FACTORS WHICH SHOULD INFLUENCE A MODEL CURRICULUM FOR PROGRAMMERS OF BUSINESS APPLICATIONS

by

JAMES B. DAVIS, JR.

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
1956

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1958

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Thesis Approved:

Thesis Adviser

Dean of the Graduate College

PREFACE

Automation is a timely topic in any conversation concerning the current activities of business and industry. The economic resource of manpower lubricates the wheels of business and industry to keep them turning; and, when a machine is developed to replace that resource, deep concern for involved manpower develops.

The concern of office or clerical staffs about automation can be expressed in three beliefs: (1) The advent of machines in business upsets the status of the human clerical resource and creates unemployment; (2) the advent of machines in business improves the operation of the economy through savings on costs and through wide distribution of final products; and, (3) the advent of machines in business causes society to be faced with the challenge of maintaining equilibrium between the labor resource utilized and the economic goods realized.

The challenge of society to maintain that equilibrium suggests that the combined efforts of business, industry, and education are needed. Through research and experimentation the best combination of all efforts can be maintained.

The use of electronic digital computers in solving business problems has added to the complexity of the educational problem of developing vocational competence. New positions have been created. One position in particular, that of programmer of business applications, has demanded much attention from educators. The programmer is the "brains" behind the computer. Many questions concerning his status have not been answered.

There has been dispute regarding where his position lies within the organizational structure. Some think that he should contribute to actual decision making; others think that he should help provide data to enhance decision making.

The programmer appears, at many times, to be a strange "breed." His proper education and training present an unique problem for computer manufacturers, prospective employers, and educational institutions.

Many research projects concerning the training of computer data processing personnel have been conducted; however, most of these research projects have been devoted to the technical composition of courses designed for various machine operators and the skill proficiencies expected of these operators. Very little research has been conducted to help determine the content of a formal education pattern for people involved with the "brain" mechanisms of the computer.

Leon Hay conducted an opinion survey in 1956 to determine the general areas of business and mathematics that should influence a curriculum for computer programmers.[1] Nine years have passed since Hay completed his study. Information has accumulated and experiences have been numerous. His method of data collection, the lapse of time since his study, changes in management emphasis, and the gradual recognition of computer programming as a profession justify a similar study to either endorse Hay's conclusions or to make new recommendations for a formal education pattern for business programmers.

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[1]Leon Hay, "A Study of Office Automation and the Functions and Qualifications of Programmers for Data Processing" (unpub. Ed.D. dissertation, University of Southern California, 1958).

Although the Hay study and a similar study conducted by Hanke[2] in 1964 have contributed much toward the organization of a formal pattern of education for programmers of business applications, the findings of both studies lack specificities that are needed to establish a sound basis for the development of a model curriculum in the business computer programming area. Hay stated in his study, "There is not yet universal information or experience to make it possible to say with any authority what the content and methods of courses should be for prospective programmers."[3]

It is the purpose of this study to gather current information that will make it possible to establish with a degree of authority a four-year curriculum for business applications programmers.

Indebtedness is acknowledged to Dr. Robert A. Lowry for the valuable guidance and assistance he offered through his capacity of major advisor and committee chairman; and to the following members of the committee for the valuable time and suggestions they contributed to the completion of this study: Dr. B. B. Griffith, Dr. H. A. Conrad, and Mr. W. L. Zimmerman.

Indebtedness is also acknowledged to each of the business programmers who was interviewed and to all of the data processing departmental supervisors for their cooperation in arranging interviews with programmers.

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[2]John Edward Hanke, "A Study of the Education and Training of Business Computer Programmers in Selected Businesses in Northern Illinois" (unpub. M.S. Thesis, Northern Illinois University, 1964).

[3]Hay, p. 79.

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CHAPTER I

INTRODUCTION

The computer industry has expanded rapidly since the installation of the first digital computer in 1951. It has expanded so rapidly that experiences in recruiting electronic data processing personnel have led to the belief that it cannot be taken for granted that well-qualified workers are available in the numbers that will be required to satisfy the needs of government and private industry for electronic data processing operations. Because of the shortage of computer personnel, it is fair to assume that there is an immediate need to provide and improve training programs for people who work with and handle computers.

In 1961, about 7,500 computers were in operation in the United States; in 1962, about 11,000 computers were in operation. Three thousand five hundred new computers were installed in 1962. For each new computer that was installed, 4 to 8 persons were estimated to have received training to qualify them as programmers, systems analysts, or console operators. On the basis of that estimate, approximately 14,000 to 28,000 employees assigned to electronic data processing units received training in computer operations in 1962.[1]

The installation of computers affects employees who perform clerical and accounting tasks. One of the chief objectives of computer

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[1]"Automatic Data Processing in the Federal Government--Its Manpower Requirements," Manpower Report Number 6 (Washington, May, 1963), p. 11.

installation is clerical labor saving. It could be argued by management that there is a need to replace with computers people who perform clerical and accounting tasks because during the ten-year period before 1963 the number of clerical personnel in the United States increased 29 per cent. Clerical salaries increased at an average of 3 per cent a year from 1953 to 1963. On an annual basis for the ten-year period between 1953 and 1963, wages for clerical personnel averaged 392 billion dollars.[2]

Further evidence to support the argument that computers should replace employees who perform routine clerical tasks is the fact that today the most powerful computer can take in and retain information at a rate of 100,000 characters per second. Compared to man's ability to absorb and retain information, the computer has an advantage factor of 1,000:1. Comparing man's ability to dispatch information with that of a computer, the computer has an advantage ratio of 2,000:1. That ratio is supported by the fact that the computer can record out on magnetic tape at the rate of 8,000 words a second compared to man's ability to record approximately four words per second.[3] Computer usage, however, will not reach its full potential until users can adapt a program for totally integrating management information systems.[4]

Installation of computers may affect the morale and job satisfaction of employees. The process of installing a computer and of adapting work methods to it should be handled with great skill by management.

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[2]"A Survey and Study of the Computer Field," Computers and Automation, Jan., 1963, p. 15.

[3]Ibid., p. 16.

[4]Ibid., p. 17.

A number of executives, for example, may owe their position to a particular system that they have been responsible for introducting and administering. They may oppose automation because automation may do away with their systems and thus their jobs.[5] The clerical employee must face constant threat to his job and the possibility that he will be subjected to a new training or retraining system to enable him to acquire new skills in order to continue to earn his livelihood. The federal government uses computers to cut clerical and administrative costs in the Federal Farm Program. It was estimated that the utilization of computers in that program would cut out 241 jobs and save a total of 1.5 million dollars a year when the program became fully effective in 1964.[6]

The advent of computers in government and industry brings about many side effects. Fewer levels of authority exist in an organizational structure. There tends to be greater centralization and less decentralization of management activities. Some argue that a blurring of staff and line functions takes place; marketing becomes stronger and more certain because of easily accessible facts; and decisions are less arbitrary because management can obtain facts more quickly and accurately. The keeper of information, furthermore, has an important position; financial control is effective and timely; and all levels of an organization are informed and more responsive because the producing of multiple

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[5]"Business Week Reports to Readers on: Computers," Business Week, June 21, 1958, p. 90.

[6]"A Survey and Study of the Computer Field," p. 21.

types of automated reports causes problems to be apparent rather than isolated within the boundaries of one department.[7]

As the number of computer installations continues to increase and as various side effects are produced, government, industry, and educational institutions are faced with the task of providing training programs and recruitment devices to attract and prepare young people for electronic data processing positions. To be of value to management, these people must possess a proper balance between technical computer knowledge and knowledge of business and operations of industry.

Some are of the opinion that it is easier to teach the machine to someone who understands the business than to teach the business to someone who understands the machine. A machines technician may not be competent to determine the best business applications for a company.

Both vocational training programs and methods of teaching should be constantly studied and revised so as to take into account the new knowledge and qualifications which the automation and mechanization of office work will require of an ever increasing number of employees. It may be desirable to increase the number of technical schools or training courses and to adapt curricula to the changing requirements of office technology. Courses may also be needed to keep workers abreast of changing requirements.

It is becoming apparent that computer programmers and systems analysts are receiving their training in colleges and universities. Their positions are rapidly becoming recognized as professional positions. The training which these people need is not of a technical nature only

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[7]R. R. Curry, "Significance of Computer Investment Decisions," Computers and Automation, September, 1962, p. 10.

but also includes a thorough knowledge of business policies, operations, financial statements and other areas of "business knowledge" that are essential for successful business management. It may be assumed that the proper training of a programmer would place him in a position of vital importance to management in the making of decisions and the carrying out of business functions.

The individual who has the potential of becoming a business applications programmer and eventually entering a management position needs some educational pattern to guide his training in that direction. There is need for a formal pattern of education that will provide the education and training needed by the programmer.

Statement of the Problem

The problem of this study is twofold. The first part of the problem is to determine the factors that should influence a four-year curriculum leading to a degree in computer science with special emphasis on business applications programming. The second part of the problem is to design a model curriculum in computer science for Central State College, Edmond, Oklahoma, with consideration given to the factors determined in part one.

The study is designed to answer these specific questions: (1) What is the nature and amount of education that business applications programmers have received? (2) What are the conditions that surround the activities of the programmer that could influence the content of a business applications curriculum? (3) With what degree of frequency are selected activities encountered by programmers of business applications? (4) What sequence of courses at Central State College should be made available to a degree-bound student who aspires to become a successful programmer of business applications?

Delimitations

As a model curriculum developed in this study is designed for Central State College in particular, certain characteristics relative to all four-year curricula at Central State College had to be recognized as limitations. In the first place, the curriculum for programmers of business applications is limited to courses that are available or that could readily be made available at Central State College.

In the second place, a four-year curriculum in this area is limited to the acceptable patterns of curriculum design at Central State College; consequently, the curriculum must contain either (1) 50 hours of general education with one major and two minor areas of subject matter concentration or (2) 50 hours of general education with two major areas of subject matter concentration.

It is assumed that a curriculum at Central State College should be largely determined by needs of business firms located within the proximity of Central State College; therefore, this study is further limited to a geographical area within a radius of 100 miles of Central State College. The business firms studied are limited to those which employ electronic data processing computers in their automation programs.

Sources of Data

The data for this study were obtained from: (1) published and unpublished materials relating to the history of the computer, the problems encountered through the installation of the computer, the operations for which the computer is used, and the achievements that have resulted from the operations of the computer; (2) published and unpublished research projects dealing with the training of individuals for

data processing positions, with emphasis on programmers; and (3) interviews with computer programmers of business applications in selected business firms within a radius of 100 miles from Central State College.

Procedure

The following procedures were followed in conducting this study:

1. Read literature relative to electronic data processing computers to acquire necessary background knowledge for this study.
2. Surveyed the related research concerning electronic data processing computers to determine the need for this study.
3. Designed an interview guide to reveal topics that could be logically included in a pattern of formal education for the programmer of business applications.
4. Compiled a list of programmers of business applications in the limited area.
5. Interviewed a sample number of programmers of business applications in order to test the usefulness of the interview guide.
6. Revised the interview guide to eliminate undesirable topics and to incorporate additional topics.
7. Justified the sample interview guides in order to include them among the usable guides.
8. Interviewed the additional programmers of business applications.
9. Analyzed data from the interview guides.
10. Formulated conclusions and made recommendations.

Definition of Terms

Gregory and Van Horn designed a glossary intended to be used by people without special training who are interested in business data

processing.[8] The terms defined in this section are used in this study. The terms and definitions are selected from pages 745-779 of Gregory and Van Horn.

Business Application. A closely related set of activities that are treated as a unit--for example, each of the following: customer accounting, inventory control, or order entry and sales may be treated as a unit for conversion to automatic data processing and operation.

Business Data Processing. Processing of data for actual transactions--purchases, sales, collections--involving file processing, calculations, and reporting; also includes processing planned transactions for budgeting and operating control purposes. Characterized by large volumes of input and output with limited amounts of computation during processing.

Computer. Any device capable of accepting data, applying prescribed processes to them, and supplying the results of these processes.

Digital Computer. A computer capable of accepting and operating on only the representations of numerals or letters coded numerically. More broadly, a digital computer handles numerals, letters, or symbols represented as discrete items of data, as opposed to measurements.

Console. Equipment that provides for manual intervention and for monitoring computer operations.

Data Processing. Rearrangement and refinement of data into a form suitable for further use; often involves file processing to update files for transactions that occur.

Debug. To test a program by running it with test, simulated, or live data on a computer to find whether it works properly, and, if mistakes are revealed either in the final answer or at various stages of processing, to discover the source and make corrections.

Decentralized Data Processing. Processing data at many locations for an organization that is decentralized managerially, geographically, or both.

Feasibility Study. Preliminary process of determining the over-all suitability of applying data processors to specific operations; involves both technical and economic considerations.

Input. The process of introducing data into the internal storage of the computer.

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[8] Robert H. Gregory and Richard L. Van Horn, Automatic Data-Processing Systems, Principles and Procedures (2d ed., Belmont, 1963), pp. 745-779.

Integrated Data Processing. A business data system designed as a whole so that data are initially recorded at the point of origin in a form suitable for subsequent processing without manual recopying.

Machine Language. Expressions used to define the operations of a computer. Written instructions which activate the computer.

Library. An organized collection of standardized programs.

Management Information System. A data-processing system designed to supply management and supervisory personnel with information consisting of data that are accurate, timely, and new.

Matrix. A rectangular array of numbers, subject to mathematical operations, such as addition, multiplication, and inversion, according to specified rules. Any table is a matrix.

Output. Process of transferring data from internal storage of a computer to some other storage device. A specific output area may be used for organizing data prior to the output operation.

Program (noun). A plan for the automatic solution of a problem. A complete program includes plans for the transcription of data, coding for the computer, and plans for the absorption of the results into the system.

Programming. The process of creating a program; includes applications analysis, design of a solution, coding for testing to produce an operating program, and development of other procedures to make the system function.

Simulation. An experimental analysis of an operating system by means of mathematical or physical models that operate in a time-sequential manner similar to the system itself.

Software Package. The programming aids supplied by the manufacturer to facilitate the user's efficient operation of equipment. Includes subroutine libraries and industry application programs.

System. Any regular or special method or plan of procedure. In a broader context, a system consists of an organization, people, hardware, and procedures that operate together to perform a set of tasks.

Systems Analysis. An orderly study of the detailed procedure for collecting, organizing, and evaluating information about an organization with the objective of improving control over its operations.

Systems Design. Formulation and description of the nature and content of inputs, files, and outputs in order to show how they are connected by processing procedures and for the purpose of developing a new or improved system.

Central State College

Central State College, the institution for which a model curriculum for business applications programmers is to be designed, is located approximately 15 miles north of the heart of Oklahoma City, the capital city of the state of Oklahoma and the largest city in the state.

Central State College was first organized as a Territorial Normal School on December 24, 1890. Since that time the nature and purpose of the institution has changed radically. On December 29, 1919, Central State College was authorized to become a four-year teachers college. Until 1939, only degrees with a teaching emphasis were granted. The college was thereafter authorized to grant a degree without a teaching certificate.

Unusual growth problems have been experienced by Central State College since the year 1960. The full-time student enrollment has increased from approximately 4,000 in 1960 to approximately 8,000 in 1965. Included in these 8,000 students are 2,500 business majors, representing nearly one-third of the total enrollment.

The business curricula offered lead to the bachelor's degree with major emphasis in Accounting, General Business, Marketing, Management, Business Education, or Secretarial Training; in addition, short vocational curricula are offered in secretarial skills and in general business with emphasis on accounting.

Sixty per cent of the business students at Central State College commute from Oklahoma City. Over one-half of these students who commute hold part-time positions in business firms located in Oklahoma City.

The number of business firms within the proximity of Central State College which employ data processing personnel places the college in an

ideal position to offer formal education and training for data processing personnel.

CHAPTER II

SUMMARY OF BACKGROUND LITERATURE

The first commercial computers installed in the United States were large-scale computers. Small and medium-scale computers have become popular within the past few years. Most of the literature written prior to the time of this study concerned the operations of large-scale computer systems.

Computers in industry would be of little consequence without the employment of computer programmers in each installation, for the programmer is the individual who is primarily responsible for the "thinking" and "reasoning" of the computer. The programmer of business applications must communicate with many departments and employees of a business firm. He must be a communications expert, a public relations man, and must possess the qualities of a manager if he expects to become successful on his job and be eligible for advancement when opportunities occur.

The atmosphere around the business applications programmer involves many things. His work is influenced by the business applications which management prescribes for computers and by the objectives which management wishes to achieve through the use of computers. This summary of related literature serves to provide a background concerning the various conditions that could affect the working atmosphere of a computer programmer and, thus, the pattern of education which he should follow.

Growth of the Computer Industry

Although the first commercial computer in the United States was installed in 1951, it was not until 1953-54 that mass production techniques were applied to computer manufacturing and commercial computers were purchased on a large scale. General Electric employed the first large-scale computer to process business data in January, 1954.[1]

Manufacturers of Computers. Over 20 firms now manufacture electronic digital computers; however, the 10 firms which have contributed most heavily to the computer industry are: (1) International Business Machines, (2) Remington Rand division of Sperry Rand, (3) Burroughs, (4) Minneapolis-Honeywell, (5) Radio Corporation of America, (6) Philco, (7) National Cash Register, (8) General Electric, (9) Control Data Corporation, and (10) Sylvania.[2]

Practically no computers were sold in 1950; in 1959, enough computers were sold to account for approximately 1.5 billion dollars in revenue. Revenue from the sale of computers in 1964 was estimated to exceed 4 billion dollars. It has been estimated that the revenue to be realized from the sale of computers in 1970 may exceed 7 to 8 billion dollars.[3]

Many computer divisions of companies which manufacture computers are presently operating at a loss and must continue to operate at a loss until expenditures are regained. Many small computer manufacturers

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[1]"A Survey and Study of the Computer Field," p. 15.

