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SUMMER INSTITUTE TO TRAIN DATA PROCESSING TEACHERS FOR THE NEW OKLAHOMA STATE-WIDE COMPUTER SCIENCE SYSTEM, FINAL REPORT ON PHASE I.

BY- TUTTLE, FRANCIS

OKLAHOMA STATE BOARD OF VOCAT. EDUC., STILLWATER

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AN INSTITUE WAS HELD TO DEVELOP TECHNICALLY QUALIFIED TEACHERS FOR DATA PROCESSING TECHNOLOGY PROGRAMS. THIRTY-FIVE TEACHERS WERE TRAINED TO HELP ALLEVIATE A CRITICAL NEED FOR QUALIFIED COMPUTER SCIENCE TEACHERS AND AT THE SAME TIME PROVIDE STAFF MEMBERS FOR A NEW STATEWIDE, DATA-COMMUNICATIONS, COMPUTER PROCESSING TECHNICAL PROGRAM. RESULTS OF THE FIRST SUMMER SEMINAR SUBSTANTIATED THE INITIAL HYPOTHESES THAT (1) QUALITY TEACHERS IN TELECOMMUNICATIONS DATA PROCESSING CAN BE TRAINED IN 2 WEEKS PROVIDING THEY HAVE AN ADEQUATE BACKGROUND, (2) CRITERIA CAN BE ESTABLISHED FOR SELECTION OF TEACHERS TO BE TRAINED TO TEACH DATA PROCESSING TECHNOLOGY IN POST-HIGH SCHOOL PROGRAMS, AND (3) PROSPECTIVE DATA PROCESSING TEACHERS CAN DEVELOP AN UNDERSTANDING OF THE ROLE OF TECHNICIANS IN AN AUTOMATED, INDUSTRIALIZED SOCIETY. MORE CONCLUSIVE RESEARCH FACTS WERE EXPECTED TO BE OBTAINED FROM THE SECOND SUMMER INSTITUTE. THE APPENDIXES INCLUDED A BIBLIOGRAPHY. A DATA COMMUNICATIONS GLOSSARY, AND A RESEARCH QUESTIONNAIRE FORM. (AL)

FINAL REPORT

ON

PHASE I

OF

SUMMER INSTITUTE TO TRAIN DATA PROCESSING
TEACHERS FOR THE NEW OKLAHOMA STATE-WIDE COMPUTER SCIENCE SYSTEM

BY

Dr. Francis Tuttle, State Coordinator
Area Vocational-Technical Education
and
Project Director

Office of Education Grant Number OEG 4-6-062040-0718
The Vocational Education Act of 1963, P.L. 88-210, Section 4(C)

Grantee Institute: Oklahoma State Board for Vocational Education, Division of Technical Education

Report Date: September 1, 1966

ED010666

The Project Reported Herein was
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U. S. Department of Health, Education, and Welfare
Office of Education
Bureau of Research
Division of Adult and Vocational Research

SUMMARY OF PROJECT

Grant Number: OEG 4-6-062040-0718

Title: Summer Institute to Train Data Processing Teachers for the New Oklahoma State-Wide Computer Science System

Investigator: Dr. Francis Tuttle, State Coordinator
Area Vocational-Technical Education

Institution or Agency: Cooperation function between

Oklahoma State Board for Vocational Education
Division of Technical Education

and

Oklahoma State University

Duration: May 1, 1966, through September 15, 1966

Purpose or Objectives: The basic purpose of the institute was to develop technically qualified teachers for data processing technology programs for both in-state and out of state. Whereas Oklahoma has established a state-wide data-communications computer processing technical program, there is an extreme need for qualified teachers.

The complex features of this system will necessitate the use of highly trained instructional personnel. Personnel who are qualified to teach in Data Processing Technology programs are very rare and their recruitment is most difficult. Technical education programs of this nature, designed for the education and preparation of computer programing and systems analyst technicians, require instructors who possess the characteristics of a good teacher as well as a solid background in computer operation and programing and analysis techniques.

Not only is there an acute need for qualified computer science teachers in Oklahoma but also throughout the nation. Therefore, this institute trained twenty (20) in-state and fifteen (15) out-of-state teachers to help alleviate this shortage while at the same time provide staff for the new Oklahoma State-Wide System.

This state-wide computer science system will allow local schools to offer an extremely high level program at a reasonable cost. Even though the local schools computing facility will be basically a terminal computing facility its capabilities will be greatly expanded due to the backup of data-communications through the data center. The local school will be somewhat limited by the background of their instructional staff; however, the data center will provide a complete library facility of varieties and types of programs in all phases of industrial production and business applications. It will also provide support personnel of an extremely high industrial and professional background to the local school. The data center will be capable of sending information to the local school within seconds once a request is received from the local school. The local schools will also have an advantage of utilizing the data center for instruction as many times per week as can be scheduled. It is planned that many of these schools will have the capabilities to transport students two or three times per month into the Oklahoma City area to utilize the data center facilities. This will provide instruction on an extremely large and complex computing facility. It will also show each student how data-communications actually operates and what function the data center will play in the total data-communication network. The local schools data-communications computer facilities will only be one aspect of the total data-communications system and the students' knowledge of the operating system in the data center and actual hands on experience in the data center will provide knowledge and experiences that will be of great value once the student enters the field of data processing. The data center will also provide for the students instruction in the specialized programing languages such as FORTRAN, COBOL, and other new programing languages as developed. Individual schools would not have the capabilities of teaching these languages without the data center. The COBOL (Business) and FORTRAN (Scientific) languages will be a necessity in the training of programers to fill positions in the present field of data processing.

The state-wide computer science system can accommodate 12 to 16 data processing technology programs in colleges, universities, technical institutes, and area schools throughout the State of Oklahoma. Each school will be provided with a remote data-communications computer with combination printing, reading, punching, data-communications and computing capabilities. This equipment will operate on-line as a data-communications terminal with the same computing capabilities as the large data center computing system. The local school will also have printing, reading, punching, processing and computing capabilities off-line but to a limited degree.

This system will use half-duplex voice grade private lines to connect the local schools data processing equipment to the data center in Oklahoma City. The data center computer will have an ultra-high speed processing unit with approximately 65,000 units of data storage, decimal arithmetic, floating point arithmetic, storage protection, console typewriter, and selector channel. This computing system will also have mass random access storage, magnetic types, data adapter units, data-communications receiving terminals, optical scanning and auxiliary supporting unit record equipment.

This system will allow each school to schedule on-line computer time of not less than five hours per day (class time 7 a.m. to 10 p.m.). Additional time for processing can be secured from 10 p.m. to 7 a.m. The system will monitor each school to determine if the schools scheduled to use the equipment are using it. Any additional time will be rescheduled for use by the schools needing it. The type of computer science system described herein which is being established in Oklahoma will eliminate the need for duplicating high cost equipment for each local school and will allow each school greater computing capabilities through direct access to the data center. This system will minimize obsolescence because the local school's program will always be as up-to-date as the data center's computing system which will be continually updated. The schools will therefore have the facilities to provide for the student's instruction on the latest and most effective equipment available at an extremely reasonable cost.

ADDITIONAL OBJECTIVES: Project objectives in addition to training teachers for a complex system included an attempt:

(1) To establish criteria for measuring an individual's aptitude, interests, and ability for teaching Data Processing Technology in post-high school technical education programs.

(2) To establish and define specific requirements for the admission of applicants to a teacher training institute to prepare teachers for post-high school technical education programs designed for the education and preparation of computer programing and systems analyst technicians.

(3) To conduct summer institute for the preparation of post-high school Data Processing Technology teachers. Twenty of these teachers will be selected from Oklahoma to staff the Oklahoma state-wide computer science system, and fifteen of the teachers will be selected from other states to staff local programs in their states.

(4) To develop, among prospective Data Processing teachers, a practical philosophy of Technical Education and an understanding of the technician's role in an automated and industrialized society.

PROCEDURES:

(1) The project director contacted personnel in both industry and education, who have exhibited leadership in the area of Data Processing education and testing and guidance services, to seek their advice and guidance for developing criteria to determine an individual's aptitude, interests, and abilities for becoming a data processing teacher.

(2) The project director consulted individuals who have shown leadership and knowledge in Data Processing education for developing and defining admission requirements for individuals to be selected for the teacher training institutes.

(3) The project director worked with the coordinator of the Data Center and with the instructional staff employed to conduct the institute to develop instructional material for the teacher training institute.

(4) (a) The first session teacher training institute was conducted to prepare teachers to teach in the Data Processing Technology Programs throughout the state. The institute was conducted on the Oklahoma State University campus with field and laboratory trips to Oklahoma City and Tulsa. This first summer session included basic computer concepts, unit record equipment, basic computer programing, and an introduction to programing systems. The second summer session will be conducted during the summer of 1967 and will be a continuation of the first session. It will cover such areas as advanced programing systems, basic and advanced scientific programing, and systems design and development. A proposal for the 1967 summer session will be submitted at the appropriate time.

(b) The teacher participants in the summer institutes were paid a travel allowance and subsistence stipend for the duration of the institute (not to exceed the maximum travel or subsistence allowance as described by the laws of the State of Oklahoma).

(c) The participants were allowed up to nine semester hours of graduate credit for the summer institute. Participants were permitted to enroll in the institute for college credit or non-credit. Participants who desired to apply for college credit were required to pay, to the university, the regular tuition charge for the nine credit hours.

(d) University housing was made available for the teacher participants; however, they were required to pay the regular rental rates in effect at the time of the institute. A bus will be provided to transport the participants to the Data Center in Oklahoma City for the portion of the institute which deals directly with the large central computer during the second summer session.

(e) The project director was employed by the State Board for Vocational Education. The salary for the project director was paid from State funds.

(f) The data center coordinator and other data center personnel were employed by the State Board for Vocational Education and were paid from their budget.

(g) Instructors for mathematics, accounting, statistics, and the systems analyst and programer were secured and the pro rata portion of time devoted to this program was paid for from 4(C) funds.

(h) Consultants were secured as needed for specialized activities at no cost to the project.

(i) Two lab assistants and two key punch operators were employed part time as needed at the data center and were paid under the proposal.

(j) One full-time secretary was employed for the period of the proposal to handle all clerical activities needed for the project.

(5) Instructors employed to teach in the institute were selected according to their background and knowledge of technical education. Instructors had a thorough knowledge of technical education programs, needs, and objectives so that, in teaching the summer institute, they developed, in the teacher participants, a practical philosophy of technical education and an understanding of the technician's role in industry and society.

(6) The project director, in cooperation with the Data Center education coordinator instructor, developed, prior to and during the institute, teaching materials used by the Data Processing teachers in their various programs in the local schools during the regular school year.

Appendix B provides a detailed outline of the curriculum used in the institute.

RESULTS AND CONCLUSIONS: For the first summer institute the results were very rewarding although incomplete because of being only the first of two summer sessions. All objectives should become a reality with the completing of the second summer institute.

Individuals participating in the institute were greatly enthused as to the far-reaching possibilities regarding such a program. The students (teacher trainees) worked and studied most diligently on an average of twelve (12) to eighteen (18) hours per day. They were most eager to begin teaching and putting to practice that knowledge and experience which they had received from the institute. The writer and others connected with the institute have had experiences in other similar institutes and the overall outcome of this institute seemed to be superb. Whereas the basic objective of the research project was to prepare teachers for a post-high technical education program designed for the education and preparation of data processing programers and systems analysts; the objective was a fundamental phase of a total feasibility study for the development of a state-wide computer science system in Oklahoma. The teacher education program provided by this research project was the first of two summer institutes to develop twenty teachers for the Oklahoma system and fifteen teachers for out-of-state data processing programs.

The teacher education phase one and phase two are the foundations on which the total state-wide system is being built; however, before this foundation could be developed certain criteria and specialized training requirements had to be identified. Once these criteria and specialized training requirements had been identified, the data processing curriculum to be taught in the schools could be properly designed and this curriculum design was then developed into the teacher education program phase one (first summer); and additional research is being conducted and data are being evaluated for phase two (second summer).

The criteria and training requirements were identified by an industrial data processing survey in Oklahoma and a feasibility study entitled "To Determine the Feasibility of Establishing a Program to Train Computer Programers Utilizing a Time-Sharing System and Remote Data-Communications Transmission Terminal."

The final draft of this feasibility study has not been completed; however, a preliminary draft is included in Appendix F of this report. A final draft will be forwarded as soon as the necessary evaluation of data has been completed for phase two (second summer) of the teacher education program.

Although conclusions regarding results cannot be recorded until the conclusion of the second summer session to be held next summer (1967); some facts seem conclusive:

(1) that quality teachers in tele-communications data processing can be trained within two (2) ten week summer sessions, providing they have a sufficient background in teaching mathematics, science, commerce, etc. or equivalent professional experience:

(2) that criteria can be established for measuring an individual's aptitude, interests, and ability for teaching Data Processing Technology in post-high school technical education programs;

(3) that specific requirements can be established and defined for the admission of applicants to a teacher training institute to prepare teachers for post-high school technical education programs designed for the education and preparation of computer programing and systems analysts technicians;

(4) that a practical philosophy of Technical Education and an understanding of the technician's role in an automated and industrialized society can be developed among prospective Data Processing teachers.

The results of the first summer institute, thus far, substantiate these hypotheses. Therefore, it is assumed that the second summer institute will result in more conclusive research facts which will result in standards and guides in not only selecting and training data processing teachers, but also in the selecting and teaching of students in data processing.

Such information can be very valuable throughout the nation and can result in a more effective way of training data processing technologists as well as more effective means of selecting and training teachers of Technical Data Processing Programs and especially those involved in data communications data processing.

APPENDICES

TO FINAL REPORT FOR

PROJECT NUMBER: 6-2040

Summer Institute to Train Data Processing Teachers for the New Oklahoma State-Wide Computer Science System

APPENDIX A

TIME AND EFFORT REPORT

for

Project Number: 6-2040

Summer Institute to Train Data Processing Teachers

for the

New Oklahoma Statewide Computer Science System

Grant No. OES-4-6-062040-0718
Project No. 6-2040

Time and Effort Report

The following report constitutes an estimate of the percentage of full-time effort rendered by each of the professional staff in fulfilling the conditions of the agreement between Oklahoma State Board for Vocational Education, Division of Technical Education and Oklahoma State University.

		May	June	July	August	Sept.
1.	Associate Project Director in Charge of Instruction					
	D. D. Grosvenor	75	50	50	25	0
2.	Instructor (Systems Analyst and Program coordinator)					
	D. S. Eaton	50	100	100	0	0
	J. M. Walden	15	10	25	0	0
3.	Programming Instructor					
	E. L. Butler	25	75	75	0	0
4.	Instructor (Mathematics)					
	D. W. McCown	0	50	50	0	0
5.	Instructor (Accounting)					
	E. H. Haworth	0	50	50	0	0
6.	Instructor (Statistics)					
	S. M. Trail	0	50	50	0	0
7.	Laboratory Assistants					
	D. J. Mickish	0	100	100	25	0
	G. L. Lance	0	60	60	0	0

APPENDIX B

CURRICULUM ORGANIZATION

for

Project Number: 6-2040

SUMMER INSTITUTE TO TRAIN DATA PROCESSING TEACHERS

FOR THE

NEW OKLAHOMA STATE-WIDE COMPUTER SCIENCE SYSTEM

Organization of Curriculum

The duration of the Institute was ten weeks. This was two weeks longer than the scheduled OSU summer term. The participants were on-campus for both the week preceding and following the regular summer term. The first week, in addition to registration and orientation, was spent in getting a thorough overview of the FORTRAN compiler language.

During the first week, the students were given a tape-slide presentation of the entire FORTRAN language. This was followed by a three-day lecture presentation of the same material. During this time, sample problems were written by the participants with attempts (usually successful) to debug them on the computer.

During the eight weeks which were concurrent with the regular OSU summer term, the following schedule of lectures and laboratories were observed:

7:30-8:20	IC2-Assembly Language (Lecture)
8:30-10:20	ID2-Data Processing Mathematics IB2-Data Processing Accounting The student enrolled in either Mathematics or Accounting. In general, he chose the course in which he was least prepared by prior training. The two-hour session was a combined lecture and supervised study period.
10:30-11:20	IA3-Compiler Language (Lecture 1)
11:30-12:00	Laboratory assistants available for diagnostic consulting
1:00-1:50	IA2-Statistics (Lecture)
2:00-2:30	Laboratory assistants available for diagnostic consulting
2:30-3:20	IA3-Compiler Language (Lecture 2)
3:30-6:20	Laboratory assistants available for diagnostic consulting.

