 | 0 | 0 | 0 | * | * | * | * | * | 0 |
| 1968-69 Needs | 12 | 0 | 99 | 0 | 1 | 0 | * | * | 0 | 0 | 0 | 0 | * | * | * | * | * | 0 |
| 1970-71 Needs | 14 | 0 | 99 | 0 | 1 | 0 | * | * | 0 | 0 | 0 | 0 | * | * | * | * | * | 0 |
| Org. # 7 | 4 | 2 | 66 | 33 | 3 | X | * | * | N | X | | X | X | X | X | X | N | N |
| Present Needs | 0 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 2 | 66 | 33 | 3 | X | * | * | | X | | X | X | X | X | X | | |
| 1968-69 Needs | 4 | 2 | 66 | 33 | 3 | X | * | * | | X | | X | X | X | X | X | | |
| 1970-71 Needs | 4 | 2 | 66 | 33 | 3 | X | * | * | | X | | X | X | X | X | X | | |

TABLE VII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP C

| Organizations in Size Group C | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 8 | 4 | 3 | 0 | 99 | 0 | X | * | 0 | 0 | 0 | X | N | X | X | 0 | 0 | N | N |
| Present Needs | 0 | 0 | | | 0 | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 3 | 0 | 99 | 0 | X | * | 0 | 0 | 0 | X | | X | X | 0 | | | |
| 1968-69 Needs | 4 | 3 | 0 | 99 | 0 | X | * | 0 | 0 | 0 | X | | X | X | 0 | | | |
| 1970-71 Needs | 4 | 3 | 0 | 99 | 1 | X | * | 0 | 0 | 0 | X | | X | X | 0 | | | |
| Org. # 9 | 3 | 3 | 0 | 99 | 0 | X | * | X | 0 | X | | X | * | X | X | X | 0 | 0 |
| Present Needs | 0 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 5 | 4 | 0 | 99 | | X | * | X | 0 | X | | X | * | X | X | X | | |
| 1968-69 Needs | 6 | 4 | 0 | 99 | | X | * | X | 0 | X | | X | * | X | X | X | | |
| 1970-71 Needs | 6 | 4 | 0 | 99 | | X | * | X | 0 | X | | X | * | X | X | X | | |
| Org. #10 | 4 | 1 | 0 | 99 | 0 | X | * | X | 0 | 0 | * | 0 | X | X | 0 | 0 | 0 | 0 |
| Present Needs | 0 | 2 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 5 | 3 | 10 | 90 | | X | * | X | X | X | X | X | X | X | X | X | 0 | 0 |
| 1968-69 Needs | 5 | 3 | 10 | 90 | | 0 | X | * | X | X | 0 | X | X | X | X | X | 0 | 0 |
| 1970-71 Needs | 6 | 3 | 10 | 90 | | 0 | X | * | X | X | 0 | X | X | X | X | X | 0 | 0 |
| Org. #11 | 4 | 1 | 0 | 99 | 0 | X | * | 0 | 0 | X | * | X | X | * | 0 | X | 0 | 0 |
| Present Needs | 4 | 2 | 0 | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 5 | 2 | 0 | 99 | | X | * | 0 | 0 | X | * | X | * | * | X | X | 0 | 0 |
| 1968-69 Needs | 7 | 2 | 20 | 80 | | X | * | X | X | X | * | X | * | * | * | * | 0 | 0 |
| 1970-71 Needs | 10 | 4 | 20 | 80 | | X | X | * | * | 0 | * | X | * | * | * | * | 0 | 0 |
| Org. #12 | 4 | 2 | 0 | 99 | 0 | X | * | X | 0 | X | 0 | 0 | * | * | X | X | X | 0 |
| Present Needs | 5 | 2 | 0 | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 5 | 3 | 0 | 99 | | 0 | * | * | 0 | X | 0 | 0 | * | * | * | * | * | 0 |
| 1968-69 Needs | 6 | 3 | 0 | 99 | | 0 | * | * | * | 0 | * | * | * | * | * | * | * | X |
| 1970-71 Needs | 8 | 3 | 12 | 88 | | 0 | X | * | * | 0 | * | * | * | * | * | * | * | * |
| Org. #13 | 4 | 1 | 0 | 99 | 0 | * | * | 0 | N | * | * | X | 0 | * | 0 | 0 | 0 | N |
| Present Needs | 5 | 1 | 0 | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 5 | 1 | 0 | 99 | | * | * | 0 | N | * | * | X | 0 | * | X | 0 | 0 | |
| 1968-69 Needs | 5 | 1 | 0 | 99 | | * | * | 0 | N | * | * | X | 0 | * | X | 0 | 0 | |
| 1970-71 Needs | 5 | 1 | 0 | 99 | | * | * | 0 | N | * | * | X | 0 | * | X | 0 | 0 | |
| Org. #14 | 3 | 2 | 0 | 99 | 1 | 0 | * | * | X | * | 0 | 0 | 0 | * | * | 0 | X | 0 |
| Present Needs | 4 | 2 | 0 | 99 | 1 | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 2 | 0 | 99 | 2 | 0 | * | * | X | * | 0 | 0 | 0 | * | * | 0 | X | 0 |
| 1968-69 Needs | 4 | 2 | 0 | 99 | 2 | 0 | * | * | X | * | 0 | 0 | 0 | * | * | 0 | X | 0 |
| 1970-71 Needs | 4 | 2 | 0 | 99 | 2 | 0 | * | * | X | * | 0 | 0 | 0 | * | * | 0 | X | 0 |

TABLE VII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP C

| Organizations in Size Group C | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. #15 | 5 | 1 | 99 | 0 | 1 | X | * | * | 0 | X | X | | 0 | * | * | 0 | 0 | 0 |
| Present Needs | 3 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 8 | 2 | 99 | 0 | 2 | X | * | * | 0 | X | X | | 0 | * | * | 0 | 0 | 0 |
| 1968-69 Needs | 11 | 4 | 99 | 0 | 2 | 0 | X | * | 0 | X | 0 | * | * | * | * | X | 0 | 0 |
| 1970-71 Needs | 11 | 5 | 99 | 0 | 2 | 0 | X | * | * | X | 0 | * | * | * | * | X | X | 0 |
| Org. #16 | 5 | 3 | 0 | 99 | 0 | 0 | X | X | * | * | * | * | * | * | * | * | 0 | X |
| Present Needs | 2 | 2 | 0 | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 8 | 5 | 0 | 99 | | 0 | X | X | * | * | * | * | * | * | * | * | 0 | X |
| 1968-69 Needs | 10 | 5 | 0 | 99 | | 0 | 0 | X | * | * | * | * | * | * | * | * | X | X |
| 1970-71 Needs | 12 | 5 | 0 | 99 | | 0 | 0 | X | * | * | * | * | * | * | * | * | X | X |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |

TABLE VIII

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 1 | 1 | 0 | 0 | 99 | 1 | | * | 0 | 0 | 0 | * | | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 1 | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 0 | 0 | 99 | 1 | | * | 0 | 0 | 0 | X | | N | N | 0 | X | 0 | N |
| 1968-69 Needs | 3 | 0 | 0 | 99 | 1 | | * | X | 0 | 0 | | * | N | N | N | * | N | N |
| 1970-71 Needs | 3 | 0 | 0 | 99 | 1 | | * | X | 0 | 0 | | * | N | N | N | * | N | N |
| Org. # 2 | 1 | 0 | 0 | 99 | 3 | 0 | * | * | X | X | * | * | * | * | X | 0 | 0 | 0 |
| Present Needs | 0 | 0 | | | 0 | | | | | | | | | | | | | |
| 1966-67 Needs | | | 0 | 99 | 3 | | | | X | X | * | * | * | * | * | 0 | 0 | 0 |
| 1968-69 Needs | | | 0 | 99 | 4 | | | | * | X | * | * | * | * | * | * | 0 | 0 |
| 1970-71 Needs | | | 0 | 99 | 3 | | | | * | X | * | * | * | * | * | * | 0 | 0 |
| Org. # 3 | 2 | 2 | 0 | 99 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 2 | 0 | 99 | 1 | * | * | * | 0 | * | 0 | 0 | * | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 2 | 0 | 99 | 2 | * | * | * | 0 | * | 0 | 0 | * | * | 0 | * | * | * |
| 1970-71 Needs | 2 | 2 | 0 | 99 | 2 | * | * | * | 0 | * | 0 | 0 | * | * | 0 | * | * | * |
| Org. # 4 | 2 | 0 | 0 | 99 | 0 | * | * | X | 0 | X | X | * | X | * | 0 | * | X | X |
| Present Needs | 2 | 0 | 0 | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 3 | 0 | 0 | 99 | | * | * | * | X | X | X | * | * | * | 0 | * | X | X |
| 1968-69 Needs | 5 | 0 | 0 | 99 | | X | * | * | * | X | X | * | * | * | 0 | * | X | X |
| 1970-71 Needs | 10 | 0 | 0 | 99 | | X | * | * | * | X | X | * | * | * | 0 | * | X | X |
| Org. # 5 | 1 | 0 | 0 | 99 | 1 | * | * | * | 0 | 0 | X | X | * | 0 | * | 0 | 0 | * |
| Present Needs | 1 | 0 | 0 | 99 | 1 | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 0 | 0 | 99 | 2 | X | 0 | * | 0 | 0 | X | * | * | 0 | * | 0 | 0 | * |
| 1968-69 Needs | 2 | 2 | 0 | 99 | 2 | 0 | 0 | * | 0 | 0 | X | * | * | 0 | * | 0 | 0 | * |
| 1970-71 Needs | 2 | 0 | 0 | 99 | 2 | 0 | 0 | * | X | 0 | X | * | * | 0 | * | 0 | 0 | * |
| Org. # 6 | 2 | 1 | 0 | 99 | 0 | * | 0 | 0 | 0 | * | | | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 0 | 99 | | * | * | 0 | 0 | * | | | 0 | 0 | 0 | N | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 99 | | * | * | 0 | 0 | * | | | 0 | 0 | 0 | N | 0 | 0 |
| 1970-71 Needs | 2 | 1 | 0 | 99 | | * | * | 0 | 0 | * | | | 0 | 0 | 0 | N | 0 | 0 |
| Org. # 7 | 2 | 1 | 0 | 99 | 1 | 0 | * | 0 | * | * | * | * | 0 | * | * | * | X | X |
| Present Needs | 1 | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 3 | 1 | 0 | 99 | 0 | 0 | * | 0 | * | * | * | * | 0 | * | * | * | X | X |
| 1968-69 Needs | 3 | 1 | 0 | 99 | 0 | 0 | * | 0 | * | * | * | * | 0 | * | * | * | X | X |
| 1970-71 Needs | 3 | 1 | 0 | 99 | 0 | 0 | * | 0 | * | * | * | * | 0 | * | * | * | X | X |

TABLE VIII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 8 | 0 | 0 | 0 | 99 | 1 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 0 | 99 | 1 | * | X | 0 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 99 | 1 | * | * | 0 | * | 0 | 0 | 0 | X | X | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 3 | 2 | 0 | 99 | 1 | * | * | 0 | * | 0 | 0 | 0 | * | * | 0 | 0 | 0 | 0 |
| Org. # 9 | 2 | 0 | 0 | 99 | 0 | * | * | 0 | 0 | 0 | N | N | * | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 0 | 0 | 99 | 0 | * | * | 0 | 0 | 0 | N | N | * | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 0 | 0 | 99 | 0 | * | * | 0 | 0 | 0 | N | N | * | 0 | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 0 | 0 | 99 | 0 | * | * | 0 | 0 | 0 | N | N | * | 0 | 0 | 0 | 0 | 0 |
| Org. #10 | 1 | 0 | 0 | 99 | 0 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 0 | 0 | 99 | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 1968-69 Needs | 1 | 0 | 0 | 99 | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 1970-71 Needs | 1 | 0 | 0 | 99 | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Org. #11 | 1 | 1 | 0 | 99 | 0 | X | | 0 | 0 | 0 | | 0 | 0 | * | 0 | 0 | N | N |
| Present Needs | 1 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 0 | 99 | 0 | X | | 0 | 0 | 0 | | 0 | 0 | * | 0 | 0 | N | N |
| 1968-69 Needs | 2 | 1 | 0 | 99 | 1 | X | | * | * | 0 | | * | * | * | * | * | N | N |
| 1970-71 Needs | 2 | 1 | 0 | 99 | 1 | X | | * | * | 0 | | * | * | * | * | * | N | N |
| Org. #12 | 1 | 0 | 0 | 99 | 1 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 0 | 0 | 99 | 1 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 1 | 0 | 0 | 99 | 1 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 1 | 0 | 0 | 99 | 1 | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Org. #13 | 1 | 1 | 50 | 50 | 0 | * | * | 0 | X | X | * | | 0 | * | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 34 | 66 | 0 | * | * | 0 | X | X | * | * | 0 | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 66 | 0 | * | * | 0 | X | X | X | * | 0 | * | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 1 | 0 | 66 | 0 | * | * | 0 | X | X | X | 8 | 0 | * | 0 | 0 | 0 | 0 |
| Org. #14 | 1 | 1 | 0 | 99 | 2 | X | 0 | 0 | 0 | X | * | 0 | X | X | X | X | 0 | 0 |
| Present Needs | 1 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | 2 | X | 0 | 0 | 0 | X | * | 0 | X | X | X | X | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 99 | 2 | X | 0 | 0 | 0 | * | X | * | X | X | X | * | 0 | 0 |
| 1970-71 Needs | 2 | 1 | 0 | 99 | 2 | X | 0 | 0 | 0 | * | X | * | * | * | * | * | 0 | 0 |

TABLE VIII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. #15 | 5 | 0 | 0 | 99 | 0 | X | * | * | X | X | * | 0 | X | * | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 7 | 1 | 14 | 86 | | X | * | * | X | X | * | X | X | * | X | X | 0 | 0 |
| 1968-69 Needs | 8 | 1 | 12 | 88 | | X | * | * | X | X | * | X | X | * | * | * | X | X |
| 1970-71 Needs | 8 | 1 | 12 | 88 | | X | * | * | X | X | X | * | * | X | * | * | X | X |
| Org. #16 | 2 | 1 | 50 | 50 | 0 | X | * | 0 | 0 | X | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 2 | 50 | 50 | | X | * | 0 | 0 | X | * | 0 | * | 0 | 0 | * | 0 | 0 |
| 1968-69 Needs | 2 | 2 | 50 | 50 | | 0 | * | 0 | * | 0 | 0 | * | * | 0 | * | * | 0 | 0 |
| 1970-71 Needs | 2 | 2 | 50 | 50 | | | * | 0 | * | 0 | 0 | * | * | 0 | * | * | 0 | 0 |
| Org. #17 | 2 | 0 | 0 | 99 | 0 | * | * | 0 | 0 | * | N | N | 0 | * | N | * | N | N |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 0 | 0 | 99 | | * | * | 0 | 0 | * | | | 0 | * | | * | | |
| 1968-69 Needs | 5 | 0 | 0 | 99 | | * | 0 | 0 | 0 | * | | | 0 | * | | * | | |
| 1970-71 Needs | 6 | 0 | 0 | 99 | | * | 0 | 0 | 0 | * | | | 0 | * | | * | | |
| Org. #18 | 0 | 2 | 0 | 99 | 2 | 0 | X | 0 | 0 | X | * | | X | 0 | * | X | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 2 | 0 | 99 | 3 | 0 | X | 0 | 0 | X | * | | X | 0 | * | X | 0 | 0 |
| 1968-69 Needs | 2 | 3 | 0 | 99 | 5 | 0 | X | * | 0 | X | * | | X | 0 | * | X | 0 | 0 |
| 1970-71 Needs | 2 | 3 | 0 | 99 | 5 | 0 | X | * | 0 | X | * | | X | 0 | * | X | 0 | 0 |
| Org. #19 | 1 | 0 | 0 | 99 | 0 | 0 | 0 | X | X | 0 | * | X | X | X | X | X | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 0 | 0 | 99 | | 0 | 0 | * | * | 0 | 0 | * | * | * | * | * | 0 | 0 |
| 1968-69 Needs | 2 | 0 | 0 | 99 | | 0 | 0 | * | * | 0 | 0 | * | * | * | * | * | 0 | 0 |
| 1970-71 Needs | 2 | 0 | 0 | 99 | | 0 | 0 | * | * | 0 | 0 | * | * | * | * | * | 0 | 0 |
| Org. #20 | 0 | 1 | 0 | 99 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 0 | 1 | 0 | 99 | | * | 0 | X | N | X | N | N | * | 0 | * | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 99 | | * | 0 | X | N | X | N | N | * | 0 | * | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 1 | 0 | 99 | | * | 0 | X | N | X | N | N | * | 0 | * | 0 | 0 | 0 |
| Org. #21 | 1 | 1 | 0 | 99 | 1 | * | * | 0 | * | 0 | 0 | * | * | 0 | * | 0 | 0 | 0 |
| Present Needs | | | | | 1 | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 0 | 99 | 1 | * | * | 0 | * | 0 | 0 | * | * | 0 | * | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 99 | 1 | * | * | 0 | * | 0 | 0 | * | * | 0 | * | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 1 | 0 | 99 | 1 | * | * | 0 | * | 0 | 0 | * | * | 0 | * | 0 | 0 | 0 |

TABLE VIII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 22 | 1 | 1 | 0 | 99 | 2 | * | * | 0 | 0 | 0 | 0 | 0 | * | * | * | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | 2 | * | * | 0 | 0 | 0 | 0 | 0 | * | * | * | 0 | 0 | 0 |
| 1968-69 Needs | 1 | 1 | 0 | 99 | 2 | * | * | 0 | 0 | 0 | 0 | 0 | * | * | * | 0 | 0 | 0 |
| 1970-71 Needs | 1 | 1 | 0 | 99 | 2 | * | * | 0 | 0 | 0 | 0 | 0 | * | * | * | 0 | 0 | 0 |
| Org. # 23 | 1 | 1 | 0 | 99 | 1 | 0 | X | 0 | 0 | 0 | X | 0 | X | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 2 | 2 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 2 | 50 | 50 | 1 | 0 | X | 0 | 0 | 0 | X | 0 | X | 0 | 0 | X | 0 | 0 |
| 1968-69 Needs | 3 | 3 | 30 | 70 | 1 | 0 | X | X | X | X | 0 | X | X | X | X | X | 0 | 0 |
| 1970-71 Needs | 3 | 3 | 30 | 70 | 1 | 0 | X | X | X | X | 0 | X | X | X | X | X | 0 | 0 |
| Org. # 24 | 0 | 0 | 0 | 99 | 2 | * | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 0 | 0 | 99 | 1 | * | * | | | * | | | | | | | | |
| 1968-69 Needs | 1 | 0 | 0 | 99 | 2 | * | * | | | * | | | | | | | | |
| 1970-71 Needs | 1 | 0 | 0 | 99 | 2 | * | * | | | * | | | | | | | | |
| Org. # 25 | 1 | 0 | 0 | 99 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N | N |
| Present Needs | 1 | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 0 | 0 | 99 | | | | | | | | | | | | | | |
| 1968-69 Needs | 1 | 0 | 0 | 99 | | | | | | | | | | | | | | |
| 1970-71 Needs | 1 | 0 | 0 | 99 | | | | | | | | | | | | | | |
| Org. # 26 | 2 | 1 | 33 | 67 | 1 | * | * | 0 | N | N | | * | 0 | 0 | 0 | 0 | N | N |
| Present Needs | 3 | 2 | 50 | 50 | | | | | | | | | | | | | | |
| 1966-67 Needs | 3 | 3 | 50 | 50 | | * | * | * | N | N | | * | 0 | * | * | 0 | N | N |
| 1968-69 Needs | 4 | 4 | 50 | 50 | | * | * | * | N | N | | * | 0 | * | * | 0 | N | N |
| 1970-71 Needs | 4 | 4 | 50 | 50 | | * | * | * | N | N | | * | 0 | * | * | * | N | N |
| Org. # 27 | 4 | 0 | 75 | 25 | 2 | 0 | * | * | 0 | 0 | * | | 0 | * | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 5 | 0 | 60 | 40 | 2 | 0 | * | * | 0 | 0 | * | * | 0 | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 6 | 0 | 50 | 50 | 2 | 0 | * | * | | 0 | | * | | * | 0 | * | 0 | 0 |
| 1970-71 Needs | 6 | 0 | 50 | 50 | 2 | 0 | * | * | | 0 | | * | | * | | * | 0 | 0 |
| Org. # 28 | 3 | 0 | 0 | 99 | 0 | X | * | 0 | N | 0 | 0 | 0 | * | X | 0 | X | X | N |
| Present Needs | | 1 | 0 | 99 | | | | | | | | | | | | | | |
| 1966-67 Needs | 3 | 1 | 0 | 99 | | X | * | 0 | N | 0 | 0 | 0 | * | X | 0 | X | X | N |
| 1968-69 Needs | 4 | 1 | 0 | 99 | | X | * | 0 | N | 0 | 0 | 0 | * | X | 0 | X | X | N |
| 1970-71 Needs | 4 | 1 | 0 | 99 | | X | * | 0 | N | 0 | 0 | 0 | * | X | 0 | X | X | N |