[2]Francis Bello, "The War of the Computers," Fortune, LX, October, 1959, p. 128.

[3]Ibid.

will probably merge, consolidate with larger manufacturers, or withdraw from the industry because they will not be able to withstand excessive operating losses.[4]

Users of Computers. It is estimated that by 1966 more than 10,000 large-scale digital computers will be in operation in the United States. About one-third of all electronic data processing systems are used by government and industry to carry out scientific and engineering calculations. Approximately two-thirds of the systems are utilized to perform routine paper work and solve business problems. Probably the five biggest electronic data processing users in industry are General Electric, American Telephone and Telegraph, General Motors, Douglas Aircraft, and General Dynamics.

There are now over 150,000 persons employed in the manufacturing, programming, operating, and maintaining of computers. In so far as the computer programming phase of the computer industry is concerned, Seligsohn, Public Relations Chairman of the Association for Computing Machinery in 1961, argues that within the next ten years some 200,000 new programmers will be needed by business, industry, and government research.[5]

According to Fortune magazine

> One very crude rule of thumb is that a firm that needs 50 clerical employees to do its record-keeping with pre-electric methods could do the same jobs electronically, and many other jobs as well, with only 30 clerks. With the roughly $100,000 saved in salaries and overhead by eliminating 20 clerks, such a firm could afford a monthly electronic data processing rental of $7,000 and have something left over to pay for installation and programming....

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[4]"A Survey and Study of the Computer Field," p. 23.

[5]Zeke Seligsohn, "Maryland High School Students Learn Computer Programming and Practice on the IBM 709," Computers and Automation, X, February, 1961, p. 5.

> While these simple rules of thumb are questionable, the computer industry finds it reassuring to know that there are now over 6,000 firms in the United States with 100 or more clerks and over 15,000 with 50 to 100 clerks. The industry has no doubt, moreover, that the wonders of EDP will be brought to a substantial percentage of these two categories within the next decade."[6]

Program Libraries. Improved ready-made programs that come with almost every new computer have reduced programming costs considerably; nevertheless, it has been estimated that over $2 billion has been spent by government and industry since 1950 on private development programs.

International Business Machines probably has the largest library with contents of close to 6,500 programs. Some of the programs contain up to 120,000 instructions. The value of the program library of IBM is hard to determine but original programming can cost from $2 to $20 per instruction. It is estimated that over 625 man years of programming effort would be required to duplicate the programs in that particular collection.[7]

The programs located in the various program libraries consist of two different types--general and specialized. The general programs are written to represent general management problems common to all industries such as linear programming, sales forecasting, scheduling complex projects, or balancing production lines. The specialized programs cover such areas as demand deposit accounting in banks, hospital accounting, automobile rating, and insurance accounting.[8]

The fact that program libraries exist and that many programs have become standardized could lead one to believe that the demand for

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[6]Bello, p. 131.

[7]"A Survey and Study of the Computer Field," p. 17.

[8]Ibid.

computer programmers will tend to lessen markedly within the next decade. However, many who have studied the phase of employment relative to computer programmers argue that the demand for computer programmers will continue. It is anticipated that computer programmers will be more and more in demand by management because of several factors: (1) While a program can be standardized to some degree, very few businesses, even branch offices, have truly identical operations; (2) A programmer of the future must not only know how to program business applications from the beginning but also must be able to interpret standardized programs written by other programmers; (3) The dynamic society that exists today demands constant change, new innovations, and experimentation within any firm. These factors will require up-to-date programmers of business applications to enable a firm to maintain competitive status.

Management Problems. The advent of the computer industry has accentuated the problems of management in the areas of information and control. Regarding information, large and relatively indigestible masses of data must be processed and presented in coherent form so that management will have timely and comprehensive knowledge of what is occurring in the organization. Control, as a result, cannot be effectively exercised unless information requirements are satisfactorily met. The control and information problem of management is further evidenced by the fact that computer usage implies greater decentralization of authority within corporate units, corporate mergers and acquisitions that increase the size of corporate units, and product diversification.[9]

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[9]Curry, p. 10.

Because such problems are apparent, technological advances in the 1970's will probably include data transmission equipment to conform to demand. Data transmission systems would perform such functions as tying together lines in a data processing center, conveying the latest market and production facts from a field to a data processing center, and providing management with up-to-date information for more accurate forecasting, inventory controls, and money savings. The linking of advanced communications devices with advanced data processing systems is providing a breakthrough to total management information systems.[10]

Applications of Computers

Business applications of computers fall roughly into three areas: (1) clerical work, (2) decision making, and (3) policy determination. Accounting for a payroll illustrates computer application to clerical work. For example, names, wage rates, hours, production, special conditions, etc., can be fed into a computer for each of 10,000 separate individuals and checks and other explanatory material will come out the opposite end of the computer.

Decision making starts where clerical work stops, and probably the most popular example of this area of application would be that of handling inventory data by the computer. The computer keeps a perpetual inventory of all materials on hand, acknowledges when a minimum supply of materials is in the inventory, and places an order for a specified quantity of materials. If the materials are not received by the time

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[10] "A Survey and Study of the Computer Field," p. 21.

the cushion of materials is used, the computer will place an expedite order that practically demands immediate shipment.[11]

Applications of Computers by Small Firms. The computer applications just described are not only available to the firm which can afford to own a computer but are also available to smaller firms. Quite often firms which physically or economically cannot afford a computer find a computer service center available for their use. Service centers are being used in three general activity areas: (1) the area of one-time peak load, (2) the utilizing of the programming and operating staff of the center to perform the complete function or any given function of a company, and (3) the utilizing of the service center by a company which is not large enough to own or lease its own equipment, yet needs advantages of the speed of the computer, or by a company which knows it will install electronic data processing and wants to utilize machines until the installation is made.[12]

Applications of Computers by Government. The internal revenue service uses computers to process its 95 million tax returns which have grown in number from 20 million two decades ago. The Social Security Administration has also been using computers to speed the processing of claims for social security benefits.[13]

Future Applications of Computers. In the future computers may also be used for weather forecasting, medical analysis, traffic control, and automatic classroom instruction.

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[11]"Business Week Reports to Readers on: Computers," p. 72.

[12]"What to Look for in Service Centers," Administrative Management, January, 1963, p. 46.

[13]"A Survey and Study of the Computer Field," p. 21.

Specific Achievements of Computer Users

In general, specific achievements which use of a computer helps to bring about are: (1) reduction of clerical costs, (2) accumulation of data fast enough and accurately enough to give management an up-to-date picture of conditions at any time, (3) closer control of inventories through better estimates of future needs, (4) better customer service through speeded up processing of orders, and (5) more efficient handling of payroll and other personnel data.[14]

Achievements of Manufacturers. Many manufacturing companies are using computers for off-line balancing, scheduling labor utilization, and numerically controlling machine tools. Advances in management science will find increasing use of computers to optimize decision making on inventory policy, long-range market strategy, plant and warehouse locations, and capital investment programs.

Evaluation of Certain Achievements by Management. Throughout the history of the computer industry, management consultants and computer manufacturers have drawn some conclusions from studying successful and unsuccessful installations of computers:

1. The feasibility of a computer installation should be carefully determined. Many unsuccessful installations have resulted when a computer has been ordered just because a top executive thought his company should have one.

2. Many firms try to do too much at once with a computer.

3. Many business record-keeping systems have grown up rather piecemeal over a period of time and the installation of a computer forces an overall look at the record-keeping system.

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[14]"Don't Be Afraid to Use a Computer," Administrative Management, January, 1963, p. 49.

4. There is a jurisdictional dispute that arises if electronic data processing is to be used with maximum effectiveness.

5. There is no substitute for meticulous preparation and programming before a computer arrives. Eighteen months should be the minimum time to spend on preparations and programming. This period of time is often required to get delivery on a particular type of computer that may have been ordered.[15]

Training for New and Displaced Personnel

Governmental Training Practices. Government agencies have experienced difficulty in securing competent personnel to fill the more complex jobs associated with automatic data processing. Consequently, they rely heavily on the training or retraining of employees so that they may be shifted from other kinds of jobs to automatic data processing positions. This scarcity of personnel is largely attributed to higher pay levels for automatic data processing personnel in private employment and to a general shortage of data processing personnel. Federal salaries were increased in 1962 to help enable government branches to retain qualified personnel. The Government Employees Training Act helped also to relieve recruitment and training problems.[16]

A survey of the Bureau of the Budget showed that governmental agencies relied almost exclusively on computer manufacturers for the training of programmers and operators. Middle and top management received indoctrination in electronic data processing from manufacturers, governmental agencies, universities, professional associations, etc.[17]

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[15]Bello, p. 164.

[16]"Automatic Data Processing in the Federal Government--Its Manpower Requirements," p. 10.

[17]"The Reactions of Employees to Office Automation," Monthly Labor Review, LXXXIII, September, 1960, p. 932.

Computer Manufacturer Training Practices. Manufacturers usually provide free courses for programmers and operators for agencies using their equipment. For example, IBM alone in 1958 put 14,000 students through three to four week programming courses for large- and medium-scale computers.[18] The content of the courses was of a technical nature.

Training programs for planning and programming jobs most frequently consist of a four-week programming course at the school of the equipment manufacturer, plus one year of on-the-job training. Console operators usually require the same degree of training that planning and programming personnel require. Auxiliary equipment operators usually receive on-the-job training as a basic preparation for good job performance.

Secondary Education Training Practices. Computer personnel training has developed on the high school level in some instances. The Washington D.C. chapter of the Association of Computing Machinery and the Board of Education of Montgomery County, Maryland, co-sponsored an experimental program for 26 junior and senior students at a high school in that area. The program was designed to attract talented young people to the computing field--and especially to the computer programming profession. They studied the history of the computer, the use of binary and octal number systems, analysis of typical problems, fundamental programming, and the application of computers. In this program, actual IBM manuals and specially designed films were used as teaching aids.[19]

More than 200 school districts and departments of education in 45 states use electronic data processing equipment to process business data.

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[18]"Business Week Reports to Readers on: Computers," p. 87.

[19]Seligsohn, p. 5.

Post High School Training Practices. As a customer of large scale computational facilities, the university should be in a position to offer training for computer personnel.

A new Data Processing Center opened in the fall of 1963 at Orange Coast College in Costa Mesa, California, operates on the principle that what is presently an employable skill on a single machine may become an unemployable skill in the future as machines, systems, methods, and computer languages are changed, improved, or rendered obsolete. Students should become familiar with a variety of equipment and understand the significance of what they are doing. The person receiving short-term training offered by computer vendors may lack the ability to grow with the job.[20]

Selection of Computer Personnel

Selection Procedures. Selection procedures for electronic data processing personnel often fall into two general types. One type involves the reviewing of personnel records and recommendations from supervisors to compile a list of employees considered qualified for various new positions. Employees who are interested in the new positions are given an aptitude test; and, from those employees who pass the test, the supervisory staff of the electronic data processing group makes its selection. Other than test scores, factors taken into consideration by the electronic data processing supervisory group are education, experience, and other personal qualifications of the employee as disclosed in interviews and records.

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[20]"Orange Coast College Opens Data Processing Center," Collegiate News and Views, December, 1963, p. 27.

The other type of selection procedure involves the announcing of any new position to all employees and inviting anyone who is interested to take tests for the new position. Employees who pass the tests form a "reserve pool" from which the company selects people to fill initial and new openings in electronic data processing.

Selection Procedures Reported by the Bureau of Labor Statistics. Illustrations of methods of selecting employees for electronic data processing positions reported by the Bureau of Labor Statistics follows:

> Company B...Reviewed employee records, sought supervisory recommendations, and gave 4 tests: Wonderlic Personnel Test; Schubert General Ability Test (to college graduates only); Differential Aptitude Tests (A. Numerical Aptitude, and B. Abstract Reasoning). Different passing grades were used for each type of job. Experience with the company was given more weight than test results. No tests were given for the auxiliary equipment operator positions.
>
> Company D...Reviewed employee records and filled key positions. Next, announced openings to all employees, selecting qualified employees on basis of interviews and records. Also ran some newspaper advertisements. No tests given.
>
> Company H...Notice given to union of positions to be made available. Positions were described, requirements established; business and academic background standards set up; positions were posted; applications reviewed; applicants interviewed. No tests were given at first. Currently, all employees eligible for positions must pass Aptitude Test for EDPM Programmers.
>
> Company Q...Department heads were asked to suggest employees to be given training courses with understanding they might be returned to their original work sections. From among those who took courses, original group was formed. No tests were given.[21]

Employment Tests. Some officials are skeptical about the reliability of tests that are available. They prefer to depend on the evaluation of the background and experience of the applicant made by the personnel officer or supervisor. The type of test generally administered to

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[21]"Adjustments to the Introduction of Office Automation," Bulletin No. 1276 (Washington, May, 1960), p. 18.

prospective employees in the electronic data processing area is designed to measure the learning ability of individuals rather than to test clerical skills or personality. Some typical objectives of tests are "to test how well you can think;" "...how well you are able to reason analytically and logically;" and "...how well you can think in math."[22] A test designed specifically for determining aptitudes in programming is in three parts covering: (1) the ability to follow instructions in completing numerical series, (2) the ability to see relationships among geometrical figures, and (3) the ability to solve problems in arithmetic reasoning.[23]

Military Agency Selection Procedure. In 1958, a survey of recruitment practices in 129 military agencies showed that nearly two-thirds of the agencies filled computer personnel positions from their own staffs only. One-tenth filled positions from outside sources only and one-fourth used both inside and outside sources of recruitment. Recruiting from within requires shorter training time because the employees already know the paper work process; and, in addition, employees' morale is kept at a high level because of advancement opportunities. Shortage of talents within a firm is the prime reason for maintaining an outside recruitment policy.[24] Seven out of 10 of the 129 agencies administered one or more tests, primarily to applicants for computer programmer or operator positions.

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[22]Ibid., p. 46.

[23]Ibid.

[24]"Office Automation in the Federal Government," Monthly Labor Review, LXXXIII, September, 1960, p. 936.

Characteristics Desirable for Computer Personnel

A brief listing of the characteristics desirable for computer personnel is: (1) thorough knowledge of company policies; (2) ability and desire to stick to endless details and persistence enough to see the job through; (3) ability to organize, direct, and supervise others; (4) knowledge of accounting systems and records retention; (5) ability to visualize installation requirements; and, (6) knowledge of the costs of operating an electronic data processing system.[25]

Characteristics Viewed by Computer Manufacturer. From a narrower point of view, perhaps, IBM educators claim that all one needs to be successful in a programming course is average ability, aptitude for logical thought, and in most cases no more than a high school diploma.[26]

Special Characteristics of Programmers and Analysts. Authorities argue, however, that computer personnel for positions such as systems analyst and computer programmer require higher education and training than most clerical employees. Systems engineers should have a college education and a considerable amount of company experience to be successful at their jobs. Four out of five men selected for the position of analyst with a major airline company had a college degree in business administration or social studies.[27]

Age of Personnel. Apparently, there is a trend toward the attracting and employing of more young personnel than older personnel in electronic

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[25]"Don't Be Afraid to Use a Computer," p. 49.

[26]"Business Week Reports to Readers on: Computers," p. 87.

[27]"Impact on Automation," Bulletin No. 1287 (Washington, November, 1960), p. 95.

data processing positions. Seventy per cent of 12,000 people classified as computer personnel are under 37 years of age; 40 per cent of the 12,000 are under 32 years of age.[28] Young employees are less bound by tradition and are willing to try new methods. As a result, some friction between younger and older employees is likely to occur.

Sex of Personnel. Men outnumber women in electronic data processing positions by eight to one. A high rate of turnover among women employees and the need for operators to work late shifts are factors which influence that ratio.

Curricula for Electronic Data Processing

The researcher was unable to find in his review of related literature and research a four-year curriculum for preparing programmers of business applications. As a general rule, most curricula designed for employees of an electronic data processing system are of a technical nature. These curricula may require a few months or two years for completion.

United States Department of Education Post High School Curriculum. The United States Department of Education adopted a suggested program for electronic data processing in January, 1963.[29] This curriculum is two years in length and has as a main objective the development of occupational competency. It includes a substantial introduction to the

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[28]Interview with Mike Lopez, Tinker Air Force Base Supervisor, May 18, 1965, Oklahoma City, Oklahoma.

[29]Electronic Data Processing--I, "Technical Education Program Series No. 4, A Suggested 2-Year Post High School Curriculum for Computer Programmers and Business Applications Analysts" (Washington, 1963).

field of specialization. The content of this curriculum is discussed in the following paragraphs.

The curriculum provides for a total of 15 hours per week to be spent in class with lectures and demonstrations in five courses during the first semester. The courses are Data Processing Mathematics I, Introduction to Business Data Processing, Electric Accounting Machines, Accounting I, and Communication Skills I.

The second semester includes courses that account for a total of 16 class hours each week. For the most part, the courses included in the second semester are courses which build upon the knowledge acquired by the student during the first semester. The courses are Data Processing Mathematics II, Data Processing Applications, Computer Programming I, Accounting II, and Communication Skills II.

The third semester consists of courses which meet for a total of 15 hours each week; they are Computer Programming II, Programming Systems, Statistics, Business Organizations, and Cost Accounting.

Four courses are included in the fourth semester. These courses meet for a total of 11 hours per week. They are Business Systems Design and Development, Advanced Programming Systems, Data Processing Field Project, and Social Science.

Data Processing Management Association Curriculum Recommendations. The Data Processing Management Association has also recommended a variety of courses for people who are interested in becoming programmers and business systems analysts. The courses which DPMA has outlined correspond somewhat to those outlined in the curriculum sponsored by the United States Department of Education. The association, however, advocates more courses and a wider variety of courses from business areas.