A description of the courses is attached. This also includes the texts which were used. Of the eight weeks in the compiler language course, three were spent on FORTRAN and five were spent on COBOL.

The final week (August 1 - August 5) was originally scheduled for group programming projects and special lectures and tours. However, during the summer the final decision was made relative to the equipment which would be installed for use in the Oklahoma State-Wide Computer Science System. This made it possible and appropriate to spend the week specializing some of the general training of the Institute to apply to the particular computer configuration (RCA) with which the majority of the participants would be working. This phase of the training was done by representatives of the manufacturer (gratis).

Some of the participants were quite certain that they would not be working with this particular equipment immediately and did have some immediate needs for additional preparation for data processing responsibilities they were assuming in September. Hence, during the final week (after the introductory presentations were made by RCA) an alternate program in unit record equipment was provided on a volunteer basis.

COURSE DESCRIPTION - IC2 - ASSEMBLY LANGUAGE

I. Basic Concepts
   a. The language
   b. The central processor

II. Organization of the Data Processing System
   a. Components
   b. Instruction format
   c. Storage organization
   d. Data formats
   e. Instruction and data flow

III. Instructions: Card system
   a. Card system input-output instructions
   b. Data movement instructions
   c. Arithmetic
   d. Branching
   e. Logic instructions
   f. Miscellaneous codes

IV. Loops and Indexing
   a. Steps in programming a loop
   b. Index register
   c. Various types of loops
   d. Indirect addressing
   e. Key instruction method for loops

V. Subroutines and Functions
   a. Use of Subroutines and Functions
   b. Calling sequences
   c. Entries and exits

VI. Types of programs
   a. Mathematical
   b. Statistical
   c. sorting

Texts: IBM 7040/7044 Operating System, Macro Assembly Program (MAP) Language, C-28-6335

IBM 7040 and 7044 Data Processing Systems, Student Text, C-22-6732

Total lecture hours - 50

COURSE DESCRIPTION - ID2 - DATA PROCESSING MATH

Math ID2 is a course designed to attempt to provide some basic mathematical principles to those students who are not mathematically oriented, either through aptitude or training.

Topics covered in the course are:

1. Some elementary ideas
2. Logic
3. Qualification and Quantification
4. Some Properties of Numbers
5. Equations, Relations, Functions
6. Linear Equations
7. The Algebra or Vectors and Matrices
8. Introduction to Linear Programming

Texts: Fowler and Sandberg, Basic Mathematics for Administration, John Wiley and Sons

Total lecture hours - 33

COURSE DESCRIPTION - IB2 - DATA PROCESS ACCOUNTING

This course comprises the basic theory of debit and credit applied formally through use of the various journals, ledgers and working papers; the concepts of adjustments of deferred and accrued amounts; preparation of financial statements for both trading and manufacturing concerns and their interpretation for use by management; basic theory and application of principles involved in Job and Process Manufacturing accounting; Budgeting and Valuation concepts.

This is the same text as is being used for Accounting 353.

Text: Accounting: Basic Financial, Cost and Control Concepts
By Anderson, Moyer and Wyatt. John Wiley and Sons. 1966.

Total lecture hours - 33

COURSE DESCRIPTION - IA2 - STATISTICS

An introduction to basic concepts and techniques of Statistical Inference; including probability, random variables, and probability distributions. Particular attention is given to the binomial, normal and t-distributions and to their application in problems of estimation and hypothesis testing.

Text: Elements of Statistical Inference, D. V. Huntsberger, Allyn and Bacon, 1961.

Total lecture hours - 33

COURSE DESCRIPTION - IA3 - COMPILER LANGUAGE

The Compiler languages FORTRAN IV and COBOL-61 were covered specifically for the IBM 7040.

These languages were presented relative to hardware, compiler techniques and assembly languages. Emphasis was on actual laboratory work with 10 problems programmed and run on the IBM 7040. Several sessions were spent discussing the IBM 1620 and the RCA 301.

TEXTS INCLUDE:

Anderson, Decima M., Computer Programming Fortran IV, Meredith Publishing Company, New York, New York, 1966.

McCracken, Daniel D., A Guide to Cobol Programming, Wiley & Sons, New York, 1963.

F28-8053-2 IBM Reference Manual, COBOL GENERAL INFORMATION.

C28-6336-2 IBM Reference Manual, COBOL LANGUAGE, 7040/7044 Operating System.

C28-6329-3 IBM Reference Manual, FORTRAN IV Language, 7040/7044 Operating System.

TOTAL lecture hours - 72

APPENDIX C

GRADES OF PARTICIPANTS

for

Project Number: 6-2040

STUDENTS ENROLLED IN THE
OKLAHOMA STATE-WIDE COMPUTER SCIENCE
SYSTEM

NAME	CLASS	GRADE
	In-State (Oklahoma) Participants	
Antwine, Donna	Assembly Languages	C
	Compiler Language Program	A
	Data Processing Accounting	A
	Statistics	B
Arthur, Larry	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Accounting	A
Bankhead, Jack	Assembly Languages	B
	Compiler Language Program	C
	Data Processing Math	B
	Statistics	C
Boydstun, Milton	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Math	A
	Statistics	B
Cruce, Bob	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Accounting	B
	Statistics	B
Denley, William	Assembly Languages	C
	Compiler Language Program	C
	Data Processing Math	B
	Statistics	C
Eckles, Jesse	Assembly Languages	D
	Compiler Language Program	B
	Data Processing Math	B
	Statistics	I
Eskew, Walter	Assembly Languages	I
	Compiler Language	A
		A
	Statistics	A

NAME	CLASS	GRADE
Fuller, Paul	Assembly Languages	B
	Compiler Language Program	A
	Data Processing Math	A
	Statistics	C
Garrett, Woodfin	Assembly Languages	B
	Compiler Language Program	A
	Data Processing Accounting	B
	Statistics	B
Gibson, Gary	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Math	A
	Statistics	B
Harris, James	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Accounting	A
	Statistics	A
Harris, Jerry	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Accounting	B
	Statistics	A
Heberlein, Al	Assembly Languages	B
	Compiler Language Program	A
	Data Processing Accounting	A
	Statistics	A
Hicks, Dorothy	Assembly Languages	C
	Compiler Language Program	C
	Data Processing Accounting	A
	Statistics	C
Higdon, James	Assembly Languages	D
	Compiler Language Program	C
	Data Processing Math	D
	Statistics	F
Hill, Bill	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Accounting	B
	Statistics	B
Hill, Kearney	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Math	B
	Statistics	B
Howard, Daugh	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Math	A
	Statistics	B

NAME	CLASS	GRADE
Kimbro, Julius	Assembly Languages	B
	Compiler Language Program	B
Kinzer, Joe	Assembly Languages	B
	Compiler Language Program	B
	Data Processing Math	B
	Statistics	B
Kite, Robert	Assembly Languages	C
	Compiler Language Program	B
	Data Processing Math	B
	Statistics	C
Klindt, Melvin	Assembly Languages	A
	Compiler Language Program	A
Knodel, Alvin	Withdrew	
Kohlman, Harold	Assembly Languages	C
	Compiler Language Program	C
	Data Processing Math	B
	Statistics	C
Krehbiel, Anthony	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Accounting	B
	Statistics	A
Newberry, Earl	Assembly Languages	B
	Compiler Language Program	B
	Data Processing Accounting	B
	Statistics	B
Palumbo, M. Gordon	Assembly Language	C
	Compiler Language Program	B
	Data Processing Math	B
	Statistics	B
Phelps, Kenneth	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Math	A
	Statistics	A
Pryor, John	Assembly Languages	B
	Compiler Language Program	C
	Data Processing Math	A
	Statistics	B

NAME	CLASS	GRADE
Pollock, Guy W.	Assembly Languages	A
	Compiler Language Program	A
	Data Processing Math	A
	Statistics	B
Smith, Virgil	Assembly Languages	C
	Compiler Language Program	B
	Data Processing Accounting	A
	Statistics	A
Spradley, Terry	Assembly Languages	B
	Compiler Language Program	A
	Data Processing Accounting	B
	Statistics	B
Strickland, Elinor	Assembly Languages	B
	Compiler Language Program	B
	Data Processing Accounting	A
	Statistics	C
Swyden, Bob	Assembly Languages	B
	Compiler Language Program	B
	Data Processing Math	A
	Statistics	B

APPENDIX D

EXPENDITURES

for

Project Number: 6-2040

EXPENDITURES FOR PROJECT NUMBER: 6-2040

Item	Expenditures	Total
A. Personnel		
1. Associate Project Director in Charge of Instruction, ½ time @ $1,200/month for 4 months	$ 2,400.00	
2. Instructor (systems analysts and program coordinator) full time @ $1,200/month for 2½ mo.	1,950.00	
3. Programing Instructor, full-time @ $1,000/month for 2½ mo.	1,500.00	
4. Instructor (Mathematics) ½ time @ $1,000/month for 2 months	1,000.00	
5. Instructor (Accounting) ½ time @ $1,000/month for 2 months	1,000.00	
6. Instructor (Statistics) ½ time @ $1,000/month for 2 months	1,000.00	
7. Lab Assistants - 1 @ $550/month-full time for 2 mo. 1 @ $550/mo. ½ time for 2 mo.	1,650.00	
8. Key Punch Operator-200 hrs @ $1.30/hr.	260.00	
9. Clerical & Secretarial Assistance --1 secretary @ $300/month for 3 months	900.00	
TOTAL PERSONNEL COSTS		$11,660.00
B. OASI and Insurance for employees (6% of salary and wages)		699.60
C. Supervision, Administration and Use of Facilities		2,471.92
D. Supplies and Materials		383.51

Item	Expenditures	Total
E. Services		
1. Rental of computer	$ 3,760.00	
Key Punch Machines - 2 @ $48/month for two months	192.00	
2. Transportation -Field trip for students	164.05	
TOTAL SERVICES		$ 4,116.05
F. Per Diem & Teacher Travel		
1. Per diem for teacher participants	22,555.00	
2. Teacher participants travel	1,141.15	
TOTAL PER DIEM AND TRAVEL		23,696.15
TOTAL PROJECT EXPENDITURES		$43,027.33

NOTE: The above figures are unofficial pending audit of the project expenditures.

APPENDIX E

Suggested Curriculum in
Electronic Data Processing for
The Oklahoma State-Wide Computer Science System*

*This suggested curriculum was developed as a result of the research material entered in Appendix F and is a result of consultation and experiences connected with this project.

SUGGESTED CURRICULUM

IN

ELECTRONIC DATA PROCESSING

OKLAHOMA STATE-WIDE COMPUTER SCIENCE SYSTEM

STATE BOARD FOR VOCATIONAL EDUCATION

DIVISION OF TECHNICAL EDUCATION

ELECTRONIC DATA PROCESSING

Suggested Curriculum

Curriculum outline, by semester	Hours per week			
	Class	Lab	Study	Total
	FIRST YEAR			
FIRST SEMESTER				
Accounting I	4	0	8	12
Data Processing Mathematics I	3	0	6	9
Communication Skills I	3	0	6	9
Electric Accounting Machines	3	5	6	14
Introduction to Business Data Processing	2	1	5	8
Total	15	6	31	52
SECOND SEMESTER				
Accounting II	4	0	8	12
Data Processing Mathematics II	4	0	8	12
Technical Writing	3	0	6	9
Computer Programming I	3	4	6	13
Data Processing Applications	2	1	4	7
Total	16	5	32	53
	SECOND YEAR			
FIRST SEMESTER				
Cost Accounting	3	0	6	9
Statistics	4	0	8	12
Computer Programming II	3	5	6	14
Business Organization	2	0	4	6
FORTRAN Programming	3	5	6	14
Total	15	10	30	55
SECOND SEMESTER				
Systems Design and Development	3	2	6	11
Programming Systems	4	4	8	16
COBOL Programming	3	5	6	14
Data Processing Field Project	1	3	6	10
Total	11	14	26	51

FIRST YEAR, FIRST SEMESTER

Accounting I

1. Assets, Liabilities, and Owners' Equity
2. Basic Accounting Procedures
3. Changes in Owners' Equity. Closing the Books
4. Adjustments for Accrued Revenue and Expense. Working Papers
5. Adjustments for Revenue and Cost Apportionments. Working Papers (Continued)
6. Merchandise Operations
7. Statement and Ledger Organization
8. Useful Accounting Techniques
9. Forms of Business Organization
10. Forms of Business Organization (Concluded)
11. Cash and Investments
12. Receivables
13. Inventory Accounting
14. Fixed Assets
15. Liabilities

Recommended Text:
Principles of Accounting (Introductory) - Finney & Miller - Prentice - Hall

Data Processing Mathematics I

1. The Concepts of Notation
2. Basic Algebra
3. The Number Systems
4. Representation of a Number With an Arbitrary Base
5. Fixed and Floating Point Numbers
6. Precision and Significance
7. Linear Equations

Recommended Text:
Any Appropriate Text

Communication Skills I

1. Dynamics of Communication
2. Qualities of Communication
3. Functions of Communication
4. Methods of Communication
5. The Report Form
6. Written Expression

Recommended Text:
Any Appropriate Text

Electric Accounting Machines

1. Card Punches and Verifiers
2. Sorting Machines
3. Accounting Machines
4. Peripheral Machines (Reproducer, Interpreter, Collator)

Recommended Text:
Data Processing - Hartkemeier - Wiley
Alternate:
IBM Machine Operation and Wiring - Salmon - Wadsworth

Introduction to Business Data Processing

1. The Development of Aids to Manpower
2. The Development of the "Thinking Machine"
3. History of Data Processing
4. Business and Scientific Data Processing
5. The Data Processing Cycle
6. Case Illustration - Payroll
7. The Punched Card
8. Input Preparation and Entry
9. Classifying Recorded Data
10. The Calculating Function and Preparation of Reports

11. The Electronic Computer - Its Elements and Capabilities
12. Coded-Data Representation
13. The Arithmetic and Control Units
14. Input-Output - Cards, Paper Tape, and Printers
15. Input-Output - Magnetic Tapes and Direct-Access Devices
16. Input-Output - Miscellaneous Devices
17. The Programming Cycle
18. Control and the Stored Program
19. Program Preparation - Flow Charts and Decision Tables
20. Systems Analysis and Procedure
21. Basic Processing Methods - Sequential (Batch) Processing with Magnetic Tapes
22. Basic Processing Methods - On-Line Processing
23. File Organization Techniques
24. Payroll - A Computer Approach
25. Career Opportunities and Management's Role

Recommended Text:
Automatic Data Processing - Elias N. Awad - Prentice Hall
Alternate:
Principles of Data Processing with Computer - Van Ness - Business Press

FIRST YEAR, SECOND SEMESTER

Accounting II

1. Accounting Principles
2. Manufacturing Operations
3. Cost Accounting
4. Cost Data and Management Needs
5. The Analysis of Financial Data
6. Price-Level Changes and Supplementary Statements
7. The Statement of Sources and Uses of Working Capital
8. Cash-Flow Statements and Cash Forecasting
9. Departmental and Branch Operations
10. Consolidated Statements
11. Budgeting and Profit Planning
12. Accounting Aids to Management
13. Importance of Income Tax Considerations

Recommended Text:
Principles of Accounting (Introductory) - Finney & Miller - Prentice - Hall

Data Processing Mathematics II

1. Concept of an Iterative Process
2. Solution of Simultaneous Linear Equations
3. Logic
4. Boolean Algebra
5. Applications of Numerical Solutions to Physical Problems
6. Classification of Errors in the Numerical Solutions of a Problem

Recommended Text:
Any Appropriate Text

Technical Writing

1. Reporting
2. Technical Report Writing
3. Research Paper
4. Group Communication

Recommended Text:
Any Appropriate Text

Computer Programming I

1. The Binary System
2. Organization of the Data Processing System
3. Man-Machine Communications
4. Instructions: Card System
5. Methods of Program Debugging
6. Housekeeping Techniques
7. Loops and Indexing
8. Subroutines

Recommended Text:
The Binary System - Glaser - Continental Press
Automatic Data Processing Systems - Gregory & Van Horn - Wadsworth
301 Programmers Reference Manual - RCA
301 Assembly System - RCA

Data Processing Applications

1. Accounts Receivable
2. Accounts Payable
3. Payroll
4. Inventory Control

Recommended Text:
Manufacturers Manuals

SECOND YEAR, FIRST SEMESTER

Cost Accounting

1. Introduction to Cost Accounting
2. Accounting for Materials
3. Accounting for Labor
4. Factory Overhead Expenses
5. Application of Principles: Job Cost System
6. Process Cost Accounting
7. Process Cost Accounting: Continued
8. Standard Cost Accounting
9. Other Cost Procedures and Factors