TABLE VIII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. #29 | 2 | 1 | 50 | 50 | 0 | * | * | * | * | * | * | X | * | X | * | X | 0 | 0 |
| Present Needs | 2 | 2 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 3 | 3 | 50 | 50 | | * | * | * | * | * | * | X | * | X | * | X | 0 | 0 |
| 1968-69 Needs | 5 | 5 | 50 | 50 | | * | * | * | * | * | * | X | * | X | * | X | 0 | 0 |
| 1970-71 Needs | 6 | 6 | 50 | 50 | | * | * | * | * | * | * | X | * | X | * | X | 0 | 0 |
| Org. #30 | 3 | 1 | 0 | 99 | 0 | * | * | 0 | 0 | 0 | * | | * | * | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 1 | 0 | 99 | | * | * | * | * | 0 | | * | * | * | 0 | * | 0 | 0 |
| 1968-69 Needs | 5 | 1 | 0 | 99 | | * | * | * | * | | | * | * | * | 0 | * | 0 | 0 |
| 1970-71 Needs | 6 | 1 | 0 | 99 | | * | * | * | * | | | * | * | * | 0 | * | 0 | 0 |
| Org. #31 | 2 | 1 | 0 | 99 | 0 | 0 | * | 0 | 0 | * | * | | * | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 2 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 0 | 99 | | 0 | * | 0 | 0 | * | * | * | * | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 99 | | 0 | * | 0 | 0 | * | * | * | * | 0 | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 1 | 0 | 99 | | 0 | * | 0 | 0 | * | * | * | * | 0 | 0 | 0 | 0 | 0 |
| Org. #32 | 3 | 0 | 0 | 99 | 0 | * | * | 0 | 0 | 0 | 0 | 0 | 0 | * | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 0 | 0 | 99 | | * | * | 0 | 0 | 0 | 0 | 0 | * | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 4 | 0 | 0 | 99 | | * | * | 0 | 0 | 0 | 0 | 0 | * | * | 0 | X | 0 | 0 |
| 1970-71 Needs | 4 | 0 | 0 | 99 | | * | * | 0 | 0 | 0 | 0 | 0 | * | * | 0 | X | 0 | 0 |
| Org. #33 | 1 | 0 | 0 | 99 | 1 | * | 0 | * | 0 | * | * | | * | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 0 | 0 | | | | | 0 | | | | | | | | | | | |
| 1966-67 Needs | 1 | 0 | 0 | 99 | 1 | * | | * | 0 | * | * | | * | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 1 | 0 | 0 | 99 | 1 | * | 0 | * | 0 | * | * | | * | 0 | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 0 | 0 | 99 | 2 | * | 0 | * | 0 | * | * | | * | 0 | 0 | 0 | 0 | 0 |
| Org. #34 | 1 | 1 | 0 | 99 | 1 | * | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | | * | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 1 | 1 | 0 | 99 | | * | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 1 | 1 | 0 | 99 | | * | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Org. #35 | 3 | 1 | 0 | 99 | 1 | * | * | 0 | 0 | 0 | | * | 0 | * | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 1 | 0 | 99 | 1 | * | * | 0 | 0 | 0 | | * | 0 | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 5 | 1 | 0 | 99 | 1 | * | * | 0 | 0 | 0 | | * | 0 | * | 0 | * | 0 | 0 |
| 1970-71 Needs | 6 | 1 | 0 | 99 | 1 | 0 | * | 0 | 0 | 0 | | * | 0 | * | 0 | * | 0 | 0 |

TABLE VIII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. #36 | 1 | 1 | 0 | 99 | 1 | 0 | * | 0 | 0 | 0 | * | 0 | X | * | X | * | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | 1 | 0 | * | X | X | X | * | * | X | * | X | * | 0 | 0 |
| 1968-69 Needs | 1 | 1 | 0 | 99 | 0 | 0 | * | X | X | X | * | * | X | * | * | * | 0 | 0 |
| 1970-71 Needs | 1 | 1 | 0 | 99 | 0 | 0 | * | X | X | X | * | * | X | * | * | * | 0 | 0 |
| Org. #37 | 1 | 1 | 0 | 99 | 1 | * | X | X | 0 | 0 | X | | X | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 0 | 99 | 1 | * | X | X | 0 | 0 | X | | X | 0 | 0 | 0 | 0 | X |
| 1968-69 Needs | 2 | 1 | 50 | 50 | 2 | * | X | X | X | N | X | | X | X | 0 | 0 | 0 | X |
| 1970-71 Needs | 2 | 1 | 50 | 50 | 2 | * | X | X | X | N | X | | X | X | 0 | 0 | 0 | X |
| Org. #38 | 0 | 1 | 0 | 99 | 1 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 0 | 1 | 0 | 99 | 0 | * | X | 0 | X | 0 | X | 0 | 0 | 0 | 0 | N | N | N |
| 1968-69 Needs | 1 | 1 | 0 | 99 | 1 | * | X | N | X | 0 | X | X | N | N | N | N | N | N |
| 1970-71 Needs | 1 | 1 | 0 | 99 | 0 | * | X | N | X | 0 | X | X | N | N | N | N | N | N |
| Org. #39 | 1 | 1 | 0 | 99 | 0 | * | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 1 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | | * | * | 0 | 0 | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 2 | 0 | 99 | | 0 | * | * | 0 | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 2 | 0 | 99 | | 0 | * | * | 0 | * | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 |
| Org. #40 | 3 | 1 | 0 | 99 | 0 | X | * | X | * | * | * | * | X | X | 0 | 0 | 0 | 0 |
| Present Needs | 4 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 8 | 1 | 0 | 99 | | X | * | X | * | * | * | * | X | X | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 11 | 1 | 0 | 99 | | X | * | X | * | * | * | * | X | X | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 14 | 1 | 0 | 99 | | X | * | X | * | * | * | * | X | X | 0 | 0 | 0 | 0 |
| Org. #41 | 1 | 1 | 0 | 99 | 0 | * | | X | | | X | 0 | * | X | X | X | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | | 0 | 99 | | * | | X | | | X | 0 | * | X | X | X | 0 | 0 |
| 1968-69 Needs | 4 | 2 | 0 | 99 | | X | N | X | N | N | X | 0 | * | X | X | X | 0 | 0 |
| 1970-71 Needs | 4 | | 0 | 99 | | X | | X | | | X | 0 | * | X | X | X | 0 | 0 |
| Org. #42 | 2 | 3 | 0 | 99 | 2 | 0 | 0 | * | 0 | 0 | 0 | 0 | X | X | 0 | 0 | X | 0 |
| Present Needs | 2 | 3 | | | 1 | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 3 | 0 | 99 | 3 | 0 | 0 | * | 0 | X | 0 | 0 | X | X | 0 | 0 | X | 0 |
| 1968-69 Needs | 2 | 3 | 0 | 99 | 3 | 0 | 0 | * | 0 | X | 0 | 0 | X | X | 0 | 0 | X | 0 |
| 1970-71 Needs | 2 | 3 | 0 | 99 | 3 | 0 | 0 | * | 0 | X | 0 | 0 | X | X | 0 | 0 | X | 0 |

TABLE VIII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. #43 | 1 | 1 | 0 | 99 | 3 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | 4 | | * | * | * | * | | X | X | X | X | X | | |
| 1968-69 Needs | 1 | 1 | 0 | 99 | 5 | | * | * | * | * | | X | X | X | X | X | | |
| 1970-71 Needs | 1 | 1 | 0 | 99 | 5 | | * | * | * | * | | * | X | X | X | X | | |
| Org. #44 | 1 | 1 | 0 | 99 | 1 | * | * | 0 | * | X | * | * | * | X | X | * | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | 2 | X | * | * | * | X | * | * | * | * | * | * | 0 | 0 |
| 1968-69 Needs | 1 | 1 | 0 | 99 | 2 | 0 | * | * | * | 0 | * | * | * | * | * | * | 0 | 0 |
| 1970-71 Needs | 1 | 1 | 0 | 99 | 2 | | * | * | * | 0 | * | * | * | * | * | * | 0 | 0 |
| Org. #45 | 3 | 1 | 0 | 99 | 1 | 0 | * | 0 | 0 | X | * | * | * | 0 | * | X | N | N |
| Present Needs | 3 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 4 | 2 | 0 | 99 | 1 | 0 | * | * | 0 | X | * | * | * | * | * | * | N | N |
| 1968-69 Needs | 4 | 2 | 0 | 99 | 1 | 0 | * | * | * | N | * | * | * | * | * | * | N | N |
| 1970-71 Needs | 5 | 2 | 0 | 99 | 1 | 0 | * | * | * | N | * | * | * | * | * | * | N | N |
| Org. #46 | 1 | 2 | 0 | 99 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N | N |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 2 | 0 | 99 | | | | | | | | | | | | | | |
| 1968-69 Needs | 1 | 2 | 0 | 99 | | | | | | | | | | | | | | |
| 1970-71 Needs | 1 | 2 | 0 | 99 | | | | | | | | | | | | | | |
| Org. #47 | 1 | 1 | 99 | 0 | 1 | * | * | 0 | 0 | 0 | 0 | 0 | 0 | X | 0 | 0 | 0 | 0 |
| Present Needs | 2 | 2 | | | 0 | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 2 | 99 | 0 | 1 | * | * | X | 0 | 0 | 0 | 0 | X | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 2 | 99 | 0 | 1 | * | * | * | 0 | 0 | 0 | 0 | * | * | 0 | X | 0 | 0 |
| 1970-71 Needs | 2 | 2 | 99 | 0 | 1 | * | * | * | 0 | 0 | 0 | 0 | * | * | 0 | X | 0 | 0 |
| Org. #48 | 1 | 0 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | X | 0 |
| Present Needs | 1 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 3 | 1 | 66 | 33 | | N | N | N | 0 | 0 | * | X | X | X | 0 | 0 | X | X |
| 1968-69 Needs | 3 | 1 | 66 | 33 | | N | N | N | N | N | N | N | X | X | N | N | N | N |
| 1970-71 Needs | 4 | 1 | 75 | 25 | | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Org. #49 | 1 | 1 | 0 | 99 | 0 | 0 | 0 | X | N | * | * | | 0 | 0 | 0 | 0 | * | * |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | | 0 | 0 | X | N | * | * | | 0 | 0 | 0 | 0 | * | * |
| 1968-69 Needs | 1 | 1 | 0 | 99 | | 0 | 0 | X | N | * | * | | 0 | 0 | 0 | 0 | * | * |
| 1970-71 Needs | 1 | 1 | 0 | 99 | | 0 | 0 | X | N | * | * | | 0 | 0 | 0 | 0 | * | * |

TABLE VIII (continued)

TABULATION OF RESPONSES FROM SIZE GROUP D

| Organizations in Size Group D | Present # Programmers | Present # Systems Analysts | % Scientific Programming | % Commercial Programming | Personnel Freed For Other Duty | Unit Record Equipment | Assembler Language Programming | Cobol-Fortran Programming | Advanced Compiler Programming | Machine Language Programming | Second Generation Hardware | Third Generation Hardware | Random Access Concepts | Magnetic Tape Concepts | Monitor Systems Concepts | Tele-Processing Technique | Process Control Concepts | Numerical Control Concepts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Org. # 50 | 1 | 1 | 0 | 99 | 1 | * | 0 | N | N | N | N | N | N | N | N | N | N | N |
| Present Needs | 1 | 1 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 1 | 1 | 0 | 99 | 1 | X | * | N | N | N | N | N | N | N | N | N | N | N |
| 1968-69 Needs | 1 | 1 | 0 | 99 | 1 | X | * | N | N | N | N | N | N | N | N | N | N | N |
| 1970-71 Needs | 2 | 2 | 0 | 99 | 2 | X | * | N | N | N | N | N | N | N | N | N | N | N |
| Org. # 51 | 2 | 1 | 0 | 99 | 0 | * | * | * | * | * | * | 0 | * | * | 0 | 0 | 0 | 0 |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 1 | 0 | 99 | | * | * | * | * | * | * | 0 | * | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 1 | 0 | 99 | | * | * | * | * | * | * | 0 | * | * | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 1 | 0 | 99 | | * | * | * | * | * | * | 0 | * | * | 0 | 0 | 0 | 0 |
| Org. # 52 | 1 | 0 | 0 | 99 | 0 | 0 | * | 0 | 0 | 0 | * | * | 0 | 0 | 0 | 0 | 0 | 0 |
| Present Needs | 0 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 2 | 0 | 0 | 99 | | 0 | * | 0 | 0 | 0 | | * | 0 | 0 | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 2 | 0 | 0 | 99 | | 0 | * | 0 | 0 | 0 | | * | * | 0 | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 2 | 0 | 0 | 99 | | 0 | * | 0 | 0 | 0 | | * | * | 0 | 0 | 0 | 0 | 0 |
| Org. # 53 | 3 | 5 | 10 | 90 | 0 | * | * | * | 0 | 0 | * | * | 0 | * | 0 | 0 | 0 | 0 |
| Present Needs | 0 | 0 | | | | | | | | | | | | | | | | |
| 1966-67 Needs | 3 | 5 | 10 | 90 | | * | * | * | * | * | | * | * | * | 0 | 0 | 0 | 0 |
| 1968-69 Needs | 3 | 5 | 10 | 90 | | * | * | * | * | * | | * | * | * | 0 | 0 | 0 | 0 |
| 1970-71 Needs | 3 | 5 | 10 | 90 | | * | * | * | * | * | | * | * | * | 0 | 0 | 0 | 0 |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |
| Org. # | | | | | | | | | | | | | | | | | | |
| Present Needs | | | | | | | | | | | | | | | | | | |
| 1966-67 Needs | | | | | | | | | | | | | | | | | | |
| 1968-69 Needs | | | | | | | | | | | | | | | | | | |
| 1970-71 Needs | | | | | | | | | | | | | | | | | | |

The final step in the procedure required the analysis of the data from the responses of the Oklahoma organizations sampled and the interpretation of the results. Data on each activity were tabulated from the punched cards. Results were run and a validity check was made. They were first tabulated in total number sampled by questionnaires, total number sampled by interview, and summaries of each group (see Table II).

Efforts are made throughout Chapter IV to point up other noteworthy and interesting features of the various groups and their responses. Findings of the study were developed in Chapter V. Conclusions and recommendations were drawn and set forth in Chapter VI.

# CHAPTER IV

## ANALYSIS OF DATA

The work of the preliminary jury of experienced leaders in the field of educational and industrial data processing together with the author carried out the first purpose of this study; to identify the items to be evaluated in the Oklahoma organizations utilizing data processing techniques and personnel. Randomly sampled responses of 269 organizations in the state of Oklahoma which utilize data processing techniques and personnel in phases of manufacturing, production, service, etc., were evaluated. These groups form the basis for carrying out the second purpose of this study--namely, to identify the existing data processing needs and practices and to determine if computer programmers and systems analysts who are trained on remote data-communication transmission terminals as part of a large data processing system would be adequately prepared to meet the demands of modern industry.

In order to simplify and clarify the great amount of data assembled on the procedures, techniques, and personnel in the field of data processing in Oklahoma, separate treatment was given to each of four groups based on the size of the programming and systems analyst personnel utilized. Each of these four groups were then subdivided into four subgroups based on the location of each organization (population density). These four major groups and each of their sub-groups were used to form the original frame of reference.

The data that were collected and interpreted are presented in two parts of this chapter. The first part consists of the tabulation of present and anticipated needs of employers in the state of Oklahoma who have positions for programmers and systems analysts. The second part consists of a summary of data relating to the qualifications needed by graduates of an educational program to be recognized as qualified programmers.

To justify any occupational education program a demand for the graduates of that program must be clearly identified before the program is initiated.

To display the present and anticipated needs, certain tabulations were made. Estimated needs for programmers and for systems analysts are being tabulated separately. The sampling ratios of 100, 75, 50, 25 percent, respectively, for the four size groups were used to project the estimates of needs to statewide totals. Thus, the estimated totals were the result of summing the projected estimates of each size group. Within each size group, these were obtained by dividing the total needs indicated in the sample by the corresponding sampling ratio for that size group.

From these extrapolations the following tabulations were made to summarize the data listed in Chapter III. Table IX shows the total number or programmers presently employed in all four size groups and the numbers needed from the present to 1971 in the state of Oklahoma. This table shows both the business programmers and the scientific programmers. For a breakdown between business and scientific programmers see Tables X and XI. Table X shows the total number of business programmers employed in all size groups and the number needed from the present to 1971.

TABLE IX

TOTAL NUMBER OF PROGRAMMERS PRESENTLY EMPLOYED, PRESENTLY NEEDED AND ANTICIPATED NEEDS TO 1971 IN THE STATE OF OKLAHOMA

| TIME PERIOD | Size A (20 or more) | Size B (10 to 19) | Size C (5 to 9) | Size D (0 to 4) | TOTAL |
|---|---|---|---|---|---|
| Presently Employed | 414 | 108 | 148 | 324 | 994 |
| Presently Needed | 475 | 129 | 170 | 396 | 1170 |
| 1966-67 | 530 | 136 | 190 | 472 | 1328 |
| 1968-69 | 581 | 156 | 224 | 556 | 1517 |
| 1970-71 | 635 | 169 | 256 | 628 | 1688 |

TABLE X

TOTAL NUMBER OF BUSINESS PROGRAMMERS PRESENTLY EMPLOYED, PRESENTLY NEEDED AND ANTICIPATED NEEDS TO 1971 IN THE STATE OF OKLAHOMA

| TIME PERIOD | Size A (20 or more) | Size B (10 to 19) | Size C (5 to 9) | Size D (0 to 4) | TOTAL |
|---|---|---|---|---|---|
| Presently Employed | 277 | 76 | 108 | 300 | 761 |
| Presently Needed | 314 | 93 | 126 | 360 | 893 |
| 1966-67 | 331 | 96 | 138 | 420 | 985 |
| 1968-69 | 361 | 106 | 154 | 492 | 1113 |
| 1970-71 | 394 | 109 | 176 | 560 | 1239 |

TABLE XI

TOTAL NUMBER OF SCIENTIFIC PROGRAMMERS PRESENTLY EMPLOYED, PRESENTLY NEEDED AND ANTICIPATED NEEDS TO 1971 IN THE STATE OF OKLAHOMA

| TIME PERIOD | Size A (20 or more) | Size B (10 to 19) | Size C (5 to 9) | Size D (0 to 4) | TOTAL |
|---|---|---|---|---|---|
| Presently Employed | 137 | 32 | 40 | 24 | 233 |
| Presently Needed | 161 | 36 | 44 | 36 | 277 |
| 1966-67 | 199 | 40 | 52 | 52 | 343 |
| 1968-69 | 220 | 50 | 70 | 64 | 404 |
| 1970-71 | 241 | 60 | 80 | 68 | 449 |

Table XI shows the total number of scientific programmers employed in all four size groups and the number needed from the present to 1971 in the state of Oklahoma.

Table XII shows the total number of systems analysts presently employed in all four size groups, present number needed in all four size groups, and the anticipated number needed in all four size groups from the present to 1971 in the state of Oklahoma. This table shows both the business and scientific applications. For a breakdown of the business application (Table XIII) and for the scientific application (Table XIV) see the following tables.

The objectives of an instructional program to train computer programmers are not designed to train systems analysts. However, becoming a systems analysts may be the ultimate objective of the higher level students in the better data processing programs. Realizing that these students seldom become systems analysts upon graduation from this type of program. The opportunities exist for them when they acquire additional experience in the field of data processing.

A composite of the Tables IX, X, XI and XII, XIII, XIV is shown on Table XV. This table shows the total number of computer programmers and systems analysts presently employed, presently needed and anticipated needs to 1971 for the state of Oklahoma in all four size groups.

Part two of this chapter is to summarize the responses for each requirement in size groups A, B, C, and D. The responses as shown on Tables V, VI, VII, and VIII of Chapter III are taken directly from the instruments completed by the organizations sampled. To adequately complete the necessary analysis of this data, a summary had to be prepared. This summary required that the nature of the responses be presented in a

TABLE XII

TOTAL NUMBER OF SYSTEMS ANALYSTS PRESENTLY EMPLOYED, PRESENTLY NEEDED AND ANTICIPATED NEEDS TO 1971 IN THE STATE OF OKLAHOMA

| TIME PERIOD | Size A (20 or more) | Size B (10 to 19) | Size C (5 to 9) | Size D (0 to 4) | TOTAL |
|---|---|---|---|---|---|
| Presently Employed | 247 | 71 | 48 | 172 | 538 |
| Presently Needed | 277 | 83 | 68 | 204 | 632 |
| 1966-67 | 308 | 91 | 72 | 216 | 687 |
| 1968-69 | 338 | 111 | 80 | 248 | 777 |
| 1970-71 | 359 | 116 | 86 | 260 | 821 |

TABLE XIII

TOTAL NUMBER OF BUSINESS APPLICATION SYSTEMS ANALYSTS PRESENTLY EMPLOYED, PRESENTLY NEEDED AND ANTICIPATED NEEDS TO 1971 IN THE STATE OF OKLAHOMA

| TIME PERIOD | Size A (20 or more) | Size B (10 to 19) | Size C (5 to 9) | Size D (0 to 4) | TOTAL |
|---|---|---|---|---|---|
| Presently Employed | 185 | 55 | 38 | 156 | 434 |
| Presently Needed | 205 | 66 | 58 | 184 | 513 |
| 1966-67 | 218 | 73 | 60 | 184 | 535 |
| 1968-69 | 237 | 85 | 64 | 208 | 594 |
| 1970-71 | 255 | 89 | 66 | 220 | 630 |

TABLE XIV

TOTAL NUMBER OF SCIENTIFIC APPLICATION SYSTEMS ANALYSTS PRESENTLY EMPLOYED, PRESENTLY NEEDED AND ANTICIPATED NEEDS TO 1971 IN THE STATE OF OKLAHOMA

| TIME PERIOD | Size A (20 or more) | Size B (10 to 19) | Size C (5 to 9) | Size D (0 to 4) | TOTAL |
|---|---|---|---|---|---|
| Presently Employed | 62 | 16 | 10 | 16 | 104 |
| Presently Needed | 72 | 17 | 10 | 20 | 119 |
| 1966-67 | 90 | 18 | 12 | 32 | 152 |
| 1968-69 | 101 | 26 | 16 | 40 | 183 |
| 1970-71 | 104 | 27 | 20 | 40 | 191 |

TABLE XV

TOTAL NUMBER OF COMPUTER PROGRAMMERS AND SYSTEMS ANALYSTS PRESENTLY EMPLOYED, PRESENTLY NEEDED AND ANTICIPATED NEEDS TO 1971 IN THE STATE OF OKLAHOMA

| TIME PERIOD | Size A (20 or more) | Size B (10 to 19) | Size C (5 to 9) | Size D (0 to 4) | TOTAL |
|---|---|---|---|---|---|
| Presently Employed | 661 | 179 | 196 | 496 | 1532 |
| Presently Needed | 752 | 212 | 238 | 600 | 1802 |
| 1966-67 | 838 | 227 | 262 | 688 | 2015 |
| 1968-69 | 919 | 267 | 304 | 804 | 2294 |
| 1970-71 | 994 | 285 | 342 | 888 | 2505 |

more condensed form. Therefore, the responses were analyzed for each of the ten requirements. They are:

1. Assembler language programming
2. Compiler language programming
3. Advanced compiler language programming
4. Machine language programming
5. Second generation hardware
6. Third generation hardware
7. Random access concepts
8. Magnetic tape concepts
9. Monitor systems concepts
10. Tele-processing techniques

For the purpose of the analysis, responses of "required" and "preferred" were considered positive responses. Responses of "not-required" and "cannot answer due to lack of knowledge of this aspect of the data processing system" were considered as negative responses. For each of the ten major requirements the number of positive and negative responses are tabulated for the present time period, the 1966-67 time period, the 1968-69 time period and the 1970-71 time period. The tabulation of responses for each requirement in size group A, B, C and D is shown on Tables XVI, XVII, XVIII, and XIX respectively.