The courses suggested by DPMA were designed to develop a professional atmosphere for electronic data processing employees.

The Data Processing Management Association has designed and is sponsoring the giving of a comprehensive examination to people who believe they can qualify as certified programmers or business analysts. The overall objective of the association is to establish an electronic data processing examination on a level equivalent to that of the American Institute of Certified Public Accountants' examination.[30] A definite curriculum leading to the taking of the electronic data processing examination has not been established, however, and DPMA urges research to aid in developing a strong curriculum which will help prepare one for the examination.

Two courses from five separate areas are found among the courses required by DPMA. Those five areas are mathematics, managerial accounting, English, statistics, and data processing systems.

Eight courses to round out the education of the programmer are to be elected from the following:

1. Budgets and Budget Control
2. Business Data Processing Applications
3. Business and Economic Models
4. Business Economics
5. Business Law
6. Business Organization and Management
7. Controllership
8. Corporation Finance
9. Cost Accounting
10. Intermediate or Advanced Statistics
11. Mathematic or Scientific Computer Programming
12. Operations Research
13. Probability Theory and Applications
14. Psychology or Sociology

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[30]American Institute of Certified Public Accountants, New York, New York, published semiannually in May and November.

15. Statistical Quality Control
16. Symbolic Logic
17. Work Measurement

Evaluation of Curricula. The curriculum sponsored by the United States Department of Education is designed for Technical Education Programs. It is primarily designed for a two-year post high school program; consequently, the inter-related courses within the curriculum are especially designed for technical emphasis. The content of courses is, therefore, basically not the same as the content of courses which are included in a typical four-year college curriculum.

The curriculum sponsored by the United States Department of Education should be considered a guide which is a product of the efforts of vocational educators, junior college administrators, and representatives of business and industry.[31] Its purpose is to serve as a guide in developing curricula that will meet local as well as national manpower needs in the field of electronic data processing. Conditions prevalent in local communities could require radical deviations from the guide.

The Data Processing Management Association advocates that its own recommendations of courses serve as a guide in the selection of courses to be included in a curriculum suitable for electronic data processing. Its recommendations are based upon theory without the support of research. While the courses DPMA recommends are representative of courses found within a four-year college curriculum, there is need for research to determine the extent to which each course should be involved.

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[31] Electronic Data Processing--I, p. iii.

CHAPTER III

RELATED RESEARCH

A large number of theses have been written on the subject of automation and data processing. E. J. Haga listed 60 of these research projects in the May, 1963, edition of the Journal of Business Education.[1]

Studies have been made concerning education and training of the computer programmer and other data processing personnel on both the secondary and higher education levels. It is the purpose of this chapter to review those studies that are involved with the designing of a curriculum for business applications programmers. A review of those studies will indicate the need for the present study.

E. Dana Gibson Studies

In 1956, E. Dana Gibson surveyed 86 colleges and universities by questionnaire and personally visited 21 of these schools and 50 business and industrial firms to determine what they were doing or planning to do in integrated and electronic data processing.[2]

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[1] E. J. Haga, "Understanding Automation," The Journal of Business Education, XXXVII, No. 8, May, 1963, p. 336.

[2] E. Dana Gibson, Integrated and Electronic Data Processing in Relation to Schools of Business Administration, Monograph C-6 (Cincinnati, 1957).

At the time of Gibson's survey very few colleges and universities were using or had access to a digital computer. His findings relative to a curriculum in computer science are paraphrased below.

1. The bookkeeping and accounting areas seem to be most amenable to a changeover from manual methods.

2. Electronic data processing demands an over-all point of view.

3. While there will be a continuing shortage of trained integrated and electronic data processing personnel, business expects to do its share in the training of such personnel.

4. A background in integrated-electronic data processing is necessary for future office workers.

5. Programming seems to be one of the bottlenecks at the present time. Business prefers to train business personnel in programming rather than to teach business to non-business people, particularly engineers.

6. Schools are getting integrated-electronic data processing equipment on a reduced-cost basis, rental or purchase, and every encouragement is given to their introducing integrated-electronic data processing courses into their curricula for basic and graduate research teaching.

7. New courses, or revised and combined courses, are needed to better educate graduates for integrated-electronic data processing job entrance and advancement. Some of the areas that the new courses should emphasize are:

    a. Logical thinking.
    b. Mathematics.
    c. Statistical methods.
    d. Systems operation.

8. Operations research is believed to be the logical approach to the solution of future business problems, and instruction in its techniques and procedures would be a major contribution to business.

9. Broad education seems to be the type business prefers.

10. Business graduates who have an industrial management background (half business, half engineering) appear to be the ones best fitted to adapt to the integrated-electronic data processing changes being made.

11. A higher type of quality of business graduate is needed.

12. Schools of business should teach the basic fundamentals of integrated-electronic data processing.

13. Business graduates must be able to communicate better than at present.

14. Schools of business must discover the new functions that business needs in the world of the future.

15. Students may be better trained through the use of the case method of teaching, particularly if work experience is added to the requirements.[3]

In 1957 and 1959 Gibson again sent questionnaires to the respondents of his 1956 study. The questionnaire was designed to obtain answers that might reflect trends as well as supply information needed by electronic data processing educators. The following questions were included:

1. How many schools owned digital computers?
2. What types of computers did these schools own?
3. Did the schools not reporting ownership of computers have access to them through other means?
4. What brands of computers were actually used by schools not reporting ownership of equipment?
5. Did the faculty and/or students of schools of business make use of the computers?
6. What courses were offered in relation to computers?
7. Did those schools not then offering courses plan to offer them later?
8. Were the courses offered required of students?
9. Did the courses carry college credit?
10. Were the courses offered at the graduate or undergraduate level?
11. Were any business students completing graduate theses in the area of integrated and electronic data processing?
12. Who taught the courses?
13. Did the schools offer scholarships, fellowships, or assistantships?
14. Did the schools of business have persons or committees working on the problem of integrated and electronic data processing?[4]

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[3]Ibid., pp. 46-47.

[4]E. Dana Gibson, Trends in the Educational Use of Computers in Schools of Business, Monograph 1.1 (San Diego, Oct., 1956), p. 27.

It was thought that the foregoing questions would supply working data to satisfy the purposes of the study. The purposes were to:

1. Determine what schools of business were doing to educate their students for the computing age.

2. Indicate whether schools of business administration were doing what they should to educate data-processing graduates.

3. Determine whether adequate emphasis was being placed on educational programs for computers.

4. Determine whether current programs might satisfy the demand--present and future--for electronic data processing personnel.

5. Determine whether schools of business administration were making the changes in the curricula necessary to prepare their graduates adequately for the automated business world.[5]

Gibson formulated four fundamental conclusions:[6]

First, he concluded that an educational pattern designed to teach a student how to think logically from facts must be designed. Computer systems supply one with data to enhance decision making. The data supplied are facts that are on a current basis. The logical thinker will be the one who can arrive at the best solution from the facts. Business will desire the logical thinker.

Second, students will encounter systems first, last, and always in business. The fundamental principles of systems operations and how to use them in practical situations will have to be taught.

Third, there is an increasing need for a knowledge of statistical analysis. Knowing how to use statistical facts to the best advantage is even more important than knowing how to collect them. Probably a minimum of one year's work will be necessary to provide training in this area.

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[5]Ibid., p. 25.

[6]Ibid., p. 107.

Fourth, business students must develop a better understanding of how business problems can be solved by mathematical models. Operations research has had a phenomenal growth in recent years. Much of it has been devoted to the solving of business problems. A background in linear programming, Boolean algebra, matrix algebra, and certain calculus relations is extremely desirable. Straight mathematics will not substitute for what is needed in this area. New courses that deal with business problems and their solutions will have to be organized.

Melvin L. Edwards Study

The Edwards study attempted to determine the nature and extent of automation in the bookkeeping and accounting phases of office work in Oklahoma City, Oklahoma. It also considered the implications for business education as the uses of automated equipment are stabilized and educational needs are identified more clearly.[7]

Edwards interviewed personnel of 42 accounting firms in Oklahoma City which utilized electronic data processing machines in their accounting functions. His interviews were reported in a case study style. His conclusions concerning educational needs were:

1. Personal traits, work habits, and job preparation required by workers in the automatic data processing field are very similar to those required by other office workers.

2. Current functioning educational facilities can be utilized in occupational preparation of prospective employees with only minor shifts in educational emphasis and a few relatively major adjustments concentrated chiefly around making machines available for instructional use.[8]

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[7]Melvin L. Edwards, "The Effect of Automation on Machine Accounting" (unpub. Ed.D. dissertation, University of Oklahoma, 1958), p. 167.

[8]Ibid., pp. 178-179.

Leon Hay Study

Leon Hay used the interview technique in collecting data for his study of office automation and the functions and qualifications of programmers.[9] He interviewed 26 people in the Los Angeles area who were interested in electronic data processing. Included were six manufacturers, 12 computer users, six then studying the use of computers, one service bureau user, and one who had completed a computer feasibility study and found the computer to be uneconomical.[10]

Twelve of the 26 people questioned considered college training an important factor in the selection of a programmer, while 14 considered it an unimportant factor.[11]

The curricular program preferences expressed by the participants in Hay's study are indicated in Table I. Hay admits that the type of curricular program selected in many cases is selected because of the nature of work that is done or is to be done in the particular firm.[12]

Tables II and III show various college subjects and how the importance of those subjects was evaluated in Hay's study. As is indicated in Table III, he used three approaches in evaluating the data. Those three approaches are described below the table. Nine of the top ten subjects are the same in all three groups. These nine subjects are mathematics, accounting, business statistics, English, symbolic logic, business letters and report writing, office management, science, and public speaking.

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[9]Hay, p. 115.

[10]Ibid., p. 116.

[11]Ibid., pp. 80-81.

[12]Ibid., pp. 81-83.

TABLE I

CURRICULAR PROGRAM PREFERENCES FOR PROGRAMMERS OF DATA PROCESSING SYSTEMS AS REPORTED IN A STUDY BY LEON HAY

Curricular Program	Responses Number	Per Cent
Exclusive mathematics, physics, or a field of engineering with strong mathematical background training	4	19.2
Exclusive liberal arts educational background (English, logic, languages, philosophy, composition, psychology, science, mathematics, etc.)	2	7.7
Exclusive general business background (accounting and economic principles, money and banking, business law, industrial management, office management etc.)	14	53.9
Approximately one-half liberal arts and one-half general business	4	15.4
Broad general business with specialization in one or two business fields	1	3.8
Total	26	100.0

Source: Leon Hay, "A Study of Office Automation and the Functions and Qualifications of Programmers for Electronic Data Processing, (unpub. Ed.D. dissertation, University of Southern California, 1958), p. 82.

TABLE II

PREFERENCES FOR COLLEGE SUBJECTS AS ACADEMIC PREPARATION FOR PROGRAMMERS OF DATA PROCESSING SYSTEMS AS REPORTED IN A STUDY BY LEON HAY

College Subjects	Number of ratings as: Essential	Advisable	Unnecessary	Total
Accounting	20	5	0	25
Business Law	3	15	8	26
Business Letter and Report Writing	15	9	0	24
Business Statistics	19	6	0	25
English (Grammar, Literature and Composition)	18	7	0	25
Finance	5	9	9	23
Foreign Languages	2	4	18	24
History	1	10	11	22
Labor Relations	1	10	10	21
Mathematics (Algebra, Geometry, Calculus)	21	3	0	24
Marketing	1	15	7	23
Office Organization and Management	13	11	0	24
Personnel Administration	3	12	9	24
Philosophy	2	17	4	23
Political Science	0	13	10	23
Public Speaking	4	15	4	23
Purchasing	0	6	18	24
Science (Biology, Chemistry, Physics)	5	15	4	24
Social Psychology	0	13	10	23
Sociology	0	13	11	24
Symbolic Logic	17	6	1	24
Theoretical Economics	2	18	3	23

Source: Leon Hay, "A Study of Office Automation and the Functions and Qualifications of Programmers for Electronic Data Processing (unpub. Ed.D. dissertation, University of Southern California, 1958), p. 85.

TABLE III

RANKING OF ACADEMIC BACKGROUND SUBJECTS FOR PROGRAMMERS OF DATA PROCESSING SYSTEMS AS REPORTED IN A STUDY BY LEON HAY

Academic Subject	Item rank as scored by three different methods:		
	A	B	C
Mathematics	1	5	1.5
Accounting	2	2	1.5
Business Statistics	3	2	3
English	4	2	4
Symbolic Logic	5	7	5.5
Business Letters and Report Writing	6	5	5.5
Office Organization and Management	7	5	7
Science	8.5	8.5	8
Finance	8.5	15	12.5
Public Speaking	10	10	9.5
Personnel Administration	11.5	14	14
Business Law	11.5	12.5	15
Philosophy	14	11	11
Theoretical Economics	14	8.5	9.5
Foreign Languages	14	21.5	21
Labor Relations	17	19.5	20
History	17	19.5	18
Marketing	17	12.5	12.5
Social Psychology	*	16.5	16.5
Political Science	*	18	16.5
Sociology	*	16.5	19
Purchasing	*	21.5	22

*Did not receive any ratings as "essential."
Column headings:
A - Inclusion of only "essential" ratings
B - A combination of both "essential" and "advisable" ratings, excluding "unnecessary" ratings.
C - Assignment of the following arbitrary numerical weights to the ratings: "Essential" plus 2, "advisable" plus 1, "Unnecessary" minus 1.

Source: Leon Hay, "A Study of Office Automation and the Functions and Qualifications of Programmers for Electronic Data Processing" (unpub. Ed.D. dissertation, University of Southern California, 1958), p. 87.

A part of the interview was designed to determine the specific courses that the colleges and universities should teach to adequately train a computer programmer. Hay summarized his recommendations as follows:

1. General knowledge and information on computers. As a movement with tremendous social, economic, philosophic, and cultural implications, automation and the development of high-speed computing techniques in business must be explained to the prospective programmer as part of general knowledge and education.

2. Organization and manipulation of data. An introductory course in programming for the application of the computer to business problems.

3. Systems analysis. A course in systems and procedures in business.

4. More training in mathematics.[13]

Pennsylvania State University Study

To get some idea of its own computer teaching problem, the Pennsylvania State University conducted a study to determine the extent to which computing facilities had become a necessity as a part of the commercial and industrial environment in which the university graduates would be employed.[14]

The researcher assumed that business itself could make the most accurate estimate of its own needs. He conducted a mail survey among business concerns. The survey population was established as a group of commercial and industrial recruiters who regularly visit Pennsylvania

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[13]Ibid., pp. 91-92.

[14]Frank R. Hartman, "The Demand for College Training in Digital Computing," Pennsylvania State University, University Park, Pennsylvania; published in Trends in the Educational Use of Computers in Schools of Business, Dana Gibson, ed., Monograph 1.1 (San Diego, Oct., 1956), p. 84.

State to interview prospective graduates and who are listed with the University Placement Division.[15]

The questionnaire asked the commercial concerns essentially three questions:

1. What is the nature of your present or contemplated computing facilities if any?
2. What is your demand for graduates in a specific curriculum possessing various levels of computer knowledge and experience?
3. By what factor would you multiply your figures to estimate your computer usage and demand for computer-trained employees in 1970?[16]

Fifty-four per cent of the 600 commercial and industrial concerns queried responded.

In regard to college training, questions that were asked which are of interest are:

1. In which curricula has knowledge of computing become a factor in training?
2. What level of knowledge about computers is required?
3. What increase in the demand for computer training is likely in the next decade?[17]

The researcher evaluated his data according to the number of times any particular item was mentioned by the respondents. The most frequently mentioned curricula for electronic data processing personnel were accounting and mathematics. Next in importance were physics, business administration, electrical engineering, industrial engineering, and chemical engineering.[18]

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[15]Ibid.

[16]Ibid.

[17]Ibid., p. 85.

[18]Ibid., p. 88.

The most common application of computers, according to the inquiry, is in bookkeeping and accounting.

Concerning mathematicians, a conclusion was drawn that they are a special case and are a necessary intermediary between the problem and the machine. Mathematicians are in short supply and some plan which will allocate many of their responsibilities to other personnel seems necessary if the application of computing to industrial and commercial problems is to proceed at a reasonable speed.[19]

The level of proficiency most frequently specified varies among the different curricula. In Accounting and Business Administration the predominate need is for more personnel who are familiar with computers. Moreover, the personnel should be able to help formulate various business problems in a logical order so the problems could be programmed by the programmers. On the other hand, necessary training for the mathematician consists of those special branches of mathematics that are particularly applicable to computing.[20]

The findings concerning the increase in the demand for computer training in the next decade were not significant. Respondents hesitated to make predictions for the future.

Adele Frisbie Study

Adele Frisbie completed a study in 1959 which was based on the technological changes in digital electronic processing equipment from 1930 to 1957, trends in office employment accompanying the

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[19]Ibid.

[20]Ibid., p. 89.

introduction of the equipment, and an examination of major cost factors associated with the changing office mechanisms.[21]

She surveyed manufacturers of electronic data processing equipment, Bureau of Labor Statistics reports for selected cities, and users of digital computers to arrive at the conclusions listed below:

1. Industries employing the largest proportions of office employees--manufacturers, government, federal government, insurance, public utilities, and banking--constitute the leading users of electronic data processing equipment for business applications.

2. Of all business applications, payroll is the most frequently programmed for large-scale, medium-scale or small-scale equipment. The second most popular application is accounting for inventories.

3. Six business applications are among the leading ones programmed by users of all types of multiple sizes of equipment. These are payroll, inventories, sales statistics, labor distribution, general accounting, and production control.

4. Users of electronic data processing equipment are primarily concerned with programming existing operations within their companies.