Recommended Text:
Principles of Cost Accounting - Chace, Schmiedicke, Sherwood - Southwestern

Statistics

1. The Field of Statistics
2. Elementary Number Usage Techniques
3. Probability
4. Principles of Sampling
5. Sampling Methods in Auditing
6. Bivariate Data and Regression Analysis
7. Correlation and the Analysis of Variance
8. Statistical Quality Control in Production and Management
9. Statistical Analysis of Time Series Data
10. Index Numbers
11. Forecasting and Market Research

Recommended Text:
Any Appropriate Text

Computer Programming II

1. Subroutines
2. Programming a Tape System
3. Macro-Programming
4. Job Timing
5. Programming a Random Access Device
6. Program Testing

Recommended Text:
Automatic Data Processing Systems - Gregory & VanHorn - Wadsworth
Spectra 70 POS-TOS Assembly System Reference Manual - RCA

Business Organization

1. Types of Business
2. Beginning of a Corporation
3. Organization Levels
4. Departments in a Business
5. Financing the Business

Recommended Text:
Any Appropriate Text

FORTRAN Programming

1. Introduction
2. Introduction to FORTRAN IV
3. Subscripted Variables
4. Input-Output Operations
5. Subroutines
6. Complex Numbers, Boolean Algebra, Simulation
7. Practices and Pitfalls in Computing

Recommended Text:
FORTRAN IV Programming and Computing - Golden - Prentice-Hall
Spectra 70 TOS FORTRAN IV Reference Manual - RCA
Alternate:
Basic FORTRAN Programming - Harvill - Prentice-Hall

SECOND YEAR, SECOND SEMESTER

Systems Design and Development

1. The Impact of the Electronic Computer
2. Fundamentals of Data Processing
3. Punched Card Data Processing
4. A Punched Card Application
5. Basic Concepts of Electronic Computers
6. Basic Programming Concepts (1)
7. Basic Programming Concepts (2)
8. Introduction to Automatic Programming
9. Development of a Computer Processing System
10. Applications of Intermediate Computers
11. Magnetic Tape Files
12. Random Access Files
13. Overview of Electronic Computers
14. Systems Analysis and Design
15. The Data Processing Organization
16. Problems Involved in Introducing a Computer
17. Information Technology and Management

Recommended Text:
Electronic Data Processing, An Introduction - Martin - Irwin

Programming Systems

1. Introduction
2. Tape/Disc Operating System
3. Executive Routine

4. File Control Processor

5. Monitor

6. Assembly System

7. Report Program Generator

8. FORTRAN IV Compiler

9. COBOL Compiler

10. Utility Routines

    Recommended Text:
    Spectra 70 TOS/TDOS System Information Manual - RCA

COBOL Programming

1. General Description

2. Identification Division

3. Environment Division

4. Data Division

5. Procedure Division

   Recommended Text:
   Spectra 70 TOS/TDOS COBOL Reference Manual - RCA

Data Processing Field Project

1. Machine Operation

2. Program Preparation

3. Program Documentation and Maintenance

4. Error Detection and Restart Procedures

5. Installation Management

6. Student Report

   Recommended Text:
   None

NOTE

1. We suggest every student have a copy of the following book for reference:

   Computer Dictionary - Sippl - Howard W. Sams & Co., Inc.
   Bobbs-Merrill Company, Inc.

2. As an aid to the instructor, we suggest the following book:

   Problems for Computer Solution - Gruenberger & Jaffray - Wiley

DATA PROCESSING TEXTS

The following books are excellent sources of information and are suggested for your library.

TITLE	AUTHOR	PUBLISHING COMPANY
Computer Programming	Stein & Munro	Academic Press
A FORTRAN Primer	Organick	Addison-Wesley
A FORTRAN IV Primer	Organick	
Principles of Data Processing with Computers	Van Ness	Business Press
Principles of Punched Card Data Processing	Van Ness	
*The Binary System	Glaser	Continental Press
*Computer Dictionary	Sippl	Howard W. Sams & Co.
Fundamentals of Data Processing	Lythel	
Business Information Processing Systems	Elliott & Wasley	Irwin
*Electronic Data Processing, an Introduction	Martin	
Systems Analysis	McMillan & Gonzales	
*Data Processing	Hartkemeier	John Wiley & Sons
Introduction to Data Processing	Arnold, Hill, Nichols	
Problems for Computer Solution	Gruenburger	
A Guide to COBOL Programming	McCracken	
Computer Programming - FORTRAN IV	Anderson	Meredith
Computer Programming Fundamentals	Leeds & Weinberg	McGraw-Hill
Principles of Automated Information Retrieval	Williams	Business Press
*Automatic Data Processing	Awad	Prentice-Hall
Business Data Processing	Awad	
Computer Software	Flores	
*FORTRAN IV Programming & Computing	Golden	
Programming Real-Time Computer Systems	Martin	
Real-Time Data Processing Systems & Introductory Concepts	Desmonde	
Basic FORTRAN Programming	Harvill	
An Introduction to Automatic Computers (Second Edition)	Chapin	Van Nostrand
*Automatic Data Processing Systems	Gregory & Van Horn	Wadsworth
Programming Package & IBM Machine Operation & Wiring	Salmon	

*Recommended as text for courses

APPENDIX F

RESEARCH STUDY REPORT

"To Determine the Feasibility of Establishing a Program to Train Computer Programers Utilizing a Time-Sharing System and Remote Data-Communications Transmission Terminal."

Connected with Project Number 6-2040

TO DETERMINE THE FEASIBILITY OF ESTABLISHING A PROGRAM TO TRAIN COMPUTER PROGRAMERS UTILIZING A TIME-SHARING SYSTEM AND REMOTE DATA-COMMUNICATIONS TRANSMISSION TERMINAL.

by

ARTHUR LEE HARDWICK

TABLE OF CONTENTS

is about 25,000 fewer than needed to efficiently handle the nation's 23,000 computers, companies."[2] The shortage of programers could be a threat to future sales of computers which currently are growing 15 per cent 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 computer programs and systems analysts. The shortage of programers 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 the 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.

Few segments of technology are advancing as rapidly as techniques in the design and manufacture of computers and data processing equipment. Thus, engineering technicians may find promising futures working with

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

LIST OF CHARTS

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, the time-sharing technique 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 chariman, 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 counselled me throughout the study, Dr. James Boggs, Dean of the Graduate School, Oklahoma State University.

Indebtedness for technical assistance is acknowledged to Ancil Buchanan, The Rand Corporation; Victor Van Hook, State Supervisor of Business and Office Education, Oklahoma State Board for Vocational Education; Bill Randolph, Data Center Coordinator, Oklahoma State-Wide Computer Science System; Jon Dell'Antonia, Assistant Data Center Coordinator, Oklahoma State-Wide Computer Science System; and Mrs. Brenda Williams, Head Secretary, Division of Technical Education, Oklahoma State Board for Vocational Education.

Special acknowledgement is given for considerable help and enthusiastic support from J. B. Perky, State Director of Vocational Education, Oklahoma State Board for Vocational Education; Dr. Francis Tuttle, State Coordinator of Vocational and Technical Education, Oklahoma State Board for Vocational Education; and the State Data Processing Advisory Committee, Oklahoma.

Invaluable assistance was given through providing useful materials and technical assistance by the following companies: American Telephone and Telegraph Company, Burroughs Corporation, Control Data Corporation, General Electric Computer Division, Honeywell Electronic Data Processing, International Business Machines Corporation, Radio Corporation of America, National Cash Register Company, Univac Division - Sperry Rand Corporation, Western Union Company, and members of the Oklahoma Data Processing Management Association.

My expressions of gratitude and appreciation would not be complete without recognition of the personal help, patience, and perseverance of my wife, Norman Jean, throughout the entire study.

CHAPTER I
THE PROBLEM

The scientific and technological developments of recent years and the advent of the space age have necessitated rapid changes in the manpower needs for both industry and business, particularly in the field of Data Processing. The processing of data by electronic equipment has created vast chan   in business and industry. Nowhere are these changes more apparent than in the occupations associated with the handling of business information. Much of the routine, time-consuming work of obtaining, compiling, and reporting the information necessary for a business to operate can now be adapted to machine processing.

The computer or electronic data processing industry has grown from an infant employing a relative 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. Programers, especially, will be in demand. A mad scramble for programers and, to a lesser extent for other trained data processing people, will take place. "Companies want programers so badly," says one educator, "they'll take anyone with a little bit of knowledge." The current corps of 100,000 programers

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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.

is about 25,000 fewer than needed to efficiently handle the nation's 23,000 computers, companies."[2] The shortage of programers could be a threat to future sales of computers which currently are growing 15 per cent 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 computer programs and systems analysts. The shortage of programers 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 the 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.

Few segments of technology are advancing as rapidly as techniques in the design and manufacture of computers and data processing equipment. Thus, engineering technicians may find promising futures working with

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

scientists in such career fields as programing, systems testing, manufacturing, systems research and development, quality control and reliability evaluation.

Technicians likewise are employed as programers and systems analysts by insurance companies, banks, manufacturing companies, commercial business, railroads, the airlines, and research firms among many others.

In these jobs, they may prepare payrolls, compute and print bank statements, keep records, do accounting, control inventory, establish time schedules, and similar data processing work.

In this highly specialized field, sound basic and technical training is essential. Preparation requires a secondary school education with a thorough background in mathematics and physical sciences. The increasing complexity of the field also demands a thorough exposure to fundamentals and theory of data processing.

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 defense and military projects.

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 programers, 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 programers and 80,000 operators, but this is still a grand total of 318,000 people.[5]

It is far-fetched to imagine that in the four 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.

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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.

The requirements indicated by these calculations raise doubt about the ability of existing educational facilities to provide this manpower by 1970. During that time, 160,000 trained computer people will have to be developed. The burden that this places on the American educational system is comparable to the situation in the late 1940's when there was a shortage of doctors. Since four to six years of education and experience are required before a person can be considered fully trained, emphasis on preparation for a career in data processing must begin now. This emphasis can take several forms:

1) Increased industry support to the teaching of data processing in schools at all levels;
2) Increased publicity concerning data processing as a profession;
3) Expanding college programs in data processing, i.e. Associate in D.P. or B.A.--Data Processing;
4) Adding data processing courses to the curricula for vocational schools.

Computers play a vital role in our lives. Things which had previously been considered impossible are being done today simply because computers are available. The analysis of many kinds of information at high speeds and with a completeness never before experienced has put a new dimension in our lives.

Along with simple knowledge of a great change, then, there is a second important reason for teaching students about computers. They must be made aware of the fact that this is a growing industry with many available opportunities. Youngsters must, however, be helped to recognize the need for formal education if they wish to operate most efficiently in the electronic data processing industry.

There exist, however, 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.

The U. S. Department of Labor predicts that the operating of computers will create the need for 8.4 million more workers in the coming decade.[6] In view of this prediction 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 programer, scientific programer and systems analysts).

A post-high school data processing program is proposed. The program comprises a succession of courses designed to provide an understanding of the concepts, principles, and techniques involved in processing data.

The proposed series of courses is intended to produce as output a programer. This person will be a candidate for a position in the business world and will be qualified to:

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

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

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[6]Data Processing Courses in Vocational and Secondary Schools," General Information Manual, New York: International Business Machines Corporation, 1962, p.3.

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

Communicate his programing decisions to personnel involved through proper documentation.

Many academic institutions are developing courses for programing. Miami-Dade Junior College in Florida says it is doubling its programer training plans because it has been unable to fill the standing requests from companies for programers.[7]

Industries in the United States are rapidly expanding their data processing facilities in the area of data communications. Data 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 occassionally 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 in 1965 that 1 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.[8] 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

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

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

communications was considered to provide this level of program. The student's knowledge of data communications would be a definite asset to him when he enters all types of data processing installations with very little, if any, training within the data processing installation in which he secures employment.

The important thing to remember and the urgent need for this program is found in the following statement:

> No matter how complicated a computer may be, its value rests in the hands of those who operate it.

The growth of the computer industry has been very rapid. The possibilities for continuing this growth in the future are unparalleled in any other field. Mankind is moving into an era in which the marvels of the computer and other machines will be able to help man to a better life in many ways.

CHAPTER II
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 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, programed and

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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.

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 what 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:

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

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 evoluationary 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 most 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

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

progress carries through the 1600's and the efforts of Pascal, Grillet, Leibnitz, and others; then to Jacquard of the late 1700's and his punched cards, the first basic form of mechanical programing.[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

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[13]Lytel, Allen. ABC's of Computer Programing, Indianapolis: Bobb-Merrill, 1962

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.

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

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

even an alphabetic character, is 100 per cent wrong. 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 must be understood. These lines can be categorized as simplex, half-duplex, and duplex, depending upon it's 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 ability 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 widly 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 to adequately instruct the students 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 2,500 bits per second. Some examples of wide-band channels are telpak A (40,800 bits per second), telpac C (105,000 bits per second), telpak D (437,500 bits per second), microwave, and coaxiol cable.

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 you understand something about these basic physical restrictions, you will see that, while we can transmit phenomenal amounts of information, we cannot violate the laws nor exceed their limitations. First, let's examine 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.

Next,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/ second and, on a private line 2400 bits/ 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 characters 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 characters/second. Others to up to 62,500 characters/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.

Another factor is distortion, sometimes called delay.

The voice (and many data codes) are 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 print a comma instead of a digit 2. What we have to do is condition the circuits so the frequencies all arrive together to create what is called a flat response. By doing this we must, in effect, slow 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.

Next is distraction: 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 mis-reads 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 noice.

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, lightning, 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. A noise on the line can be caused by lightning, switches operating in the central office, by people lifting an extension, etc. In any case it may change a mark to a space or vice versa 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.

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

The relationship requires that the phone companies work very closely with all of the equipment manufacturers to standardize equipment between all equipment concerned. The interfacing equipment that connects the data transmission line and the terminal itself is known as the "Dataphone" data set.[16] The Dataphone 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 Dataphone 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. At the present stage of development, number of classrooms, each working at a different task can use the computer simultaneously. The time-sharing capability puts the entire potential of the computer at the service of the individual learner, and assures the maximum, and therefore the most economical, use of each machine.[18]

The time-sharing technique also provides dimensional data communication, a merger of two technologies. The computer at the hub of the system

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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, 7-23-66.

provides a modular facility for processing large volumes of data at high speeds. The responsiveness of the system is tailored to a user's on-line requirements by selecting a combination of transmission facilities and terminal divices best suited to serve the needs.

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 broadband 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

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

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]

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 communications 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. The problem that developed with the batch processing technique was that it required the computer to run a complete program without stopping. Since programs often must wait in line a long time to get on the computer, frequently, the total system was stopped while a program was debugged.

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

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

demand from the remote terminals, and programs run in batch-process mode give the computer something to do in these idle intervals.

Even though the batch processing technique will still be utilized, the main-stay of data communications will be the time-sharing technique. The general definition in the preceeding 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 multiprograming, multiprocessing, and on-line real time.

First, consider the multiprograming aspect of time-sharing. This aspect refers to when several programs being stored in a computer system at once. In time-sharing the programs are loaded from remote consoles or computers, but only one program can run at any given time. The multi-programed computer immediately switches to another program after one program is completed or reaches a point where more information is needed.[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. In some multiprocessing systems, there is communications between computers, making it possible for one computer to control another. The controlling computer would generally be classified as the data center hardware or configuration.[22]

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

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

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 a particular set of input values is available. The time shared computer is on-line because the computer user interacts directly with the computer and real time because the computer gives answers immediately.[23]

Although the achievement of practical time-sharing techniques made use of the trends 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 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 programing overhead.

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

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 cent al computer to inquire continualiy 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 is not really 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. The entire data base of this system is made up in layers (hierarchies) of memory. 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.

Generally, the preceding problem areas have received a great deal of attention. Satisfactory solutions have been found for all but categories number 6 and 7, and these two are being subjected to a great deal of promising research. Only the next generation of time-sharing equipment will tell if adequate facilities and techniques for handling memory allocation have been discovered.

Major developments of hardware, software, and their combined techniques for adaptation of hierarchal files visible in today's systems will be considerably more apparent in the next generation. More work is required for full fruitation.[24]

The entire field of present day time-sharing can be characterized as being at the end of its first cycle of practical experience and experiment. Several time-sharing installations have been active now for a number of years. Table I delineates some of the best known, the dates of their first practical activity, the kinds of equipment used, and

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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.

other pertinent information. What Table I does not show, however, is that in the time-sharing installations active today, virtually all the equipment in use was not specifically designed for time-sharing. Rather, these devices have been modified to make time-sharing possible in a limited fashion.