TABLE XVI

Summary of Responses for Each Requirement in Size Group A

| REQUIREMENTS | Responses in Time Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Present | | | | 1966-67 | | 1968-69 | | 1970-71 | |
| | Business | | Scientific | | | | | | | |
| | P* | N* | P | N | P | N | P | N | P | N |
| Assembler Language Programming | 11 | 0 | 1 | 0 | 12 | 0 | 12 | 0 | 12 | 0 |
| Compiler Language Programming Cobol-Fortran | 11 | 0 | 1 | 0 | 12 | 0 | 12 | 0 | 12 | 0 |
| Advanced Compiler Language Programming | 6 | 5 | 1 | 0 | 9 | 3 | 10 | 2 | 10 | 2 |
| Machine Language Programming | 9 | 2 | 0 | 1 | 9 | 3 | 9 | 3 | 9 | 3 |
| Second Generation Hardware | 11 | 0 | 1 | 0 | 12 | 0 | 12 | 0 | 12 | 0 |
| Third Generation Hardware | 9 | 2 | 1 | 0 | 10 | 2 | 10 | 2 | 10 | 0 |
| Random Access Concepts | 9 | 2 | 1 | 0 | 10 | 2 | 10 | 2 | 10 | 2 |
| Magnetic Tape Concepts | 11 | 0 | 1 | 0 | 12 | 0 | 12 | 0 | 12 | 0 |
| Monitor Systems Concepts | 11 | 0 | 1 | 0 | 12 | 0 | 12 | 0 | 12 | 0 |
| Tele-Processing Techniques | 8 | 3 | 1 | 0 | 9 | 3 | 9 | 3 | 9 | 3 |

*P = Positive responses are a combination of required responses and preferred responses.

*N = Negative responses are a combination of not-required responses and cannot answer due to lack of knowledge of this aspect of the data processing system responses.

TABLE XVII

Summary of Responses for Each Requirement in Size Group B

| REQUIREMENTS | Responses in Time Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Present | | | | 1966-67 | | 1968-69 | | 1970-71 | |
| | Business | | Scientific | | | | | | | |
| | P* | N* | P | N | P | N | P | N | P | N |
| Assembler Language Programming | 6 | 3 | 1 | 1 | 7 | 4 | 7 | 4 | 7 | 4 |
| Compiler Language Programming Cobol-Fortran | 7 | 2 | 2 | 0 | 9 | 2 | 9 | 2 | 9 | 2 |
| Advanced Compiler Language Programming | 2 | 7 | 2 | 0 | 7 | 4 | 8 | 3 | 8 | 3 |
| Machine Language Programming | 4 | 5 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 |
| Second Generation Hardware | 6 | 2 | 2 | 0 | 8 | 2 | 8 | 2 | 8 | 2 |
| Third Generation Hardware | 5 | 4 | 2 | 0 | 9 | 2 | 9 | 2 | 10 | 1 |
| Random Access Concepts | 6 | 3 | 1 | 1 | 8 | 3 | 9 | 2 | 9 | 2 |
| Magnetic Tape Concepts | 8 | 1 | 2 | 0 | 11 | 0 | 11 | 0 | 11 | 0 |
| Monitor Systems Concepts | 4 | 5 | 2 | 0 | 9 | 2 | 10 | 1 | 10 | 1 |
| Tele-Processing Techniques | 6 | 3 | 2 | 0 | 9 | 2 | 10 | 1 | 10 | 1 |

*P = Positive responses are a combination of required responses and preferred responses.

*N = Negative responses are a combination of not-required responses and cannot answer due to lack of knowledge of this aspect of the data processing system responses.

TABLE XVIII

Summary of Responses for Each Requirement in Size Group C

| REQUIREMENTS | Responses in Time Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Present | | | | 1966-67 | | 1968-69 | | 1970-71 | |
| | Business | | Scientific | | | | | | | |
| | P* | N* | P | N | P | N | P | N | P | N |
| Assembler Language Programming | 13 | 0 | 2 | 0 | 15 | 0 | 15 | 0 | 15 | 0 |
| Compiler Language Programming Cobol-Fortran | 7 | 7 | 2 | 0 | 13 | 3 | 14 | 2 | 14 | 2 |
| Advanced Compiler Language Programming | 3 | 10 | 0 | 2 | 8 | 5 | 9 | 3 | 9 | 3 |
| Machine Language Programming | 8 | 6 | 2 | 0 | 12 | 3 | 12 | 3 | 12 | 3 |
| Second Generation Hardware | 10 | 2 | 0 | 1 | 10 | 3 | 10 | 3 | 10 | 3 |
| Third Generation Hardware | 9 | 5 | 1 | 1 | 11 | 4 | 13 | 1 | 13 | 1 |
| Random Access Concepts | 8 | 6 | 1 | 1 | 13 | 3 | 14 | 2 | 14 | 2 |
| Magnetic Tape Concepts | 13 | 1 | 1 | 1 | 16 | 0 | 16 | 0 | 16 | 0 |
| Monitor Systems Concepts | 6 | 8 | 1 | 1 | 13 | 3 | 14 | 2 | 14 | 2 |
| Tele-Processing Techniques | 5 | 9 | 2 | 0 | 9 | 7 | 11 | 5 | 11 | 5 |

*P = Positive responses are a combination of required responses and preferred responses.

*N = Negative responses are a combination of not-required responses and cannot answer due to lack of knowledge of this aspect of the data processing system responses.

TABLE XIX

Summary of Responses for Each Requirement in Size Group D

| REQUIREMENTS | Responses in Time Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Present | | | | 1966-67 | | 1968-69 | | 1970-71 | |
| | Business | | Scientific | | | | | | | |
| | P* | N* | P | N | P | N | P | N | P | N |
| Assembler Language Programming | 19 | 15 | 4 | 2 | 33 | 17 | 33 | 17 | 33 | 17 |
| Compiler Language Programming Cobol-Fortran | 11 | 33 | 3 | 3 | 23 | 25 | 30 | 20 | 30 | 20 |
| Advanced Compiler Language Programming | 9 | 35 | 0 | 6 | 9 | 41 | 9 | 41 | 9 | 41 |
| Machine Language Programming | 19 | 27 | 3 | 3 | 27 | 23 | 27 | 23 | 27 | 23 |
| Second Generation Hardware | 25 | 17 | 4 | 2 | 29 | 17 | 29 | 17 | 29 | 17 |
| Third Generation Hardware | 11 | 24 | 2 | 4 | 23 | 16 | 28 | 11 | 28 | 11 |
| Random Access Concepts | 24 | 22 | 2 | 4 | 37 | 15 | 37 | 15 | 37 | 15 |
| Magnetic Tape Concepts | 20 | 32 | 4 | 2 | 30 | 21 | 30 | 21 | 30 | 21 |
| Monitor Systems Concepts | 16 | 30 | 0 | 6 | 20 | 29 | 21 | 26 | 21 | 26 |
| Tele-Processing Techniques | 11 | 35 | 2 | 4 | 13 | 39 | 13 | 39 | 27 | 24 |

P* = Positive responses are a combination of requires responses and preferred responses.

N* = Negative responses are a combination of not-required responses and cannot answer due to lack of knowledge of this aspect of the data processing system responses.

## CHAPTER V

## FINDINGS OF THE STUDY

This chapter reports the results of the empirical research to determine if computer programmers and systems analysts who are trained on remote data communications transmission terminals would be adequately prepared to meet the needs of modern industry. It is based on the responses of the 92 organizations in the sample.

Statistical treatment of the data was employed to test responses among classifications by I (size groups), II (types of applications), III (locations), and IV (a combination of selected size, application and location groups).

As indicated in Chapter IV, the responses of "required" and "preferred" were considered as positive responses. Responses of "not-required" and "cannot answer" were considered as negative responses. The analysis for testing of hypotheses I, II and III is based on the relationship of positive to negative responses for the aggregate of all of the ten major items, on the questionnaire (see page 165). In this study, the prepondence of positive responses for an item or group of items is an indication of its level of "acceptance". A high level of "acceptance" indicates that the item or group of items is important or required in any training program. The statistic used was the fraction positive in the total of all responses using the ten major items from all organizations. A summary of the results of statistical tests is given in Table XX.

For hypothesis I using the aggregate data, a chi square test among the four size groups revealed a significant difference at the .05 level. Chart I was developed to illustrate the differences among the size groups.

A test of the difference between application groups (hypotheses II) was made. The method was to test the total responses in the business application group compared to the scientific application group. The statistical treatment (chi square) revealed that there was no significant difference at the .05 level between the acceptance of the business application group and the scientific application group. Chart II was developed to illustrate the difference between the application groups.

A test of the differences among location groups (hypotheses III) was made. The method was to test the total responses in the four location groups. The statistical treatment (chi square) revealed that there was a significant difference at the .05 level among the acceptance of the groups A, B, C and D. The basic pattern was as anticipated for location groups B, C and D. However, data on location group A revealed that acceptance existed at a much lower level than location group B.

It was originally anticipated that location Group A would have a higher level of acceptance than location Group B, and location Group B would have a higher level of acceptance than location Group C and so on. The variation from the anticipated pattern of Group A can be easily explained. Location Group A consisted of organizations of all types of applications and organizations of all sizes where location Group B generally consisted of organizations of a specific size and type of application. For example, the majority of the large oil companies in

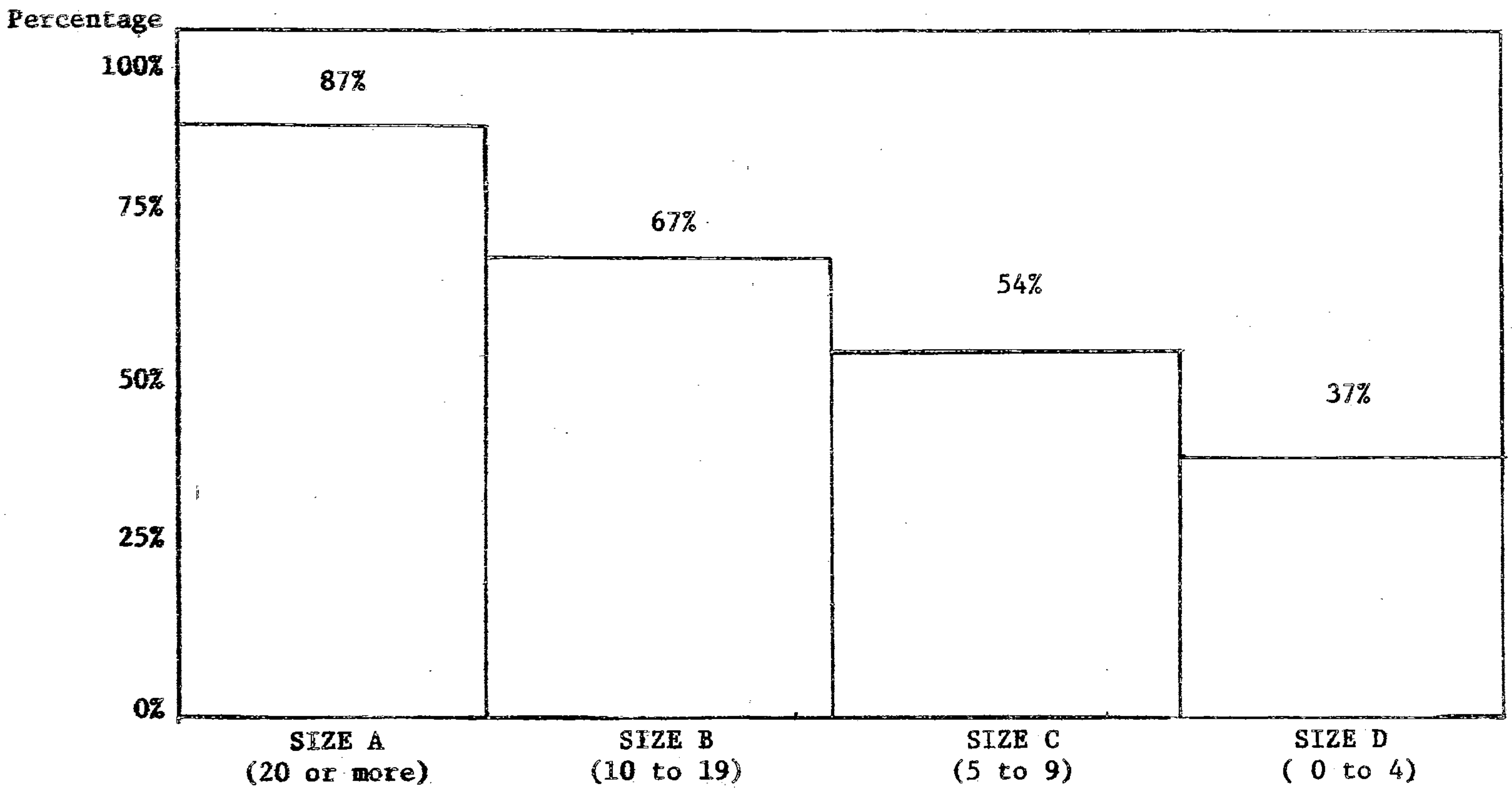
TABLE XX

SUMMARY OF HYPOTHESES

| HYPOTHESES NUMBER | SIGNIFICANT DIFFERENCE AT .05 LEVEL | NO SIGNIFICANT DIFFERENCE AT .05 LEVEL |
|---|---|---|
| HYPOTHESES # I | X | |
| HYPOTHESES # II | X | |
| HYPOTHESES # III | | X |
| HYPOTHESES # $IV^1$ | X | |
| HYPOTHESES # $IV^2$ | X | |
| HYPOTHESES # $IV^3$ | X | |
| HYPOTHESES # $IV^4$ | X | |
| HYPOTHESES # $IV^5$ | X | |
| HYPOTHESES # $IV^6$ | X | |
| HYPOTHESES # $IV^7$ | X | |
| HYPOTHESES # $IV^8$ | | X |
| HYPOTHESES # $IV^9$ | X | |
| HYPOTHESES # $IV^{10}$ | X | |
| HYPOTHESES # V | X | |
| HYPOTHESES # VI | X | |
| HYPOTHESES # VII | X | |

CHART #1

OKLAHOMA EMPLOYERS (BY SIZE GROUPS) ACCEPTANCE FOR LEVEL OF TRAINEE DEVELOPED BY STATE-WIDE TECHNICAL EDUCATION TIME-SHARING SYSTEM



the state were found in location Group B, and they are larger organizations of a specific type. The make-up of location Group C had some of the same general characteristics as location Group B and this also affected to some degree the acceptance level in location Group D. To illustrate the differences between each location group percentage Chart III was developed.

Statistical treatment of Hypothesis IV was tested as ten subhypotheses. These ten were formulated as the ten possible pairwise combinations of the five selected size, application and location, classifications indicated in Table III (A-A-A, A-A-B, A-A-C, A-A-D, and C-A-D). They are listed as follows.

$IV^1$ Size A - Application A - Location A (Group #I)
Size A - Application A - Location B (Group #II)

$IV^2$ Size A - Application A - Location A (Group #I)
Size A - Application A - Location C (Group #III)

$IV^3$ Size A - Application A - Location A (Group #I)
Size A - Application A - Location D (Group #IV)

$IV^4$ Size A - Application A - Location A (Group #I)
Size C - Application A - Location D (Group #V)

$IV^5$ Size A - Application A - Location B (Group #II)
Size A - Application A - Location C (Group #III)

$IV^6$ Size A - Application A - Location B (Group #II)
Size A - Application A - Location D (Group IV)

$IV^7$ Size A - Application A - Location B (Group #II)
Size C - Application A - Location D (Group #V)

$IV^8$ Size A - Application A - Location C (Group #III)
Size A - Application A - Location D (Group #IV)

$IV^9$ Size A - Application A - Location C (Group #III)
Size C - Application A - Location D (Group #V)

CHART #2

COMPARISON OF ACCEPTANCE LEVEL BY TYPE
OF APPLICATION

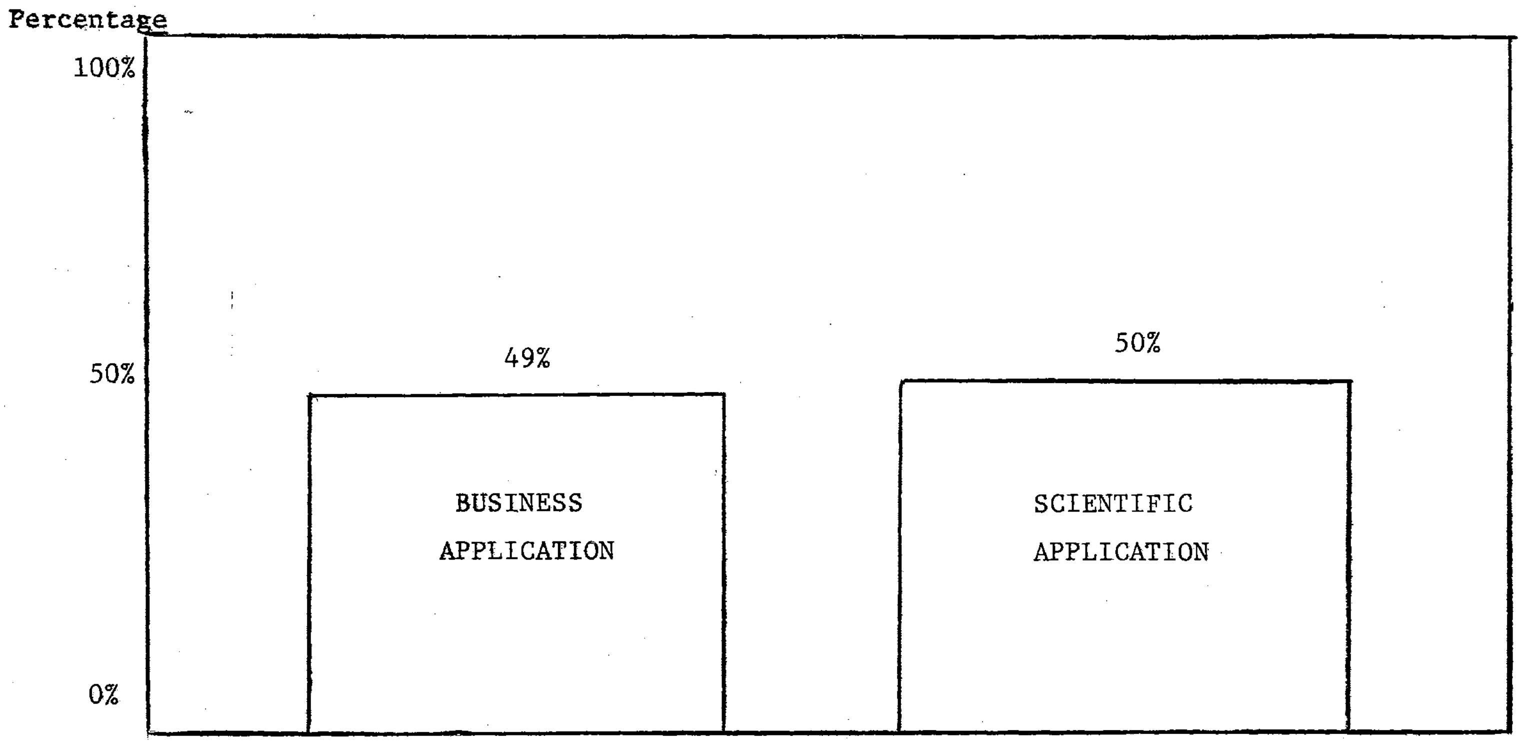
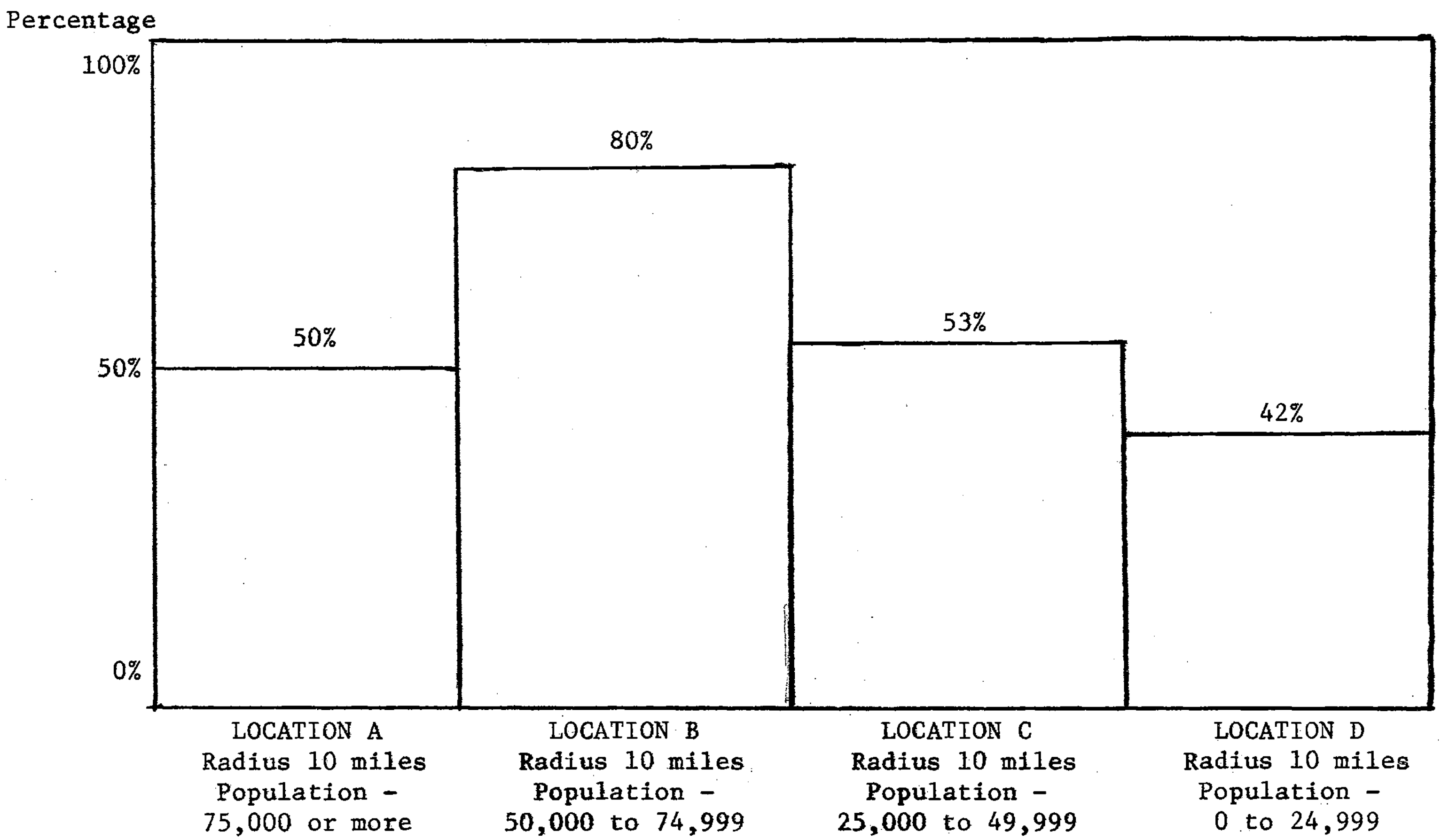


CHART #3

PERCENTAGE OF ORGANIZATIONS ACCEPTANCE
BY THEIR LOCATION



IV[10] Size A - Application A - Location D (Group #IV)
Size C - Application A - Location D (Group #V)

Each of the ten subhypotheses were tested to see if there was a significant difference in the ability of groups with fewer programmers, less scientific application, or less populated area, to assess the need for this type of program compared to groups with a larger number of programmers, more scientific application, or more populated area. Due to the lack of familiarity with and knowledge of the newly developing concepts in data processing (such as operating under monitor systems, process control, third generation hardware, tele-processing, PL/I, etc.), some of the groups would probably be less able to evaluate the needs for qualified trainees.