5. There is little agreement on the part of businessmen concerning adequacy of background for occupations.... For the most part, businessmen evaluate the educational background of the workers on a basis of the interpretations of the firms' needs for each job and of the equipment sizes and combinations employed.

6. Companies are aware of their responsibilities in training executives in the capabilities of these electronic systems; and they are seeking means of accomplishing the goal. The most popular means reported are conferences and seminars, company training programs, and periodicals.[22]

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[21]Adele Frisbie, "Emerging Electronic Data Processing and Its Relation to Office Employment and Costs, 1930-1957; and Implications for Business Training" (unpub. Ph.D. dissertation, New York University, 1961).

[22]Ibid., pp. 504-507.

Edward J. Laurie Study

Laurie conducted a study in 1958 to investigate the current, committed future, and potential future applications of domestic digital data processing computer systems as they are being developed in American businesses and college and university schools of business. The areas of computer personnel training and computer operation as they are related to successful application of those systems were studied.[23]

Questionnaires were used by Laurie to gather information. One-hundred and sixty-one business firms in the United States,[24] collegiate schools of business, and 33 other colleges and universities[25] were respondents to his inquiry.

Laurie summarized his findings relative to the business firms participating as follows:

1. The three heaviest users of computers among American businesses are manufacturing, insurance, and public utility enterprises. Main offices house over half of the computers used.

2. Slightly over half of the responding business firms indicate that they are currently conducting training activities in regard to computer personnel. Principal trainers of current computer personnel were the firms operating the equipment and the manufacturers of digital data processing systems.

3. Most selected future sources of trained computer personnel were manufacturers of equipment and operating firms.

4. Over half of the firms believe it is easier to train their present employees to program than it is to teach programmers the particular business. About 60 per cent of the firms indicate that in their experience people with mathematical aptitude have proved to be the best programmers.

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[23]Edward J. Laurie, Digital Computing Systems in Businesses and Schools of Business, Monograph C-7 (Cincinnati, 1960), p. 1.

[24]Ibid., p. 4.

[25]Ibid., p. 29.

5. Most committed future applications are to payroll, accounts receivable, accounts payable, inventory control, general accounting, expense accounting, production accounting, cost accounting, and budget preparation.

The findings of Laurie's efforts dealing with the collegiate schools of business and other colleges and universities appear below:

1. One-third of the colleges included in this study had at least one digital computer on the campus. The members of the American Association of Collegiate Schools of Business had a higher percentage of computers available than non-association schools.

2. About 60 per cent of the total responding schools note that they visit computer installations in their own areas. About 30 per cent report that they use an off-campus computer for faculty research, student instruction, and the like. Very few business divisions actually house the computer they use, and very few actually have complete jursidiction over such equipment.

3. Over half of the schools report that they include computer programming and general data processing problems in their current course offerings. This covers courses offered for credit only.

4. The two sources of future computer personnel mentioned most frequently by collegiate respondents are the manufacturers of computer equipment and the firms operating the computers. In this regard the collegiate respondents are in agreement with the business firms who responded to the questionnaire.

5. Over half of the colleges responding indicate that they believe it is easier to train present employees to program than to teach trained programmers a particular business. About one-third of the college respondents believe that people with mathematical aptitude will prove to be the best programmers. Forty per cent of the respondents thought computer personnel could be selected through the use of aptitude tests.[26]

Leo Niemi Study

Leo Niemi completed a dissertation in 1959 on the subject of data processing and computers. This study was undertaken to determine

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[26]Ibid., pp. 47-48.

(1) the training and educational needs of those people who head electronic data processing units in the various organizations; (2) the training and educational needs as they arise in electronic data processing experiences of other managers; and (3) who should provide the needed training and education.[27]

Niemi's study was directly concerned with the educational needs of electronic data processing personnel at the management level. He placed special emphasis on the needs of the managerial or supervisory personnel who are in charge of the analyzers, programmers, console operators, clerical workers, and others who make up the electronic data processing department.[28]

Niemi sought a solution to his problem by surveying a sampling of computer users in governmental agencies, public utility companies, insurance and banking firms, a variety of manufacturing firms, computer manufacturers, public accounting and management consulting firms, and colleges and universities.[29]

Four hundred and fifty-two questionnaires were sent to potential respondents. One hundred eight-two usable replies were received.

A part of Niemi's questionnaire was developed for the purpose of determining which electronic computer is being used and the extent and the nature of computer applications. He thought that knowledge of the frequencies of application of electronic data processing to certain

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[27]Leo Niemi, "Electronic Data Processing and Its Implications for the Collegiate Business Curriculum (unpub. Ph.D. dissertation, Ohio State University, 1959), p. 17.

[28]Ibid., p. 7.

[29]Ibid., p. 11.

business problems would be helpful in determining the content of college electronic data processing courses.[30]

In an attempt to answer the question, "Is breadth of education rather than specialization wanted in electronic data processing managers?" information was sought to determine what percentages of the curriculum should be devoted to business administration, liberal arts, mathematics, and electrical engineering.[31]

Ninty-seven per cent of the respondents in this study recommended four years of college. Their recommendations as to curricular content based on the modal and median points of the response were as follows:

1. The modal and median responses for business courses were 40 per cent of the curriculum, which placed business courses first.
2. Mathematics was next with a median response of 30 per cent and a modal response of 20 per cent of the curriculum.
3. Liberal arts was third with a modal and median response of 20 per cent of the curriculum.
4. Electrical engineering was in fourth place with a modal response of zero and a median response of 10 per cent.[32]

The respondents selected colleges and universities as first choice of training agencies for General Orientation to Computers, Business Applications, Business Systems Analysis, Industrial Applications, Numerical Analysis, Operations Research, Methods and Applications of Analog Computing and Analog and Digital Computer Design.

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[30]Ibid., p. 9.

[31]Ibid.

[32]Ibid., p. 167.

Neither company on-the-job nor high school programs were indicated as the first choice of training agency for any of the courses.[33]

Corresponding closely to the recommended curriculum for data processing managers is the actual training and education of employed data processing managers who were involved in the study. Those persons actually employed and participating in this study possessed a large number of degrees in business, a smaller number of degrees in mathematics, and a still smaller number of degrees in liberal arts and engineering.[34]

The courses which managers took and the courses which managers recommended for prospective programmers reflect a trend away from the study of the physical aspect of the computer itself and toward the study of uses that can be made of the computer.[35]

Niemi summarizes his findings:

1. Computers are being installed at an unprecedented rate to provide managers with more and better data faster and at lower cost.

2. Personnel need to be trained in the knowledge, skills, and understandings of computers and electronic data processing.

3. Electronic data processing managers should receive, as a minimal requirement, training in the following specialized courses highly recommended by the respondents:

   a. General Orientation to Computers and EDP. This is an introductory course which lays the foundation for more advanced work.

   b. Business Systems Analysis and Design for EDP. Since electronic data processing must be incorporated within the paper work and communications systems, they should

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[33]Ibid., p. 169.

[34]Ibid., p. 170.

[35]Ibid., p. 171.

be devised according to accepted systems principles for the greatest efficiency.

c. Business and Other Applications of Digital Computers. Electronic data processing managers should know the possibilities and limitations of the equipment.

d. Digital Computer Programming. Flow charting a sequence of operations in a particular application and coding it into machine language is an essential phase of electronic data processing.

4. Electronic data processing managers, to increase their competence, should receive training in the following courses:

a. Digital Computer Operation. The electronic data processing manager should know how to operate the computer as he supervises, and may have to train the operators.

b. Advanced Programming Techniques. This course is desirable especially for the manager who has charge of a large computer system. As these systems are more complex and costly, additional training helps assure optimal utilization of the computer.

c. Numerical Analysis. Quantitative methods are becoming increasingly more important in management decision making. This course provides background in topics such as the numerical solution of algebraic and ordinary differential equations, numerical differentiation and integration, and preparation of problems for large scale computation.

d. Operations Research. Operations research techniques are being applied to business and industrial problems at an accelerated rate. These techniques are more reliable than rule-of-thumb measures for management decision making.

5. General Orientation to Computers and EDP and Business Applications should be made available to all business administration students. The fact that the computer is an efficient data processing and operations research tool for all areas of business and industry accounts for this recommendation. Accountants and office managers, as they are very much involved with data processing, should be required to take these two courses.

6. General Orientation to Computers and EDP, Business Systems Analysis and Computer Applications should be taught in departments of business. College professors, in teaching these courses, have the advantage of being able to take a broad, detached viewpoint in each subject. They would not be hindered with the necessity for promoting a certain kind

of computer or limiting themselves to computer applications of a certain kind of business as would the computer manufacturer or the computer user.

7. Numerical Analysis and Operations Research Techniques should be taught in departments of mathematics because of their content. Operations Research Applications could very well be taught in business departments, however.

8. Digital Computer Programming, Advanced Programming Techniques, and Digital Computer operation should be taught by the equipment manufacturer. The manufacturers have the advantage of having the equipment and qualified instructors available for instructional purposes. It would also seem reasonable that the electronic data processing manager take these courses on equipment his company uses.

9. The data processing manager should have a minimum of four years of college education. A large percentage of the respondents had graduate degrees and recommended the same level of accomplishment for prospective electronic data processing managers. The feeling is that in today's complex dynamic economy, the manager needs greater levels of competence.

10. Business competence is the major requisite for success for the prospective head of an electronic data processing unit.

11. Mathematics is becoming increasingly more important to electronic data processing and other managers. The use of operations research, which employs some sophisticated mathematical techniques, is gaining in popularity as a more effective approach to business problems.[36]

James Frank LaSalle Study

LaSalle attempted to determine the role of the secondary school business education department in preparing students for employment in business offices using data processing equipment.[37] His study was completed in 1963. He sought to answer three specific questions:

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[36]Ibid., pp. 173-176.

[37]James F. LaSalle, "The Role of the Secondary School Business Education Department in Preparing Students for Employment in Business Offices Using Electronic Data Processing Equipment" (unpub. Ed.D. dissertation, Pennsylvania State University, 1963), p. 2.

1. Is there agreement on the part of the business educators and businessmen that the business education programs in the secondary schools should include preparation for employment in the automated business office as one of their objectives?

2. To what extent are the business education programs in the secondary schools offering instruction on automated data processing equipment?

3. Do business educators and businessmen agree on the curriculum experiences which should be included in the business education programs of the secondary schools to prepare students for employment in the automated business office?

LaSalle used the questionnaire technique to gather data from heads of secondary business education departments, business educators, machine manufacturers, and machine users. He designed two questionnaires--one for the business education departmental chairman and business educators and one for the users and manufacturers of the machines.[38]

The questionnaire distributed to the business education departments in the secondary schools and to selected business educators on both the secondary and higher education levels was constructed to obtain the following information:

1. The activities and procedures being used to prepare students for employment in business offices using automated data processing equipment.

2. The extent and types of automated data processing equipment on which formal instruction is being given.

3. The attitudes of business educators toward the role of the secondary school business education department in the area of preparation for automation.[39]

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[38]Ibid., p. 56.

[39]Ibid., p. 56.

The questionnaire distributed to the representative business office and to the producers of automated data processing equipment was constructed to obtain the following informations

1. The most common types of automated data processing equipment being used by business offices.
2. The skills and training required of workers in automated business offices.
3. The attitudes of businessmen toward the role of the business education department in the secondary schools in preparing students for employment in business offices using automated data processing equipment.[40]

Although the findings reported by LaSalle may be significant for those who are interested in curriculum development on the secondary school level, these findings are not considered to be of major importance in relation to curriculum development on the college level and are not, therefore, reviewed in this chapter.

J. E. Hanke Study

Hanke conducted a study to determine what conditions now prevail in the education and training of business computer programmers and what additions or changes might be suggested concerning curricular patterns for business students. His study was completed in 1964.[41]

The purposes of the Hanke study were twofold:

1. To determine the educational and training requirements of business computer programmers based on (a) what is being done at the present and (b) what should be done in the near future.
2. To determine what part of these requirements should be provided in the collegiate school or department of business and what can or should be provided elsewhere

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[40]Ibid., p. 57.

[41]Hanke, p. 6.

(as in high school, on-the-job in-service programs of a company, equipment manufacturer training programs; or in other college departments).

Hanke limited his study to include 123 business programmers and 100 of their employers associated with firms in Northern Illinois. Programmers responded by completing a questionnaire designed to ascertain the educational background of the programmers and what college courses they would suggest as being essential, desirable, or unnecessary for a successful programmer.

Employers responded by completing a questionnaire designed to establish points of view regarding the background of programmers.[42]

Table IV shows the item ranks given to background subjects by business computer programmers.

Hanke formulated several conclusions. His conclusions relative to a curriculum for business programmers follow:

1. Apparently a good business background, especially in accounting and general business, is necessary in educating business programmers.[43]

2. Collegiate courses in logic, English and communication skills, mathematics, and accounting respectively were decreed essential in the preparation of business programmers.

3. Deficiencies in training of programmer applicants exist primarily in English and communication skills, logic, mathematical reasoning and accounting.[44]

4. It appears that on-the-job in-service company training, colleges, and equipment manufacturers respectively are considered the best sources for preparing business programmers.[45]

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[42]Ibid., p. 7.

[43]Ibid., p. 75.

[44]Ibid., p. 76.

[45]Ibid., p. 77.

TABLE IV

RANKING OF BACKGROUND SUBJECTS RECOMMENDED BY BUSINESS COMPUTER PROGRAMMERS IN A STUDY BY JOHN EDWARD HANKE

College Subject Area	Item Rank
Logic	1
Mathematics	2
Accounting	3
English and Communication Skills	4
General Business	5
Business Statistics	6
Engineering	7
Natural and Applied Sciences	8
Social Sciences	9

Source: John Edward Hanke, "A Study of the Education and Training of Business Computer Programmers in Selected Businesses in Northern Illinois" (unpub. M.S. Thesis, Northern Illinois University, 1964), p. 46.

Summary of Research to Support the Need For This Study

Three research studies have contributed much toward the development of a formal curriculum for business applications programmers; yet, none of those studies had as an objective the designing of a four-year, formal curriculum for programmers. The Gibson studies were initiated in 1956. The Hay study was completed in 1958 and the Hanke study was completed in 1964.

The Gibson study could be the foundation for curriculum concern. The study provided curriculum recommendations on a general basis. Gibson advocated that a curriculum for programmers should provide: (1) learning experiences that would produce logical thinking, (2) learning experiences that would include the analysis of various systems of procedure, (3) learning experiences that incorporate statistical analysis, and (4) learning experiences that would develop a good mathematical background. In so far as the investigator can determine, Gibson did not include in his curriculum recommendations courses which would provide the learning experiences he advocated. Possibly Gibson did not wish to recommend specific courses for business programmers because most of his conclusions were based upon opinions of educators and employers of programmers or upon historical practices of training institutions.

The Hay study was conducted in Los Angeles. The conclusions were based upon the opinions of employers of business programmers and equipment manufacturers. The conclusions of the Hay study were influenced by the qualities an employer thought he would prefer in a programmer rather than by the qualities the programmer should really possess. That

which is theoretically ideal may not be the best practice when actual programming activities are involved.

Also, there is reason to question the validity of the conclusions of the Hay study because of the small number of participants involved. Only 26 people were interviewed. Guided by the opinions of these 26 people, Hay outlined nine subjects he considered important to the education and training of a business programmer. These nine subjects are: (1) Mathematics, (2) Accounting, (3) Business Statistics, (4) English, (5) Symbolic Logic, (6) Business Letters and Report Writing, (7) Office Management, (8) Science, and (9) Public Speaking.

The curricular program which over one-half of the interviewees of the Hay study preferred was one which would have an exclusively general business background--accounting and economic principles, money and banking, business law, industrial management, office management, and general business courses.

The Hanke study was based on the theory that a curriculum for business programmers should be determined by what business programmers and the employers of business programmers consider ideal. The conclusions were based upon opinions collected with a questionnaire. The participants in the study were limited to Northern Illinois.

Employers of programmers preferred that a prospective programmer be permitted to pursue a curriculum of which 39 per cent would be devoted to business subjects. Programmers recommended that a curriculum include the following subjects, respectively: (1) Logic, (2) Mathematics, (3) Accounting, (4) English and Communication Skills, (5) General Business, (6) Business Statistics, (7) Engineering, (8) Natural and Applied Science, and (9) Social Sciences.

None of the three studies offers a special formula to measure how detailed the treatment of a given subject should be within a curriculum. Both Hay and Hanke mention the importance of accounting mathematics, and English and communication skills; but neither indicates how detailed these courses should be treated within a curriculum for business programmers.

There is need for a sound four-year curriculum which could be criticized by employers of programmers, prospective programmers, and institutions which are in a position, or which will be in a position, to train and educate programmers.

Activities which the business programmer actually performs should influence the selection of the content of a four-year curriculum. In so far as the researcher can find, the present study is the first formal effort to determine, upon the basis of the job performance activities of successful programmers, what should be the content of a curriculum designed to educate programmers.

Analyses of frequency of occurrence of selected topics which the programmer encounters in his job performance should help to determine how detailed the treatment of a given subject in a curriculum should be. Through the findings of the present study, educators should be able to determine what accounting courses to specify in a formal training curriculum. Also, educators should be able to specify the mathematical courses and topics that should be pursued.

Gibson, Hay, and Hanke indicate, through the opinions of their respondents, the need for learning experiences in English and communication skills. It appears, however, that those researchers did not present objective evidence to support that need. Factual evidence to support or reject the need for training in English and communication skills should

be analyzed. The present study attempts to objectively account for factual evidence by examining the activities of the programmer in relation to the size of the firm for which he works and the number of departments for which he programs activities.