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 1966.

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 or 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 present group.[25]

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,

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

ORGANIZATION	DATE	COMPUTER(S)
Carnegie Institute of Technology Pittsburgh, Pennsylvania	(3/65)	2 G-20
Dartmough College Hanover, New Hampshire	(9/64)	GE-235 DATANET-30
General Electric Company Phoenix, Arizona	(11/64)	GE-235 DATANET-30
IBM QUICKTRAN Service New York, New York	(5/65)	IBM-7040 7044
MIT Computation Center Cambridge, Massachusetts	(9/63)	IBM-7094
Project MAC-MIT (Phase One) Cambridge, Massachusetts	(9/63)	IBM-7094
RAND Corporation Santa Monica, California	(2/64)	Johnniac
Space Technology Laboratory El Segundo, California (Culler-Fried System)	(1/65)	Bunker-Ramo 340
Stanford University Stanford, California	(6/64)	IBM-7090 PDP-1
Systems Development Corp. Santa Monica, California	(6/64)	AN/FSQ-32 PDS-1
U.C.L.A. Western Data Processing Center	(11/64)	IBM-7740 IBM-7040/7094

TABLE I - CURRENT TIME-SHARING SYSTEMS

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.[26]

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

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, and its average access time is in the tens of milliseconds. The magnetic drum 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.

Users' programs are typically carried in a magnetic drum memory. These programs 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

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

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 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, core memories of computers, keyboards and magnetic discs, 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, 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 with a density of approximately 200 characters per inch. 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 2,000 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 computer programers. 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 data center to the local school but it would also provide a personnel backup to the local school from the data center. 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 knowledgable personnel at the data center to help solve these problems, it would prevent the breakdown of communications 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 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, disc, 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 consideration of 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 programer 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 time tasks. These include charge accounting and language choice. The system supervisory program must keep track 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 compiler from a library of subroutines and stores it on the drum or disk for quick access.

For time-shared systems, the supervisory program must be large because of the complex sequence that must be controlled. But the size of the program increases less rapidly than would the size of the computer itself.

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 effecient 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 Programers Utilizing a Time-Sharing System and Communications Transmission Terminal?

The first step of the study was to obtain a group of suggested activities which are, or might be, engaged in by computer programers 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 experiences. A copy of the inquiry form is in Appendix B. The inquiry form provided for division or classification of activities under eight main headings; namely, (I) Replacement of Professional Personnel, (II) Personnel Requirements, (III) Percentage of Program Activities, (IV) Personnel Available and Professional Updating, (V) Equipment Knowledge Required, (VI) Programing Knowledge Required, (VII) Data Processing Concepts and Techniques Required, and (VIII) Miscellaneous. The miscellaneous classification was used to stimulate suggestions from jury members without regard to any specific phase of the program. The classifications used were broadly based on standard data processing practices, concepts, and techniques which provided familiarity to the members on the jury. These classifications were intended to serve as a frame of reference to guide them in thinking of meaningful educational data processing activities.

Illustrations of all necessary activities were listed under each classification 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.

The pre-test of the instrument was obtained from the forty industrial and educational leaders on the preliminary jury who examined the transmital letter, the outline of the study, and the instrument. 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 II on the next page lists the preliminary jury members.

The suggestions regarding the preliminary inquiry form received from the preliminary jury were assembled exactly as submitted, considering each of the eight major classifications. 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 items were then rephrased and rewritten when they were justified as being specifically related to the educational data processing activity.

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

1. That the statement would have application in the area of educational data processing of a level necessary to train programers and data processing technicians.
2. That the statement was specific enough to be developed as a statement on the inquiry form and would be of practical value to the problem.
3. That the statement 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 a statement regarding

TABLE II

NAMES, ORGANIZATIONS AND LOCATIONS OF PRELIMINARY JURY MEMBERS

NAME	ORGANIZATION	LOCATION
Mr. Amos Kimberling	State Dept. of Education	Oklahoma City, Okla.
Mr. Carl Aschbacker	San Antonio College	San Antonio, Texas
Mr. Bill Randolph	State Dept. of Education	Oklahoma City, Okla.
Dr. Roy W. Dugger	Connelly Technical Institute	Waco, Texas
Mr. Averil Bates	Kilgore Junior College	Kilgore, Texas
Mr. Louis J. Centile	Chaffey College	Ontario, California
Mr. Bert E. Woodruff	Kilgore Junior College	Kilgore, Texas
Mr. D. Thomas	Contra Costa Junior College	Martinez, California
Mr. Ronnie Brown	South Plains College	Levelland, Texas
Mr. Bob Lukeman	IBM	Oklahoma City, Okla.
Mr. Donald Bergman	Weatherford Junior College	Weatherford, Texas
Mr. Al Ducat	U. S. Office of Education	Washington, D. C.
Mrs. Iva Nolting	OSU Technical Institute	Oklahoma City
Dr. Jim Snyder	University of Illinois	Urbana, Illinois
Dr. Robert Knoebel	U. S. Office of Education	Washington, D. C.
Dr. C. J. Roothaan	University of Chicago	Chicago, Illinois
Mr. Roy Sinclair	IBM	Oklahoma City, Okla.
Dr. W. G. Kehl	University of Pittsburg	Pittsburg, Pa.
Mr. Ancel Buchanan	The Rand Corporation	Santa Monica, Calif.
Dr. R. C. F. Bartels	University of Michigan	Ann Arbor, Michigan
Mr. L. E. Harvey	Foothill College	Mountain View, Calif.
Dr. Donald Laird	Pennsylvania State University	University Park, Pa.
Dr. S. D. Conte	Purdue University	Lafayette, Indiana
Dr. Bob Simms	State Department of Education	Tallahassee, Florida
Dr. Walter Hoffman	Wayne State University	Detroit, Michigan
Mr. John Lloyd	Oklahoma City Court House	Oklahoma City, Okla.
Dr. John Dolch	State University of Iowa	Iowa City, Iowa

TABLE II
NAMES, ORGANIZATIONS AND LOCATIONS OF PRELIMINARY JURY MEMBERS
(Continued)

NAME	ORGANIZATION	LOCATION
Dr. Walter Brooking	U. S. Office of Education	Washington, D. C.
Dr. Koenig	University of Wisconsin	Madison, Wisconsin
Dr. P. Lykos	Illinois Institute of Technology	Chicago, Illinois
Mr. Jon C. Dell'Antonia	U. S. Army Logistics Design Group	San Francisco, Calif.
Dr. C. Maple	Iowa State University	Iowa City, Iowa
Dr. R. A. Dammkoehler	Washington University	St. Louis, Missouri
Dr. A. L. Perlis	Carnegie Institute of Technology	Pittsburg, Pa.
Mr. Alfred Taylor	Northeastern Oklahoma A&M College	Miami, Oklahoma
Mr. Jerry Bradley	OSU Technical Insitute	Oklahoma City, Okla.
Dr. Bob Gates	State Department of Education	Tallahassee, Florida
Miss Mary Ellis	American Vocational Association	Washington, D. C.
M. J. Dufour	Orange Coast College	Costa Mesa, Calif.
Mr. John L. Buller	Orange Coast College	Costa Mesa, Claif.

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 inquiry form and the transmittal letter are on the following pages.

The Final Jury - In order to gather the necessary list of educational data processing activities, a final jury of randomly selected industrial concerns, agencies, or institutions in the State of Oklahoma that employed data processing programers 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 State 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 secondary contributions and 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

TECHNICAL EDUCATION

OKLAHOMA STATE BOARD FOR VOCATIONAL EDUCATION

J B PERKY, DIRECTOR .. 1515 WEST SIXTH AVENUE .. STILLWATER, OKLAHOMA 74074

November 15, 1965

Dear Sir:

Technical education data processing programs are being developed in the State of Oklahoma for the training of programers 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

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:____

____

____

programers 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. After the total list of 274 organizations was divided into the four size groups (Group Size A = 20 or more programers or systems analysts, Group Size B = 10-19 programers or systems analysts, Group Size C - 5-9 programers or systems analysts, Group Size D = 1-4 programers or systems analysts. Group Size A consisted of a total of twelve organizations. Questionnaires were sent to all twelve. It was felt that organizations using more programers or systems analysts would need a higher sampling rate than those organizations using fewer. For this reason, a percentage scale based on the four size groups above was established by members of the graduate committee to provide a better sampling rate of the population. After sending follow-up questionnaires to those who had not returned their original questionnaire at the end of one month, an additional month was given to answer the second or follow-up questionnaire. If at the end of two months no questionnaire was received, an interview was conducted by a staff member of the division of technical education.

Table III lists the organizations in size group A that were sampled by questionnaire that were interviewed. Table III also gives a tabulation of organizations in size group A.

TABLE III
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. E. Moody, Chief
General Electric Computing Center	Oklahoma City, Okla.	Joe Tracy
Tinker Air Force Base	Oklahoma City, Okla.	Maj. D. T. Klingman

TABULATION OF ORGANIZATIONS IN SIZE GROUP A

Total Number of Firms		12
Questionnaires)	100%	9
Interviews)		3

Size group B (10 to 19 programs or systems analysts) required a random sample of seventy-five per cent of all fourteen organizations in that group (the sample nearest the 75%). Of the fourteen in size group B, the percentage scale required that ten be sampled. The ten were randomly selected. After two months of original and follow-up questionnaires, all ten were returned and complete. Table IV lists the organizations in size group B that were sampled by questionnaires and the organizations that were not sampled. Table IV also gives a tabulation of organizations sampled in size group B and a listing of the remaining 25% of organizations that were not sampled in size group B.

Size group C (5 to 9 programers or systems analysts) required a random sample of fifty per cent of all thirty-one organizations in that group. Of the thirty-one in size group C, the percentage scale required that sixteen be sampled. The sixteen were randomly selected; and after the original and follow-up questionnaires were returned, two additional interviews were required to complete the fifty per cent. Table V lists the organizations in size group C that were sampled by questionnaries and interviewed and the organizations in size group C that were not sampled. Table V also gives a tabulation of organizations sampled in size group C and a list of the remaining fifty per cent of organizations that were not sampled in group C.

Size Group D (0 to 4 programmers or systems analysts) required a random sample of twenty-five per cent of all two hundred and seventeen organizations in that group. Of the two hundred and seventeen in size group D, the percentage scale required that fifty-five be sampled. The fifty-five were randomly selected and after the original and followup questionnaires were returned, seven of the fifty-five had to be interviewed. In a few cases the interviews were required to clarify a statement or reaction to the questionnaire. With the forty-eight questionnaires and the seven interviews, the twenty-five per cent sample was complete. Table VI lists the organizations in size group D that were sampled by questionnaire and interview and the organizations in size group D that were not sampled. Table VI also gives a tabulation of organizations sampled in size group D and a list of the remaining seventy-five per cent of organizations that were not sampled in size group D.

TABLE IV
SIZE GROUP B

ORGANIZATIONS SAMPLED BY QUESTIONNAIRE

COMPANY	LOCATION	RESOURCE PROGRAM
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, Okla.	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 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

TABULATION OF ORGANIZATIONS IN SIZE GROUP B

Total Number of Firms	14
Questionnaires) :75%	10
Interviews)	0
25% not required	4

TABLE V
SIZE GROUP C

ORGANIZATIONS SAMPLED BY QUESTIONNAIRES

COMPANY	LOCATION	RESOURCE PERSON
American General Life Insurance Co.	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 SAMPLED

AVCO	Tulsa, Oklahom	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

ORGANIZATIONS NOT SAMPLED
(Continued)

COMPANY	LOCATION	RESOURCE PERSON
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
Southwast Computer Service	Tulsa, Oklahoma	

TABULATION OF ORGANIZATIONS IN SIZE GROUP C

Total Number of Firms		31
Questionnaires)	50%	14
Interviews)		2
50%		15

TABLE VI
SIZE GROUP D

ORGANIZATIONS SAMPLED BY QUESTIONNAIRES

COMPANY	LOCATION	RESOURCE PERSON
Aero Commander Division	Norman, Oklahoma	John Morehead
Altus Air Force Base	Altus, Oklahoma	Lt. 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
Industrial Fab Company	Tulsa, Oklahoma	Herre Danne
Jarboe Sales Company	Tulsa, Oklahoma	Dean Hedberg
Mercy Hospital	Oklahoma City, Okla.	Sister Mary Rosalia
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

ORGANIZATIONS SAMPLED BY QUESTIONNAIRES (Continued)

COMPANY	LOCATION	RESOURCE PERSON
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

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 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, Okla.	Dan Coffelt
Blue Cross-Blue Shield	Tulsa, Oklahoma	
Born Engineering	Tulsa, Oklahoma	George Rose

ORGANIZATIONS NOT SAMPLED
(Continued)

COMPANY	LOCATION	RESOURCE PERSON
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
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 Association	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.	Walter S. Thornton
Hart Ind. Supply Co.	Oklahoma City, Okla.	Paul Gassoway
Hayes International	Midwest City, Okla.	Ed Helm
Helmeric & Payne	Tulsa, Oklahoma	

ORGANIZATIONS NOT SAMPLED
(Continued)

COMPANY	LOCATION	RESOURCE PERSON
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	Wm. C. Richardson
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 Farrish
Metro Data Center	Tulsa, Oklahoma	A. C. Medin
Mid-Continental Casualty	Oklahoma City, Okla.	
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	Edwin 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

ORGANIZATIONS NOT SAMPLED

COMPANY	LOCATION	RESOURCE PERSON
Petroleum Marketing Corp.	Tulsa, Oklahoma	LeRoy Newbrough
Pioneer Telephone	Kingfisher, Oklahoma	Charles Davis
Ponca City Savings	Ponca City, Okla.	Dick Ptts
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, Oklahom	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
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

ORGANIZATIONS NOT SAMPLED
(Continued)

COMPANY	LOCATION	RESOURCE PERSON
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	
Veterans Administration Regional Office	Muskogee, Oklahoma	William Fr eman
Video Theaters	Oklahoma City, Okla.	Orau Rose
Warner Lewis Co.	Tulsa, Okla.	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, Oklahom	Wayne Weese
Wilson Shipley Co.	Enid, Oklahoma	
WKY Television Systems Inc.	Oklahoma City, Okla.	Field Duskin

TABULATION OF ORGANIZATIONS IN SIZE GROUP B

Total Number of Firms		216
Questionnaires)	:26%	48
Interviews)		7
74%		161

Actually, a random selection method was used to obtain the samples, but a percentage scale 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 sub-hypotheses in hypotheses #IV. This was the basic reason that the total number of sub-hypotheses in hypotheses number IV was reduced to ten. (See Appendix C).

After an exceptionally gratifying response on the original questionnaire of 73 per cent (68 out of 93), 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 25 industries, organizations, or agencies of the final jury who had not completed the inquiry form. The follow-up questionnaire consisted of the original transmital letter and questionnarie. The number of follow-up questionnaries received was 15 or 16 per cent of all organizations sampled.

A delay of one additional month was given 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 10 interviews were made or a total of 11 per cent of all organizations sampled. The assistance given in acquiring the responses and the responses themselves were gratifying, and the interest in the concept far exceeded expectations. Tables III, IV, V, and VI list the total number of organizations employing programers or systems analysts in the fiel of data processing in the State of Oklahoma, total number sampled by questionnaires, total number sampled by interviews, and a summary of each size group, respectively.

The 93 responses were tabulated in the computer center of the State Department of Education in Oklahoma City, Oklahoma. 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 cards 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 Tables III, IV, V, and VI) a tabulation was made of the responses of all ninety-three participants by size group A (see Table VII), size group B (see table VIII), size group C (see table IX), size group D (see table X). The composite tables VII, VIII, IX and X were designed to record the number of responses and percentages in each of the described classifications.