A "cannot answer" response was used as a measure of an individual's lack of ability to assess the need for an item. The statistic used was the fraction of "cannot answer" responses in the totality of responses within a group using all thirteen items.

The fraction for "cannot answer" responses were tabulated for Group I (A-A-A), Group II (A-A-B), Group III (A-A-C), Group IV (A-A-D), and Group V (C-A-D). The fraction for a group was compared with the fraction for each of the other four groups. The total of ten combinations of group comparisons were made; each combination represents one of the subhypotheses. Nine of the ten subhypotheses tested revealed a significant difference in the ability to assess the need for this type of program at the .05 level of significance.

The nine subhypotheses which showed at the .05 level, a significant difference in their ability to assess the need for this type of program were: Group I (A-A-A) over Group II (A-A-B), Group I (A-A-A) over group III (A-A-C), Group I (A-A-A) over Group IV (A-A-D), Group I (A-A-A) over Group V (C-A-D), Group II (A-A-B) over Group III (A-A-C), Group II (A-A-B) over Group IV (A-A-D), Group II (A-A-B) over Group V (C-A-D), Group III (A-A-C) over Group V (C-A-D), Group IV (A-A-D) over Group V (C-A-D).

The one hypothesis which did not show, at the .05 level, a significant difference in their ability to assess the need for this type of program was: Group III (A-A-C) over Group IV (A-A-D).

Statistical treatment of Hypothesis V revealed that there was a significant difference in the ability of the scientific application groups to assess the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing in comparison with the business application groups. The same statistic was used here as in Hypothesis IV, i.e., fraction of "cannot answer" responses for the thirteen items.

Statistical treatment of Hypothesis VI was to establish if a significant difference existed between the requirements for adequately trained data processing personnel in the present time period compared to the 1970-71 time period. It was to test if requirements were upgraded or improved by comparing the fraction of positive responses for each of the thirteen items.

There was a significant difference between the present time period and the 1970-71 time period concerning the improvement or upgrading of requirements for adequately trained data processing personnel in ten of the thirteen items of knowledge requirements on the inquiry form. They are: (1) Compiler language programming (COBOL and FORTRAN), (2) Advanced compiler language programming, (3) Machine language programming,

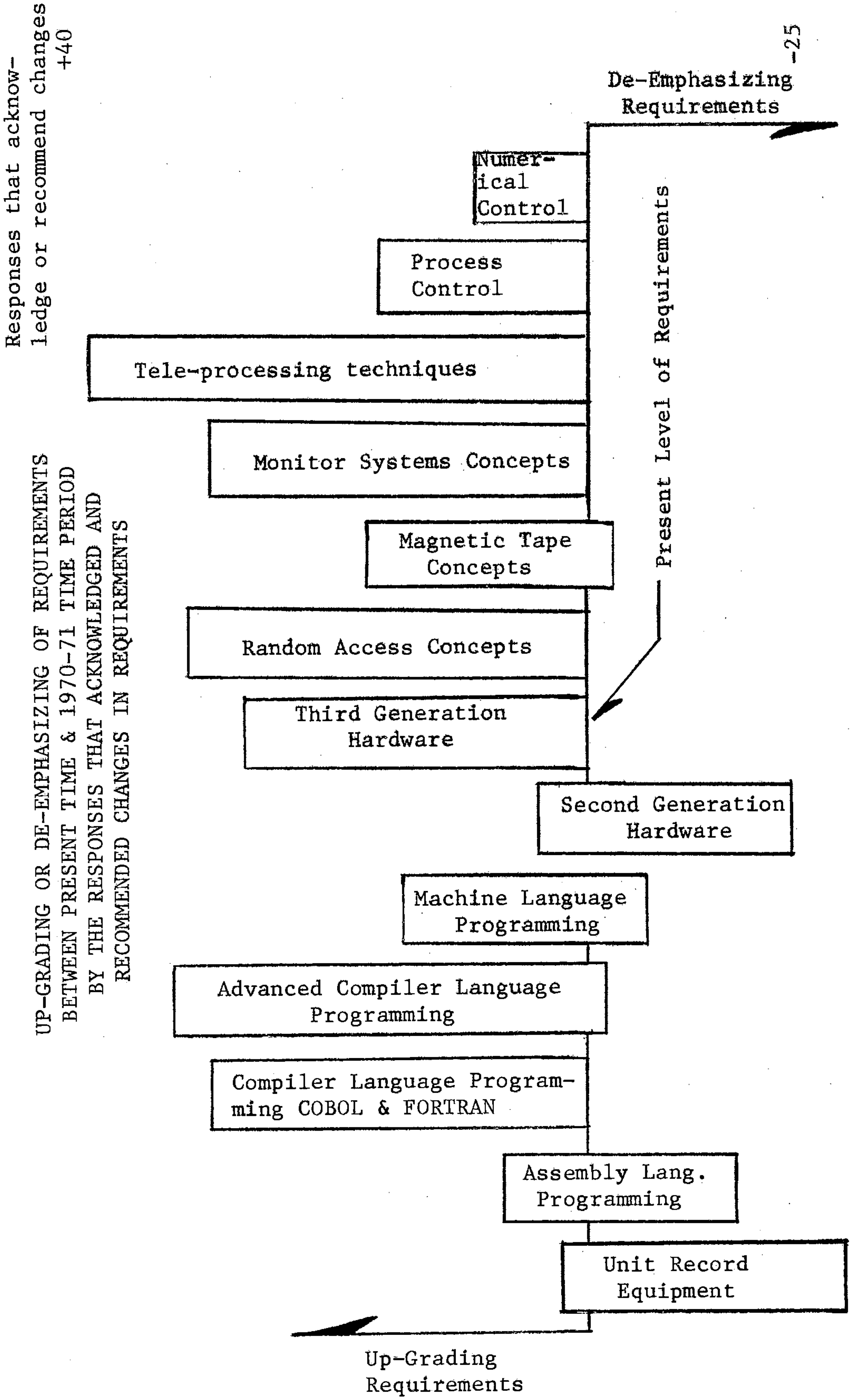
(4) Third generation hardware, (5) Random access concepts, (6) Magnetic tape concepts, (7) Monitor systems concepts, (8) Tele-processing techniques, (9) Process control concepts and (10) Numerical control concepts.

The three other items of knowledge requirements on the inquiry form (1. Unit record equipment, 2. Assembly language programming, 3. Second generation hardware) did not show a significant difference between the present time period and the 1970-71 time period concerning the improvement or up-grading of requirements for adequately trained data processing personnel. In fact, they were tested to show if a significant difference between the present time period and the 1970-71 time period revealed de-emphasizing of requirements in these three items. This statistical treatment showed that a significant difference at the .05 level did exist between the present time period and the 1970-71 time period. This indicated a reduction in the emphasis in these three items of knowledge required. The statistical findings concerning these last three items should be thoroughly understood before any new program of this type is undertaken. To better illustrate the improvement or up-grading of requirements compared to the de-emphasizing of requirements, Chart 4 was developed.

To provide additional constructive results the data was used to examine how each of the size groups differed in their rate of acceptance of the individual requirements. The significant differences between requirements in the present time period and the 1970-71 time period has been established in Hypothesis VI. However, the data assembled for Hypothesis VI was tested still further anticipating that the additional statistical treatment would increase the potential of the study. The additional test of the data was to establish the time period when

CHART #4

UP-GRADING OR DE-EMPHASIZING OF REQUIREMENTS BETWEEN PRESENT TIME & 1970-71 TIME PERIOD BY THE RESPONSES THAT ACKNOWLEDGED AND RECOMMENDED CHANGES IN REQUIREMENTS



acceptance was first established for size groups A, B, C and D. The same test was made for combinations of these size groups. The combinations are (A, B and C) and (A, B, C, and D).

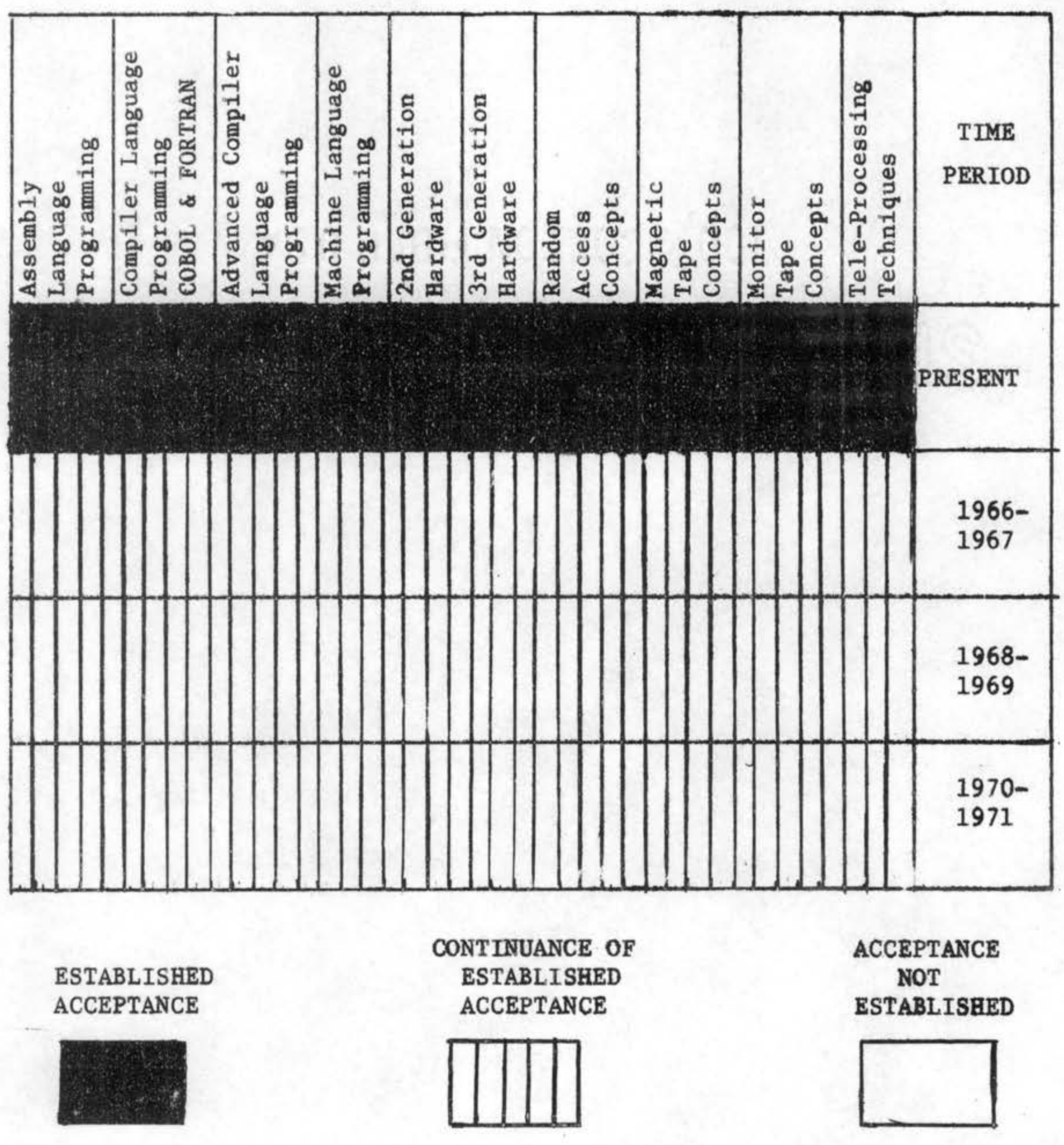
All size groups were tabulated in each of the above ten items and statistical treatment of the data on the present needs were made to test if a significant difference existed at the .05 level. For example, to test an item in a certain time period and a specific size group the procedure would be as follows: let's assume we use item number one (assembler language programming) in the 1966-67 time period and size Group A. The number of positive responses (12) and the number of negative responses (0) would be secured from Table XVI, and tested to reveal if significant differences existed at the .05 level; chi square would be utilized as the method of statistical treatment. The test would reveal that significant difference does exist at the .05 level.

If a significant difference did not exist in the present needs the data was tested for each succeeding two year period up to 1970-71 period to see if a significant difference could be established in that time. If a significant difference existed in the data for an item for the present, there was no reason to attempt to establish a significant difference in the following two year periods.

Statistical treatment of all ten items in size group A, revealed a significant difference in acceptance of all ten items in the present time period. This is a complete acceptance of all the items by size group A. Table XXI shows the period in which acceptance level was first established. It is assumed, that acceptance would be continued following the first year of acceptance.

TABLE XXI

TIME PERIOD WHEN ACCEPTANCE WAS
FIRST ESTABLISHED FOR SIZE GROUP A



Statistical treatment of all ten items in size group B, established a significant difference in acceptance of seven of the ten items in the present time period. They are: assembly language program, compiler language programming, 2nd generation hardware, 3rd generation hardware, random access concepts, magnetic tape concepts, and tele-processing techniques. The next time period of 66-67 established a significant difference in acceptance two more of the ten items. They are: advanced compiler language programming and monitor systems concepts. The remaining item (machine language programming) failed to establish a significant difference in acceptance for any of the four time periods surveyed. Table XXII shows the time period in which acceptance was or was not established.

Statistical treatment of all ten items in size group C, established a significant difference in acceptance of seven of the ten in the present time period. They are: assembly language programming, compiler language programming (COBOL & FORTRAN), machine language programming, 2nd generation hardware, 3rd generation hardware, random access concepts, magnetic tape concepts. The next time period, established a significant difference in acceptance of the three remaining items (advanced compiler programming, monitor systems, tele-processing). Table XXIII shows the time periods in which acceptance was established.

Statistical treatment of all ten items in size group D revealed a significant difference in acceptance of two of the ten items in the present time period. The two items accepted in the present time period were assembly language programming and second generation hardware. The 66-67 time period established acceptance of machine language programming, third generation hardware, random access comcepts, and magnetic tape

TABLE XXII

TIME PERIOD WHEN ACCEPTANCE WAS
FIRST ESTABLISHED FOR SIZE GROUP B

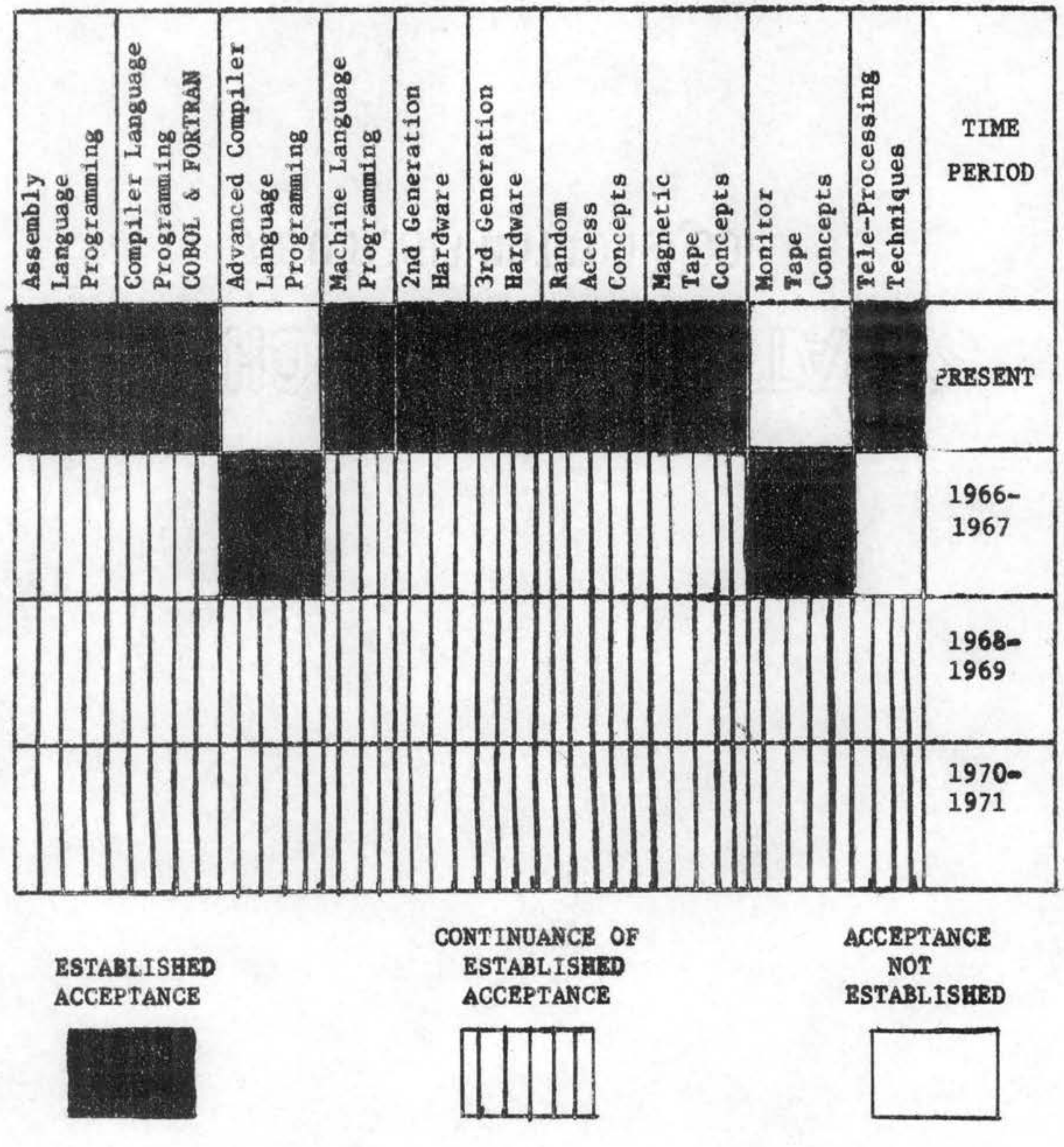
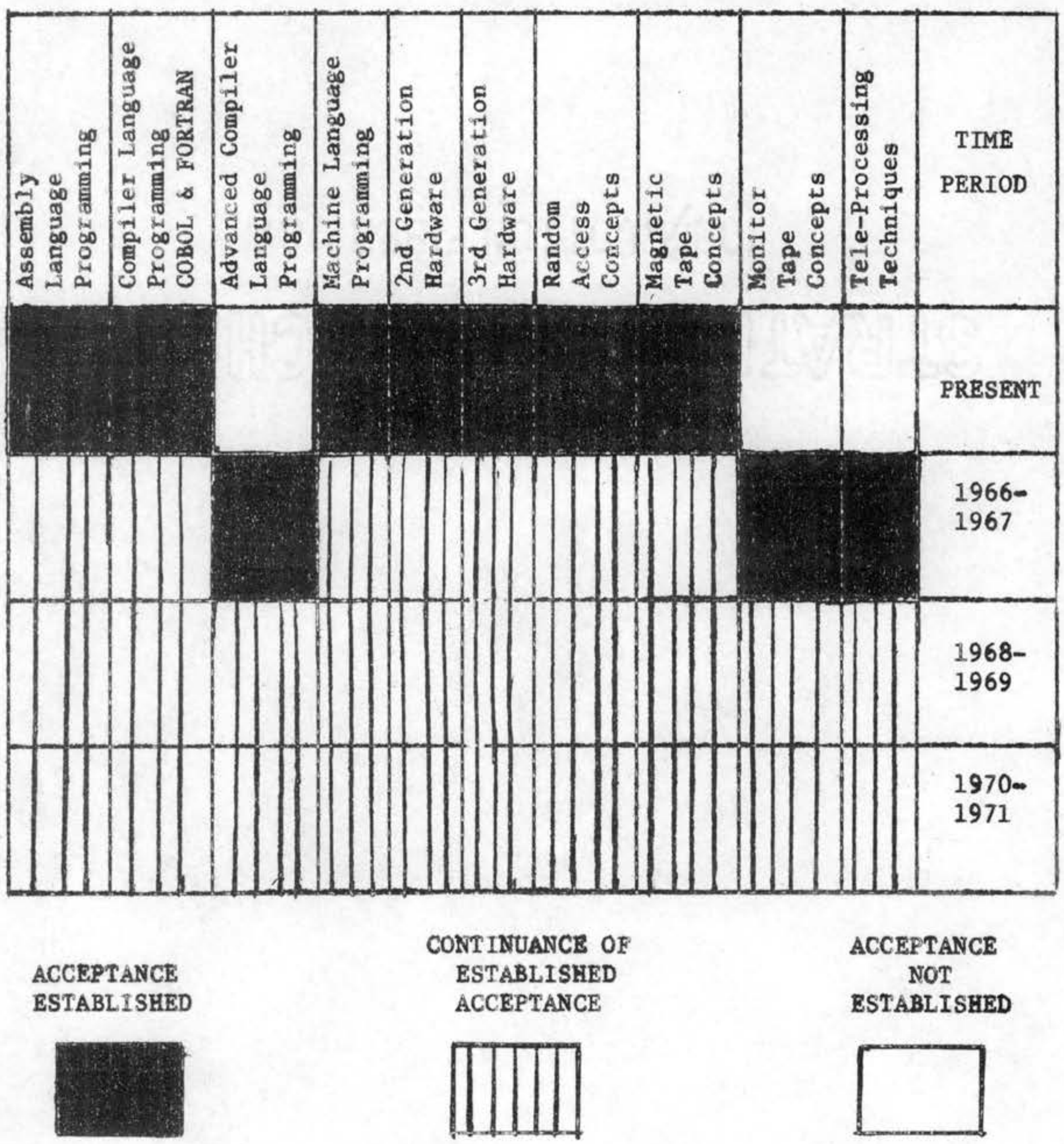