Study of the research reports of Gibson, Hay, and Hanke has assured the investigator that the problem of the present study has not been previously solved. Moreover, the investigator has found no evidence to indicate that there has been any prior effort to design, on the basis of research findings, a model curriculum that would be appropriate for Central State College.

CHAPTER IV

METHODS AND PROCEDURES OF THE INVESTIGATION

The primary problem of this study was to determine the factors that should influence a four-year curriculum for programmers of business applications. The secondary problem was to develop a four-year curriculum for Central State College. The findings relative to the primary problem were to be used as guides in developing the curriculum.

The methods and procedures used in the investigation are summarized in this chapter. Because it was believed that more reliable information could be obtained through personal visits with respondents, the interview technique of gathering data was used; consequently, one of the first problems encountered was that of developing an adequate interview guide.

Development of Interview Guide

The interview guide serves the purpose of guiding the interviewer as he gathers information relative to the solving of the problem. It helps the interviewer gather homogeneous data from each interviewee.

One of the primary considerations in the developing of the interview guide was the time to be required of those who would be interviewed. With the time factor in mind, the investigator endeavored to design a guide that would seek out the specificities needed for the solution of

the problem and at the same time require a minimum amount of the time of each person to be interviewed.

The interview guide was designed to gather the same basic information from each respondent. Information sought from those interviewed was limited to that which would be helpful in the construction of a curriculum leading to a degree in the area of computer science with emphasis on business applications programming. As a result, the researcher did not endeavor to find out the ages of interviewees, tenure of each, types of computers used, brand names of computers, etc.; instead he sought information concerning education each interviewee had attained, the programming activities of each interviewee, and the duties that each interviewee performed in his job.

To determine what factors should be included in the interview guide relative to education, programming activities, and duties involved in programming functions, representatives from major companies within the Oklahoma City area and business educators in four-year, degree-granting institutions were visited. Their suggestions were helpful in identifying important aspects that should be included in the interview guide. After major topics of information and a logical sequence of the arrangement of that information were determined, it was decided that the interview guide should be refined to the extent that it could be sent through the mail as a follow up of this project at some future date; therefore, most of the questions were designed to be answered with a "yes" or "no" or with some other objective-type answer.

After all questions were formulated, the researcher organized an interview guide consisting of three general areas. The first area of the guide was devoted to questions concerning the educational background

of the interviewee. The interviewer sought information relative to the respondent's college education in terms of years completed, source, degrees earned, and major and minor subject matter concentrations. The investigator further sought to ascertain the extent and source of each person's technical education.

The second part of the interview guide was devoted to the programming activities of each individual. The interviewer sought information concerning the position of the programmers in the organizational structure of their company, the size of each company, and the number of departments involved in programming activities within each company. This part also required information to help determine the importance of "software packages" or standardized programs in the programming activities of the business applications programmer.

The third part of the interview guide was concerned with the collection of data that would have a more direct influence on a curriculum to be designed in the area of computer programming. A sequence of course topics included in areas of accounting, mathematics, statistics, economics, marketing, and management was prepared. Emphasis was placed on the areas of accounting, mathematics, and statistics because most related literature suggested that mathematics, accounting, and statistics were the areas which should most influence a curriculum for programmers of business applications.

Each interviewee was asked to rate each topic as to its frequency of occurrence within his job performance duties. The rating scale involved three ratings--one for "frequently," two for "seldom," and three for "never occurs." Each person interviewed responded by checking 1, 2, or 3.

This interviewer thought that providing only three ratings would encourage each interviewee to rate each topic accurately. Also, the person being interviewed would be less likely to ponder over rating the topics.

Selection of Interviewees

The firms within a 100-mile radius of Central State College that employed electronic data processing equipment which included a computer had to be identified before the 100 people to be interviewed could be selected. As a first source of help in identifying those firms, the headquarters of International Business Machines in Oklahoma City was visited. That was thought to be a logical starting point as IBM dominates the computer business in the Oklahoma City area.

The policy of management at IBM, however, did not permit its representatives to give information relative to its customers. The only information that could be readily obtained from the representatives of that firm was general in nature. It concerned the number of firms within the Oklahoma City area which would possibly be using a computer of the kind with which this study is concerned. It was indicated that perhaps 20 firms within the Oklahoma City area had regular programming crews that programmed business applications, while there were probably 10 to 15 other institutions with only one or two people performing programming duties.

Representatives from IBM also helped by identifying businessmen within Oklahoma City who had educational interests in electronic data processing. Information obtained through visits with three of those businessmen helped to establish the beginning of a list of names of

programmers who could be visited. Twenty interviews were personally conducted by the researcher to determine the effectiveness of the interview guide. A few modifications were made in the guide before it was used with the remaining 80 interviewees.

The researcher, in a further attempt to gather names of people who program business problems within the prescribed area, joined the Data Processing Management Association chapter that meets monthly in Oklahoma City. Many members of that organization became interested in the study and offered further help in establishing a list of firms which were using a computer in their data processing departments. The membership of the Data Processing Management Association consists of people who are in a supervisory capacity associated with an electronic data processing department. Many, however, are not supervisors of people who perform programming functions. The majority of the members are supervisors of departments of data processing that employ only unit record equipment.

Individuals who were performing programming functions within those firms which employ computers were contacted through their immediate supervisor at their respective companies. The supervisor was consulted by telephone and was told the purpose of the study. With his cooperation, the interviewer arranged individual interviews with programmers of business applications.

An attempt was made to visit with each supervisor of programmers of business applications before the programmers under his supervision were interviewed. The purpose of the visits with supervisors was to get a definite concept of the background of the firms for which the programmers were functioning and to learn about the basic operations of the companies. Programmers from 26 business firms were interviewed.

The supervisors of programmers were able to identify those programmers who were considered to be key programmers and those who were considered to be successful, but not key, programmers. The researcher personally conducted all 100 interviews, which varied in length from a minimum of 15 minutes to a maximum of one and one-half hours. Seventy-five per cent of the programmers were employed in Oklahoma City and 25 per cent were employed in Tulsa, Oklahoma.

Procedure for Analysis of Data

It was readily recognized that the duties of different programmers of business applications would vary with industries. As a result, an endeavor was made to get an adequate representation of programmers from all industries located within the prescribed area. The number of programmers representing each industry is tabulated in Table V.

Representatives from banking, finance, manufacturing, distribution, state government, educational institutions, utilities, insurance, federal government, and petroleum were interviewed. Because the banking and finance industries are similar in their organization and operations, those two industries were combined to faciiitate the analyzing of responses. Likewise, manufacturing and distribution were combined and state government and educational institutions were combined. Considering those combinations as one industry each, data were analyzed for seven different industries--banking and finance, manufacturing and distribution, state government and educational institutions, utility, insurance, federal government, and petroleum.

Within each industry, as defined in the preceding paragraph, the frequency ratings of topics that might occur in each programmer's job

TABLE V

TYPES OF INDUSTRIES IN WHICH PROGRAMMERS OF BUSINESS APPLICATIONS WERE EMPLOYED

Types of Industries	Number of Programmers	Per Cent of Programmers
Utility	2	2
Insurance	10	10
Federal Government	15	15
Petroleum	16	16
State Government and Educational Institutions	16	16
Manufacturing and Distribution	17	17
Banking and Finance	24	24
Total	100	100

This table should be read: 2, or 2 per cent, of the 100 programmers were employed in the Utility industry.

performance were studied. The number of programmers rating a given topic "one" was multiplied by one; the number of programmers rating the same topic "two" was multiplied by two; and, the number of programmers rating that same topic "three" was multiplied by three. Those products were added together to get for each topic a sum which was divided by the total number of programmers within that area. The resulting quotient for each industry was considered a weighted average frequency rating. These ratings are presented in Tables XIX through XXX.

A second way in which data were analyzed was by making tabulations on all industries combined. Given a chosen topic, the number of all programmers from all industries who rated the topic "one" was multiplied by one; the number of all programmers from all industries who rated it "two" was multiplied by two; and, the number of all programmers from all industries who rated the topic "three" was multiplied by three. Those product tabulations were added together, giving a sum which was divided by the total number of programmers interviewed. The resulting quotient was analyzed as a weighted average frequency rating for that given topic for all industry programmers combined.

A third way in which frequency of occurrence of topics within a programmer's duties was analyzed was by the key programmer from each firm that was visited. The supervisor of the business applications programmers at each firm was able to identify the key programmer in his firm. The key programmer was considered to be the most experienced of the programmers employed by his firm and to be involved with programming activities that would most accurately define the programming functions of his firm. Given a specific topic, the number of key programmers who rated the topic "one" was multiplied by one; the number of key programmers

who rated it "two" was multiplied by two; and, the number of key programmers who rated it "three" was multiplied by three. The tabulations on those products were added together, yielding a sum which was divided by the total number of key programmers to provide a weighted average frequency rating for all key programmers from all industries.

A fourth way in which frequency ratings of the occurrence of various topics within a programmer's job performance was analyzed was by all programmers except the key programmers. Given a certain topic, the number of non-key programmers who rated the topic "one" was multiplied by one; the number who rated it "two" was multiplied by two; and, the number who rated it "three" was multiplied by three. The resulting tabulations of products were added together to provide a sum which was divided by the total number of non-key programmers involved in this study to yield a weighted average of the frequency of occurrence of that topic for all non-key programmers from all industries combined.

The weighted averages for key programmers and the weighted averages for non-key programmers were used as the main criteria to aid in determining whether or not a given topic is important enough to be considered an element to be included in a four-year curriculum for business applications programming. Rational judgment was used to establish cut-off figures which would indicate whether a topic was or was not worthy of being included in the curriculum.

The arbitrary ranges of 1 through 1.5, 1.6 through 2.5, and 2.6 through 3.0 were chosen as crucial frequency rating ranges to guide the selection of those topics that should influence a curriculum.

To draw conclusions limited to the business applications programming profession in general terms, the data analyzed for key programmers and

for non-key programmers were studied. Basing general conclusions on those analyses tended to prevent data for any one industry from biasing the selection of factors that should influence a four-year curriculum. Those topics with weighted average frequencies for key programmers and for non-key programmers between 1 and 1.5 were considered "absolutely essential" as factors that should influence a curriculum for business applications programming. Those topics with weighted average frequencies for key programmers and/or non-key programmers between 1.6 and 2.5 were considered factors that should be "recommended" for inclusion in the content of the curriculum; and those topics with weighted average frequencies for key programmers and for non-key programmers between 2.6 and 3.0 were considered factors that should not be included.

The courses that were available or that could reasonably be made available at Central State College had to comprise the model curriculum that was designed. For that reason it was necessary to analyze existing courses in terms of which courses include topics that were found to be important in programming activities.

Procedure for Reporting Analysis of Data

Answers to four specific questions were sought to help effect solutions to both phases of the problem of this study. These questions are: (1) What is the nature and amount of education that business applications programmers received? (2) What are the conditions that surround the activities of the programmer that could influence the content of a business applications curriculum? (3) With what degree of frequency are selected activities encountered by programmers of business applications? (4) What sequence of courses at Central State College

should be made available to a degree-bound student who aspires to become a successful programmer of business applications?

The researcher chose to analyze the data gathered through the use of the interview guide through separate chapters based around each of the four specific questions. The next three chapters will, therefore, analyze data relative to the factors which should influence the content of a curriculum for business applications programmers. These chapters will be followed by the fourth chapter which will analyze courses that should logically be recommended to be included in a curriculum for business programmers at Central State College.

CHAPTER V

ANALYSIS OF DATA REGARDING THE NATURE AND AMOUNT OF EDUCATION THAT SUCCESSFUL BUSINESS APPLICATIONS PROGRAMMERS RECEIVED

A designer of a curriculum for business applications programmers might logically be influenced by information concerning the educational experiences of successful business applications programmers. This chapter will answer the following questions relative to the education of the programmers who were interviewed: (1) What evidence is available to substantiate the idea that programmers of business applications should receive training in college? (2) Which institutions granted the degrees that are possessed by business applications programmers? (3) What are the major and minor subject matter areas of concentration evidenced by the college education of programmers of business applications? (4) What kinds of education have the programmers received other than formal education offered in colleges and universities?

What Evidence is Available to Substantiate the Idea That Programmers of Business Applications Should Receive Training in College?

Each programmer was asked to approximate the number of years of college education he had received. As a guide to what constituted a year of college education, 15 semester hours were considered equal to a load for one semester and two semesters were considered equal to one year of college education.

Table VI shows that 47 per cent of the 100 programmers interviewed for this study had received bachelors' degrees. In addition, 6 per cent of the 100 programmers interviewed had also received masters' degrees. Only 16 per cent of the 100 programmers interviewed had had no college education. Eleven per cent had had as much as one year; 15 per cent had had as much as two years; and 11 per cent had completed three years of college education. Seven per cent of the programmers had completed five years of college education, and 6 per cent had completed six or more years.

The fact that 84 per cent of the 100 programmers interviewed had received some college education is objective evidence that the majority of successful programmers had attended college. Whether or not their job performance has been enhanced through their choice of college courses remains to be determined. The Hanke study and the Hay study suggest that employers doubt the value of college education as it contributes to the success of the programmer.

Which Institutions Granted the Degrees that are Possessed by Business Applications Programmers?

Each programmer was asked to identify the institution from which he received his college education. The objective of this study was not to investigate the purposes and philosophy behind the existence of any institution. It was thought, however, that knowledge of the location of each institution which had granted a degree to any one of the 100 programmers might be useful in developing a model curriculum for business applications programmers at Central State College.

The sources of the degrees held by 47 of the 100 programmers who were interviewed are shown in Table VII. Of the 47 bachelors degrees,

TABLE VI

COLLEGE EDUCATION OF BUSINESS APPLICATIONS PROGRAMMERS
BY NUMBER OF YEARS ATTENDED

Years of College Education	Number of Programmers	Per Cent of Programmers	Number with Bachelors' Degrees	Number with Masters' Degrees
None	16	16.0	0	0
1	11	11.0	0	0
2	15	15.0	0	0
3	11	11.0	1	0
4	34	34.0	33	0
5	7	7.0	7	2
6	5	5.0	5	4
6+	1	1.0	1	0
Total	100	100.0	47	6

This table should be read: 16 programmers, or 16 per cent of all programmers, did not attend college and possess neither a bachelor's nor a master's degree.

15, or 31.9 per cent, were conferred by the University of Oklahoma, Norman. Seven, or 14.9 per cent, were conferred by Central State College, Edmond; and, six or 12.8 per cent, were conferred by Oklahoma State University, Stillwater. Two, or 4.2 per cent, were conferred by Oklahoma City University, Oklahoma City, and 2, or 4.2 per cent, by Phillips University, Enid. As is shown in Table VII, each of the remaining 14 bachelors' degrees was conferred by a different college or university. Thirty-six of the 47 bachelors' degrees were conferred by institutions located in Oklahoma and the remaining eleven by institutions outside Oklahoma. Thirty-four, or 72.3 per cent, of the 47 bachelors' degrees were conferred by institutions that are located within a 100-mile radius of Central State College.

Four of the six masters' degrees were conferred by institutions of higher education within the state of Oklahoma and two were conferred by institutions outside Oklahoma.

What are the Major and Minor Subject Matter Areas of Concentration Evidenced by the College Education of Programmers of Business Applications?

A curriculum designed to educate and train programmers of business applications, according to Niemi, should stress either business courses, mathematics courses, liberal arts courses, or engineering courses. An analysis of the major and minor concentrations of successful business applications programmers should be of interest.

Programmers who had attended college, even though for only one year, were asked to discuss their major subject matter areas of concentration. The 84 programmers who had received one year or more of college education mentioned the major areas of concentration which are listed in Table VIII.

TABLE VII

INSTITUTIONS IN WHICH ACADEMIC DEGREES HELD BY 47 BUSINESS APPLICATIONS PROGRAMMERS WERE EARNED

Name of Institution	Number of Programmers	Per Cent of Programmers	Bachelors' Degrees	Masters' Degrees
Central State College	7	13.2	7	0
DePaul University	1	1.8	1	0
Indiana University	1	1.8	1	0
Kansas University	1	1.8	0	1
Missouri University	1	1.8	1	0
Ohio University	1	1.8	1	0
Oklahoma City University	4	7.5	2	2
Oklahoma State University	6	11.3	6	1
Oklahoma University	16	30.0	15	1
Phillips University	2	3.7	2	0
Rice University	1	1.8	1	0
St. John's University	1	1.8	1	0
Southwestern State College Kansas	1	1.8	1	0
Southwestern State College Oklahoma	1	1.8	1	0
Texas Christian	1	1.8	1	0
Texas Lutheran College	1	1.8	1	0
Tulsa University	2	3.7	1	1
University of Texas	1	1.8	0	1
University of Wisconsin	1	1.8	1	0
Wichita State University	1	1.8	1	0
Total	53	98.3*	47	6

*Rounded to nearest tenth.

This table should be read: 7 programmers, or 13.2 per cent of the 47 programmers who possess college degrees, were granted 7 bachelors' degrees and no masters' degrees from Central State College.

Twenty-six, or 30.0 per cent, of these 84 programmers chose accounting as a major area; 23, or 27.4 per cent, mentioned mathematics as a major. Other major areas mentioned were, in the rank of their frequency of mention: general business, business management, business administration, and engineering. Five, or 4.9 per cent, of the programmers who had attended college for one year or longer mentioned no major.

Eighteen, or 33.96 per cent, of the 47 bachelors' degrees, plus four masters' degrees, were in the field of accounting. Thirteen, or 24.5 per cent, of the 47 bachelors' degrees, plus one master's degree, were in the field of mathematics. Thirty, or 64.04 per cent of all bachelors' degrees were in the fields of business. Forty-three, or 88.54 per cent, of all bachelors' degrees were in the field of business or mathematics.