Table VII Page 1 Organizations in Size Group A	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	7	10	90	0	*	*	*	X	*	*	X	*	*	*	*	*	*
Present Needs	4	1			0													
1966-67 Needs	4	8	20	80	0	*	*	*	*	*	*	*	*	*	*	*	*	*
1968-69 Needs	4	8	20	80	0	X	*	*	*	*	*	*	*	*	*	*	*	*
1970-71 Needs	15	5	20	80	0	0	*	*	*	*	*	*	*	*	*	*	*	*
Org. # 2	29	76	10	90	0	X	X	*	*	X	*	0	X	*	X	X	X	N
Present Needs	5	5																
1966-67 Needs	6	4	12	88		X	X	*	*	X	*	0	*	*	X	X	X	N
1968-69 Needs	2	3	12	88		X	0	*	*	X	0	*	*	*	X	*	X	N
1970-71 Needs	3	2	12	88		X	0	*	*	X	0	*	*	*	X	*	X	N
Org. # 3	30	23	13	87	0	*	*	*	*	*	*	*	0	*	*	0	0	0
Present Needs	30	23	13	87	0	*	*	*	*	*	*	*	0	*	*	0	0	0
1966-67 Needs	7	5	16	84		0	X	*	*	X	*	*	*	*	X	*	0	0
1968-69 Needs	9	2	9	91		0	X	*	*	X	0	*	*	*	X	*	0	0
1970-71 Needs	11	5	9	91		0	X	*	*	X	0	*	*	*	X	*	0	0
Org. # 4	13	10	10	90	23	X	X	X	0	X	X	X	X	X	X	X	X	X
Present Needs	1	1																
1966-67 Needs	2	1	10	90	26	0	X	X	X	X	X	X	X	X	X	X	X	X
1968-69 Needs	3	2	15	85	30	0	X	X	X	X	X	X	X	X	0	X	X	X
1970-71 Needs	2	2	20	80	35	0	X	X	X	X	X	X	X	X	0	X	X	X
Org. # 5	45	20	40	60	65	X	X	*	0	0	*	0	0	*	*	0	0	*
Present Needs	0	0																
1966-67 Needs	65	30	45	55	95	0	X	*	0	0	*	*	*	*	*	*	0	*
1968-69 Needs	65	30	45	55	95	0	X	*	*	0	*	*	*	*	*	*	*	*
1970-71 Needs	50	30	45	55	80	0	X	*	*	0	*	*	*	*	*	*	*	*
Org. # 6	20	10	20	80	5	X	*	*	X	X	X	X	X	*	*	X	X	0
Present Needs		15																
1966-67 Needs	25	15	30	70	7	0	*	*	*	X	*	X	X	*	*	*	*	0
1968-69 Needs	25	15	30	70	7	0	*	*	*	X	*	X	X	*	*	*	*	0
1970-71 Needs	25	15	30	70	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	6	0	70	30														
1966-67 Needs	15	0	50	50		0	X	*		0	0	*	*	X	*	X	0	0
1968-69 Needs	10	0	60	40		0	0	*		0	0	*	*	X	*	*	X	0
1970-71 Needs	10	0	70	30		0	0	*		0	0	*	*	X	*	*	X	0

Table VII Page 2 Organizations in Size Group A	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	13	17	40	0	X	*	*	X	X	*	*	*	*	*	X	0	0
Present Needs	26	19	17	42	82													
1966-67 Needs	26	20	17	42	0	X	*	*	*	X	*	*	*	*	*	X	X	0
1968-69 Needs	30	22	20	30	0	X	*	*	*	X	0	*	*	*	*	*	X	0
1970-71 Needs	35	25	20	30	0	X	*	*	*	X	0	*	*	*	*	*	*	0
Org. # 9	40	10	99	0	4	0	*	*	*	*	N	*	*	*	*	*	*	N
Present Needs	50	15		0														
1966-67 Needs	50	20		0	4	0	*	*	*	N	N	*	*	*	*	*	*	N
1968-69 Needs	45	25		0	5	N	*	*	*	N	N	*	*	*	*	*	*	N
1970-71 Needs	45	25		0	5	N	*	*	*	N	N	*	*	*	*	*	*	N
Org. # 10	99	50	25	75	0	*	*	*	X	0	*	X	*	*	*	X	X	X
Present Needs	24	5																
1966-67 Needs	24	5				*	*	*	X	0	*	X	*	*	*	X	X	X
1968-69 Needs	24	5				X	*	*	X	0	*	*	*	*	*	*	*	*
1970-71 Needs	24	5				X	*	*	X	0	*	*	*	*	*	*	*	*
Org. # 11	8	4	0	99	0	*	*	0	0	*	*	*	*	*	*	*	*	*
Present Needs	2	2	0	99														
1966-67 Needs	10	5	0	99	0	*	*	*	0	*	*	*	*	*	*	*	*	*
1968-69 Needs	20	10	0	99	0	*	*	*		*	*	*	*	*	*	*	*	*
1970-71 Needs	30	15	0	99	0	*	*	*		*	*	*	*	*	*	*	*	*
Org. # 12	58	24	33	67	0	*	*	*	0	*	*	*	*			0	0	0
Present Needs																		
1966-67 Needs			33	67		0	*	*	*	*	*	*	*	*	*	0	0	0
1968-69 Needs			33	67		0	*	*	*	*	*	*	*	*	*	*	0	0
1970-71 Needs			33	67		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																		

Table VIII Page 1 Organizations in Size Group B	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 2	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. # 3	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. # 4	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. # 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	*	D	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 VIII
Page 1

Organizations in Size Group B

Organizations in Size Group B	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 9	5	7	10	90	3	0	*	0	0	0	*	0	X	*	*	*	*	*
Present Needs	1	0	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. # 10	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. # 11	11	6	5	95	0	*	*	*	N	0	*	*	*	*	*	*	N	0
Present Needs	6	2	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. #																		
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 IX Page 1 Crganizations in Size Group C	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 2	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. # 3	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. # 4	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. # 5	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. # 6	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. # 7	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 IX Page 2 — Organizations in Size Group C	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 9	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. # 10	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. # 11	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		*	*	*	*	0	0	0
Org. # 12	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. # 13	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. # 14	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 IX Page 3 Organizations in Size Group C	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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 X Page 1 Organizations in Size Group D	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 2	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. # 3	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. # 4	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. # 5	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. # 6	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. # 7	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 X Page 2 — Organizations in Size Group D	Present # Programers	Present # Systems Analysts,	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 9	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. # 10	2	0	0	99	0	*	*	0	0	*	N	N	0	*	N	*	N	N
Present Needs																		
1966-67 Needs	2	0	0	99		*	*	0	0	*			0	*		*		
1968-69 Needs	1	0	0	99		*	0	0	0	*			0	*		*		
1970-71 Needs	1	0	0	99		*	0	0	0	*			0	*		*		
Org. # 11	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. # 12	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. # 13	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. # 14	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 X Page 3 — Organizations in Size Group D	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 16	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. # 17	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. # 18	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. # 19	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. # 20	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	*	0	*	0	0	0	0
Org. # 21	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 X Page 4 — Organizations in Size Group D	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 23	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. # 24	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. # 25	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. # 26	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	0	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. # 27	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. # 28	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 X Page 5 — Organizations in Size Group D	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 30	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. # 31	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. # 32	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. # 33	3	1	0	99	0	X	*	X	*	*	*	*	X	X	0	0	0	0
Present Needs	1	1																
1966-67 Needs	4	1	0	99		X	*	X	*	*	*	*	X	X	0	0	0	0
1968-69 Needs	3	1	0	99		X	*	X	*	*	*	*	X	X	0	0	0	0
1970-71 Needs	3	1	0	99		X	*	X	*	*	*	*	X	X	0	0	0	0
Org. # 34	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. # 35	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 X Page 6 — Organizations in Size Group D	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	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. # 37	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. # 38	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. # 39	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. # 40	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. # 41	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. # 42	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 X Page 7 Organizations in Size Group D	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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	2	1	50	50	0	*	*	*	*	*	*	X	*	X	*	X	0	0
Present Needs	2	2																
1966-67 Needs	1	1	50	50		*	*	*	*	*	*	X	*	X	*	X	0	0
1968-69 Needs	2	2	50	50		*	*	*	*	*	*	X	*	X	*	X	0	0
1970-71 Needs	1	1	50	50		*	*	*	*	*	*	X	*	X	*	X	0	0
Org. # 44	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. # 45	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. # 46	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. # 47	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. # 48	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. # 49	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 X Page 8 Organizations in Size Group D	Present # Programers	Present # Systems Analysts	% Scientific Programing	% Commercial Programing	Personnel Freed for Other Duty	Unit Record Equipment	Assembler Language Programing	Cobol-Fortran Programing	Advanced Compiler Programing	Machine Language Programing	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 valid check was made. They were first tabluated in total number, sampled by questionnaires, total number sampled by interviews, and summaries of each size group (see tables III, IV, V, and VI. They were then tabulated into responses of each organization in Oklahoma by size groups (see tables VII, VIII, IX and X.) The third tabulation of responses of the organizations was to secure the total number of programers (see Table XI), total number of business programers (see Table XII), total number of scientific programers (see Table XIII), total number of systems analysts (see Table XIV), total number of systems analysts for business application (see Table XV), total number of systems analysts for scientific application (see Table XVI), total number of professional personnel that could be freed for other duties if qualified programers or systems analysts were available (see Table XVII), and total number of data processing programers and systems analysts needed in Oklahoma (see Table XVIII). Percentages of responses of these groups were calculated and listed on forms designed for this purpose as shown in Table XVIII to XXIII, inclusive.

Efforts were made throughout Chapter IV to point up other note-worthy and interesting features of the various groups and their responses. Conclusions and recommendations were drawn and set forth in Capter V.

CHAPTER IV
ANALYSIS OF DATA & FINDINGS OF STUDY

The work of a jury of selected leaders, experienced in the field of educational data processing and industrial data processing, and the author, as described in Chapter III, carried out the first purpose of this study; to identify the items to be evaluated in the Oklahoma organization utilizing data processing techniques and personnel. Randomly sampled responses of 274 organizations in the state of Oklahoma which utilize data processing techniques and personnel in all 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 governed by the size of the programing and systems analysts personnel staff utilized. These four groups were then subdivided into four sub-groups under each major group. These sub-groups were governed by the location of each organization. These four major groups and each of their sub-groups were used to form the original frame of reference.

The data was assembled into the four major groups for interpreting and analyzing. The data in 13 cases could not be interpreted properly so interviews were made to clarify the organization evaluation.

The data that were collected and interpreted are presented in this chapter. The first part consist 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 consist of the empirical research section to determine if computer programers 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 needs of modern industry.

To justify any occupational education program a demand for the graduates of that program must be clearly identified before the program is initiated. The need for qualified programers is evidenced in almost all the literature in the field.

The data were classified into major groups of size of data processing operation before the random sample was made. This classification into size groups formed the basis for the first basic tabulation of data. Projections were made from the data received within each size group to adequately establish the present and anticipated needs for programers, systems analysts, and professional personnel currently used as programers and systems analysts who could be freed for other duties if trained technicians were available. The projections were based on the fact that size A was 100% of data available, size B was 75% of data received, size C was 50% of data received, and size D was 25% of data received. The size groups were extrapolated to estimate population totals in all four size groups. Size group A had 12 industries, organizations, or agencies with 20 or more programers or systems analysts in the state of Oklahoma and size group A required that 100% be sampled. Size group B had fourteen industries, organizations, or agencies with 10 to 19 programers or systems analysts in the state of Oklahoma and size group B required that 75% be sampled. A projection of 25% was made to secure the 100% required. Size group C had thirty-two organizations with 5 to 9 programers on systems analysts in the State, and size group C required that 50% be sampled. A projection of 50% was made to secure the 100% required. Size group D had two hundred and twenty-four organizations, with 0 to 4 programers or systems analysts in the state, and size group D required a 25% sample; therefore, a projection of 75% was made to secure the 100% required.

From these projections the following tabulations were made. Section one will be devoted to programers in Oklahoma.

TABLE XI

TOTAL NUMBER OF PROGRAMERS

YEAR	Size A	Size B	Size C	Size D	TOTAL
Presently Employed	373	107	146	296	922
Presently Needed	476	128	170	376	1150
1966-67	426	136	194	426	1182

1968-69	572	156	226	476	1430
1970-71	590	163	252	500	1505

This table shows the total number of programers presently employed in all four size groups, present number needed in all four size groups, and the numbers needed from present to 1971 in Oklahoma. This table shows both the business programer and the scientific programer. For a breakdown between business and scientific programers see tables XI and XII.

TABLE XII

TOTAL NUMBER OF BUSINESS PROGRAMERS

YEAR	Size A	Size B	Size C	Size D	TOTAL
Presently Employed	333	90	122	264	809
Presently Needed	426	104	146	340	1016
1966-67	476	112	166	378	1132
1968-69	527	124	194	428	1273
1970-71	550	124	216	448	1338

Total number of business programers presently employed, presently needed and anticipated to 1971 in the state of Oklahoma.

TABLE XIII

TOTAL NUMBER OF SCIENTIFIC PROGRAMERS

YEAR	Size A	Size B	Size C	Size D	TOTAL
Presently Employed	40	17	24	32	113
Presently Needed	50	24	24	36	134
1966-67	50	24	28	48	150
1968-69	45	32	32	48	157
1970-71	40	39	36	52	167

Total number of Scientific programers presently employed, presently needed, and anticipated to 1971 in the state of Oklahoma.

Section two is devoted to systems analysts in Oklahoma. (See table XIV)

TABLE XIV

TOTAL NUMBER OF SYSTEMS ANALYSTS

YEAR	Size A	Size B	Size C	Size D	TOTAL
Presently Employed	247	72	51½	176	546½
Presently Needed	294	78	62½	204	638½
1966-67	333	90	70	216	709
1968-69	342	110	80	232	768
1970-71	376	114	86	248	824

This table 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 in all four size groups to 1971 in Oklahoma. This table shows both the business and scientific applications. For a breakdown of the business application and the scientific application, see the two following tables. (See tables XV and XVI)

TABLE XV

TOTAL NUMBER OF SYSTEM ANALYSTS (BUSINESS APPLICATION)

YEAR	Size A	Size B	Size C	Size D	TOTAL
Presently Employed	237	69	47½	144	497½
Presently Needed	279	74	58½	164	575½
1966-67	313	86	66	176	641
1968-69	317	106	76	188	687
1970-71	346	110	82	204	742

Business application of systems analysts in Oklahoma.

TABLE XVI

TOTAL NUMBER OF SYSTEMS ANLYSTS (SCIENTIFIC APPLICATION)

YEAR	Size A	Size B	Size C	Size D	TOTAL
Presently Employed	10	3	4	32	49
Presently Needed	15	4	4	40	63
1966-67	20	4	4	40	68

1968-69	137	46	24	192	399
1970-71	127	46	36	200	409

This table shows the number of professional personnel presently employed who could be freed for other duties in their organization, if adaquate trained personnel were available. For example, there are many scientists, mathematicians, and engineers performing duties as programers or systems analysts in organizations in the state of Oklahoma who could resume the type of work for which they were trained if qualified programers and systems analysts were available.

Realizing that from an instructional program that trains programers a certain percentage of systems analysts will be developed; not necessarily directly out of the instructional program but many of the higher level of students in the better programs will become systems analysts with additional experience in the field.

The fourth section shows a composite of the previous three sections to attempt to show the true overall presently employed, presently needed, and anticipated to 1971 for the state of Oklahoma in all four size groups.

TABLE XVIII

TOTAL NUMBER OF DATA PROCESSING PROGRAMERS & SYSTEMS ANALYSTS NEEDED IN OKLAHOMA

YEAR	Size A	Size B	Size C	Size D	AMOUNT
Presently Employed	717	217	213½	632	1779½

Presently Needed	867	244	248½	740	2099½
1966-67	991	271	284	802	2348
1968-69	1051	312	330	900	2593
1970-71	1093	323	364	948	2728

Statistical treatment of the data was employed to find significant differences between percentages of responses from I (size groups), II (types of applications), III (locations), and IV (a combination of selected size, application and location 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 XIX 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 on Table XIX; 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 XIX. They are Group I (size A, application A, location A).