TABLE XXIII

TIME PERIOD WHEN ACCEPTANCE WAS
FIRST ESTABLISHED FOR SIZE GROUP C

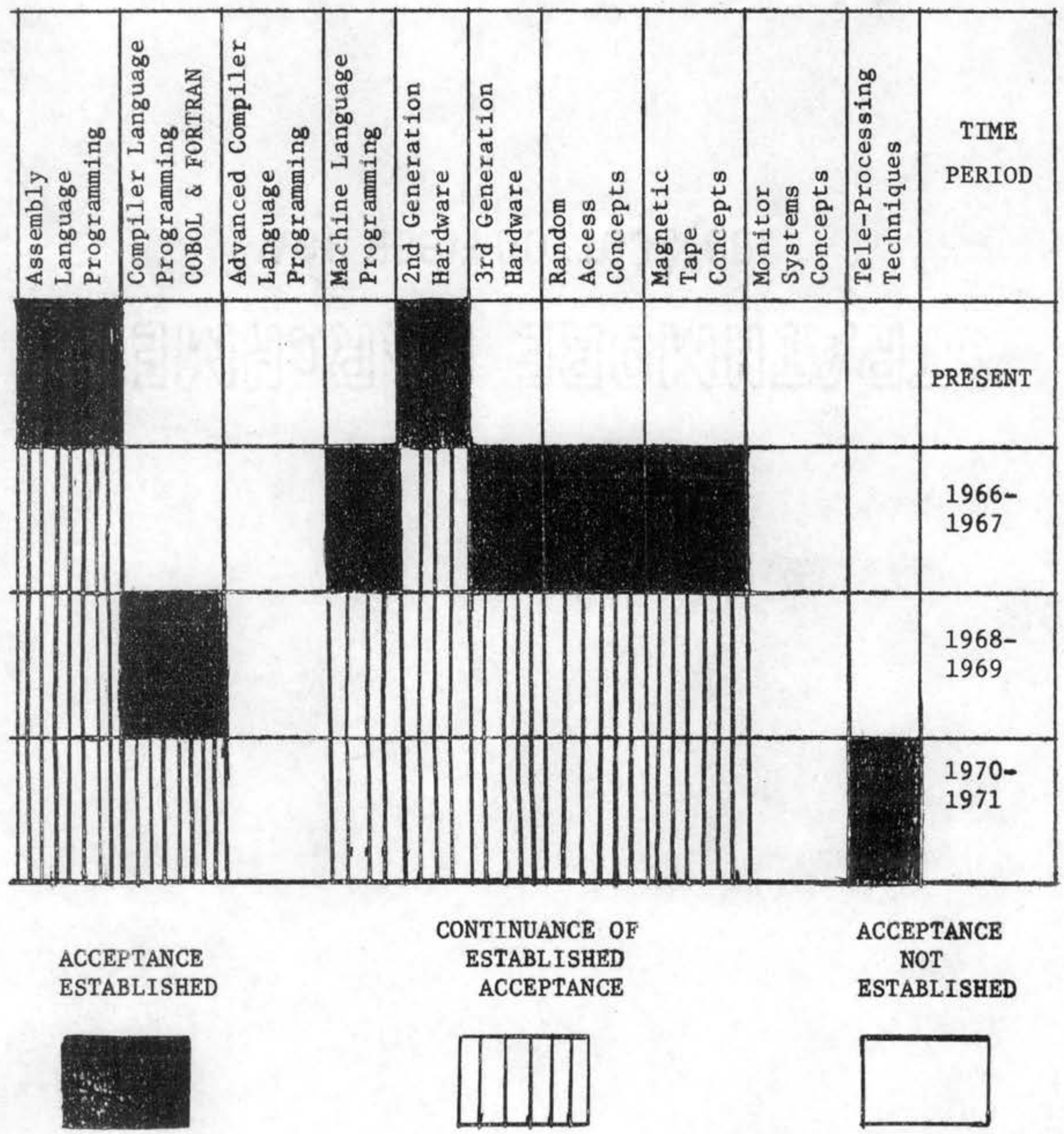


concepts. The 68-69 time period established acceptance of compiler language programming, (COBOL & FORTRAN). The 70-71 time period, established acceptance of tele-processing technique. The remaining two items of advanced compiler language programming, and monitor systems failed to establish a significant difference in acceptance for any of the four time periods surveyed. Table XXIV shows the time period in which acceptance was or was not established.

The statistical treatment of the ten items in each size group was tested to show a significant difference in the acceptance of each item. This acceptance of these items has developed a basis for designing the education program to provide qualified employees for these organizations. The time period for each item's acceptance was established for each size group, to show when acceptance is predicted to occur in the individual size groups. However, a regional or state-wide data communications system, should not be based on one limited group of employers; but on the most totally represented group or combinations of groups of organizations in that region or state. For this reason, the responses for each of the ten items, was combined from all four size groups. The responses were statistically treated to establish a significant difference of acceptance for each of the ten items by all the organizations responses. The responses established a significant differences in acceptance of five of the ten items in the present time period. The five items accepted in the present time period were; assembly language programming, machine language programming, second generation hardware, random access concepts and magnetic tape concepts. The 66-67 time period established acceptance of three additional items: compiler language programming, third generation hardware, and monitor systems. The two remaining items established

TABLE XXIV

TIME PERIOD WHEN ACCEPTANCE WAS FIRST ESTABLISHED FOR SIZE GROUP D



a significant difference of acceptance in the 68-69 time period. These two items were advanced compiler language programming and tele-processing concepts. These two items received negative responses until this time period, because of the lack of adequate development of supporting software. The tele-processing item was not a necessary item for the instructional aspects of the total education program; however, it is a necessary development for the total concept of time-sharing or data-communications. This technique can be taught in a time-sharing or data-communications system as a secondary item, mainly, because the technique would be used to provide a more economical system. It would be available to teach the basic concepts of such a system.

The total responses of all four size groups showed a significant difference in acceptance of all ten items in various time-periods; which is significant in itself. However, the statistical treatment of data was developed with one additional step to show a more adequate representation of the groups employing the most programmers. It was revealed in the tabulation of data for Table XXV, that approximately 70% of all data processing programmers and technicians were employed by the size groups (A, B, C). For this reason statistical treatment of these three size groups to establish acceptance was given. This revelaed that in size groups (A, B, C) a significant difference of acceptance was established for all ten items in the present time period. Table XXV shows the time period when acceptance was established for a combination of size groups A, B and C.

Table XXVI shows the established acceptance of each of the ten items for the combination of all size groups (A, B, C, D).

TABLE XXV

TIME PERIOD WHEN ACCEPTANCE WAS FIRST ESTABLISHED FOR A COMBINATION OF SIZE GROUPS A, B AND C.

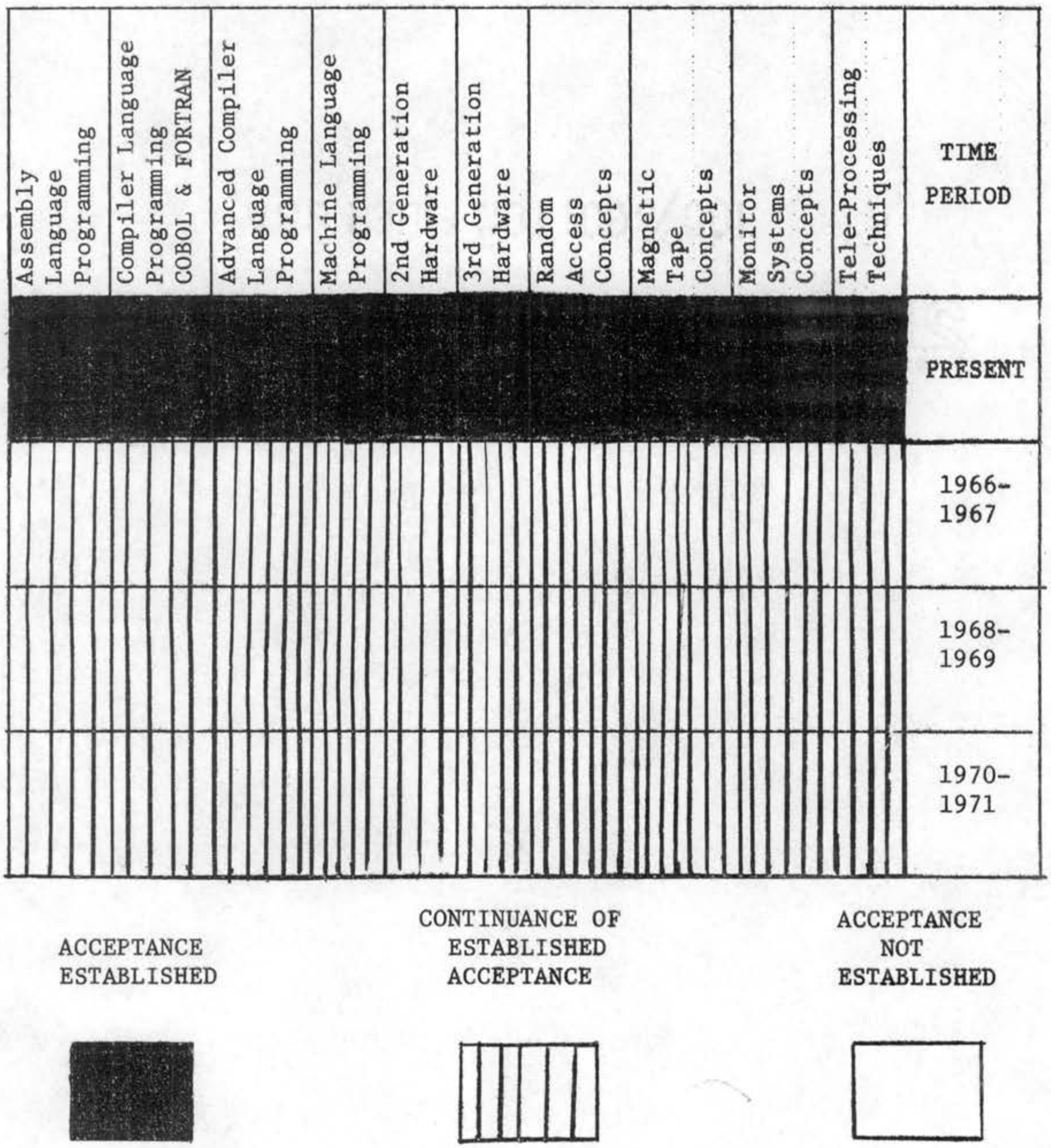
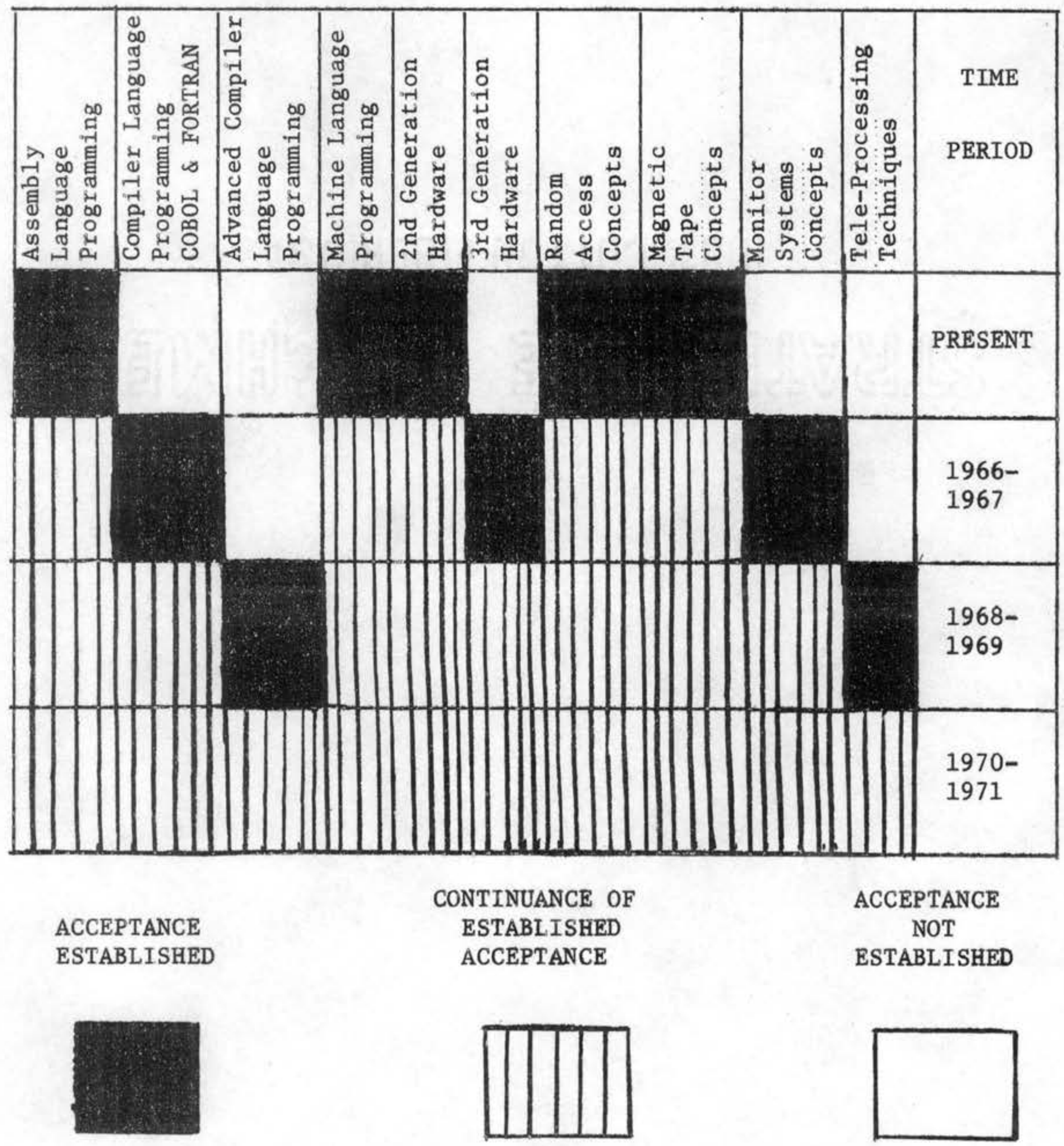


TABLE XXVI

TIME PERIOD WHEN ACCEPTANCE WAS ESTABLISHED FOR SIZE GROUPS A, B, C AND D.



Statistical treatment of Hypothesis VII was a test specifically of the tele-processing technique item. This was a test to indicate whether the level of acceptance changed throughout the four time periods covered in the study.

There was a significant difference among the four time periods concerning the tele-processing technique. The same statistic was used as in Hypothesis VI, i.e., comparing the fraction of positive responses for the items of tele-processing technique.

# CHAPTER VI

# SUMMARY, CONCLUSIONS & RECOMMENDATIONS

## Problem Briefly Stated

This study has been concerned with the problem of the adequate preparation of data processing programmers and systems analysts at the most reasonable cost to the local school. The basic purposes were to identify the newly developed concept of data-communications as it would relate to the training of data processing programmers and systems analysts, and to identify the specialized items required by state organizations to adequately train these individuals on such a system to best serve the existing and anticipated needs of this highly specialized field. The work and proceedings of the study have been to identify these two basic purposes. However, to better illustrate a basic factor in the consideration of a data-communications system to train data processing programmers and systems analysts utilizing the specialized training requirements established in Chapter IV, a comparison will be made between data communications system and a stand-alone system emphasizing the cost to the local school to accomplish the basic purpose of adequately trained personnel.

## Important Findings Summarized

First, to summarize the specialized training requirements established in Chapter IV, Table XXV presents the combined established acceptance of size groups (A, B, & C) and Table XXVI presents the combined established acceptance of size groups (A, B, C, & D) which will be the basis for the establishment of these specialized training requirements. The time period to be used in this summary will be the 1966-67 time period because it most nearly correlates to the effective completion data of the research and the proper utilization of the findings. The established acceptance of the specialized training requirements for the items of assembler language programming, compiler language programming (COBOL and FORTRAN), machine language programming, second generation hardware, third generation hardware, random access concepts, magnetic tape concepts, and monitor systems concepts were made in 1966-67 time period. The established acceptance of the specialized training requirements for the items of advanced compiler language programming and tele-processing (data communications) techniques in the 1968-69 time period. However, Chart V, concerned with the upgrading or de-emphasizing of requirements between the present time and the 1970-71 time period, points out four key factors that must be taken into consideration if this system is to be adequately developed. They are first that a major de-emphasizing is being placed on the two training requirements items of unit record equipment and second generation hardware; secondly, that an upgrading of training requirements in the two items of advanced compiler language programming and tele-processing (data communications) techniques.

Therefore, to adequately design a system based on the established acceptance of the specialized training requirements outlined by the findings of the study the system must include the following:

1. A limited configuration of unit record equipment to teach the basic concepts of the equipment and the relationship of this equipment to the total system. The school should

keep constantly abreast with the trends in the use of unit record equipment to make sure that a de-emphasis in the use of this equipment may justify elimination of some of the unit record equipment.

2. Assembler language programming for third generation hardware is a necessity and consideration should be given to assembler language programming of second generation hardware if this equipment is still in use.
3. Compiler language programming consisting of the two basic languages of COBOL and FORTRAN must be taught if the student is to be employed by the majority of organizations. These two languages were required by the organizations that employed approximately 70% of all the programmers and systems analysts (see Table XXV).
4. Advanced compiler language programming should be developed into the instructional program as soon as the utilization of advanced compiler languages, such as program language #1, becomes sufficient enough to justify its use.
5. Machine language programming for the type of system utilized should be included in the instructional program.
6. Second generation equipment should not be considered when it is planned to be the complete (stand-along) instructional system. As a back-up system to third generation hardware or as terminal equipment on-line to third generation hardware, it could be utilized effectively.
7. Third generation hardware is a necessity in the instructional program to adequately instruct data processing personnel. The

data center or the main processing unit of a data-communications system must be a third generation hardware. The terminal equipment should if economically feasible be third generation hardware, and if it is not in the original planning the possibility of upgrading to this generation of hardware should be present. A stand-alone system for an instructional program if the program is designed to serve the needs of the field of data processing should be third generation hardware, unless the second generation hardware is only designed to serve as an interim system.

8. The concepts of random access, magnetic tapes, and monitor systems techniques must be taught if the instructional program is to produce an adequately trained data processing programmer or systems analysts.

9. Data-communications technique should be considered as a method to provide more computing power for the program. The key to better instructional programs is more computer power, and the best way to offer more power to more students is with time-sharing or the data communications techniques.

Cost figures for four configurations are given to indicate the economic feasibility of a data-communications system. All figures will be monthly rental costs. These four configurations are as follows:

Configuration 1. (data-communications system serving 15 schools)

Configuration 2. (stand-alone system - third generation hardware with tapes and disk)

Configuration 3. (stand-alone system - third generation hardware without tapes and disk)

Configuration 4. (stand-alone system - second generation hardware with tapes and disk)

Table XXVII shows the degree to which each configuration can fulfill the ten major items which are considered important.