Several minor areas of emphasis were evident in the educational backgrounds of programmers who had attended college. Table IX lists 20 separate areas of minor subject matter concentration. Business administration was mentioned most often as a minor concentration. Eight, or 9.5 per cent, of all programmers with college training had had a minor concentration in business administration. It should be kept in mind that the area of business administration is broad in concept. Many institutions break this broad area down into multiple concentration areas.

Physics and business law were each listed as a minor concentration by six, or 7.1 per cent, of the programmers. Accounting, economics, finance, and chemistry were each named as minor areas by four programmers. Twenty-nine, or 34.0 per cent, of the programmers with some

TABLE VIII

MAJOR CONCENTRATION AREAS AND YEARS SPENT PURSUING MAJORS BY 84 BUSINESS PROGRAMMERS

Major Concentration Areas	Years Spent Pursuing Majors							Total Programmers	Per Cent
	1	2	3	4	5	6	6+		
	13%	18%	11%	46%	7%	2%	3%		
Accounting	1	4	3	12	3	1	2	26	30.0
Agriculture	0	0	0	1	0	0	0	1	1.1
Biology	0	0	0	1	0	0	0	1	1.1
Business Administration	1	1	0	2	0	0	0	4	4.7
Business Education	1	0	0	0	0	0	0	1	1.1
Business Management	0	1	2	3	0	0	0	6	7.1
Economics	1	0	0	0	0	0	0	1	1.1
Engineering	3	1	0	0	0	0	0	4	4.7
General Business	0	1	0	6	0	0	0	7	8.3
Home Economics	0	1	0	0	0	0	0	1	1.1
Industrial Psychology	0	0	0	1	0	1	0	2	2.3
Mathematics	1	4	5	9	3	0	1	23	27.0
Pharmacy	0	1	0	0	0	0	0	1	1.1
None	3	1	1	0	0	0	0	5	5.9
Total	11	15	11	39	6	2	3	84	98.0*

*Rounded to nearest tenth.

This table should be read: 1 programmer spent 1 year, 4 programmers spent 2 years, 3 programmers spent 3 years, 12 programmers spent 4 years, 3 programmers spent 5 years, 1 programmer spent 6 years, and 2 programmers spent more than 6 years pursuing accounting as a major concentration area. These programmers represent 26, or 30.0 per cent, of the 84 programmers who received at least one year of college education.

TABLE IX

MINOR CONCENTRATION AREAS AND YEARS SPENT PURSUING MINORS BY 84 BUSINESS PROGRAMMERS

Minor Concentration Areas	Years Spent Pursuing Minors							Total Programmers	Per Cent
	1	2	3	4	5	6	6+		
Accounting	0	3	0	1	0	0	0	4	4.7
Art	0	1	0	0	0	0	0	1	1.1
Business Administration	0	0	0	7	1	0	0	8	9.5
Business Education	0	0	0	1	0	0	0	1	1.1
Business Law	0	0	1	4	0	0	1	6	7.1
Business Statistics	0	0	0	1	0	0	0	1	1.1
Chemistry	0	1	1	0	1	0	1	4	4.7
Economics	0	1	1	1	1	0	0	4	4.7
Education	0	0	0	1	0	0	0	1	1.1
Engineering	0	0	1	0	0	0	0	1	1.1
English	0	0	0	2	0	0	0	2	2.3
Finance	0	0	0	1	2	0	1	4	4.7
General Science	0	0	0	2	0	0	0	2	2.3
Management	0	0	1	1	0	0	0	2	2.3
Marketing	0	0	0	1	0	0	0	1	1.1
Mathematics	1	0	0	2	0	0	0	3	3.5
Philosophy	0	0	0	1	0	0	0	1	1.1
Physics	0	0	2	2	1	1	0	6	7.1
Psychology	0	0	0	0	0	1	0	1	1.1
Social Studies	0	0	0	2	0	0	0	2	2.3
None	10	9	4	6	0	0	0	29	34.0
Total								84	98.0*

*Rounded to nearest tenth.

This table should be read: 3 programmers spent 2 years and 1 programmer spent 4 years pursuing accounting as a minor concentration area. These 4 programmers represent 4.7 per cent of the 84 programmers who received at least one year of college education.

college education mentioned no particular area of minor emphasis. A student often does not select a minor area of concentration until his third year of college. Nineteen programmers who mentioned no minor had attended college for two years or less.

Judging by the subject matter areas in which successful programmers have concentrated, a curriculum designed to educate and train business applications programmers should strongly emphasize accounting and mathematics. No one minor area of concentration should be considered ideal for the business programmer.

What Kinds of Education have the Programmers Received Other than Formal Education Offered in Colleges and Universities?

The terms "technical training" and "technical education" as used in this study mean that type of training which would familiarize the programmer with the actual functioning of the digital computer and the unit record equipment which surrounds the digital computer. Technical training for the programmer should polish his talents to the extent that he is professional and a specialist at writing programmed instructions which activate the computer, regardless of the amount of formal education he has acquired.

The occupation of a business applications programmer is technical in nature. The programmer must understand the degrees of proficiency required for the operation of the computer and auxiliary equipment.

Table X indicates that 45 per cent of all programmers had received less than one year of technical education. Twenty-seven per cent had received one year and 26 per cent had received two or more years of

TABLE X

TECHNICAL EDUCATION OF 100 PROGRAMMERS BY NUMBER OF YEARS

Number of Years of Technical Education Received	Number of Programmers	Per Cent of Programmers
None	2	2.0
Less than 1	45	45.0
1	27	27.0
2	13	13.0
3	4	4.0
4	1	1.0
5	1	1.0
6 or more	7	7.0
Total	100	100.0

This table should be read: 2 programmers, or 2.0 per cent of the 100 programmers, had received no technical education.

technical education. Two programmers had had no technical training to prepare them for their programming positions.

The sources of technical education experienced by programmers are revealed in Table XI. Sixty-three per cent of the 100 programmers had attended manufacturers' training schools. Sixty-two per cent had participated in some type of on-the-job training program. Thirteen per cent had taken advantage of independent technical school training. Five per cent had received technical education in armed service training schools and 2 per cent had received education of this kind in publicly supported institutions.

The manufacturers' training schools involve short courses that vary in length from three weeks to several months. These schools are conducted by specially trained representatives of the manufacturer of the computer which a firm employs. These courses always involve teaching the future programmer a particular "machine language." The programmer is expected to master the language to the extent that he can communicate with the digital computer and cause the computer to react favorably.

On-the-job training programs involve actual programming functions for the business applications programmer. His performance, however, is closely supervised by a skilled and experienced programmer. In rare situations, where on-the-job training programs are one or more years in length, programmers are expected to participate in the actual training programs which their employers have designed for all potential managers.

Objective evidence indicates that programmers must receive technical training to enable them to perform their duties satisfactorily, regardless of whether or not they possess a college degree.

TABLE XI

TECHNICAL EDUCATION OF 100 PROGRAMMERS BY SOURCE

Source of Technical Education	Number of Programmers	Per Cent of Programmers
Independent Technical School	13	13.0
Manufacturers' Training Schools	63	63.0
On-the-job Training Programs	62	62.0
Public Supported Institutions	2	2.0
Armed Service Training Schools	5	5.0

This table should be read: 13 programmers, or 13.0 per cent of the 100 programmers, received technical education from an independent technical school.

There is further evidence that the type of technical training needed by business applications programmers is no different for those who possess degrees and those who do not possess degrees. Consequently, a curriculum designed to train programmers should not be too specialized. Manufacturers' training schools and on-the-job training programs could more adequately satisfy the specialized training needs of programmers since the training involved would be based on the type and brand of computer with which the programmer is associated while on the job.

A curriculum for programmers of business applications should include courses of general nature concerning the computer. These courses should primarily develop working skills and knowledges to the extent that the student will be prepared to master easily the training provided by manufacturers' training schools and to quickly complete any on-the-job training program he may encounter.

Summary

Eighty-four per cent of the 100 programmers who were interviewed had attended an institution of higher education. Forty-seven per cent of the 100 programmers possess bachelors' degrees. Thirty-six of these degrees were conferred by institutions of higher education within the state of Oklahoma and eleven were conferred by institutions outside Oklahoma. Six programmers possess masters' degrees, four of which were conferred by Oklahoma institutions and two of which were conferred by institutions outside Oklahoma

Twenty-six programmers had chosen accounting as a major area of concentration for their college education, while 23 had chosen

mathematics. Other areas mentioned were general business, business management, business administration, and engineering.

Sixty-three per cent of the 100 programmers had received specialized training in manufacturers' training schools and 62 per cent had received specialized training in on-the-job training programs. Both computer manufacturers' training schools and on-the-job training programs served as primary sources of the technical training of the programmers, regardless of their college experience.

CHAPTER VI

ANALYSIS OF DATA REGARDING THE CONDITIONS THAT SURROUND THE ACTIVITIES OF THE BUSINESS PROGRAMMER

The conditions which surround the activities of a programmer are many in number. The characteristics relevant to those conditions should influence the content of a curriculum for business applications programmers. Characteristics concerning the position of the programmer in an organizational structure, the size of the firm for which the programmer performs programming activities, the activities which a programmer encounters before he writes a program, and the writing of programs are analyzed in this section.

These characteristics are analyzed by answering the following questions: (1) What position within the organizational structure does the programmer occupy? (2) What is the scope of a programmer's activities in relation to the size of the firm? (3) What on-the-job preparation must a programmer perform before he writes a program? (4) What is the scope of the programmer's actual programming activities?

What Position Within the Organizational Structure Does the Programmer Occupy?

The 100 business applications programmers who were interviewed were asked to identify their position in the organizational sturcture of their firms. As the belief exists that the programmer occupies some position in or closely associated with management, it was considered

pertinent to ask each of the 100 programmers interviewed to indicate the management level of his own position within the organizational structure of his firm.

The levels of management with which the programmer was asked to associate himself and his working activities were operative level, middle level, upper level, and less than operative level. Being at the operative level of management implies that the programmer is responsible to personnel in higher echelons of management, yet is the supervisor of employees who are responsible to him. Middle level management implies that the programmer is responsible to upper level management, yet is the supervisor of programmers and other personnel who are classified as being in the operative level of management. Upper level management includes those programmers who help management make top level decisions.

Table XII indicates that 62 per cent of the 100 programmers considered themselves as being in the operative level of management, while 22 per cent classified themselves as being in middle level management. Only 5 per cent classified themselves as being in the upper level of management. The remaining 11 per cent did not consider themselves to be in a management position. It should be kept in mind that all data relating to the management levels of their positions were obtained from the programmers themselves.

The large majority of business applications programmers occupied positions within the operative level of management as opposed to the middle and upper levels of management. Only five of the programmers were found to have upper management status and to contribute to top management decision making. These facts would seem to imply that the

TABLE XII

MANAGEMENT LEVEL CLASSIFICATION OF 100 PROGRAMMERS OF BUSINESS APPLICATIONS

Management Level	Programmers	
	Number	Per Cent
Operative level	62	62.0
Middle level	22	22.0
Upper level	5	5.0
Less than operative	11	11.0
Total	100	100.0

This table should be read: 62 programmers, or 62.0 per cent of all programmers, considered themselves as being in the operative level of management.

business applications programmer is not likely to be directly involved in making decisions which influence the major policies of a firm; however, data that the programmer produces through his programming efforts might serve to activate decision making and policy forming by top management.

The position of the business applications programmer within the organizational structure was further identified through inquiry concerning the types of decisions which the programmers made. Table XIII shows that 53 per cent of all the programmers helped management make some decisions, while 47 per cent helped make no decisions. The nature of those decisions which the programmers helped to make, however, was very basic to the daily operations of the data processing department within which they were employed. Only 16 varieties of decisions are listed in Table XIII. It was impossible to list more than 16 distinct varieties of decisions without a serious degree of overlapping. It should be noted that that small variety of decisions proves that programmers for different firms often make the same types of decisions.

The data shown in Tables XII and XIII provide little evidence that would justify including a large number of management courses in a curriculum for business applications programmers. A basic course in the principles of management might be worthwhile to broaden the understandings of the programmer concerning the field of management.

What is the Scope of the Activities of the Programmer in Relation to the Size of his Firm?

The training and education which a programmer of business applications should receive in a formal curriculum should be influenced by the size of the firms which employ programmers. If the programmer works for a large organization with many departments or subsidiaries, he could be

TABLE XIII

NATURE OF DECISIONS MADE BY 53 PROGRAMMERS
WITHIN THEIR PROGRAMMING ACTIVITIES

Help Make Decisions 53%	Do Not Help Make Decisions . . . 47%

Illustrations of Nature of Decisions Made

1. Decide how much of a departmental workload is to be automated and how it should be done.
2. Help make decisions on whether it is practical and feasible for a job to be done on the computer system as opposed to manual labor.
3. Help decide which type of program language to use and when a machine will be replaced.
4. Determine a systems procedure for accounts receivable and computer applications.
5. Decide programming design for the department.
6. Develop new payroll procedure, including new method of appointment.
7. Decide what method will be used to solve a problem in business applications.
8. Direct the flow of work involving the use of the computer.
9. Help set policy in division for retail philosophy reporting.
10. Decide which computer, if any, to acquire; whether to rent or buy.
11. Decide on financial systems for better accounting control.
12. Evaluate working forms and choose those best suited for purposes of the firm.
13. Help make policy of standard pricing for the inventories.
14. Decide how company expenses should be reported by machines.
15. Decide the number of production items to manufacture by use of inventory and production control.
16. Decide what to charge a data processing customer for writing his programs.

involved with a large variety of activities. The association of the programmer with the different subsidiaries and departments within the large firm could present a need for many facets of training in a curriculum which is designed to educate programmers of business applications.

Table XIV compares by size the various firms for which the 100 programmers performed programming duties. The number of departments within each firm ranged from three to 110. Fifty-two per cent of all programmers worked for firms which had 16 or more departments within their structure. Eight per cent worked for firms with 11 to 15 departments, and 9 per cent worked for firms with ten departments.

Table XV reveals the multiple numbers of departments that are involved in the programmers' programming activities. Twenty-five per cent of all programmers programmed business applications for 16 or more different departments within their firms, while 15 per cent programmed business applications for 11 to 15 departments.

In view of the data presented in Tables XIV and XV, it seems clear that the programmer must communicate with multiple departments within the firm by which he is employed. Inherent within the communication activities of the programmer are numerous sociological and psychological problems involving personnel relations. His association with multiple departments also suggests the desirability of a broad general business background for the business applications programmer.

Survey courses in the fields of sociology and psychology as well as specialized courses in communications should help the programmer develop the ability to handle problems he might encounter. General sociology, general psychology, and business communications could be

TABLE XIV

SIZE OF FIRMS FOR WHICH PROGRAMMERS WERE EMPLOYED CLASSIFIED BY NUMBER OF DEPARTMENTS WITHIN THE FIRM

Departments Within the Firm	Number of Programmers
52	16 or more
8	11-15
9	10
0	9
0	8
10	7
1	6
10	5
3	4
7	3
0	2
0	1

This table should be read: 52 programmers were employed by firms with 16 or more departments within their structures.

TABLE XV

NUMBER OF DEPARTMENTS SERVED BY THE BUSINESS PROGRAMMER WITHIN THE FIRM

Number of Departments Served by the Programmers	Number of Programmers
25	16 or more
15	11-15
9	10
5	9
1	8
17	7
0	6
6	5
8	4
7	3
2	2
5	1

This table should be read: 25 programmers served 16 or more departments within their firms.

designated as the basic topics around which courses could be designed to help educate the programmer of business applications.

What on-the-job Preparation Must a Programmer Perform Before he Writes a Program?

Before a programmer can write a program to solve a business problem, he must have an understanding of the basic nature of the problem that is to be solved. He must become familiar with many business applications so that he can construct a route to pursue toward solving a business problem. The programmer often goes to the department which anticipates mechanizing a business problem. There he studies the flow of work that involves the problem until he can design a program which will solve the problem. The process of studying the flow of work that is involved is called "systems analysis."

The amount of time necessary for the study of systems and procedures varies with the complexity of the business problem that is to be programmed. In order to program an accounts receivable problem the programmer might need to spend one day studying the accounts receivable system; yet, in order to program an installment loans problem the programmer might need to spend several months studying the systems and procedures which are basic to installment loans accounting. The fact that a business application must be studied by the programmer for a period of time before he attempts to write a program should influence the content of a curriculum designed to educate business applications programmers.

Table XVI indicates the importance of systems analysis by showing the time that each programmer spent studying various phases of business problems associated with his company before he attempted to write

TABLE XVI

MINIMUM AND MAXIMUM TIME SPENT BY 82 PROGRAMMERS IN STUDYING PHASES OF A BUSINESS APPLICATION

Time Spent	Programmers			
	Minimum Time		Maximum Time	
	Number	Per Cent	Number	Per Cent
Less than 1 day	3	3.6	1	1.2
1 day	16	19.0	3	3.6
2-7 days	27	32.0	14	17.0
8-21 days	8	9.7	5	6.0
22-30 days	11	13.0	10	12.0
31-60 days	8	9.7	7	8.5
61-90 days	8	9.7	17	20.0
91-180 days	1	1.2	6	7.3
181-360 days	0	0.0	14	17.0
1 year plus	0	0.0	5	6.0
Total	82	97.9*	82	98.6*

*Rounded to nearest tenth.

This table should be read: 3 programmers, or 3.6 per cent of the 82 programmers who studied phases of business applications, spent a minimum time of less than 1 day studying phases of business applications and 1 programmer, or 1.2 per cent of the 82 programmers who studied phases of business applications, spent a maximum time of less than 1 day studying phases of business applications.

programs for the applications involved. The time spent studying those applications was varied, ranging from less than one day to more than one year.