TABLE XIX

Number of Responses in Business Application Groups Randomly Sampled

SIZE GROUPS		LOCATION GROUPS			
		L-A	L-B	L-C	L-D
	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 XX

Number of Responses in Scientific Application Groups Randomly Sampled

SIZE GROUPS		LOCATION GROUPS			
		L-A	L-B	L-C	L-D
	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

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)

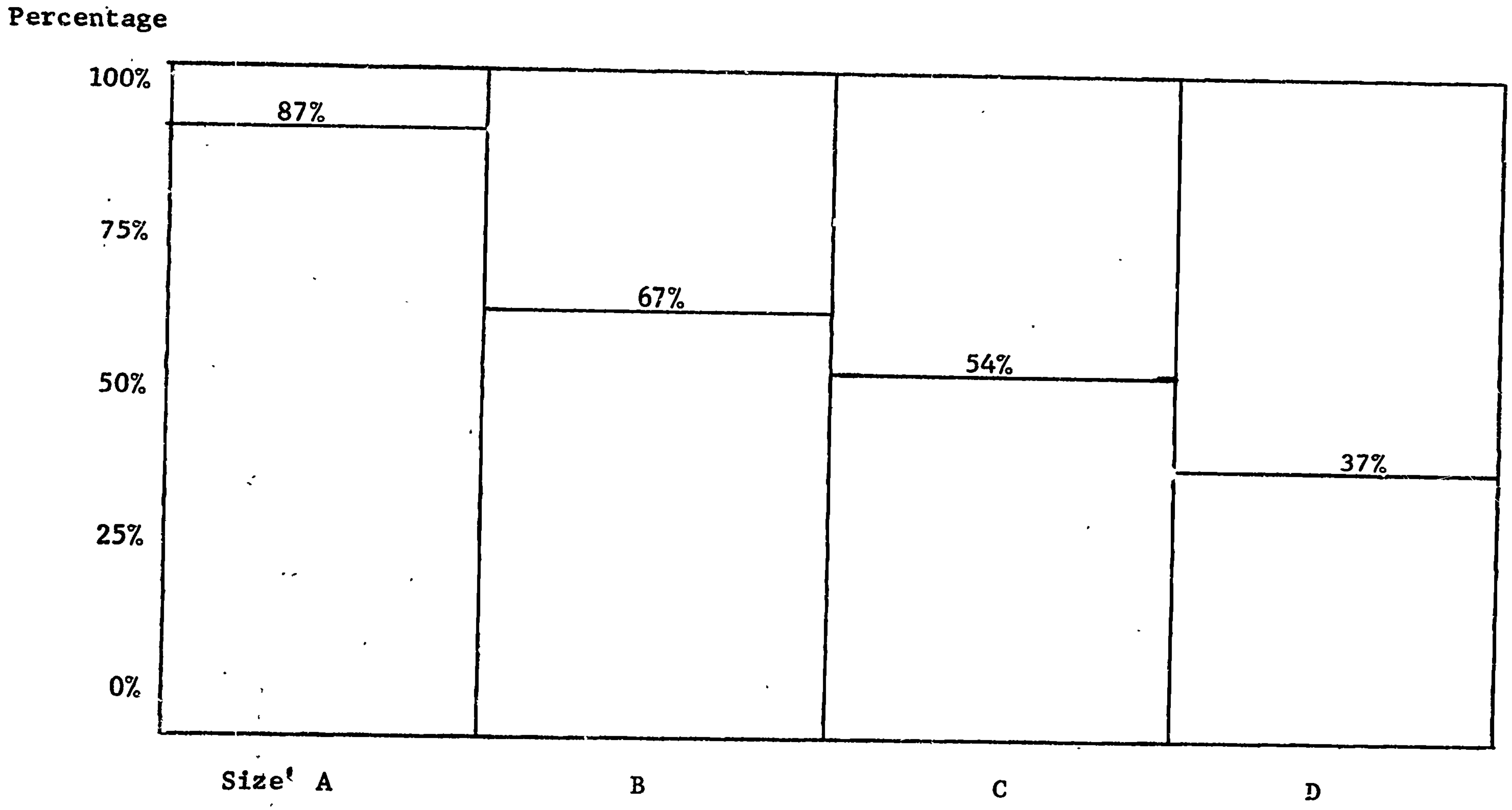
These five groups were used in combination to become the ten sub-hypotheses for hypothesis number four.

The signficant difference between percentages of size of groups, (hypothesis #1), was treated by two different methods. The first was by the total responses in each size group. The second was by the responses of size groups (A, B, C, D) to each of the ten major items on the questionnaire (items 9 through 18).

The first method, to show the significant difference, was by total responses in each size group compared with all other size groups. The percent of positive responses was taken for each organization and then a percentage of acceptance was established by adding all positive percentages in each group and then dividing that total by the total number of responses in that size group. These size group percentages were than tested to establish the significant difference between these groups. The statistical treatment (chi square) revealed a significant difference at the .05 level in all four size groups. To better illustrate the differences between each size group, percentage Chart I was developed and is shown on the following page. The second method of treatment for hypotheses #1, will be by the responses to each of ten major items on the questionnaire by size group (A, B, C, D). The ten items are:

1. Assembly language programing,
2. Compiler language programing (COBOL & FORTRAN),
3. Advanced compiler language programing,
4. Machine language programing,

CHART #1



SIZE

A - Organization employing 20 or more programers or systems analysts.

B - 10-19 programers or systems analysts

C - 5-9 programers or systems analysts

C - 0-4 programers or systems analysts

Oklahoma Employers (by size groups) acceptance for level of trainee developed by state-wide technical education time-sharing system.

5. Second generation hardware,
6. Third generation hardware,
7. Random access concepts,
8. Magnetic tape concepts,
9. Monitor systems concepts, and
10. Tele-processing techniques.

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 establish if a significant difference existed at the .05 level. If significant difference did not exist in the present needs the data, was tested for each preceeding two year period up to 1970-71 period to show if a significant difference could be established in that item. For example, if a significant difference existed in the data for one item for the present, there was no reason to attempt to establish a significant difference in the following two year periods. However, if a significant difference could not be established in the data for one item at the present; the data for that item in the next two year period was tested. If a significant difference was not established from the data for that item; the data for the next two year period was tested. Testing of the data for these items was concluded in the 1970-71 period.

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 level would be consistant after the first year of acceptance.

Assembly Language Programming	Compiler Language Programing COBOL & FORTRAN	Advanced Compiler Language Programing	Machine Language Programing	2nd Generation Hardward	3rd Generation Hardware	Random Access Concepts	Magnetic Tape Concepts	Monitor Systems Concepts	Tele-Processing Techniques	TIME PERIOD
										PRESENT
										1966-1967
										1968-1969
										1970-1971

ESTABLISHED ACCEPTANCE

CONTINUED ESTABLISHED ACCEPTANCE

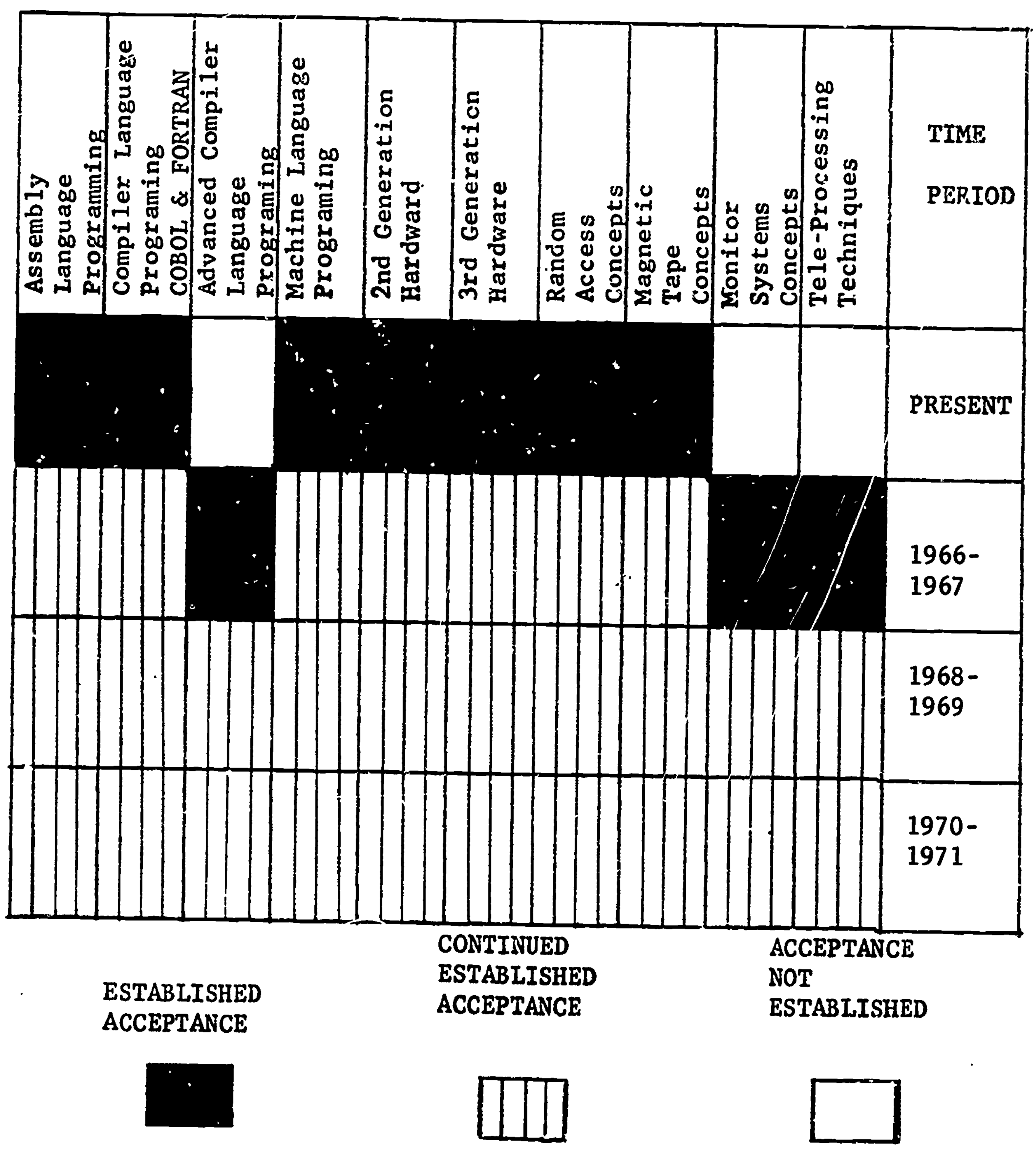
ACCEPTANCE NOT ESTABLISHED

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 programing, 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 of nine of the ten items. They are: advanced compiler language programing and monitor systems concepts. The remaining item (machine language programing) 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.

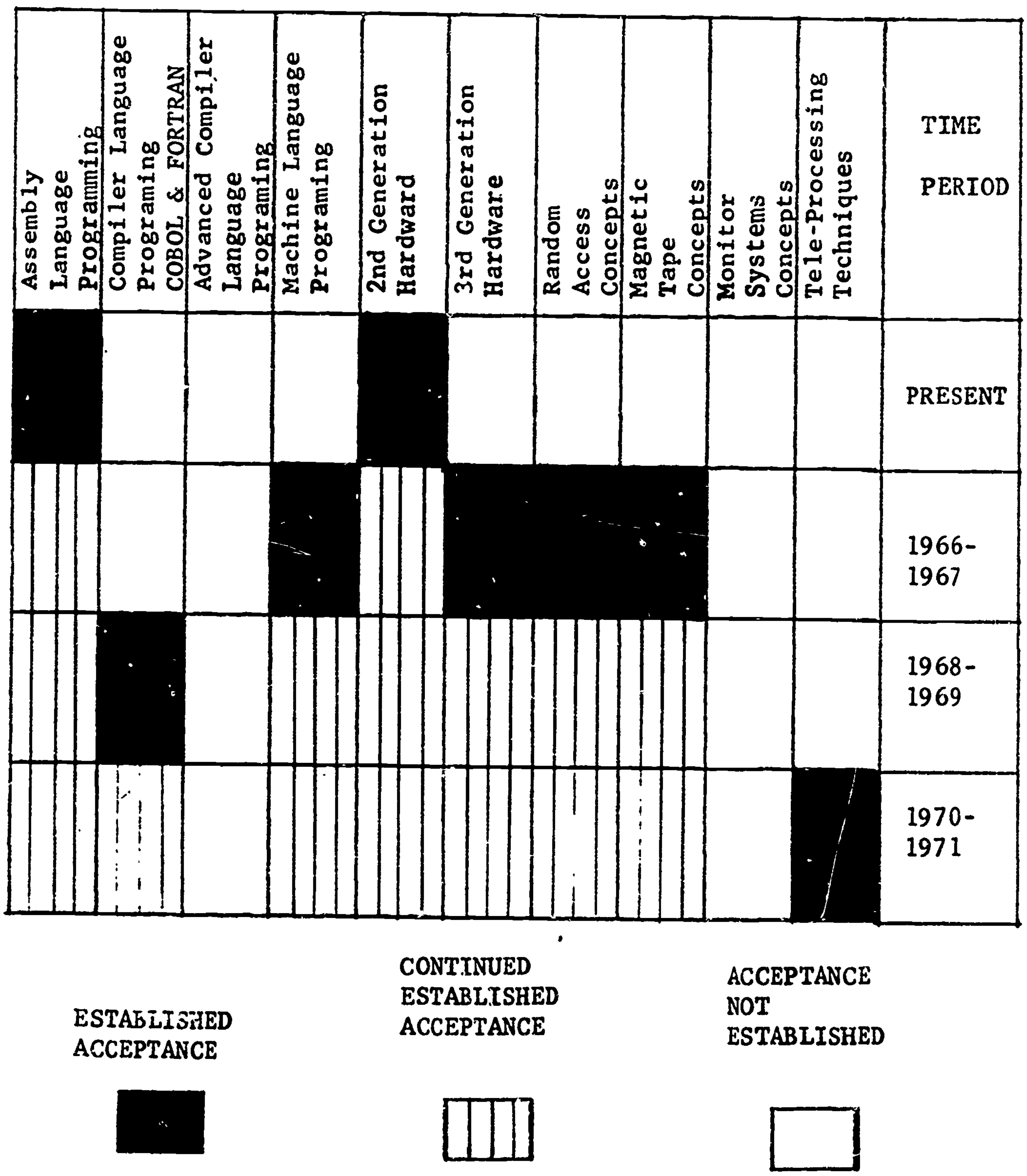
TIME PERIOD	Assembly Language Programming	Compiler Language Programing COBOL & FORTRAN	Advanced Compiler Language Programing	Machine Language Programing	2nd Generation Hardward	3rd Generation Hardware	Random Access Concepts	Magnetic Tape Concepts	Monitor Systems Concepts	Tele-Processing Techniques
PRESENT	ESTABLISHED ACCEPTANCE	ESTABLISHED ACCEPTANCE	ACCEPTANCE NOT ESTABLISHED	ACCEPTANCE NOT ESTABLISHED	ESTABLISHED ACCEPTANCE	ESTABLISHED ACCEPTANCE	ESTABLISHED ACCEPTANCE	ESTABLISHED ACCEPTANCE	ACCEPTANCE NOT ESTABLISHED	ESTABLISHED ACCEPTANCE
1966-1967	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	ESTABLISHED ACCEPTANCE	ACCEPTANCE NOT ESTABLISHED	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE
1968-1969	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	ACCEPTANCE NOT ESTABLISHED	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE
1970-1971	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	ACCEPTANCE NOT ESTABLISHED	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE	CONTINUED ESTABLISHED ACCEPTANCE

ESTABLISHED ACCEPTANCE (solid black)   CONTINUED ESTABLISHED ACCEPTANCE (vertical stripes)   ACCEPTANCE NOT ESTABLISHED (blank)

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 programing, compiler language programing (COBOL & FORTRAN), machine languages programing, 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 programing, monitor systems, tele-processing). Table XXII 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 programing and second generation hardware. The 66-67 time period established acceptance of machine language programing, third generation hardware, random access concepts, and magnetic tape concepts. The 68-69 time period established acceptance



of compiler language programing, (COBOL & FORTRAN). The 70-71 time period, established acceptance of tele-processing technique. The remaining two items of advanced compiler language programing, 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 organizational size group, to establish a significant difference in the acceptance of each item; has developed a basis for designing the education program to provide qualified employees for these organizations. The time period for each items acceptance was established for each size group, to show when acceptance occurred 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 programing, machine language programing, second generation hardware, random access concepts and magnetic tape concepts. The 66-67 time period established acceptance of three additional items; of compiler language programing, third generation hardware, and monitor systems.

The two remaining items established a significant difference of acceptance in the 68-69 time period. These two items were advanced compiler language programing 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; and, 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 are 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 programers. It was revealed in the tabulation of data for Table XVIII, that approximately 70% of all data processing programers 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 revealed that in size groups (A, B, C) a significant difference of acceptance was established for all ten items in the present time period. The acceptance of all ten items continued in the remaining time period.