TABLE XXVII

CONFIGURATION SYSTEMS DEGREE OF FULFILLING THE TEN MAJOR REQUIREMENT ITEMS.

| ITEMS | Configuration 1 | Configuration 2 | Configuration 3 | Configuration 4 |
|---|---|---|---|---|
| Assembly Language Programming | X | X | X | X |
| Compiler Language Programming | X | X | X | X |
| Advanced Compiler Language Programming | X | X | | |
| Machine Language Programming | X | X | X | X |
| Second Generation Hardware | X | X | X | X |
| Third Generation Hardware | X | X | X | |
| Random Access Concepts | X | X | | X |
| Magnetic Tape Concepts | X | X | | X |
| Monitor Systems Concepts | X | X | X | X |
| Tele-Processing Techniques | X | | | |

Configuration 1

(data-communications system - serving 15 schools)

Data Center Computing Hardware

| Quantity | Description |
|---|---|
| 1 | Central processing unit (one microsecond unit speed) including approximately 102,000 characters of memory and scientific instruction set. |
| 1 | Card reader control |
| 1 | Card reader (800 cards per minute) |
| 1 | Card punch control |
| 1 | Card punch (100-400 cards per minute) |
| 1 | Printer control unit |
| 1 | Printer (650 lines per minute) |
| 1 | Disk storage control unit |
| 3 | Disk drive unit (access time 8.5 milliseconds, 9.5 million characters) |
| 1 | Magnetic tape control unit |
| 1 | Magnetic tape unit, 44,000 characters per second, primary unit |
| 3 | Magnetic tape units, 44,000 characters per second, secondary unit |
| 1 | Multi-channel communications unit (for 4-15 lines) |
| 5 | Multi-channel adapter |

Local School Terminal Hardware (15 schools)

| Quantity | Description |
|---|---|
| 15 | Central processing unit (two microsecond unit speed) including 4,096 characters of memory |

| | |
|---|---|
| 15 | Card reader/punch (400 cards per minute read, 100-400 cards per minute punch) |
| 15 | Printer control unit |
| 15 | Printer (450 lines per minute) |
| 15 | I/O adapter |
| 15 | Communications control unit |

Communications Hardware

| Quantity | Description |
|---|---|
| 20 | Bell data sets 201-B-3 |
| 5 | Private full-duplex voice grade communications lines (three schools per line) |

Configuration 2

(stand-alone system - third generation hardware with tapes and disk)

| Quantity | Description |
|---|---|
| 1 | Central processing unit (1.5 microsecond unit speed) including approximately 16,000 characters of memory, memory protect features, edit instruction, decimal arithmetic, and floating point hardware |
| 1 | Card reader (600 cards per minute) |
| 1 | Card punch (250 cards per minute) |
| 1 | Printer control unit |
| 1 | Printer (600 lines per minute) |
| 1 | Disk storage control unit and drive (access time 25 milliseconds, 7.25 million characters) |
| 1 | Magnetic tape unit, 15,000 characters per second, primary unit |
| 3 | Magnetic tape unit, 15,000 characters per second secondary unit |

## Configuration 3

(stand-alone system - third generation hardware without tapes and disk)

Computing Hardware

| Quantity | Description |
| --- | --- |
| 1 | Central processing unit (1.5 microsecond unit speed) including approximately 16,000 characters of memory, memory protect feature, edit instruction, decimal arithmetic, and floating point hardware |
| 1 | Card reader (600 cards per minute) |
| 1 | Card punch (250 cards per minute) |
| 1 | Printer control unit |
| 1 | Printer (600 lines per minute) |

## Configuration 4

(stand-alone system - second generation hardware with tapes and disk)

Computing Hardware

| Quantity | Description |
| --- | --- |
| 1 | Central processing unit (11.5 microsecond unit speed) including approximately 12,000 characters of memory, multiply - divide, advanced programming, and sense switches |
| 1 | Card reader (800 cards per minute) |
| 1 | Card punch (250 cards per minute) |
| 1 | Printer control unit |
| 1 | Printer (600 lines per minute) |
| 1 | Disk storage control unit and drive (access time 25 milliseconds, 7.25 million characters) |
| 1 | Magnetic tape unit, 15,000 characters per second, primary unit |
| 3 | Magnetic tape unit, 15,000 characters per second, secondary unit |

Cost per school per month for all four configurations are as follows:

| | |
|---|---|
| Configuration 1 | $ 2,402.21 |
| Configuration 2 | $ 5,346.00 |
| Configuration 3 | $ 3,388.00 |
| Configuration 4 | $ 4,136.00 |

The above costs per school have been calculated with all educational allowances offered by the manufacturers. For example in configuration 4, the current educational allowance of 60% has been deducted from the original cost of the equipment to result in the above figure.

The above figures show that the data-communications system is approximately $1,000.00 per month cheaper than the next closest system. The next closest system is a third generation stand-alone system without tapes and disk which can only meet 6 of the 10 major requirement items outlined in the findings of the study (see Table XXVII). The only equipment configuration that would be able to meet all 10 of the major requirement items would be the data-communications system. The equipment configuration that would come closest to meeting the number of requirement items of the data-communications system (see Table XXVII) would be Configuration 2. However, this configuration would cost the local school $5,346.00 per month or approximately $3,000.00 per month more than the data-communications system.

After analyzing the costs of all four equipment configurations it is clear that the technique of data-communications will have a great impact on the training programs of the near future. It will provide more computer power, hardware backup, personnel backup from the data center personnel, greater service for students and faculty and at lower costs to the local school. This type of system must play an important role in the training of qualified data processing personnel and in the total educational program.

In order to establish the complete cost figures of an installation a certain amount of unit record equipment is required. The following is a typical set of unit record equipment:

| Quantity | Description |
|---|---|
| 4 | Key punch |
| 1 | Interpreter |
| 1 | Reproducer |
| 1 | Collator |
| 1 | Accounting Machine |
| 1 | Sorter |

The above unit record equipment with all educational allowances would be approximately $750.00 per month. For realistic total cost of any of the four configurations these unit record equipment figures should be added to each cost per school. But this additional cost does not affect the relative comparisons.

One of the most serious problems associated with the use of time-shared computers and special-purpose problem-oriented languages is that with a few statements on the input device, it is possible to call into action an enormous collection of programs which may require substantial computer time in execution. This problem decreases to some extent because of the increased capacities and speeds of the time-shared computing equipment. Nevertheless, there will always be an upper limit on the demands which student or instructor can make on the computing resource.

The time-sharing computing system for the technical education program will provide the greatest flexibility and capacity employing one or more large central processing units. The principal type of an on-line terminal to be used in the basic technical education business or scientific program facility should be one with additional off-line computing ability. The terminal should have the capabilities of card reading, card punching, printing, on-line computing ability, off-line computing ability and expansion features. The data-communications configuration used for earlier comparisons had all these capabilities. The on-line computing ability should have a communication line speed of not less than 2,000 bits per second and not to exceed 2,400 bits per second.

Basically, voice grade lines are used because narrow band or teletype lines are much too slow and less reliable than voice grade lines, and wide-band or broad band service is too expensive. In many ways, the possibility of using micro-wave equipment to provide broad band service has some outstanding features. The improvement in the quality and reliability of data transmission would offer great advantages in the total system if the financial aspect of the microwave service can be overcome. There is a good possibility that the micro-wave equipment can be acquired through the surplus property agency in federal government. Even if this equipment can be acquired a value judgement will have to be made concerning such an installation. However, this study is only concerned with the standard methods of supplying data-transmission service.

The on-line ability of 2,000 bits per second will utilize the standard half-duplex communications lines while the 2,400 bits per second transmission rate will require a full-duplex communications line. To develop full capacity of the lines used, special line conditioning equipment may be required, especially if the terminal or the central processing unit is in a remote area utilizing lines of supporting telephone companies. All line service from remote terminals to a central processing unit or units should be completely detailed before hardware or software transactions are completed.

A major question regarding this remote time-sharing terminal configuration is, why is the off-line computing ability necessary when on-line computing ability is available through direct transmission to the central processing unit? To adequately answer this question you must first consider the types of school offering the technical education business and scientific program curriculum. The majority of these schools will be junior colleges, technical institutes, and area vocational-technical schools which lack any type of computing facility on their campus. This factor will cause two basic weaknesses in the total program. They could be solved without off-line computing ability if the central processing unit had a great deal of additional time that was not being used. If this additional time were available, the planning and effectiveness of the total system should be questioned. The value of a time-sharing system for instructional purposes is based on its full utilization for that purpose. For this reason off-line computing ability in the remote terminal is necessary so the more time-consuming operations can be accomplished without requiring the main central processing unit to do the calculations. If each school with a remote terminal could do much of the lower level processing which does not require a highly specialized configuration of equipment, this would allow time for more schools to participate and be served by the total system. For example, the local schools could process programs off-line in the basic assembly languages which would not require a great mass of storage for the compiler programs and a high level of sophistication in the central processing unit. On the other hand they could switch to on-line processing to do the compiler programming languages such as FORTRAN and COBOL which would require a highly sophisticated configuration of equipment that would be completely impractical to duplicate in a local school environment.

A second item which would require a terminal with off-line computing abilities would be that of processing data for the individual school. If a school has computing facilities and qualified personnel available and they can save a great deal of time and labor using this potential, they should and will. If they plan to use these facilities in the operation of the school, they must have a small processing unit to perform the functions. This school processing should not be an on-line function because it would become a time consuming factor. There are other factors that would stress the need for off-line computing ability; however, the two described above are the two prime considerations.

As the time-sharing system is developed to a higher level of sophistication within the technical education teaching facility, special devices can be employed easily. Devices especially useful for design and theory applications such as the cathode ray tube, line-drawing plotters, process control devices, etc., can be used. Many will also have hardcopy or microfilm reading and reproduction equipment. For financial reasons, it would not be feasible for individual technical schools to develop a system using these devices. A part of a large time-sharing system, these special devices could be more readily employed.

The development of a time-sharing system which would provide a wide variety of applications for the computer would give each technical school an opportunity to offer a high level of business programming, scientific programming, design and theory problem solving, basic computer concepts instruction for all technical majors, and the possibility of computer application in the process control or instrumentation areas.

The trend toward a large centralized computing system seems inevitable. Files of data and other technical information will be accessible via large information-processing systems over area-wide communications networks. It is not unreasonable to expect the eventual development of one or more computer utility systems supplying technical and programming services to a wide variety of users virtually anywhere in the country.

The degree to which information-processing systems are introduced into the teaching-learning environment of the modern technical school depends upon the value judgments of technical school administrators.

## Conclusions and Recommendations

1. If a basis for cooperative planning can be established whereby the computing needs of technical education in a state or region can be effectively met with a minimum outley of funds then to establish a data-communications (time-sharing) system, a central planning council, board, or group should be established to serve in an advisory capacity. All institutions to be involved should be included in such an advisory group. Other representatives, as needed, should be selected on the basis of individual qualification and could represent either organizations in

that state or region that employed the types of data processing personnel that would be trained in the program. Educational data processing consultants from outside the institutions involved might be very helpful in maintaining an impartial balance in the planning of the program. It is very doubtful that a person who is not extremely knowledgeable about computers and their capacities for broad application could make a continuing contribution to the work of an advisory committee or planning group. It should be made clear that it is not suggested that such an advisory group should be a control group but should point the way for cooperative efforts for maximum returns.

2. The large computer data communications systems concept now coming into use in modern industry can be used in educational institutions and may permit the institutions to concentrate the processing power and required technical staff in a centralized data-center, yet at the same time decentralize the input-output stations and take them into laboratories and classrooms where the students and instructors originate the data. Intra-institution cooperation will be necessary to support these complex systems. The computer systems of the future will stress modularity and upward compatibility even more than at the present in order that a system may grow without upsetting the previous operation; therefore, our concept of training qualified personnel to program these systems must grow with them.

3. In contemplating the vast potential of large computerized data-communication systems, it has often been suggested that a given state-wide or region-wide system could handle all of the information of two or more types of state or federal agencies. Insofar as the hardware is concerned, such an approach might be possible. However, such a complex

computer-communication system requires an equally complex software system before it is operational. Furthermore, as the number of functions in a given information system increases, the complexity of the logistics in the information flow increases many fold. Consequently, the designs of the information system should not introduce or combine more functions or departments than are absolutely necessary to achieve an integrated information system and yet make efficient use of a large computerized data-communication system.

4. Efficient computer to computer data-communications requires a communications link capable of handling data at speeds of 2,000 bits per second or greater. The communication links ranging from 2,000 to 2,400 bits per second may be categorized as half-duplex, duplex, voice band, and provided on wide-band facilities.

5. Collectively, the planning group should be well informed about patterns, purposes, and costs of computer education and associated computer costs. They should be able to differentiate between the characteristics of different types of educational programs such as business data processing, scientific data processing, information storage and retrieval, etc. It would also be of value if they were aware of the different requirements for research, instruction, administration, and area service use of computers.

6. Inter- and intra-institutional planning for computer science education and computer use should be related to planning for education in other technical education occupations such as instrumentation, electronics, drafting and design, etc.

7. Cooperative planning for a state-wide or region-wide computerized data-communications system for computer science education programs

should include an information summary estimate and recognition of trends, development, needs, and resources of other such educational facilities in the state, region, and the nation. Along with the information summary which should include message sizes, operation hours, response times, accuracy requirements, existing input/output media, and costs of present system, a map should be prepared showing the geographical distribution of remote stations, WATS zones, and existing networks. In addition, charts may be required, showing:

1) Volumes of data to and from each remote location with transmission times for each of the possible speeds available (e.g., 10 "characters per second", 75 "characters per second," 100 "characters per second").

2) Transmission characteristics for each remote location (e.g., speed, code level, parity, simplex or duplex, error correction and retransmission schemes).

3) Data processing requirements for each application.

8. A list of newly established computerized organizations in the geographic area planned to be served by the new data-communications system, the present computer users, and those planning to make a marked expansion of facilities should be developed and kept up to date for the purposes of interpreting trends, personnel needs, and informing the advisory group, administrators, general educators, public, etc.

9. Careful assessments of new faculty needs against the availability of qualified faculty will be essential. Qualified instructors in the computer areas are hard to obtain since the need for their talents outside of education is so great. Generally, a student population for a computer education program can be assembled much faster than the

needed faculty can be obtained.

10. The basic systems design, research and findings outlined in the study have applicability to other states, regions and multi-campus institutions. All seven hypotheses have significant implications to technical education programs in areas outside the state of Oklahoma.

11. The proposed data-communications system represents a workable system. It has a sound basis, both from the economic and systems aspect. The proposed data-communications system can provide all the training requirements established in the study and offer a curriculum that will greatly enhance the position of the graduates.

## Suggested Further Studies

1. Some study should be given to the possibility of expanding other areas of technical education such as instrumentation, electronics, drafting and design, etc., into a total data-communications system. This area has some great possibilities for providing highly sophisticated configurations of equipment at a much lower cost through the use of a centralized data center.

2. Some study should be given to the kinds of procedures and practices that might be effectively used in the implementation of cooperative activity between a post-secondary technical program and a secondary pre-technical program utilizing some basic course materials and lower speed transmission data terminals as part of a data-communication system.

3. The complete set of punched cards used in this study are available for comparisons of responses from other local, state, or regional groups who might be considering such a system or trying to upgrade their existing one. Such comparisons might reveal differences in responses which might be of value to others considering such a system.

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# DATA COMMUNICATIONS GLOSSARY

Automatic Exchange

An exchange in which communication between subscribers is effective without the intervention of an operator by means of devices set in operation by the originating subscriber's instrument.

Automatic Error Correction

A technique, usually requiring the use of special codes and/or automatic retransmission which detects and corrects errors occuring in transmission.

Bits (Contraction of "Binary Digits")

From a communication standpoint, "bits" are the smallest point of information which are transmitted. This information may be a 0 (zero) or 1 (one) which may be recognized as an "on" or "off", a "yes" or "no", etc. One unit of information.

Bit Rate

The speed at which bits travel over a communication channel (e.g., 1200, 200, or 2400 bits per second).

Block

A group of consecutive characters handled as a unit. It has special emphasis in determining the method of error correction and detection which effects the speed of transmission.

Carrier

A high-frequency signal suitable for modulation by another signal.

Carrier Frequency

The particular frequency of the carrier signal.

Communications Channel

A path for the flow of information, particularly digits or characters.

Central Office

Office in a telephone system that provides service to the general public, where requests for telephone connections are received via controlling signals and connections are established.

Character

One representation of a numeric digit, letter of the alphabet or special symbol.

Circuit

A number of conductors connected for the purpose of carrying on electrical current to convey communications.

Common Carrier

A company recognized by the FCC or appropriate state agency as having a vested or rightful interest in furnishing communications services to the public (e.g., AT&T Company, Western Union, etc.).

Code, Excess-three

A coded decimal notation for decimal digits which represents each decimal digit as the corresponding binary number plus three; e.g., the decimal 0, 1, 7, 9 are represented as 0011, 0100, 1010, 1100, respectively.

Data Set (Modem)

AT&T modulating-demodulating device which, in sending, accepts a signal from the originating machine and converts it into a tone for transmission over a communication channel (e.g., Data Set 201A)

Direct Distance Dialing (DDD)

Method of making long-distance telephone calls whereby the call can be dialed directly without the services or intervention of an operator.

Dataphone

Trade name of AT&T for the service of utilizing Data Sets on the Local and Direct Distance Dialing network for the purpose of data transmission.

Echo

A portion of the transmitted signal returned from a distant point to the transmitting source with sufficient time delay to be received as interference.

Echo Suppressor

A device of the Common Carrier installed in a communication circuit for the purpose of partially reducing the echo (reflected energy).

Error Correction

A system (in hardware and/or software) which inherently provides correction of errors received during transmission.

Error Detection

A system (in hardware and/or software) which detects and identifies errors caused during transmission.

Half Duplex Service (Operation)

A communication channel which is capable of transmitting and receiving information in either direction, but not simultaneously.

Full Duplex Service (Operation)

A communication channel which is capable of transmitting and receiving information in either direction simultaneously.

Identifying Codes

Codes in tapes or cards which identify their origin and/or content.

Interface

A common boundary between two or more devices, items of equipment, or systems, mechanical or electrical.

Loop

The portion of the communications channel which connects the subscriber to the central office, usually a metallic circuit.

Leased Line (Private Line)

Communication channels reserved by the Common Carrier for the exclusive use of a particular subscriber.

Modem (Data Set)

Contraction of the two words, modulator-demodulator.

Modem Adapter

A device which is capable of connecting two dissimilar units together by means of converting and/or transferring the controls and functions between the two units.

Multiplexing

Many-to-one as the way of combining many communications channels into one channel.

Off-Line

Implies that a computer is not connected to another computer or terminal by the means of communication channels and is operating independently. An off-line system is commonly referred to as a stand-alone system.

On-Line

Implies a direct connection between a computer and another computer or terminal by the means of communications line with operations of either having an effect on both.

Parity Check

A system of error detection in which a certain block of bits is examined to see that it has a particular arrangement or quality of bits.

Serial Transmission

Sequential transmission of bits that make up a character over a communication circuit.

Signalling

A method of transmitting control signals between two or more terminals to set data transmission in operation. These signals are other than the normal data flow.

Subscriber (Customer)

This refers to the individual, company, corporation, agency, etc., who rents or leases the service (tariff offering) for their particular use. (e.g., person calling or being called.)

Switching Center

A location in which incoming data from one circuit is transferred to the proper outgoing circuit.

Synchronization

The process of making the signal received correspond in time to the signal transmitted. Commonly referred to as "to be in Sync."

Synchronization Character

A unique character transmitted to the receiving terminal with the purpose of setting the two or more units in synchronization with each other.

Tariff

A schedule of communication rates and services offered by a Common Carrier with the approval of the FCC or state regulatory agency.

Terminal Unit

Equipment on a communication channel which may be used for either input or output.

Turn Around Time

The time required to condition a half-duplex carrier facility so that the direction of transmission can be reversed. During this time, the facility is not available for transmission in either direction. Control of this turn around operation is the responsibility of the data set.

WADS (Wide Area Data Service)

A low-speed (200 bits/second maximum) dial data offering similar in structure to WATS. Available on a measured time basis from one to six access area zones. Terminal equipment may be teletypewriter or low-speed business machine. This tariff not approved as yet.

WATS (Wide Area Telephone Service)

This is a Bell System tariff offering which divides the continental United States into six zones emanating from the home state (but not including) of the subscriber. An access line from the subscriber's premises to the telephone company's DDD network may be leased at flat monthly rates per circuit.

APPENDIX A

OKLAHOMA STATE BOARD FOR VOCATIONAL EDUCATION
J. B. Perky, Director    1515 West Sixth Avenue    Stillwater, Oklahoma

September 8, 1965

Dear

Technical education data processing programs are being developed in the State of Oklahoma for the training of programmers and systems analysts. To adequately develop these programs, the participation of professional personnel directing the operation of all types of data processing sections are essential. For this reason we are requesting your participation in the development of an occupational survey in the field of data processing for the State of Oklahoma.

This occupational survey is being conducted and supervised by the State Board for Vocational Education - Division of Technical Education, State Board of Education - Division of Statistical Services, and the U.S. Department of Health, Education and Welfare - Office of Education - Division of Vocational & Technical Education.

Our request for your participation consists of the enclosed questionnaire, on your present and anticipated needs and any additional comments or pertinent information that will assist in making this occupational survey more effective.

This information given by you is strictly confidential and will be handled as research data available only for analysis by our staff. No information on any specific company will be revealed in the analysis or final report. Please return the questionnaire to Division of Technical Education, Oklahoma State Board for Vocational Education, 1515 West Sixth Avenue, Stillwater, Oklahoma, in the enclosed self-addressed envelope for which no postage is needed; the form will remain there until destroyed.

Your cooperation is most urgently solicited and will be sincerely appreciated. May we take this opportunity to thank you for your time used in fulfilling our request.

We shall be happy to send you a copy of the final report upon its completion.

Enclosed please find a typical curriculum guide.

Arthur Lee Hardwick, State Supervisor
Technical Education

J. B. Perky, State Director
Vocational Education

## APPENDIX B

## OCCUPATIONAL SURVEY OF DATA PROCESSING PROGRAMMERS & SYSTEMS ANALYSTS FOR THE STATE OF OKLAHOMA

Please complete all sections and return in enclosed self-addressed envelope or return directly to State Supervisor of Technical Education, 1515 West 6th, Stillwater, Oklahoma - Telephone FR 2-6211, Ext. 7235.

Name of Company ______________________________________________

Nature of Business or Industry ________________________________

Address ______________________________________________________

Name of Person Completing Questionnaire ______________________

Title ________________________________________________________

Telephone Number and Extension ________________________________

### EMPLOYMENT NEEDS

1. Number of programmers & systems analysts now employed Men___Women___

2. Total number of programmers & systems analysts needed at the present time_____

3. Anticipated number of programmers and systems analysts needed between the present time and 1967_____

4. Anticipated number of programmers and systems analysts needed between 1967 and 1970_____

   Example If you have 2 programmers or systems analysts employed now, these figures should include anticipated replacement of these employees for reasons of retirement, death, secure other position, etc. So the anticipated need could read 2 employees even though you do not plan to enlarge your operation.