A programmer could not indicate with any degree of accuracy the exact time he spent studying any particular business application; moreover, a single programmer might have studied several business applications within any given year. When the programmer was asked to reveal the amount of time he spent studying a business application, his answer was rather general. In most instances, his response indicated that he never spent less than a specified amount of time and never more than a different specified amount of time; hence, the data in Table XVI are analyzed by the minimum and maximum times indicated by each of the 82 programmers who studied business applications. The majority of the 18 programmers who did not study business applications indicated that a full-time systems analyst was employed by their firms. The systems analysts studied the business applications and interpreted them to the programmers.

Forty-nine programmers spent a maximum of two months to one year studying the flow of business applications before attempting to program them. Twenty-seven programmers mentioned a minimum of two to seven days time, while 14 programmers mentioned a maximum of two to seven days time devoted to studying business applications. Sixteen programmers mentioned one day as a minimum time for study compared with three programmers who mentioned one day as a maximum time for study of phases of business common to their programming activities.

Table XVII lists the business applications and systems which 82 programmers studied before writing a program.

TABLE XVII

PHASES OF BUSINESS APPLICATIONS STUDIED BY 82 PROGRAMMERS OF BUSINESS APPLICATIONS

Studied Business Systems. . . .	82%	Did Not Study Business Systems	.18%

Illustrations of Business Systems Studied*

1. Transit savings, demand deposits, oil leases, realty payments, and installment loans.
2. Mortgage loans, money order accounting, safe keeping.
3. Trust department accounting.
4. Stock transfers, investment securities, loan applications.
5. Inventory, payroll and cost accounting systems.
6. All accounting systems and statistical setups.
7. Admitting routine, medical records, cashiers' receipts.
8. Stock records, equipment inventory, budgets.
9. Policy issue department, claims and accounting, agency services.
10. Customer and journal accounting.
11. Credit department and marketing accounting.
12. Production department regarding applications and flow.
13. Credits and collections, produce, sales departments.
14. Trucking and produce departments.
15. Fund accounting departments.
16. Medical vendor payments.
17. Accounts payable, manufacturing department, purchasing department.
18. Income tax and withholdings.
19. Manufacturing, financial, marketing, personnel, engineering.
20. Sales taxes.
21. Cataloging and supply.
22. Medical records, standard costs, payroll, and inventory control.
23. Fixed assets, retail billing.
24. Standard accounting procedures, stock transfer procedures.
25. Production and quality control tactics.
26. Oil and gas accounting, trust accounting.
27. Sales analysis.
28. Plant and expense accounting.
29. Casualty insurance.

*Do not account for 82 because of repetition of business systems and procedures studied.

The fact that business applications programmers analyze a business application before they attempt to write a given program is evidence that a curriculum which is designed to produce effective business programmers should include basic training in systems designing and analyzing. The future programmer might also benefit by first-hand observation of a variety of business problems and applications which could be mechanized.

What is the Scope of the Actual Programming Activities of the Programmer?

The actual programming activities of the programmers involved: (1) writing an entire program that would mechanize a given application for the firm which employs the programmer, (2) writing an entire program that would mechanize a given application for a customer of the firm which employs the programmer, or (3) modifying a standardized program to the extent that it would mechanize an application for the firm which employs the programmer or for a customer of the firm which employs the programmer.

Standardized programs are those programs which are prepared by the manufacturer of a particular computer or by a firm which specializes in writing programs to mechanize simple business applications. Almost all standardized programs require major modifications by programmers of businsss applications before the programs are effective in solving an unique business problem.

Most programmers of business applications are not involved to a significant degree with standardized business programs. Table XVIII shows that 80 per cent of all programmers visited do not prepare standard programs for use by other business firms. It also shows that 54 per cent of all programmers visited do not utilize standardized

TABLE XVIII

PROGRAMMING ACTIVITIES ANALYZED BY USE OF STANDARDIZED PROGRAMS WRITTEN OUTSIDE AND WITHIN PROGRAMMERS' FIRMS

Programs Written Outside Firm and Used by Programmers			Programs Written Within Firm and Used by Other Firms		
Per Cent of Total Programs	Programmers Number	Programmers Per Cent	Per Cent of Total Programs	Programmers Number	Programmers Per Cent
0	54	54.0	0	80	80.0
1-5	26	26.0	1-5	1	1.0
6-10	7	7.0	6-10	7	7.0
11-20	4	4.0	11-20	2	2.0
21-30	5	5.0	21-30	2	2.0
31-40	0	0.0	31-40	0	0.0
41-50	0	0.0	41-50	0	0.0
51-80	0	0.0	51-80	0	0.0
81-90	3	3.0	81-90	3	3.0
91-100	1	1.0	91-100	5	5.0
Total	100	100.0		100	100.0

This table should be read: 0.0 per cent of the programs used by 54, or 54 per cent of all programmers, were written by outside firms; 0.0 per cent of the programs written by 80, or 80.0 per cent of all programmers, were used by outside firms.

programs which are produced by an outside agency. Less than 5 per cent of the total programs written by each of 26 programmers incorporated standardized programs. Each of seven programmers incorporated standardized programs in his activities for between 6 to 10 per cent of the programs he wrote. Each of nine programmers incorporated standardized programs within 11 to 30 per cent of his programs.

There exist few, if any, standardized programs that would handle the business problems of any two firms regardless of similarities in the operations of the firms. The fact that standardized programs must be modified by the programmer emphasizes the element of single identity associated with each firm. As a result, courses which encourage and develop actual programming abilities seem desirable in a curriculum for programmers of business applications. The machine language which a programmer employs toward the writing of a program is secondary in importance to the discipline he experiences as he learns to design and write a program.

The programmer of business applications often finds that he must operate the digital computer. Once he has written a program, there must be some reasonable assurance that the program will solve the problem that is involved. As a general rule, it is the responsibility of the programmer to test each of his programs. The program is tested by submitting it to the computer through an appropriate input device.

The data derived through the solving of a problem by a computer frequently must be analyzed for upper management. Programmers of business applications who were interviewed indicated that an effort was made to have the computer prepare any particular report <u>per se</u>;

for example, a programmer of business applications may design a program which will instruct the computer to produce a classified balance sheet or income statement.

The limited amount of computer operating which the programmer must encounter makes training for computer operating an essential component of a curriculum for programmers of business applications; however, the programmer should not be expected to become an expert in every phase of the operation of the computer. The level of operating knowledge that is essential to the success of a computer programmer should be low. The console operator, a trained specialist for operating computers, is usually available for consultation concerning operating problems of a severe or complex nature.

Summary

The majority of programmers identified themselves as being in the operative level of management as opposed to the middle and upper levels of management. Although the programmers helped to make management decisions, the characteristics of these decisions were closely associated with the data processing department in which the programmers were employed.

More than half of the 100 programmers interviewed work for a firm which has within its structure 16 or more departments. As a result of the multiple departments within the firms for which the programmers work, the programmers encounter many problems common with human relations.

Eighty-two of the 100 programmers spent time on the job analyzing a business application before they attempted to write a program for that application. The time which programmers spent studying the various

business applications varied from less than one day to more than one year, depending upon the complexity of the applications involved.

The programming activities of the programmer involve the designing of original programs or the modifying of standardized programs which will accomplish his objective of mechanizing a business application. No standardized program exists that would mechanize a given business application for two separate firms. There is an element of single identity associated with each firm.

CHAPTER VII

ANALYSIS OF DATA REGARDING THE DEGREE OF FREQUENCY WITH WHICH SELECTED ACTIVITIES AND TOPICS ARE ENCOUNTERED BY PROGRAMMERS OF BUSINESS APPLICATIONS

Hay sought the opinions of computer manufacturers and computer users to help determine the qualifications of a programmer.[1] Hanke sought the opinions of employers of programmers to help determine the unique characteristics or skills thought desirable for prospective programmers.[2] This section of data analysis identifies the relative importance of selected activities within the programming functions of the business programmer. The data reported here are analyzed to support the theory that the frequency with which unique activities are encountered by successful programmers should influence their training and education.

Each programmer was asked to rate topics in the subject areas of accounting, mathematics, statistics, economics, marketing, and management as to the frequency of occurrence of each topic within his job performance duties. The rating scale involved three ratings--one for "frequently," two for "seldom," and three for "never occurs." Each programmer evaluated each topic by rating it 1, 2, or 3.

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[1]Hay, p. 76.

[2]Hanke, p. 7.

Weighted average frequencies for each topic were determined for programmers from all industries, for total programmers from each industry, for all key programmers from all industries, and for all non-key programmers from all industries. The weighted average frequencies for key programmers and non-key programmers were studied to determine the topics which should be included in a curriculum for business applications programmers.

The arbitrary ranges of 1 through 1.5, 1.6 through 2.5, and 2.6 through 3.0 were chosen as crucial frequency rating ranges to guide the selection of those topics that should influence a curriculum. The topics with weighted average frequencies between 1 and 1.5 were considered "absolutely essential" as factors that should influence a curriculum for business applications programmers. The topics with weighted average frequencies between 1.6 and 2.5 were considered factors that should be "recommended" to influence the content of a curriculum; and the topics with weighted average frequencies between 2.6 and 3.0 were considered factors that should not be included in a curriculum.

Frequency of Occurrence of Major Activity Areas

The 100 programmers who were interviewed were asked to associate their working activities within six selected major areas of emphasis. These areas are: (1) accounting, (2) statistics, (3) management, (4) mathematics, (5) marketing, and (6) economics.

Table XIX shows a tabulation of major areas involved in the duties expected of business applications programmers. The table indicates that the area of accounting is definitely involved in the job activities of business applications programmers because key programmers rated

TABLE XIX

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF MAJOR AREAS OF ACTIVITY
INVOLVED IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Major Areas of Activity	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Accounting.	1.167	1.118	1.313	1.000	1.400	1.333	1.200	1.167	1.514	1.427
Statistics.	2.250	2.118	1.250	2.000	1.800	1.600	1.636	1.333	1.972	1.813
Management.	1.917	1.941	2.313	3.000	2.200	1.867	1.909	1.833	2.069	2.010
Mathematics	1.833	1.706	1.813	3.000	1.700	1.533	1.364	1.458	1.764	1.688
Marketing	2.708	2.471	2.813	3.000	2.300	2.867	2.182	2.333	2.583	2.625
Economics	2.750	2.706	2.750	3.000	2.900	2.667	2.455	2.667	2.694	2.689

B&F . . . Ratings of 24 programmers representing 6 business firms.
M&D . . . Ratings of 17 programmers representing 2 manufacturing and 1 distributing firms.
SG&EI . . Ratings of 16 programmers representing 2 educational and 3 state government institutions.
UTIL. . . Ratings of 2 programmers representing 1 utility firm.
INS . . . Ratings of 10 programmers representing 3 insurance firms.
FED G . . Ratings of 15 programmers representing 2 federal government installations.
PETR. . . Ratings of 16 programmers representing 5 petroleum firms.
KEY P . . Ratings of 25 programmers representing 1 key programmer from each of the 25 installations visited.
N-KEY . . Ratings of 75 programmers representing all non-key programmers from all installations visited.
ALL . . . Ratings of 100 programmers representing all programmers that were interviewed.

accounting with a frequency of occurrence of 1.167 and non-key programmers rated it 1.514. It is clear that accounting should be included in a curriculum for business programmers. The table also indicates that the areas of mathematics, statistics, management, and marketing have frequency ratings between 1.6 and 2.5. The field of economics was seldom encountered by programmers of business applications.

Although accounting is the only major area rated between 1.0 and 1.5 by both key and non-key programmers, the areas of statistics and mathematics are worthy of specific consideration. As these two areas received a frequency rating between 1.0 and 1.5 by key programmers, it seems clear that both mathematics and statistics should be widely surveyed in a curriculum designed to educate and train programmers.

Frequency of Occurrence of General Accounting Topics

Table XX provides additional evidence that the accounting field and topics involved within the accounting field are essential to the working knowledge of the programmer. The table presents a selected number of general accounting topics and indicates how frequently these topics were encountered within the programming activities of the 100 programmers.

Basic accounting concepts and accrual concepts have a frequency rating between 1 and 1.5. A programmer of business applications must know the significance of debits, credits, accounts, journals, etc. The fact that accounting information for use of management is rated 1.292 by key programmers indicates that business applications programmers were concerned with preparing and interpreting financial statements for use by management. Payroll accounting is rated 1.458 by both key programmers and non-key programmers.

TABLE XX

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF GENERAL ACCOUNTING TOPICS IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

General Accounting Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Basic accounting concepts	1.250	1.176	1.438	1.000	1.600	1.600	1.455	1.292	1.417	1.385
The accrual concepts	2.792	1.765	1.813	1.000	2.100	2.533	1.909	1.583	2.028	1.917
Accounts, debits, credits, etc.	1.042	1.176	1.750	1.000	1.400	2.067	1.364	1.208	1.556	1.469
Techniques of adjusting and closing	1.750	1.647	1.875	1.000	1.900	2.333	1.545	1.792	1.806	1.802
Information for management's use.	1.583	1.294	1.625	1.000	1.500	1.867	1.636	1.292	1.639	1.552
Overall reporting and analysis using the funds flow technique.	2.417	2.294	2.250	1.000	2.700	2.467	2.545	2.042	2.472	2.365
Overall reporting and analysis using ratios and percentages.	2.125	1.588	1.875	1.000	2.200	2.133	2.091	1.875	1.972	1.947
Control by use of analysis of cost accounting variances.	2.458	1.529	1.938	3.000	2.900	2.133	3.000	1.792	2.305	2.281
Payroll accounting.	1.667	1.588	1.625	1.000	1.800	2.533	1.455	1.458	1.458	1.458
Period planning and budgeting	2.500	1.941	2.313	1.000	3.000	2.467	2.273	2.083	2.417	2.333
Break-even chart characteristics.	2.792	2.529	2.938	3.000	2.900	2.733	2.909	2.583	2.764	2.719
Relevant cost (profit maximization)	2.750	2.235	2.938	3.000	3.000	2.733	2.727	2.500	2.750	2.688
Future costs.	2.583	2.353	2.563	3.000	3.000	2.400	2.727	2.458	2.583	2.552
Differential costs.	2.667	2.588	2.500	3.000	2.800	2.600	2.636	2.375	2.681	2.604
Income tax (individual and business).	2.292	2.529	2.250	2.500	2.600	3.000	2.636	2.375	2.528	2.489
Fiduciary accounting.	2.000	2.882	2.563	2.000	2.800	3.000	2.909	2.642	2.642	2.542
Municipal or governmental principles.	2.542	2.542	2.706	2.188	3.000	2.000	2.800	2.636	2.628	2.552

See Table XIX for details concerning columnar headings.

Accounting offered in the curriculum for business applications programmers should include as essential general accounting topics: (1) basic accounting concepts, (2) accrual concepts, (3) the use of debits and credits, (4) accounts, (5) journals, (6) accounting data for use of management, and (7) characteristics of payroll accounting.

The concern of the programmer with reporting and controlling devices in the accounting field is indicated by frequency ratings between 1.6 and 2.5 for topics such as the mechanics of accounting involving adjusting and closing techniques, the funds flow technique and the ratios and percentages technique of reporting and analyzing accounting information, and the cost accounting variances for controlling devices. It seems logical, therefore, to recommend that accounting courses offered in a curriculum for business applications programmers include learning experiences relating to: (1) adjusting and closing accounts, (2) analyzing accounting information through both the funds flow technique and ratios and percentages technique, and (3) controlling costs through the analysis of cost accounting variances.

The fact that programmers of business applications were cost conscious is indicated by the frequency ratings between 1.6 and 2.5 for topics such as period planning and budgeting, break-even chart analysis, construction and interpretation, relevant cost factors leading to profit maximization for a firm, and future and differential cost factors. Income tax accounting for both the individual and business was encountered with a frequency of 2.375 by key programmers from all firms. Based upon these ratings, topics that should also be recommended as a part of the content of accounting courses taught to business applications programmers are: (1) period planning and budgeting, (2) break-even chart analysis,

(3) relevant cost factors, (4) future and differential cost factors, and (5) income tax accounting.

Most of the general accounting topics listed in Table XX can be found in the first two introductory courses of college accounting; however, it is doubtful that the first two courses of college accounting adequately involve the flow of funds and the analysis of cost attributes. Courses directly involving cost accounting principles and concepts could provide the future business programmer with a broad background of the cost elements essential to good management.

Frequency of Occurrence of Asset Accounting Topics

The frequency ratings of assets listed by broad classifications are tabulated in Table XXI. Those classifications of assets often comprise the asset section of a classified balance sheet for a business firm. No particular classification of assets was indicated as "absolutely essential" to the working knowledge of a programmer; however, accounting for cash and cash funds, receivables, inventories, fixed assets, and deferred charges to operations have weighted average frequencies between 1.6 and 2.5, which indicates that knowledge of these classifications of assets was considered necessary to the successful performance of the activities of business applications programmers. It therefore seems clear that the asset accounting topics to be recommended for inclusion in the accounting courses which are a part of the curriculum for business programmers are: (1) cash, (2) receivables, (3) inventories, (4) fixed assets, and (5) deferred charges to operations.

Accounting for securities, although not rated with a high degree of frequency by all programmers, should be noted as that topic was

TABLE XXI

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF BROAD ASSET TOPICS IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Broad Asset Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Accounting for cash (special funds) . .	2.333	2.588	2.188	3.000	2.300	2.933	2.455	2.167	2.528	2.438
Accounting for securities	2.125	2.882	2.875	3.000	2.600	3.000	2.818	2.625	2.653	2.646
Accounting for receivables.	1.750	2.353	2.125	1.000	1.900	2.533	1.636	1.625	2.083	1.969
Accounting for inventories.	2.583	1.294	2.000	1.000	2.200	1.333	2.091	2.125	1.833	1.906
Accounting for fixed assets	2.750	2.176	2.000	3.000	2.300	2.467	1.545	2.000	2.222	2.270
Accounting for wasting assets	2.958	2.824	3.000	3.000	3.000	2.733	2.455	2.667	2.875	2.823
Accounting for intangible assets. . . .	2.917	2.824	3.000	3.000	3.000	3.000	2.818	2.833	2.986	2.950
Accounting for deferred charges to operations.	2.541	2.471	2.500	3.000	2.400	3.000	2.091	2.208	2.417	2.500

See Table XIX for details concerning columnar headings.

rated 2.625 by key programmers. Accounting for wasting assets and for intangible assets was not involved to a significant degree in the activities of a programmer.