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

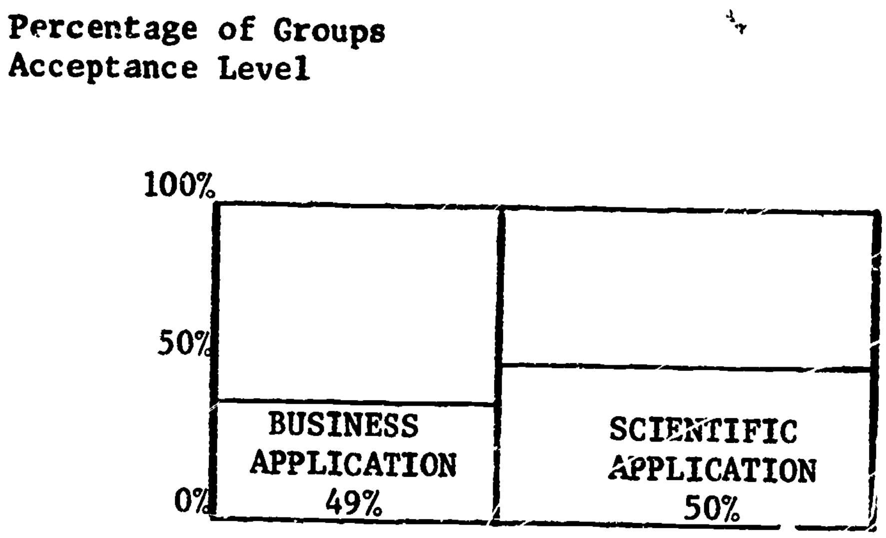
Assembly Language Programming	Compiler Language Programing COBOL & FORTRAN	Advanced Compiler Language Programing	Machine Language Programing	2nd Generation Hardward	3rd Generation Hardware	Random Access Concepts	Magnetic Tape Concepts	Monitor Systems Concepts	Tele-Processing Techniques	TIME PERIOD
Established acceptance	Acceptance not established	Acceptance not established	Established acceptance	Established acceptance	Acceptance not established	Established acceptance	Established acceptance	Acceptance not established	Acceptance not established	PRESENT
Continued established acceptance	Established acceptance	Acceptance not established	Continued established acceptance	Continued established acceptance	Established acceptance	Continued established acceptance	Continued established acceptance	Established acceptance	Acceptance not established	1966-1967
Continued established acceptance	Continued established acceptance	Established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Established acceptance	1968-1969
Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	Continued established acceptance	1970-1971

ESTABLISHED ACCEPTANCE (solid) — CONTINUED ESTABLISHED ACCEPTANCE (striped) — ACCEPTANCE NOT ESTABLISHED (blank)

The significant difference between percentages of application groups (hypotheses #2) will be treated by one method. This method will be to test the significant difference in the total responses in business application groups compared to the scientific application groups. The percent of positive responses over negative responses was taken by each organization and then a percentage was established by adding all the organizations percentages in the business application group and then dividing that figure by the total number of organizations in that group. The procedure was completed for the scientific application group. The data was then statistically treated to establish significant difference in acceptance of the business or 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. To better illustrate the difference between each application, Chart II was developed and is shown on a following page.

The significant difference between percentages of location groups (hypotheses #3) will be treated by one method. This method will be to test the significant difference in total responses in each of the four location groups compared with the next location group. The percent of positive responses over negative responses was taken by each organization and then a percentage was established by adding all of the organizations percentages in one location group and then dividing that figure by the total number of organizations in that group. This

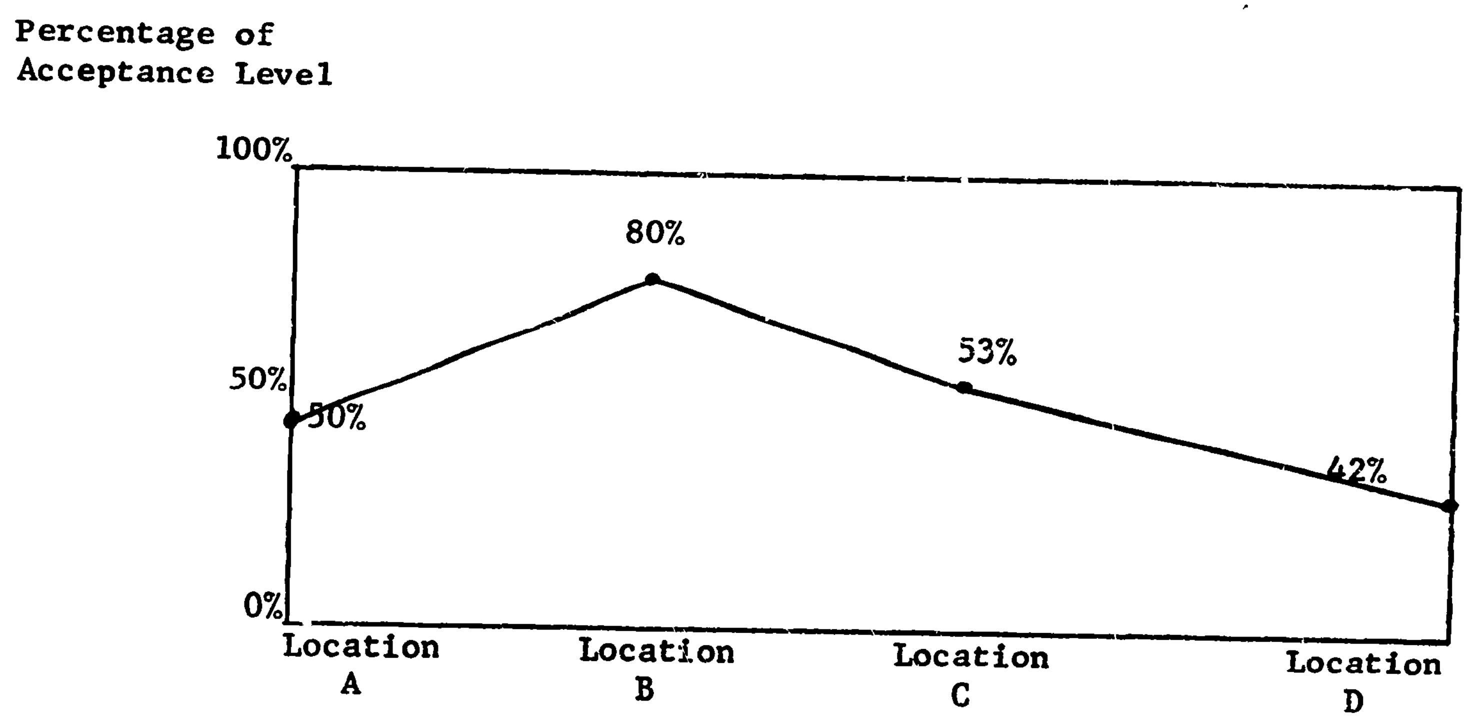
CHART #II



Comparison of acceptance level by type of application procedure was completed for all four location groups.

The data was then statistically treated to establish significant difference in acceptance of each of the location groups. The statistical treatment (chi square) revealed that there was significant difference at the .05 level between the acceptance of the groups A, B, C, and D. The significant difference formed the basic pattern anticipated in the hypotheses #3 for location groups B, C, and D. However, data on location Group A revealed that significant difference of acceptance existed but 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 original pattern of Group A can be easily explained. Location Group A consisted of organizations of all types of applications and organization of all sizes where location Group B generally consisted of organizations of specific size and type of application. For example, the majority of the large oil companies in 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 of location Group B and this also effected to some degree the acceptance level in location Group D. To better illustrate the differences between each location group percentage Chart III was developed and is shown on a following page.

CHART #III



Group - Location

Location A - Radius 10 miles, population 75,000 or more

Location B - Radius 10 miles, population 50,000 or more

Location C - Radius 10 miles, population 25,000 or more

Location D - Radius 10 miles, population 0 to 24,999

Acceptance level of state-wide data processing system by the location of organizations.

Statistical treatment of hypotheses #4 was given to ten sub-hypothese, which tested five selected size, application, and location groups (A-A-A, A-A-B, A-A-C, A-A-D, C-A-D), and combinations of these groups. The ten sub-hypothese are as follows:

IV^{1} Size A - application A - Location A (Group #1)
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)

IV^{10} Size A - application A - Location D (Group #IV)
Size C - application A - Location D (Group #V)

Each of the ten sub-hypothese were tested to establish that there was a significant difference in the ability of the lower number group in that sub-hypothese to access the needs for this type of program over the higher number groups. 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, program language #I, etc.), some of the groups would have less ability to assess the needs for qualified trainees. For this reason a method for marking the form to show that the individual could not answer due to lack of knowledge of a certain aspect of data processing systems.

The total of the responses marked in this method were tabulated for groups 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 responses for each of the five groups were compared with the responses of the other four groups. The total of ten combinations of group comparisons were made; each combination is represented by one of the sub-hypothese. Nine of the ten sub-hypothese tested revealed a significant difference in the ability to assess the need for this type of program at the .05 level of significants. The nine sub-hypothese that showed a significant difference at the .05 level are:

IV[1] Group I (A-A-A) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newlv developing concepts in data processing compared to group II (A-A-B).

IV[2] Group I (A-A-A) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group III (A-A-C).

IV[3] Group I (A-A-A) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group IV (A-A-D).

IV[4] Group I (A-A-A) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group V (C-A-D).

IV[5] Group II (A-A-B) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group III (A-A-C).

IV[6] Group II (A-A-B) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group IV (A-A-D).

IV[7] Group II (A-A-B) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group V (C-A-D).

IV^8 Group III (A-A-C) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group V (C-A-D).

IV^9 Group III (A-A-C) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group V (C-A-D).

IV^{10} Group IV (A-A-D) showed a significant difference at the .05 level in the ability to access the need for this type of program due to their familiarity with and knowledge of the newly developing concepts in data processing compared to group V (C-A-D).

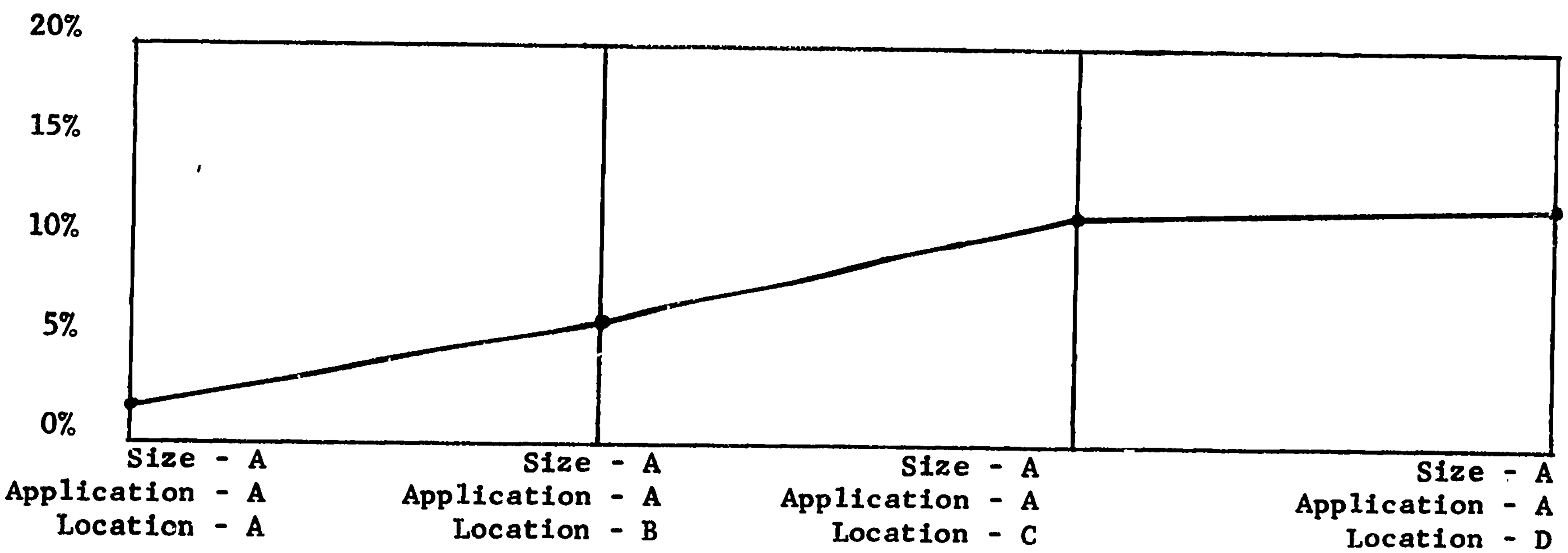
The one sub-hypothese that did not reveal a significant difference at the .05 level of significancy was sub-hypothese IV^8 which compared group III (A-A-C) and group IV (A-A-D). There was a slight difference however, it was not significant at the .05 level.

To better illustrate the ability of the location sub-groups in size group A to access the need for this type of program Chart IV was developed and is shown on a following page.

Statistical treatment of (hypothese #5) 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.

CHART IV

PERCENT OF GROUPS THAT LACK THE FAMILIARITY WITH AND KNOWLEDGE OF THE NEWLY DEVELOPING CONCEPTS IN DATA PROCESSING.



COMPARISON OF GROUPS ABILITY TO ASSESS THE NEED FOR THIS TYPE OF PROGRAM
-BY-
LOCATION OF GROUPS

Statistical treatment of (hypothese #6) will be to establish if a significant difference existed between the requirements for adequately trained data processing personnel in the present time period and the 1970-71 time period. It is to test if requirements were upgraded or improved by the responses that acknowledged and recommended changes in the requirements over the four time periods concerned.

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 all thirteen items of knowledge requirements on the inquiry form. They are: (1) Compiler language programing (COBOL and FORTRAN), (2) Advanced compiler language programing, (3) Machine language programing, (4) Third generation hardware, (5) Random access concepts, (6) Magnetic tape concepts, (7) Tele-processing techniques, (8) Process control concepts and (9) Numerical control concepts.

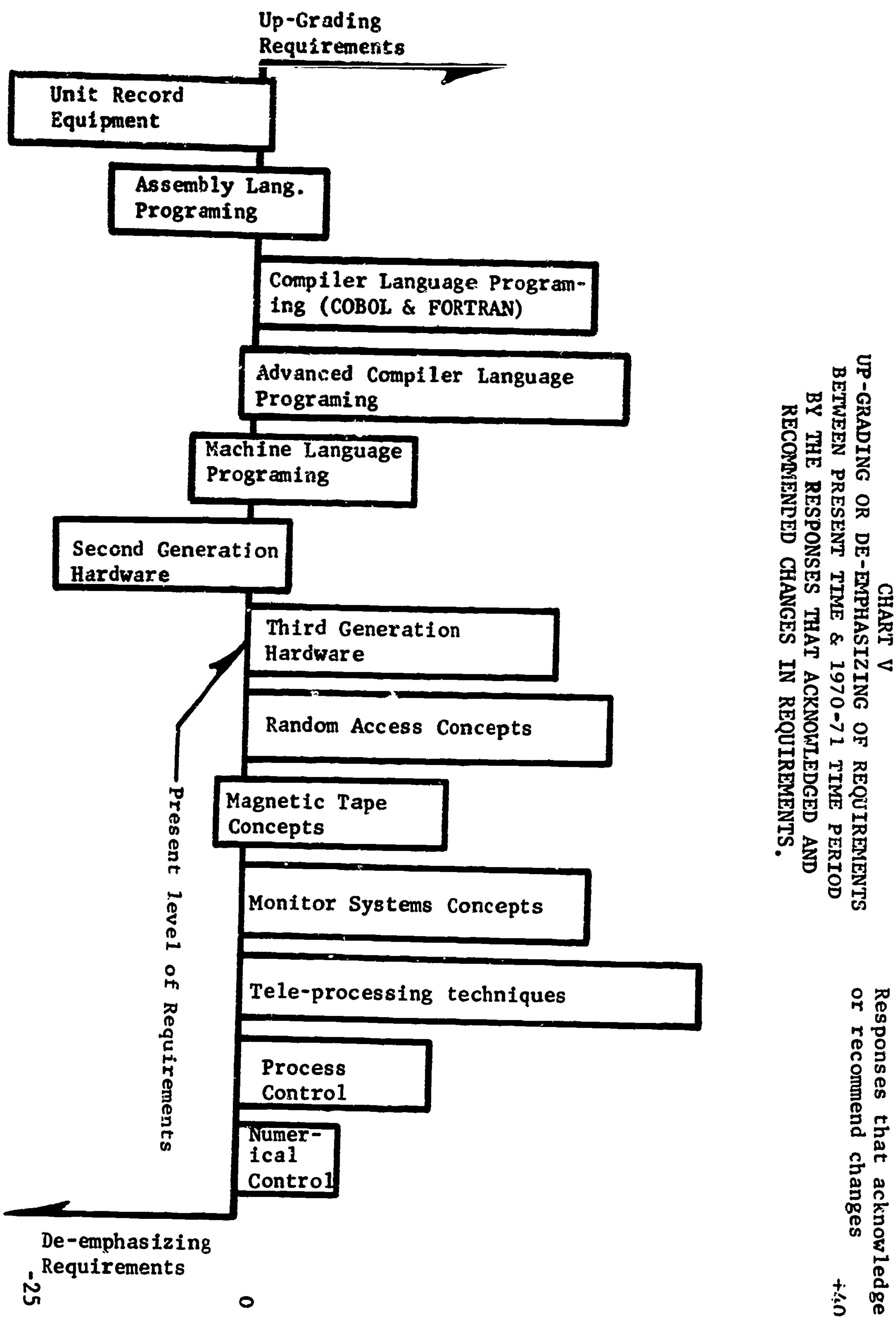
The three other items of knowledge requirements on the inquiry form (1. Unit record equipment, 2. Assembly language programing, 3. Second generation hardware) did not show a significant difference between the present time period and the 1970-71 time period concerning the improvement or up-grading of requirements for adequately trained data processing personnel. In fact, they were tested to show if 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 to reduce the emphasis or requirements 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 V was developed and is shown on a following page.