5. What percentage of your professional personnel currently used as programmers & systems analysts could be replaced by trained

technicians? (Enclosed please find copy of sample data processing curriculum guide to be used in these programs)____________________

## TRAINING REQUIREMENTS FOR PROGRAMMERS & SYSTEMS ANALYSTS

1. Check type of degree required - if any A.A.( ) B.S.( ) M.S.( )

2. Based upon mathematical requirement in curriculum guide page 2, would you require Less( ) More( ) Same( )

3. Based upon accounting requirement in curriculum guide page 2, would you require Less( ) More( ) Same( )
   If more or less, please specify_________

4. Number of years experience required currently of new workers in data processing None( ) 1 year( ) 2 years( ) over 2 years( )

5. Do you prefer that your programmers and systems analysts receive training on any specific types of equipment? Yes( ) No( )

6. Is experience with unit record equipment required? Yes( ) No( )

7. Is experience with unit record equipment recommended? Yes( ) No( )

8. Type of programmers of systems analysts preferred. Male___Female___ Either___

## ANTICIPATED TRAINING REQUIRED

1. What number of your programmers and systems analysts in the future will be recruited by upgrading present employees through training or further education?________________

2. If local evening technical courses were available to upgrade your programmers and systems analysts, would they attend? Yes___ No___

3. From what source do you employ most of your data processing programmers and systems analysts?
   High School _____ Junior College, Technical Institute, Area Voc.-Tech. School College or University______

4. In the future from what source would you prefer to recruit your programmers and systems analysts?
   High School _____ Junior College, Technical Institute, Area Voc.-Tech. School College or University_____

5. In a technical education program of this type would you prefer that instructors emphasize theoretical knowledge rather than practical knowledge? Yes( ) No( )

6. Are qualified graduates from technical education data processing programs without actual work experience acceptable to fill your vacancy, if available vacancies exist? Yes( ) No( )

7. Would you be willing to consider hiring students on a part-time basis? Yes( ) No( )

## DATA PROCESSING EQUIPMENT
(present & anticipated)

1. Present type of data processing equipment available_______________

2. Does present equipment configuration include
   A. Random access techniques Yes( ) No( )
   B. Magnetic tape techniques Yes( ) No( )
   C. Paper tape techniques Yes( ) No( )
   D. Direct transmission techniques Yes( ) No( )

3. Equipment expansions anticipated for the data processing section___

4. Will the anticipated equipment expansions include
   A. Random access techniques Yes( ) No( )
   B. Magnetic tape techniques Yes( ) No( )
   C. Paper tape techniques Yes( ) No( )
   D. Direct transmission techniques Yes( ) No( )

   Special comments_____________________________________________.

APPENDIX C

TO DETERMINE THE FEASIBILITY TO ESTABLISH A PROGRAM TO TRAIN COMPUTER PROGRAMMERS UTILIZING A TIME-SHARING SYSTEM AND REMOTE DATA-COMMUNICATIONS TRANSMISSION TERMINALS

1. Problem:

The scientific and technological developments of recent years and the advent of the space age have necessitated rapid changes in the manpower needs of both industry and business, particularly in the fields of science. One of the crucial shortages has been that of adequately trained technicians to fill positions as programmers and systems analysts. The shortage of programmers and systems analysts is becoming increasingly more severe due to the continuous development of more complex and advanced data processing equipment and techniques.

Because it is generally conceded that the education and preparation of technical manpower is a functional responsibility of educational institutions, an increased demand is being placed on technical institutes, junior colleges, and area vocational-technical schools to expand their programs to include Data Processing Technology.

In general, the problem to be investigated in the project herein described is whether and to what extent it is feasible to train computer programmers and systems analysts by the use of a statewide data information system consisting of a centralized large computing system directly connected to data processing transmission terminals located in the individual local schools. More specifically attempts will be made to survey a number of potential users of such a system to determine: present and anticipated services needed (including frequency and volume), nature of current systems in use, number of Data Processing technicians presently employed, and the number of Data Processing technicians needed for the future.

The ultimate system, as presently envisioned, will include 15 technical education data processing centers in colleges, universities, and area schools throughout the State of Oklahoma and a data center located in Oklahoma City in the State Department of Education. The local technical education programs would be connected directly to the data center by the means of direct transmission lines to and from the computer at the data center and the local school computer system.

Before making definite decisions as to where this type of system will be most effective, it is considered imperative to collect pertinent information from a large variety of agencies and groups who might be interested. These sources of information will include representatives from various educational institutions, selected industrial and governmental firms and agencies, and from various divisions of the State Department of Education.

Although the primary purpose of this system is to train computer programmers and systems analyst technicians, it is felt that this state-wide system for data information and processing would bear relevance to a number of different areas of activity, including: (1) school administration (2) state administration and (3) educational research.

This system would support school administration by having available in the school data processing equipment that would have the capabilities of doing a large number of the repetitious and involved aspects of school administration; such as student scheduling, school records, and etc. This work can be accomplished to serve the schools and to complete administrative functions as long as this work does not interfere with the instructional programs offered. It would also provide support for state administration of the State Department of Education and the Division of Vocational Education. A cooperative agreement can be made between the Division of Statistical Services, State Department of Education and the Division of Technical Education, State Board for Vocational Education. The reason for this type of agreement would be that each division would have funds available to operate a limited data processing system and if an agreement can be made between the two divisions to cooperate on a program of this type, a greater data processing system with greater speed and more capabilities as far as hardware and backup could be made available for both divisions and in this way the state administration can be handled much faster and to a greater depth. Support could also be given in the area of educational research through a system of this type. Support not only to the universities in the state but also to the State Department of Education and the State Board for Vocational Education could be rendered. There will be time available when research data and statistics can be compiled and this work would not affect the instructional program of this system.

To develop individual systems that would be adequate to serve all these areas of the state separately, the overall cost for Oklahoma would be prohibitive. However, if the survey results indicate that computer programmers and systems analysts can be adequately trained on this type of remote data communications transmission terminal, as part of a large data processing system of which the cost would be considerably less, it is towards this end that the proposed research is oriented.

2. Objectives:

The research proposed has six objectives:

A. To identify existing data processing practices in selected agencies and institutions (including a description of present procedures, facilities, equipment, personnel, etc.).

B. To determine if computer programmers and systems analysts who are trained on remote data communications transmission terminals as part of a large data processing system would be adequately prepared to meet the needs of modern industry.

C. To determine the willingness of various sizes and types of data processing operations to accept graduates of this type of state-wide computer data communications system. (A comparison will be drawn between the sizes of data processing operations and their support of the system. A comparison will also be drawn between the type of data processing operations and their support of the system. A comparison will be drawn between location of data processing operations and their support of the system).

D. To measure anticipated needs (in terms of service volume, personnel, etc.)

E. To determine willingness to cooperate in the development of a state-wide data information system.

F. To identify how a data processing system could be used to support and improve the operation of school administration, state administration and educational research.

G. The preparation of a set of recommendations and conclusions based on results of the survey.

The satisfactory fulfillment of these objectives will make possible reasoned decisions regarding the nature of the approach to be made with respect to initiating the proposed state-wide system if it appears feasible and will, in addition, tend to indicate something about the specific nature and scope if the system is needed.

3. The procedure for the investigation is as follows:

A. Establish a jury for selected leaders, experienced in the field of educational data processing and industrial data processing, for evaluating the questionnaire which will be used.

B. Revise questionnaire as suggested by the jury.

C. Send questionnaire to randomly selected organizations in the State of Oklahoma that employ data processing programmers or systems analysts for their response.

D. Analyze questions numbered 9 through 18 to establish an acceptance level of a state-wide technical education data tele-processing system by the size of organizational groups S-A, S-B, S-C, S-D. Analyzing and interpreting data for hypothesis No. 1

Group S-A (Organizations employing 20 or more programmers or technicians)

Group S-B (Organization employing 10 to 19 programmers or technicians)

Group S-C (Organization employing 5 to 9 programmers or technicians)

Group S-D (Organization employing 1 to 4 programmers or technicians)

E. Analyze questions number 9 through 18 to establish an acceptance level of a state-wide technical education data tele-processing system by the type of organization groups A-A, A-B. Analyzing and interpreting data for hypotheses No. II

F. Analyze questions numbered 9 through 18 to establish an acceptance level of a state-wide technical education data-processing system by the location of all organization groups L-A, L-B, L-C, and L-D. Analyzing and interpreting data for hypotheses No. III.

Group L-A (Radius 10 miles, population 75,000 or more)
Group L-B (Radius 10 miles, population 50,000 to 74,999)
Group L-C (Radius 10 miles, population 25,000 to 49,999)
Group L-D (Radius 10 miles, population 0 to 24,999)

G. Analyze questions numbered 11, 12, 14, 17, 18, 19, 20 to establish the ability of Group XXXI to assess the need for this type of program. Due to the lack of familiarity with and knowledge of the newly developing concepts in data processing in comparison with Group I. Analyzing and interpreting data for hypotheses No. $IV^{1}$ through $IV^{31}$.

| | SIZE | TYPE | LOCATION |
|---|---|---|---|
| GROUP I | S-A | A-A | L-A |
| GROUP II | S-A | A-B | L-A |
| GROUP III | S-A | A-A | L-B |
| GROUP IV | S-A | A-B | L-B |
| GROUP V | S-A | A-A | L-C |
| GROUP VI | S-A | A-B | L-C |
| GROUP VII | S-A | A-A | L-D |
| GROUP VIII | S-A | A-B | L-D |
| GROUP IX | S-B | A-A | L-A |

| | SIZE | TYPE | LOCATION |
|---|---|---|---|
| GROUP X | S-B | A-B | L-A |
| GROUP XI | S-B | A-A | L-B |
| GROUP XII | S-B | A-B | L-B |
| GROUP XIII | S-B | A-A | L-C |
| GROUP XIV | S-B | A-B | L-C |
| GROUP XV | S-B | A-A | L-D |
| GROUP XVI | S-B | A-B | L-D |
| GROUP XVII | S-C | A-A | L-A |
| GROUP XVIII | S-C | A-B | L-A |
| GROUP XIX | S-C | A-A | L-B |
| GROUP XX | S-C | A-B | L-B |
| GROUP XXI | S-C | A-A | L-C |
| GROUP XXII | S-C | A-B | L-C |
| GROUP XXIII | S-C | A-A | L-D |
| GROUP XXIV | S-C | A-B | L-D |
| GROUP XXV | S-D | A-A | L-A |
| GROUP XXVI | S-D | A-B | L-A |
| GROUP XXVII | S-D | A-A | L-B |
| GROUP XXVIII | S-D | A-B | L-B |
| GROUP XXIX | S-D | A-A | L-C |
| GROUP XXX | S-D | A-B | L-C |
| GROUP XXXI | S-D | A-A | L-D |
| GROUP XXXII | S-D | A-B | L-D |

H. Analyze questions number 11, 12, 14, 17, 18, 19, 20 to establish the ability of groups A-A (Business Applications) to assess the need for this type of program due to the lack of familiarity with and knowledge of the newly developing concepts in data processing in comparison with groups A-B (Scientific Applications). Analyzing and interpreting data for hypotheses No. V.

I. Analyze questions numbered 9 through 18 in present time period and 1970-71 time period to establish an improvement of requirements by all groups for adequately trained programmers and systems analysts. Analyzing and interpreting data for hypotheses No. VI.

J. Analyze question number 18 in present time period and 1970-71 time period to establish a significant difference in the requirement for tele-processing techniques. Analyzing and interpretating data for hypotheses No. VII.

K. To analyze the recommendations for adequately trained programmers and systems analysts for hypotheses I, II, and III, to show a positive acceptance level of this type of system with the recommendation or preferred categories checked, to show the negative acceptance level in recommendation or cannot answer due to the lack of knowledge of this aspect of data processing system categories for hypotheses IV and V, to show that a significant difference in the abilities of groups to assess the need for this type of programmer which will be based on the category that cannot be answered due to the lack of knowledge of this aspect of data processing which is to be checked for hypotheses VI and VII, to show a significant difference in the present time period and in the 1970-71 time period. The time periods must show an increase in the time periods from not-required to preferred to required.

L. The hypotheses will be statistically tested by the means of chi square. Chi square will be used because of the advantage of this type of statistical test that allows for certain added properties, which will make the combination of several statistics or other values in the same test. Thus, a hypotheses involving more than one set of data at one time can be tested for significance.

4. Significance of Study

Several factors operate to lend justification to the proposed study of training computer programmers and systems analysts on remote tele-processing terminals tied to a large computer system as a part of a state-wide data information system. From the technical education standpoint, it is recognized that students in this field must, in order to have a background adequate to meet employment needs, have familiarity with the general field of data processing, have operational knowledge of more than one basic computing system, and understand the <u>total system concept</u> of data processing as it has progressed and the trend in which it is developing. They must also have knowledge of the various types of handling data, types of input-output devices, etc. For example, all students should have work experience on the latest types of computers, knowledge of and experience on random access approaches to data processing. In addition, they need experience with magnetic type and experience in the applications of direct transmission of data via communication lines from one terminal to other terminals tied to a computing system. All these necessary experiences and required areas of knowledge cannot feasibly be gained unless a state-wide system can be developed. A definite part of this proposal would be to utilize this data to justify need for technical education programs throughout the state and to determine in what geographic areas these programs will be located. In addition, this occupational analysis will help develop technical education programs and locations for technical education programs that will function as a part of the total system concept for the Oklahoma State Data Information System.

5. <u>Hypotheses to be Tested</u>:

No. I There will be a significant difference in the acceptance level of a state-wide technical education data tele-processing system by the size of industrial organizations, or agency groups S-A, S-B, S-C, and S-D surveyed $P < .05$

No. II There will be a significant difference in the acceptance level of a state-wide technical education tele-processing system by the type of industrial organization or agency groups A-A (Business Applications), A-B (Scientific Applications) surveyed $P < .05$

No. III There will be a significant difference in the acceptance level of a state-wide technical education tele-processing system by the location of the industrial, organization, or agency groups L-A (Radius, 10 miles, population 75,000 or more), L-B (Radius, 10 miles, population 50,000 to 74,999), L-C (Radius, 10 miles, population 25,000 to 49,999), L-D (Radius, 10 miles, population 24,999 or less) $P < .05$

No. $IV^1$ There will be a significant difference in the ability of group I to assess the need for this type of program due to the lack of familiarity with and knowledge of the newly developing concepts in data processing (such as operating under monitor systems, process control, 3rd generation solid logic, e.g. tele-processing, P. L. #1, access tele-processing methods) in comparison with group II, $P < .05$.

No. $IV^2$ group I compared with group III $P < .05$

No. $IV^3$ group I compared with group IV $P < .05$

No. $IV^4$ group I compared with group V $P < .05$

No. IV$^{5}$ group II compared with group III $P \angle .05$

No. IV$^{6}$ group II compared with group IV $P \angle .05$

No. IV$^{7}$ group II compared with group V $P \angle .05$

No. IV$^{8}$ group III compared with group IV $P \angle .05$

No. IV$^{9}$ group III compared with group V $P \angle .05$

No. IV$^{10}$ group IV compared with group V $P \angle .05$

No. V. There will be a significant difference in the ability of groups A-A to assess the need for this type of program due to the lack of processing (such as operating under monitor systems, process control, 3rd generation solid logic, e.g. tele-processing, P. L. #1, access tele-processing methods) in comparison with groups A-B $P \angle .05$/

No. VI. There will be a significant difference between the present time period and the 1970-71 time period concerning the improvement of requirements for adequately trained programmers and systems analysts by all groups involved. $P \angle .05$

No. VII. There will be a significant difference in the requirement for tele-processing techniques in the present time period and the 1970-71 time period even though this technique will be mainly used as an access method to provide the best possible training with a reduction in cost and obsolence for each local school. $P \angle .05$

6. Assumptions of the Study:

It is assumed that the industries surveyed will show a willingness to cooperate in this occupational survey and will also agree with the definition of the technical education programmer or technician.

It will also be assumed that if the personnel requirements set forth by these industrial groups, organizations, or agencies were met by technical education trainees seeking employment, these trainees would be qualified for positions with these groups if employment opportunities existed. It would be assumed that no attempts would be made to dictate or determine the results of the survey. However, the selection of the samples by size and by the number of data processing programmers or technicians employed would tend to determine the needs and qualifications set forth by larger industrial groups, organizations, and agencies.

7. <u>Limitations of the Study</u>:

No attempt will be made to survey all industrial groups, organizations, or agencies using data processing programmers or technicians. However, 100 per cent of all industrial groups, organizations, or agencies employing 20 or more data processing programmers or technicians (group S-A) will be surveyed. Seventy-five per cent of all industrial groups, organizations, or agencies employing 10 to 19 data processing programmers or technicians (group S-B) will be surveyed. Fifty per cent of all industrial groups, organizations, or agencies employing five to nine data processing programmers or technicians (group S-C) will be surveyed. Twenty-five per cent of all industrial groups, organizations, or agencies, employing one to four data processing programmers or technicians (group S-D) will be surveyed. The companies surveyed from each group listed above will be randomly selected. Some of these industrial groups, organizations, and agencies will be business and scientific applications so they can not be taken as separate samples. Seventy-five per cent or greater is necessary of one application to be classified as a type of application.

APPENDIX D

OKLAHOMA STATE BOARD FOR VOCATIONAL EDUCATION
J. B. Perky, Director   1515 West Sixth Avenue   Stillwater, Oklahoma

November 15, 1965

Dear Sir:

Technical education data processing programs are being developed in the State of Oklahoma for the training of programmers and systems analysts. To adequately develop these programs, the participation of professional personnel directing the operation of all types of data processing sections are essential. For this reason we are requesting your participation in the development of an occupational survey in the field of data processing for the State of Oklahoma.

This occupational survey is being conducted and supervised by the State Board for Vocational Education - Division of Technical Education, State Board of Education - Division of Statistical Services, and the U. S. Department of Health, Education and Welfare - Office of Education-Division of Vocational & Technical Education.

Our request for your participation consists of the enclosed questionnaire, on your present and anticipated needs and any additional comments or pertinent information that will assist in making this occupational survey more effective.

This information given by you is strictly confidential and will be handled as research data available only for analysis by our staff. No information on any specific company will be revealed in our analysis or final report. Please return the questionnaire to the Division of Technical Education, Oklahoma State Board for Vocational Education, 1515 West Sixth Avenue, Stillwater, Oklahoma, in the enclosed self-addressed envelope, for which no postage is needed; the form will remain there until destroyed.

Your cooperation is most urgently solicited and will be sincerely appreciated. May we take this opportunity to thank you for your time used in fulfilling our request.

We shall be happy to send you a copy of the final report upon its completion.

Enclosed please find a typical curriculum guide.

Arthur Lee Hardwick, State Supervisor
Technical Education

J. B. Perky, State Director
Vocational Education

APPENDIX E

NAME OF COMPANY____________________

NATURE OF BUSINESS OR INDUSTRY____________________

ADDRESS____________________

NAME OF PERSON COMPLETING QUESTIONNAIRE____________________

TITLE____________________

Please fill in the following blocks, showing your present and anticipated needs, capabilities and functions in the area of data processing.

| | PRESENT | | ANTICIPATED | | |
|---|---|---|---|---|---|
| | EMPLOYED | NEEDED | 66-67 | 68-69 | 70-71 |
| 1. Number of professional personnel currently used as programers and systems analysts who could be freed for other duties if trained technicians were available* | | X | | | |
| 2. Number of programers | | | | | |
| 3. Number of systems analysts | | | | | |
| 4. Per cent of programers & systems analysts that are scientific programers. | | | | | |
| 5. Per cent of programers & systems analysts that are commercial programers. | | | | | |
| 6. Number of employees in company. | | | | | |
| 7. Number of employees that you would assist in attending a night program (See enclosed curriculum guide). | | X | | | |

*See enclosed curriculum guide for description and information concerning data processing programers or technicians.

Please check the following blocks indicating your present and anticipated requirements for adequately trained programers and systems analysts.

Required (✓)   Preferred( X )   Not-Required( 0 )   Cannot Answer due to lack of knowledge of this aspect of the data processing system ( N )

| KNOWLEDGE REQUIRED | PRESENT | 66-67 | 68-69 | 70-71 |
|---|---|---|---|---|
| 8. Unit Record Equipment | | | | |
| 9. Assembler Language Programing | | | | |
| 10. Compiler Programing COBOL &/or FORTRAN | | | | |
| 11. Advanced Compiler Programing (Programing Language #1) | | | | |
| 12. Machine Language Programing (Operational System) | | | | |
| 13. 2nd Generation Central Processing Units | | | | |
| -OR- | | | | |
| 14. 3rd Generation Solid Logic Central Processing Units | | | | |
| 15. Random Access Concepts (Disk) | | | | |
| 16. Magnetic Tape Concepts | | | | |
| 17. Monitor Systems Concepts | | | | |
| 18. Tele-processing Techniques | | | | |
| 19. Process Control(Instrumentation) | | | | |
| 20. Numerical Control Equipment | | | | |

COMMENTS:________________________________________________

__________________________________________________________

__________________________________________________________

# APPENDIX F

## ORGANIZATIONS, LOCATIONS, RESOURCE PERSONS AND METHODS OF SAMPLING BY SIZE GROUPS

### SIZE GROUP A

#### ORGANIZATIONS SAMPLED BY QUESTIONNAIRE

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| American Airlines | Tulsa, Oklahoma | W. H. Rugeley |
| Cities Service Oil | Bartlesville, Okla. | John P. Steeper |
| Continental Oil Company | Ponca City, Oklahoma | W. M. McGee |
| North American Aviation | Tulsa, Oklahoma | Don Dollar |
| Pan American Petroleum | Tulsa, Oklahoma | Jim Kendall |
| Phillips Petroleum | Bartlesville, Okla. | M. L. Ussery |
| Sinclair Oil & Gas | Tulsa, Oklahoma | M. J. Verry |
| Skelly Oil Company | Tulsa, Oklahoma | Bill Stevens |
| Sunray DX Oil Co. | Tulsa, Oklahoma | Gordon Hillhouse |

#### ORGANIZATIONS SAMPLED BY INTERVIEWS

| | | |
|---|---|---|
| FAA | Oklahoma City, Okla. | J. H. Moody |
| General Electric Computing Center | Oklahoma City, Okla. | Joe Tracy |
| Tinker Air Force Base | Oklahoma City, Okla. | D. T. Klingman |

### SIZE GROUP B

#### ORGANIZATIONS SAMPLED BY QUESTIONNAIRE

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| Kerr-McGee Oil Company | Oklahoma City, Okla. | John Hawes |
| Service Pipe Line | Tulsa, Oklahoma | C.E. Poythress |
| Shell Oil Company | Tulsa, Oklahoma | Leo Rasinski |
| Skelly Oil Company | Tulsa, Oklahoma | Tom Lindal |
| Sohio Petroleum Company | Oklahoma City, Okla. | Sid Williams |
| Tuloma Gas Products | Tulsa, Oklahoma | Inston Cooper |
| U.S. Army Missile Center | Ft. Sill, Oklahoma | B. G. Graser |
| University of Oklahoma | Norman, Oklahoma | C. E. Maudlin |
| O.U. Medical Center | Oklahoma City, Okla. | Dr. E. N. Brandt |
| Warren Petroleum CP | Tulsa, Oklahoma | James Morris |

#### ORGANIZATIONS NOT INCLUDED IN SAMPLED

| | | |
|---|---|---|
| American Fidelity Assurance Company | Oklahoma City, Okla. | Jerry Hurst |
| Apco | Oklahoma City, Okla. | A. W. Green |

| | | |
|---|---|---|
| Atlas Life Insurance Co. | Tulsa, Oklahoma | Buddy Bryant |
| Western Electric Company | Oklahoma City, Okla. | F. A. Steele |

SIZE GROUP C

ORGANIZATIONS SAMPLED BY QUESTIONNAIRES

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| American General Life Insurance Company | Oklahoma City, Okla. | Bill Fuson |
| Computer Service Center | Tulsa, Oklahoma | Jerry Wiseley |
| First Nat'l Bank & Trust | Oklahoma City, Okla. | June Bushe |
| Globe Life Insurance Co. | Oklahoma City, Okla. | Maurice Cline |
| Halliburton Company | Duncan, Oklahoma | Ted Legg |
| Liberty Nat'l Bank & Trust | Oklahoma City, Okla. | B. Frank |
| National Bank of Tulsa | Tulsa, Oklahoma | Herb Nance |
| Oklahoma Publishing Co. | Oklahoma City, Okla. | Bill Williams |
| Oklahoma State University | Stillwater, Oklahoma | Dr. D. Grosvenor |
| Oklahoma Tax Commission | Oklahoma City, Okla. | Kenneth Moore |
| Seismograph Service | Tulsa, Oklahoma | Lloyd Core |
| Standard Life & Accident Insurance Co. | Oklahoma City, Okla. | Gentry Faulkner |
| Group Hospital Service | Tulsa, Oklahoma | Al Tomassi |
| U.S. Bureau of Mines | Bartlesville, Okla. | George Guthrie |

ORGANIZATIONS SAMPLED BY INTERVIEWS

| | | |
|---|---|---|
| Amerada Petroleum Co. | Tulsa, Oklahoma | Charles Roller |
| Oral Roberts Evangelistic Association | Tulsa, Oklahoma | George Stovall |

ORGANIZATIONS NOT INCLUDED IN SAMPLED

| | | |
|---|---|---|
| AVCO | Tulsa, Oklahoma | Jean Denniston |
| City National Bank | Oklahoma City, Okla. | Ed Kahoe |
| Douglass Aircraft | Tulsa, Oklahoma | Paul Christ |
| Dowell Division, Dow Chemical | Tulsa, Oklahoma | Clem Stivers |
| Dowell Research | Tulsa, Oklahoma | Tom Clark |
| Farm Bureau Mutual Ins. | Oklahoma City, Okla. | Jim Ditmars |
| First National Bank | Tulsa, Oklahoma | Jack Fenton |
| Champlin Petroleum Co. | Enid, Oklahoma | F. D. Peterson |
| Oklahoma Natural Gas Co. | Tulsa, Oklahoma | Francis McManus |
| Oklahoma State Budget | Oklahoma City, Okla. | Leon Autry |
| Public Service Company | Tulsa, Oklahoma | Jim Abernathy |
| Southwestern Bell Telephone Company | Tulsa, Oklahoma | Pat Eischen |
| Southwest Insurance Co. | Oklahoma City, Okla. | W. E. Biggs |
| W. C. Norris Manufacturing | Tulsa, Oklahoma | Jack Slack |
| Southwest Computer Service | Tulsa, Oklahoma | |

SIZE GROUP D

ORGANIZATIONS SAMPLED BY QUESTIONNAIRES

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| Aero Commander Division | Norman, Oklahoma | John Morehead |
| Altus Air Force Base | Altus, Oklahoma | C. B. Brightwell |
| Amax Petroleum Corp. | Tulsa, Oklahoma | Lloyd Parks |
| American Steel Pump | Tulsa, Oklahoma | J. E. Wise |
| Anderson Wholesale | Muskogee, Oklahoma | John Young |
| Bell Oil and Gas Co. | Tulsa, Oklahoma | Homer Scott |
| Boecking Berry Company | Oklahoma City, Okla. | John Davis |
| Braden Winch | Broken Arrow, Okla. | Darrel Long |
| Capitol Beverage Co. | Oklahoma City, Okla. | George Farha |
| Cities Service Gas | Oklahoma City, Okla. | Cliff McAlister |
| City of Oklahoma City | Oklahoma City, Okla. | Robert Byers |
| Commercial Finance Co. | Muskogee, Oklahoma | Harold Patterson |
| Commercial Nat'l Bank | Muskogee, Oklahoma | Bob Morehart |
| Corporation of Engineer | Tulsa, Oklahoma | Wayne Clark |
| Farmers and Merchants | Tulsa, Oklahoma | Jerry Lewis |
| Fidelity National Bank | Oklahoma City, Okla. | Harry Schnittger |
| First Southwest Corp. | Ardmore, Oklahoma | J. W. Grissom |
| Flint Steel Corporation | Oklahoma City, Okla. | Steve Sedita |
| Griffin Grocery | Muskogee, Oklahoma | John Priest |
| Gulf Oil Company | Oklahoma City, Okla. | Steve Garrity |
| Helmerich & Payne | Tulsa, Oklahoma | R. E. Chestnut |
| Home Federal Savings & Loan | Tulsa, Oklahoma | Ray Sanderson |
| Humpty Dumpty Market | Oklahoma City, Okla. | John Trelford |
| Jarboe Sales Company | Tulsa, Oklahoma | Dean Hedberg |
| Mid American Pipeline | Tulsa, Oklahoma | Jerome S. Wing |
| Mid Continental LIfe Insurance | Oklahoma City, Okla. | J. Green |
| Nelson Electric | Tulsa, Oklahoma | Ray Poiriez |
| Oklahoma Army Nat'l Guard | Oklahoma City, Okla. | Colonel Adler |
| Oklahoma City Board of Education | Oklahoma City, Okla. | Mr. Acers |
| Oklahoma Medical Research Foundation | Oklahoma City, Okla. | J. Milton Smith |
| Oklahoma Planning & Resources Board | Oklahoma City, Okla. | Bill Holt |
| Pure Milk Produce | Tulsa, Oklahoma | Tom Hampton |
| Republic Supply Co. | Oklahoma City, Okla. | George Wallis |
| Seampruff, Inc. | McAlester, Oklahoma | John Tallon |
| Scrivner Stevens Co. | Oklahoma City, Okla. | Chet Blackledge |
| T. G. & Y. | Oklahoma City, Okla. | E. Braun |
| United Founders | Oklahoma City, Okla. | Ed Cox |
| U. S. Navy Depot | McAlester, Oklahoma | M. F. McRee |
| University Fidelity Life Insurance Co. | Duncan, Oklahoma | D. Adkins |
| University Computing Co. | Oklahoma City, Okla. | David R. Edgar |
| University of Oklahoma Education Department | Norman, Oklahoma | C. M. Bridges |

| | | |
|---|---|---|
| Western Security Life Insurance | Oklahoma City, Okla. | Garth Byington |
| Western Supply Company | Tulsa, Oklahoma | C. D. Paine |
| Woods Industries | Oklahoma City, Okla. | Andy Anderson |
| Zebco Company | Tulsa, Oklahoma | Gene Howard |

## ORGANIZATIONS SAMPLED BY INTERVIEWS

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| Oklahoma Tire & Supply | Tulsa, Oklahoma | John Willis |
| Fleming Company | Oklahoma City, Okla. | John Mieluin, Jr. |
| Data Processing Associates | Tulsa, Oklahoma | Rollie Wright |
| Groendyke Transportation | Enid, Oklahoma | Glenn Wehrhan |
| Central State College | Edmond, Oklahoma | John P. Robertson |
| Champlin Petroleum Co. | Enid, Oklahoma | F. D. Peterson |
| Yeager Wholesale | Tulsa, Oklahoma | Jim Graham |

## ORGANIZATIONS NOT INCLUDED IN SAMPLED

| | | |
|---|---|---|
| Affiliated Foods | Tulsa, Oklahoma | Bob Schooley |
| Alcohol Beverage Control Bd. | Oklahoma City, Okla. | |
| All Brands Sales Co. | Oklahoma City, Okla. | Owen Johnson |
| Allis Chalmers Mfg. Co. | Oklahoma City, Okla. | |
| Americans Building | Oklahoma City, Okla. | David Bradshaw |
| American First Title and Trust | Oklahoma City, Okla. | Bill Outland |
| AMFO Division | Del City, Oklahoma | Don Cain |
| American Iron Works | Oklahoma City, Okla. | Everett Cole |
| Ardmore Data Processing | Ardmore, Oklahoma | Charlie Greenwood |
| Baptist Memorial Hospital | Oklahoma City, Okla. | Bob Walker |
| Bartlesville Board of Education | Bartlesville, Okla. | Earl Hammond |
| Bartlett Collins Co. | Sapulpa, Oklahoma | Lester Wright |
| Blackwell Zinc Co. | Blackwell, Oklahoma | Dan Coffelt |
| Blue Cross-Blue Shield | Tulsa, Oklahoma | |
| Born Engineering | Tulsa, Oklahoma | George Rose |
| Brookside State Bank | Tulsa, Oklahoma | Mike Brennan |
| Bryan and Sons | Tulsa, Oklahoma | Dick Bryan |
| Bunte Candies, Inc. | Oklahoma City, Okla. | Dick Taylor |
| Comanche County Hospital | Lawton, Oklahoma | Murphy Cole |
| Cameron Oil Company | Oklahoma City, Okla. | Dean Selby |
| Canadian Valley Electric | Seminole, Oklahoma | Pearl Coppedge |
| Central Liquor Company | Oklahoma City, Okla. | Earl Kendrick |
| Century Geophysical | Tulsa, Oklahoma | Joe Cole |
| Chevrolet Division - GM Corporation | Oklahoma City, Okla. | Dale Rutland |
| City of Ponca City | Ponca City, Oklahoma | Dee Walters |
| City National Bank | Tulsa, Oklahoma | Bob Kay |
| City of Stillwater | Stillwater, Okla. | Curtis Stotts |
| City of Tulsa | Tulsa, Oklahoma | John Spiegel |

ORGANIZATIONS NOT INCLUDED IN SAMPLED
(Continued)

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| Citizens National Bank | Muskogee, Oklahoma | Bob Karch |
| Commission of Land Dept. | Oklahoma City, Okla. | Bob Massey |
| Comp. Consulting Corp. | Norman, Oklahoma | Harold Gay |
| Crane Carrier Company | Tulsa, Oklahoma | Leslie Kovats |
| Dale Frederick | Oklahoma City, Okla. | |
| Data Processing Assoc. | Tulsa, Oklahoma | |
| Data Control Company | Tulsa, Oklahoma | Ed Henderson |
| Davis Field | Muskogee, Oklahoma | Roy Clement |
| Dept. of Public Safety | Oklahoma City, Okla. | Delbert Wilson |
| Department of Health | Oklahoma City, Okla. | Jerry King |
| Dept. of Public Works | Oklahoma City, Okla. | Oliver Pruitt |
| Doric Corporation | Oklahoma City, Okla. | Tom Lamb |
| Drill Equipment Mfg. Co. | Oklahoma City, Okla. | E. J. Maddox |
| Earlougher Engineering Co. | Tulsa, Oklahoma | R. C. Earlougher |
| Employees Retirement | Oklahoma City, Okla. | J. T. Langford |
| Engineering Computing Center | Stillwater, Oklahoma | P. S. McCollum |
| Famous Brands Liquor | Oklahoma City, Okla. | Tom Milam |
| Federal Credit Union | Bartlesville, Okla. | Vernon Reynolds |
| Federal Reserve Bank | Oklahoma City, Okla. | Bill Evans |
| Fibercase | Sand Springs, Okla. | Harold Hovis |
| First National Bank | Stillwater, Okla. | Lannie Kershaw |
| First National Bank | Elk City, Oklahoma | H. A. Carlson |
| Ford Motor Company | Oklahoma City, Okla. | Don McCloud |
| Frisco Railroad | Tulsa, Oklahoma | Lloyd Ables |
| General Motors Corp. | Oklahoma City, Okla. | Paul Smith |
| George E. Failing Co. | Enid, Oklahoma | Norvell Dailey |
| Gleason Romans Company | Tulsa, Oklahoma | Lou James |
| Goodwin Company | Oklahoma City, Okla. | W. S. Thornton |
| Hart Ind. Supply Co. | Oklahoma City, Okla. | Paul Gassoway |
| Hayes International | Midwest City, Okla. | Ed Helm |
| Helmeric & Payne | Tulsa, Oklahoma | |
| Hillcrest Medical Center | Tulsa, Oklahoma | Don Rogers |
| Home Federal Savings & Loan | Tulsa, Oklahoma | R.R.A. Eakin |
| Home Mortgage Investment | Oklahoma City, Okla. | Bert Hodges |
| Humble Oil & Refinery Co. | Tulsa, Oklahoma | W. C. Richardson |
| Industrial Fab Company | Tulsa, Oklahoma | Herre Danne |
| Inter State Library | Oklahoma City, Okla. | Nolan Newman |
| Jones & Laughlin | Tulsa, Oklahoma | Dick Lukehart |
| John E. Wolf Company | Oklahoma City, Okla. | Bill Crooks |
| John Roberts Mfg. Co. | Norman, Oklahoma | Joe Hogan |
| Kingwood Oil Company | Oklahoma City, Okla. | Bob Littlepage |
| Leeway Motor Freight | Oklahoma City, Okla. | |
| Loffland Brothers | Tulsa, Oklahoma | J. W. Perry |
| Macklanburg Duncan | Oklahoma City, Okla. | C. B. Chestnut |
| Marathon Oil Company | Tulsa, Oklahoma | Jim Parrish |
| Mercy Hospital | Oklahoma City, Okla. | Mary Rosalia |
| Metro Data Center | Tulsa, Oklahoma | A. C. Medin |
| Mid-Continental Casualty | Oklahoma City, Okla. | |

## ORGANIZATIONS NOT INCLUDED IN SAMPLED
(Continued)

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| Midwestern Life Insurance | Enid, Oklahoma | Bob Clift |
| Mustang Public Schools | Mustang, Oklahoma | Charles Holleyman |
| National Trailer Co. | Tulsa, Oklahoma | Gary Calbert |
| National Bank of Commerce | Tulsa, Oklahoma | Garland Hill |
| National Founders Life | Oklahoma City, Okla. | Bill Breageale |
| Nipah | Tulsa, Oklahoma | Kenneth Smith |
| North American Aviation | McAlester, Okla. | Bill Lowary |
| Northern Oklahoma College | Tonkawa, Oklahoma | Edwon Forsbery |
| Northeastern Oklahoma A&M | Miami, Oklahoma | Al Taylor |
| Northwest State University | Alva, Oklahoma | Mike Higgins |
| Okeene Public Schools | Okeene, Oklahoma | Stanley Dixon |
| Oklahoma City Clinic | Oklahoma City, Okla. | Tom Emel |
| Okla. Air National Guard | Oklahoma City, Okla. | Col. Frank Nosan |
| Oklahoma Baptist Conv. | Oklahoma City, Okla. | Bellzora Jones |
| Oklahoma Baptist Univ. | Shawnee, Oklahoma | Gene Lucas |
| Oklahoma Corp. Commission | Oklahoma City, Okla. | Al Blakey |
| Oklahoma Drug Sales | Lawton, Oklahoma | Walt Campbell |
| Oklahoma Employment Security Commission | Oklahoma City, Okla. | C. L. Gandy |
| O. G. & E. | Oklahoma City, Okla. | L. E. Babcock |
| Oklahoma Mortgage Co. | Oklahoma City, Okla. | J. J. Hohl |
| Oklahoma News Company | Tulsa, Oklahoma | Stanley White |
| Oklahoma State University | Okmulgee, Oklahoma | Daugh Howard |
| OSU Tech Institute | Oklahoma City, Okla. | Paul Bickford |
| Oklahoma State Tech | Okmulgee, Oklahoma | J. F. Taylor |
| Oklahoma Turnpike Authority | Oklahoma City, Okla. | Bob Logston |
| Olds Division GMC | Oklahoma City, Okla. | J. F. Wilson |
| Peoples State Bank | Tulsa, Oklahoma | Sam Turner |
| Petroleum Marketing Corp. | Tulsa, Oklahoma | LeRoy Newbrough |
| Pioneer Telephone | Kingfisher, Oklahoma | Charles Davis |
| Ponca City Savings | Ponca City, Okla. | Dick Pitts |
| Pontiac Division GMC | Oklahoma City, Okla. | R. D. McKinnon |
| Republic National Bank | Tulsa, Oklahoma | Joe Leonta |
| Reserve National Insurance | Oklahoma City, Okla. | John Gammell |
| Robberson Steel Company | Oklahoma City, Okla. | Dick Grutter |
| Saffa Beverage Company | Tulsa, Oklahoma | Bob Boyd |
| Samedan Oil Corp. | Ardmore, Oklahoma | H. Seeleger |
| Security National Bank | Duncan, Oklahoma | G. McFarland |
| Service Air Inc. | Enid, Oklahoma | Jerry Roberts |
| Security Bank | Ponca City, Okla. | Roger Shields |
| Shawnee Industries | Shawnee, Oklahoma | H. K. Staub |
| Southwest Distributor Co. | Lawton, Oklahoma | Jim McConahay |
| Southwest Parts Company | Oklahoma City, Okla. | M. Murphy |
| Southwest Power Adm. | Tulsa, Oklahoma | Jim Pendergrass |
| Stand Industries | Tulsa, Oklahoma | Bob Oliver |
| State Dept. of Education | Oklahoma City, Okla. | Bill Crutcher |
| State Insurance Finders | Oklahoma City, Okla. | Tom Stephens |
| State Board for Vocational Rehabilitation | Oklahoma City, Okla. | Dr. Vialle |

ORGANIZATIONS NOT INCLUDED IN SAMPLED
(Continued)

| COMPANY | LOCATION | RESOURCE PERSON |
|---|---|---|
| State Capitol Bank | Oklahoma City, Okla. | Leland Gourley |
| State Treasurer | Oklahoma City, Okla. | John Moreland |
| Surplus Property | Oklahoma City, Okla. | State Agency |
| Swan Sigler, Inc. | Oklahoma City, Okla. | David Hughes |
| T. D. Williamson, Inc. | Tulsa, Oklahoma | Burk Gilbreath |
| Texaco, Inc. | Tulsa, Oklahoma | J. W. Frick |
| The Dolese Company | Oklahoma City, Okla. | A. K. Harris |
| Thomas N. Berry Company | Stillwater, Okla. | Art Bergman |
| Thurston National Insurance | Tulsa, Oklahoma | Coy Steward |
| Tidewater Oil Company | Oklahoma City, Okla. | Walter Hart |
| Town and Country Insurance | Oklahoma City, Okla. | McClain |
| Tri State Insurance | Tulsa, Oklahoma | T. Weaver |
| Tulsa Purch Company | Oklahoma City, Okla. | Paul Holsinger |
| Tulsa City Tag Agent | Tulsa, Oklahoma | |
| Tulsair Distrib. Company | Tulsa, Oklahoma | George Clard |
| Union Nat'l Bank | Bartlesville, Oklahoma | Charles Lanham |
| United Beverage Company | Tulsa, Oklahoma | Charles Papen |
| United Beverage Company | Oklahoma City, Okla. | Ken Pickard |
| Union National Bank | Oklahoma City, Okla. | Bill Haney |
| Union Petroleum | Tulsa, Oklahoma | C. F. Barnett |
| U. S. Gypsum Co. | Southard, Oklahoma | R. N. Rector |
| U. S. Jaycees | Tulsa, Oklahoma | Jack Friedreck |
| U. S. Navy Depot | McAlester, Okla. | Harold Cloer |
| Unit Parts Company | Oklahoma City, Okla. | Eugene Martin |
| Unit Rig & Equipment | Oklahoma City, Okla. | D. L. Brown |
| University of Tulsa | Tulsa, Oklahoma | M. M. Hargrove |
| V. A. Hospital | Oklahoma City, Okla. | |
| Veterans Administration Regional Office | Muskogee, Oklahoma | William Freeman |
| Video Theaters | Oklahoma City, Okla. | Oran Rose |
| Warner Lewis Co. | Tulsa, Oklahoma | M. H. Rutter |
| Weather Bureau | Norman, Oklahoma | Mrs. Kathryn Gray |
| West & Mikesell | Clinton, Oklahoma | Don West |
| Whitten Whitten | Oklahoma City, Okla. | Joe Whitten |
| Williams Bros. Company | Tulsa, Oklahoma | Wayne Weese |
| Wilson Shipley Co. | Enid, Oklahoma | |
| WKY Television Systems Inc. | Oklahoma City, Okla. | Field Duskin |

VITA

**Arthur Lee Hardwick**

Candidate for the Degree of

Doctor of Education

Thesis: THE FEASIBILITY OF ESTABLISHING A PROGRAM TO TRAIN COMPUTER PROGRAMMERS UTILIZING A TIME-SHARING SYSTEM AND REMOTE DATA-COMMUNICATIONS TRANSMISSION TERMINALS

Major Field: Higher Education

Biographical:

Personal Data: Born in Wichita, Kansas, March 3, 1935, the son of Lee T. and Esther E. Hardwick.

Education: Attended grade school in Wichita, Kansas; graduated from Wichita High School East in 1954; received the Bachelor of Science degree from Kansas State Teachers College, at Pittsburg, with a major in Industrial Education, in August, 1958; received the Master of Science degree from Kansas State Teachers College, with a major in Industrial Education, in August, 1960; received the Education Specialist degree from Kansas State College, with a major in Industrial Education, in August, 1961; completed requirements for the Doctor of Education degree in May, 1967.

Professional experience: Industrial experience was gained at Boeing Aircraft Corporation, plant engineer and plant planner; McNally Manufacturing Company, engineering department. Educational experience was gained at Riverside, California Public Schools, drafting instructor; Cameron State College, head of drafting and design department and chairman of engineering department; Oklahoma State University Technical Institute, Oklahoma City Branch, head of drafting and design and director of Manpower Development Training; Oklahoma State Board for Vocational Education, Assistant State Supervisor of Technical Education, Oklahoma State Board for Vocational Education, State Supervisor of Technical Education; Oklahoma State Board for Vocational Education, Assistant State Coordinator of Area Vocational Education; United States Office of Education, Education Research and Program Specialist-Technical Education.