Statistical treatment of (hypothese #VII) established that there was a significant difference at the .05 level of significance in the requirement for tele-processing technique in the present time period for size groups A & B (See tables XXI & XXII). Size group C established a significant difference at the .05 level of significance in the 1966-67 time period (see Table XXIII). Size group D established a significant difference at the .05 level of significance in the 1970-71 time period (see Table XXIV).

The combination of size groups A, B, & C established significant difference at the .05 level of significance in the present time period (see Table XXIV). The combination of size groups A, B, C, & D established significant difference at the .05 level in the 1968-69 time period (see Table XXIV).

Even though the tele-processing technique will be mainly used as an access method to provide the best possible training with a reduction in cost and reducing obsolence for each school; the basic technique must be taught to the students to best serve the organizations that employ these students. To further substantuate this point hypothese

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



#VI and Chart V show that the tele-processing technique will be the requirement that shows the most emphasis in up-grading requirements for adequately trained data processing personnel from the present time period to the 1970-71 time period.

CHAPTER V
SUMMARY, CONCLUSIONS & RECOMMENDATIONS

This study has been concerned with the problem of the adequate preparation of data processing programers 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 programers 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 programers and systems analysts utilizing the specialized training requirements established in Chapter IV, a comparison will be made between data communications system and a stand-along system emphasizing the cost to the local school to accomplish the basic purpose of adequately trained personnel.

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 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 collates 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 programing, compiler language programing (COBOL and FORTRAN), machine language programing, second generation hardware, third generation hardware, random access concepts, magnetic tape concepts, and monitor systems concepts were made in this 1966-67 time period. The established acceptance of the specialized training requirements for the items of advanced compiler language programing and tele-processing (data communications) techniques in the 1968-69 time period. However, Chart V, concerned with the up-grading 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 up-grading of training requirements in the two items of advanced compiler language programing 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 programing for third generation hardware is a necessity and consideration should be given to assembler language programing of second generation hardware if this equipment is still in use.
3. Compiler language programing consisting of the two basic language of COBOL and FORTRAN. These two languages must be taught if the student is to be employed by the majority of organizations requiring employees. These two languages were required by the organizations that employed approximately 70% of all the programers and systems analysts (see Table XXV).
4. Advanced compiler language programing should be developed into the instructional program as soon as the organizational organization of advanced compiler languages such as program language #1 become sufficient enough to justify it's use.
5. Machine language programing for the type of system utilized in the instructional program.
6. Second generation equipment should not be considered when it is planned to be the complete (stand-alone) instructional system for a program. As a back-up system to third generation hardware or as terminal equipment on-line to third generation,

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 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 up-grading 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 interm 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 programer 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 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.

Considering these ten requirement items three equipment configuration comparisons are given below to more completely establish the economic hardware and personnel feasibility of a data-communications system. These three equipment configerations comparisons will be to compare the cost of a local school as part of 15 school data-communications (time-sharing) system that can offer an instructional program that can provide all ten of the specialized training requirements outlined in the findings of the study (see a following page for equipment and cost summary) to:

1. Third generation stand-alone system with tapes and disk and that can meet 9 of the 10 specialized training requirements. (see page #117)
2. Third generation stand-alone system without tapes or disk and that can only meet 6 of the 10 specialized training requirements. (see page #119)
3. Second generation stand-alone system with tapes and disk and that can meet 6 of the 10 specialized training requirements. (see page #120). With a 60% educational allowance.

DATA CENTER - HARDWARE

A. A central processing unit (one micro-second unit speed) including approximately 100,000 characters of memory, control panel, power supply, scientific unit, and peripheral equipment.

B. Quantity

1.	1	Tape Control Unit
2.	1	Magnetic Tape Unit, ½ inch tape, 44,000 characters per second, primary unit
3.	3	Magnetic Tape Unit, ½ inch tape, 44,000 characters per second, secondary unit

4.	1	650 lpm printer and control
5.	1	Card Reader and Control 800cpm
6.	1	Card Punch Control
7.	1	Card Punch 100-400 cpm
8.	1	Disk Storage Control Unit
9.	3	Disk Drives Units (9½ million characters) 8.5 mil.-sec. access time
10.	1	Multi-channel Communication Unit (for 4-15 lines).
11.	5	Multi-channel Adapter

C. Local Technical Education Data Processing Hardware (15 schools)

1.	15	Central Processor including 4,096 characters of memory, control panel, power supply (two micro-sec unit speed)
2.	15	450 lpm printer and control
3	15	Card reader/punch 100/400 cpm
4.	15	1/0 adapter
5.	15	Communication control unit

This equipment configuration can offer an instructional program that can provide all ten of the specialized training requirements outlined in the findings of the study.

I-A	Control Processing Unit @ Data Center		
		per month	$5,387.00
I-B	Peripheral Equipment @ Data Center		
		per month	6,596.00

I-C	15 Local Schools-Terminal Computing Equipment		
		per month	28,803.70
		Sub total per month	41,236.70
		Education Allowance	8,403.42
		Computing Hardware Total	32,833.28
II-A	American Telephone & Telegraph 20-201-B-3 Bell Data Sets @$75.00 per month		1,500.00
B.	5- private full-duplex voice grade lines @ $400./mo. average per month		2,000.00
		Communications Hardware Total	3,500.00

III-A Unit Record Equipment Each Local School

3 - 026 Key Punch @ $60/mo. = 180./mo.

1 - 029 Key Punch @ $60/mo. = 60./mo.

1 - 557 Interpreter @ $104./mo. = 104./mo.

1 - 519 Reproducer Document original machine
@ 85/mo = 85./mo.

1 - 085 Collator @ 95/mo. = 95./mo.

1 - 407 (E-8) Accounting Machine
@400/mo = 400./mo.

1 - 082 Sorter @ 40/mo - 40./mo.

Sub Total = 964/mo.

20% Education Allow = 193.80/mo.

Total = 770.20/mo.

Total of computing hardware and communications hardware for data-communications system (these cost figures are based on systems costs submitted to the State Board for Vocational Education by vendors).

Per Month $36,333.20

This cost divided by the fifteen local schools offering data-processing instructional programs as part of the state-wide computer science system would produce the cost for one local school.

Local school cost for computing hardware and communications hardware (I & II) Per Month 2,402.21

Local school cost for unit record equipment per month 770.20

Total cost per local school of al' hardware and unit record equipment for data communication system per month 3,172.41

The above data communications (time sharing) system will first be compared with a third generation stand-alone system with tapes and disk. This system can meet all the specialized training requirements that the data communications system did except for the tele-processing techniques. The equipment configuration and cost summary is listed below.

Third generation central processing unit, (1.5 micro-sec. unit speed) Minimum 16,000 character of memory protect features, edit instruction, decimal arithmetic, floating point hardware = $2,000/mo.

1 card reader 600 cards per minute	=	260/mo.
1 card punch 250 cards per minute	=	375/mo.
1 printer and control 600 lines per minute	=	750/mo.
and control	=	600/mo.

1 disk storage control unit access time 25 mil. sec. (7.25 million characters)= $575/mo.

1 disk storage drive

1 magnetic tape unit - ½" tape (15,000 characters per second, primary unit)= 525/mo.

and

3 magnetic tape, secondary unit	1,200/mo.
Sub Total =	$6,285/mo.
20% & 10% Education allow. =	939/mo.
Computing Hardware - Total =	5,346/mo.
Unit Record Equipment Total= (same local cost for this equipment as in the data-communication system)	770.20/mo.
Total System Cost =	7,055.20 per month

This equipment configuration is a good instructional system and if cost was not a major factor this system would have to be a major consideration. However, if cost is a major consideration, the cost of this system is approximately $3,882.00 per month higher than the cost per local school in the data-communications (time-sharing) system.

The cost of comparison #I third generation stand-alone system with tapes, disk and unit record equipment is $7,055.20 with all educational allowances available, while the data-communications system with tapes, disk, and unit record equipment is only $3,172.41 per month for each local school.

The data-communications (time-sharing) system will be next compared with a third generation stand-alone system without tapes and disk.

This system can only meet 6 of the 10 specialized training requirements outlined in the findings of the study. This equipment configuration is listed below.

Third generation central processing unit, (1.5 micro-sec. unit speed) minimum 16,000 characters of memory, memory protect feature, edit instruction, decimal arithmetic, floating point hardware $2,000/mo.

1 - card reader 600 cards per minute	= 260./mo.		
1 - card punch 250 cards per minute	= 375./mo.		
1 - printer 600 lines perminute	= 750./mo.		
1 - printer control	= 600./mo.		
	Sub Total	=	$3,985.00/mo.
	10% and 20% Educational Allowance	=	597.00/mo.
	Computing Hardware Total	=	3,388.00/mo.*
	Unit Record Equipment Total (Same Local cost for this equipment as in the data-communications system)	=	770.20/mo.
	Total System Cost	=	4,158.20/mo.*

*This system does not include magnetic tapes or disk.

The full eq.'pment configeration of third generation equipment as presented in comparison #I is a good instructional system; however, the equipment configuration in comparison #II is extremely limited in ability to provide an adequate instructional program to train data-processing personnel. Some schools obtain this limited equipment configuration and then expand their system as financing becomes available. The cost of the equipment in the second comparison is $4,158.20 per month with all educational allowances including computing hardware and unit record equipment. This is approximately $985.00 per month higher than the data-communications system costs for each local school.

The third and final comparison to be made will be to compare a second generation stand-alone system with magnetic tapes, disk and unit record equipment to the data communications system. The second generation configuration can only meet 6 of the 10 specialized training requirements outlined in the findings of the study. This equipment configuration is listed below.

Second Generation Central Processing Unit, 12,000 characters of core memory, multi-divide, advance programing, sense switches, compare (11.5 micro-sec. unit speed) = 2,775.00/mo.

1 card reader 800 cards per minute/

1 card punch 250 cards per minute/

1 printer & control 600 lines per minute - 775./mo.
& Control = 120./mo.

1 disk storage control unit = 885.00/mp
(access time 250 mil.sec) (2mil. characters)

1 disk storage drive = 360.00/mo.

1 magnetic tape unit, 15,000 characters/sec. primary unit = 450/mo.

3 magnetic tape units 15,000 char./sec. secondary unit = 1350/mo.

Sub Total = 7,285/mo.

20% and 60% Educational Allowance = 3,149/mo.

Computing Hardware Total = 4,136/mo.

Unit Record Equipment Total (Same local school cost for this equipment in the data-communication system)	770.20/mo.
Total System Cost	$4,906.20/mo.

The third comparison is to compare a second generation stand-alone system with a third generation data-communications system. The capabilities of the data-communications system is much greater than the second generation equipment and it is even less expensive for the local school. The cost of the second generation stand-alone system as configurated (with an educational allowance on part of the equipment figured at 60%) is $4,906.20 per month while the data-communications system is less by approximately $1,733.00 per month at $3,172.41 per month. The data-communications system therefore must be considered if state and federal funding is involved.

After considering the three comparison of equipment configurations and the data-communications system it is clear that the technique of data-communications or time-sharing will have a great impact on the utilization of computing power, reduce cost of local school equipment, personnel back-up from the data-center personnel, and greater service for students and faculty this system must play an important role in the training of qualified data processing personnel, and in the total education program.

One of the most serious problems associated with the use 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 unit. The principle 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 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 micro-wave 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, lower-level languages and 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 programing, scientific programing, 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 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 programing 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.

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 outlay 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 trai. . 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 and operating 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 as- aociated 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. (Frequently the prospect will already have a map depicting some of this information for his own purposes.)

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. Faculty people in the computer area 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.

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 still available for additional comparisons of responses from other local, state, or regional groups who might be considering such a system or trying to up-grade their existing one. Such additional comparisons might reveal worthwhile significant differences in responses of states' organizations 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 pieces 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, 2000, 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 an 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 communication 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 placed in tape or cards to 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 communication 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 regulartory 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

TECHNICAL EDUCATION
OKLAHOMA STATE BOARD FOR VOCATIONAL EDUCATION
J B PERKY, DIRECTOR · · 1515 WEST SIXTH AVENUE · · STILLWATER OKLAHOMA 74074

September 8, 1965

Dear

Technical education data processing programs are being developed in the State of Oklahoma for the training of programers 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 PROGRAMERS & 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 Business or Industry________________________________

Address________________________________

Name of Person Completing Questionnaire________________________________

Title________________________________

Telephone Number and Extension________________________________

EMPLOYMENT NEEDS

1. Number of programers & systems analysts now employed Men___Women___
2. Total number of programers & systems analysts needed at the present time______
3. Anticipated number of programers and systems analysts needed between the present time and 1967______
4. Anticipated number of programers and systems analysts needed between 1967 and 1970______

   Example If you have 2 programers 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 programers & 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 PROGRAMERS & 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 programers and systems analysts receive training on any specific types of equipment? Yes ( ) No ( )
   Specify type__________

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

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

8. Type of programers of systems anaylsts preferred. Male__Female__Either__

ANTICIPATED TRAINING REQUIRED

1. What number of your programers 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 programers and systems analysts, would they attend? Yes____ No____ Doubtful____

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 programers 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 PROGRAMERS 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 computer programers and systems analysts. The shortage of programers 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 programers and systems analysts by the use of a state-wide 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, the number of Data Processing technicians needed for the future, and willingness of industries and educational institutions to cooperated in a state-wide venture to provide the services needed.

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 programers and systems analyst technicians, it is felt that this state-wide system for data information and processing would bare 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 programers 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 programers 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. Procedures:

The procedure for the investigation is as follows:

1. Establish a jury of selected leaders, experienced in the field of educational data processing and industrial data processing, for evaluating the questionnaire which will be used.
2. Revise questionnaire as suggested by the jury.
3. Send questionnaire to randomly selected organizations in the State of Oklahoma that employ data processing programers or systems analysts for their response.
4. 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 organiz :ional groups S-A, S-B, S-C, S-D. Analyzing and interpreting data for hypotheses No. 1

   Group S-A (Organization employing 20 or more programers or technicians)
   Group S-B (Organization employing 10 to 19 programers or technicians)
   Group S-C (Organization employing 5 to 9 programers or technicians)
   Group S-D (Organization employing 1 to 4 programers or technicians)

5. 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 . ,potheses No. II
6. 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, group 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 o to 24,999)

7. 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 1. 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
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

8. 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.
9. 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 programers and systems analysts. Analyzing and interpreting data for hypotheses No. VI.
10. 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.
11. To analyze the recommendations for adequately trained programers 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 tnat a significant difference

in the abilities of groups to access the need for this type of programer 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 in the 1970-71 time period. The time periods must show an increase in the time periods from not-required to preferred to required.

12. 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 programers 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 total system concept of data processing as it has progressed and the trend in which it is developing. They must also have knowledge of the various types and means 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 $P \angle .05$

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 $P \angle .05$

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) $P \angle .05$

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, $P \angle .05$.

No. IV^{2} group I compared with group III $P \angle .05$

No. IV^{3} group I compared with group IV $P \angle .05$

No. IV^{4} group I compared with group V $P \angle .05$

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 $P \angle .05$

IV^{8} group III compared with group IV P /_ .05

IV^{9} group III compared with group V P /_ .05

IV^{10} group IV compared with group V P /_ .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 /_ .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 programers and systems analysts by all groups involved. P /_ .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 /_ .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 programer 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 programers or technicians employed would tend to determine the needs and qualifications set forth by larger industrial groups, organizations, and agencies.

7. Limitations of the Study:

No attempt will be made to survey all industrial groups, organizations, or agencies using data processing programers or technicians. However, 100 per cent of all industrial groups, organizations,or agencies employing 20 or more data processing programers 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 programers or technicians (group S-B) will be surveyed. Fifty per cent of all industrial groups, organizations, or agencies employing five to nine data processing programers 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 programers 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.