Table XXII analyzes the frequency of occurrence of specific topics which could be associated with the current assets--securities, receivables, and inventories. Programmers did not encounter accounting for securities and investments or any specific topic within that category to a significant degree; however, frequency ratings between 1.6 and 2.5 for a number of receivable asset classifications indicate that accounting for receivables is fairly common for programmers. Programmers need to know the applications common to discounting the note of a customer, handling a note in payment of a customer's account, and accounting for notes receivable which are past due. Assigned accounts receivable, installment accounts receivable, and intercompany accounts receivable have frequency ratings between 1.6 and 2.5. It is therefore not recommended that securities be given detailed recognition within the accounting courses designed for the business applications programmer; however, it is recommended that accounting courses for programmers give detailed recognition to the following accounting for receivables topics: (1) notes, (2) assigned accounts, (3) installment accounts, and (4) intercompany accounts.

Programmers of business applications did not encounter consignment accounts receivable nor capital stock subscriptions to an appreciable degree.

It is clear that inventory accounting lends itself to programming applications. The programmers gave frequency ratings between 1.6 and 2.5 to all topics concerning inventory accounting except some

TABLE XXII

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF CURRENT ASSET TOPICS IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Current Asset Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Securities										
Securities as permanent and temporary investments	2.167	2.882	2.813	3.000	2.700	3.000	2.818	2.708	2.708	2.708
Listed and unlisted securities	2.250	2.882	2.875	3.000	2.800	3.000	2.818	2.708	2.708	2.708
Marketable and nonmarketable securities	2.250	2.824	2.875	3.000	2.800	3.000	2.818	2.708	2.708	2.708
Receivables										
Notes receivable	1.917	2.647	2.750	3.000	2.700	2.600	2.091	2.208	2.458	2.396
Trade customers' notes receivable	2.375	2.764	2.875	3.000	2.800	2.867	2.455	2.500	2.667	2.625
Discounting notes receivable	2.167	2.882	2.813	3.000	2.800	2.867	2.545	2.542	2.638	2.614
Past-due notes	1.917	2.825	2.625	2.000	2.700	2.867	2.545	2.208	2.549	2.479
Aging and evaluating accounts receivable	2.042	2.529	2.313	2.000	2.600	2.600	1.636	2.000	2.333	2.250
Assigned accounts receivable	2.333	2.765	2.500	3.000	2.800	2.600	2.000	2.375	2.375	2.375
Installment accounts receivable	1.917	2.882	2.875	3.000	2.900	2.933	2.000	2.417	2.556	2.708
Capital stock subscriptions receivable	2.750	2.825	3.000	2.000	2.900	3.000	2.909	2.833	2.819	2.833
Intercompany accounts receivable	2.583	2.412	2.813	1.000	2.200	2.867	2.455	2.458	2.556	2.531
Advances to employees	2.542	2.059	2.875	2.000	2.400	3.000	2.273	2.292	2.667	2.573
Accruals receivable	2.500	2.353	2.688	3.000	2.200	3.000	2.545	2.292	2.583	2.542

TABLE XXII (Continued)

Current Asset Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Inventories										
Perpetual and periodic inventories. . .	2.583	1.294	2.125	1.000	2.400	1.333	2.091	2.083	1.903	1.948
Goods not possessed	2.750	2.412	2.500	1.000	3.000	1.667	2.818	2.333	1.611	2.448
Goods in transit.	2.625	2.529	2.563	2.000	3.000	1.600	2.636	2.458	2.514	2.500
Goods pledged	2.708	2.235	2.625	3.000	3.000	1.600	3.000	2.625	2.417	2.479
Valuation by lower of cost or market. .	2.833	2.353	2.813	3.000	3.000	2.600	3.000	2.833	2.681	2.719
Valuation by cost basis	2.667	1.941	2.625	3.000	2.900	2.267	2.727	2.417	2.500	2.480
Valuation by retail method.	2.917	2.588	3.000	3.000	3.000	2.800	2.818	2.708	2.819	2.792
Valuation by gross profit method. . . .	2.875	2.412	3.000	3.000	3.000	2.667	2.818	2.792	2.750	2.760
Valuation using first-in, first-out method.	2.792	2.353	2.688	3.000	3.000	2.400	2.727	2.708	2.597	2.625
Valuation using last-in, first-out method.	2.708	2.412	2.938	3.000	3.000	2.600	2.727	2.667	2.694	2.688

See Table XIX for details concerning columnar headings.

specialized evaluation topics. The programmers were concerned with evaluating an inventory using the first-in, first-out and specific cost identification methods. They were also concerned with both perpetual and periodic inventory keeping and goods not possessed, in transit, or pledged.

Frequency of Occurrence of Fixed Assets, Intangible Assets and Deferred Charges to Operations

The frequency rating of 2.406 given by all programmers to the topic of accounting for land, buildings, machinery, and equipment, as shown in Table XXIII, indicates that programmers of business applications should be acquainted with accounting for fixed assets in this category. Lower ratings were given to the other specific topics relating to fixed assets.

Specific topics in intangible asset accounting were not rated with a frequency high enough to indicate importance to programmers.

In the field of deferred charges to operations, business programmers were confronted with insurance, interest, organization expenses, and advertising expenses that are paid in advance. This is apparent from the frequency ratings between 1.6 and 2.5 given to these topics. The programmer was not concerned with discounts on bonds and capital stock that are associated with securities and investments nor with experimental expenses that are paid in advance by a firm. It seems reasonable, therefore, to recommend that the following topics within the classifications of fixed assets, intangible assets, and deferred charges to operations be included in the accounting courses designed for programmers of business applications: (1) land, building, plant, and machinery, (2) insurance, (3) interest, (4) organizational expenses, (5) and advertising expenses.

TABLE XXIII

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF CLASSES OF FIXED ASSETS, INTANGIBLE ASSETS, AND DEFERRED CHARGES TO OPERATIONS IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Classes of Fixed and Intangible Assets and Deferred Charges to Operations	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Fixed Assets										
Land, buildings, machinery and equipment	2.792	2.235	1.875	3.000	2.600	2.533	2.545	2.875	2.583	2.406
Patterns, dies, drawings, and electrotypes	2.958	2.412	2.813	3.000	3.000	2.933	1.636	2.708	2.819	2.792
Wasting assets (depletion items)	2.958	2.824	3.000	3.000	3.000	2.733	2.455	2.667	2.875	2.823
Intangible Assets										
Goodwill	2.917	2.882	3.000	3.000	3.000	2.867	2.909	2.917	2.847	2.865
Patents	2.958	2.882	3.000	3.000	3.000	3.000	2.727	2.917	2.861	2.875
Copyrights	2.958	2.882	3.000	3.000	3.000	3.000	2.909	2.917	2.889	2.896
Trademarks	2.958	2.882	3.000	3.000	3.000	3.000	2.909	2.958	2.889	2.896
Franchises	2.958	2.882	3.000	3.000	3.000	3.000	3.000	2.958	2.931	2.938

TABLE XXIII (Continued)

Classes of Fixed and Intangible Assets and Deferred Charges to Operations	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Deferred charges to operations										
Prepaid insurance	2.458	2.471	2.625	3.000	2.600	3.000	2.545	2.250	2.708	2.594
Prepaid interest	2.375	2.647	2.813	3.000	2.800	3.000	2.636	2.500	2.694	2.646
Discount on bonds	2.458	2.824	2.938	3.000	2.700	3.000	2.818	2.625	2.777	2.740
Discount on capital stock	2.417	2.706	2.938	3.000	2.900	3.000	2.818	2.708	2.736	2.729
Experimental expenses	2.625	2.588	2.625	3.000	2.800	3.000	2.818	2.542	2.764	2.708
Prepaid advertising	2.583	2.588	3.000	3.000	2.500	3.000	2.455	2.375	2.778	2.677

See Table XIX for details concerning columnar headings.

The first two courses in accounting should offer adequate training concerning those topics rated worthy of consideration, i.e., between 1.0 and 2.6, in Table XXIII.

Frequency of Occurrence of Liability Topics

The broad liability classifications used in Table XXIV would normally be found on the balance sheet of a business firm. The table indicates that the current, fixed, and deferred credit to income liability classifications were commonly encountered by business applications programmers. The frequency rating for each of these topics is between 1.6 and 2.5. Contingent liabilities were seldom encountered by programmers of business applications.

Table XXV reveals that the business programmer is concerned with a limited number of liability topics. With frequency ratings between 1.6 and 2.5, notes, accounts, dividends, salaries and wages, interest and taxes payable may be regarded as important to the knowledge of business programmers. Based upon these ratings, it seems reasonable to recommend for inclusion in the current liability segment of the accounting courses designed for the business applications programmer: (1) notes payable, (2) accounts payable, (3) devidends payable, (4) salaries and wages payable, (5) interest payable, and (6) taxes payable.

Long-term liabilities such as mortgages and bonds payable were encountered by programmers with a frequency indicated by a weighted average rating of 2.469. A general knowledge of long-term liabilities should be sufficient for the programmer. The programmers indicated that they had relatively little need for knowledge concerning classifying bonds, recording bond issues, amortizing bond premiums or

TABLE XXIV

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF COMMON LIABILITY CLASSES
IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Common Liability Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Current liabilities	2.208	2.059	1.875	3.000	2.200	2.800	1.727	1.875	2.250	2.156
Contingent liabilities.	2.750	2.647	2.813	3.000	3.000	3.000	2.727	2.708	2.764	2.750
Fixed liabilities	2.167	2.588	2.750	3.000	2.300	2.933	2.727	2.292	2.528	2.469
Deferred credits to income.	2.375	2.471	2.875	3.000	2.400	2.867	1.818	2.375	2.500	2.469

See Table XIX for details concerning columnar headings.

TABLE XXV

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF SPECIFIC LIABILITY TOPICS
IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Specific Liability Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Current Liabilities										
Notes payable	2.375	2.588	2.438	3.000	2.700	3.000	2.364	2.250	2.639	2.542
Accounts payable	2.375	2.176	2.313	3.000	2.600	2.933	1.818	2.083	2.458	2.365
Dividends payable	2.125	2.882	3.000	3.000	2.100	3.000	2.818	2.417	2.681	2.615
Merchandise received on consignment	2.875	2.884	2.750	3.000	3.000	2.867	2.727	2.667	2.861	2.813
Contracts for future delivery	2.875	2.647	2.375	3.000	2.800	2.733	2.909	2.667	2.708	2.677
Goods in transit	2.875	2.706	2.688	3.000	3.000	2.733	2.727	2.708	2.792	2.760
Accruals payable	2.542	2.471	2.563	3.000	2.600	3.000	2.545	2.750	2.639	2.219
Salaries and wages	2.208	2.000	2.125	2.500	2.100	2.933	2.000	2.058	2.306	2.219
Interest payable	1.958	2.529	2.813	3.000	2.000	3.000	2.636	2.208	2.528	2.448
Commissions payable	2.750	2.706	3.000	3.000	1.900	3.000	2.000	2.417	2.583	2.542
Royalties payable	2.833	2.765	3.000	3.000	3.000	3.000	2.182	2.625	2.764	2.729
Taxes payable	2.375	2.353	2.563	3.000	2.500	3.000	1.909	2.333	2.403	2.385
Fixed Liabilities										
Mortgage payable	2.167	2.824	2.875	3.000	2.500	2.933	2.727	2.500	2.569	2.552
Bond payable	2.250	2.882	2.813	3.000	2.700	3.000	2.818	2.708	2.583	2.615
Classification of bonds	2.792	2.882	2.875	3.000	2.800	3.000	2.818	2.667	2.722	2.708
Recording bond issue	2.458	2.882	2.875	3.000	3.000	3.000	2.818	2.792	2.681	2.708
Amortization of premium and discount	2.375	2.882	2.875	3.000	2.900	3.000	2.707	2.708	2.653	2.667
Bond sinking fund	2.798	2.882	2.875	3.000	3.000	3.000	2.818	2.792	2.764	2.771

See Table XIX for details concerning columnar headings.

discounts, and establishing bond sinking funds. Table XXV shows all of these topics have weighted average ratings above 2.5.

Frequency of Occurrence of Business Ownership Topics

The business applications programmer did not often encounter topics relative to accounting for ownership of business firms. The frequency ratings for all topics in this area are between 2.6 and 3.0. The ratings of the specific topics relating to business ownership are given in Table XXVI. It is therefore apparent that accounting courses for programmers should not stress the study of business ownership topics.

Summary of Analysis of Accounting Activities Encountered by Business Programmers

Programmers of business applications were especially concerned with reporting, interpreting, and analyzing accounting data. Acquaintanceship with the funds flow technique and ratios and percentages technique of analyzing and reporting business data was necessary to the success of the programmer. Business programmers are also concerned with accounting applications involving accounting for cash, receivables, inventories, fixed assets, deferred charges to operations, current liabilities, and deferred credits to income.

Programmers must have a working knowledge of cost control through use of break-even chart construction and interpretation, through use of analysis of cost accounting variances, and through the preparation of relevant, future, and differential cost reports for management.

Accounting for business ownership problems, details of long-term liabilities, intangible assets, wasting assets and securities is not

TABLE XXVI

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF BUSINESS OWNERSHIP TOPICS
IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Business Ownership Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Sole proprietorship	2.917	2.882	3.000	3.000	2.400	3.000	2.818	2.875	2.861	2.865
Partnership (formation, operation, and disolution)	2.833	2.882	3.000	3.000	3.000	3.000	2.818	2.875	2.903	2.865
Corporation	2.583	2.882	3.000	3.000	2.600	3.000	2.545	2.750	2.764	2.760
Organization of corporation	2.708	2.882	3.000	3.000	2.900	3.000	2.727	2.833	2.792	2.802
Capital stock of corporation.	2.625	2.882	3.000	3.000	2.600	3.000	2.818	2.833	2.708	2.740
Treasury stock of corporation	2.667	2.882	3.000	3.000	2.600	3.000	2.000	2.833	2.819	2.823
No-par-value stock of corporation . .	2.708	2.882	3.000	3.000	2.800	3.000	2.000	2.833	2.861	2.854
Retained earnings of corporation. . .	2.667	2.882	3.000	3.000	2.600	3.000	2.818	2.708	2.847	2.813
Appropriated retained earnings. . . .	2.708	2.882	3.000	3.000	2.800	3.000	2.818	2.792	2.861	2.844

See Table XIX for details concerning columnar headings.

rated sufficiently important within the activities of the programmer to merit being included within a training program for business programmers.

Frequency of Occurrence of Statistical Topics

The frequency of occurrence of statistical topics for the programmer of business applications is shown in Table XXVII. Key programmers encountered the field of statistics with a frequency rating of 1.5; therefore, knowledge of topics within the field of statistics may be considered as essential. Statistical topics with a frequency rating between 1.6 and 2.5 were elementary number usage techniques, probability of equally likely outcome of a number of reoccurring events, and methods and principles involved in sampling. These topics are recommended for inclusion in the statistics courses designed for business applications programmers.

Programmers of business applications programmed applications which involved random selecting of scientific samples, determining the standard error of the mean, making statements of reliability, and drawing statistical inferences. These topics have frequency ratings between 1.6 and 2.5; therefore, it is recommended that they be included in the content of a statistics course that is within the curriculum of the programmer.

Key programmers were concerned with the correlation and the analysis of variances techniques of comparing data. Their concern is indicated by a frequency rating of 2.458. The programmers also utilized knowledge concerning statistical quality control techniques in production and management and often helped prepare control charts of variables concerning business problems. The programmers' need for knowledge concerning

TABLE XXVII

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF STATISTICAL TOPICS
IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Statistical Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
The field of statistics	2.417	2.176	1.438	3.000	1.800	1.533	1.545	1.500	2.028	1.896
Elementary number usage techniques. . .	2.459	2.235	2.000	3.000	2.300	2.067	2.545	2.083	2.528	2.417
Probability (equally likely outcome). .	2.667	2.235	2.313	3.000	2.700	2.067	2.636	2.083	2.528	2.417
Principles involved in sampling	2.667	2.059	2.000	3.000	2.700	1.667	2.545	2.125	2.306	2.260
Random selection--scientific sampling	2.750	2.176	2.125	3.000	2.800	1.867	2.636	2.250	2.417	2.375
Standard error of the mean.	2.708	2.412	2.375	3.000	2.700	2.200	2.636	2.292	2.556	2.490
The statement of reliability.	2.750	2.353	2.500	3.000	2.600	2.333	2.727	2.333	2.583	2.521
Statistical inference	2.708	2.294	2.438	3.000	2.700	2.200	2.727	2.417	2.514	2.490
Sampling methods.	2.667	2.294	2.063	3.000	2.700	1.933	2.545	2.209	2.403	2.354
Bivariate data and regression analysis.	2.968	2.647	2.688	3.000	2.700	2.667	2.818	2.625	2.792	2.740
Confidence intervals.	2.968	2.706	2.750	3.000	2.700	2.733	2.818	2.667	2.806	2.771
In economics and business	2.968	2.647	2.625	3.000	2.700	2.733	2.818	2.708	2.792	2.771
Correlation--the analysis of variance .	2.968	2.647	2.438	3.000	2.400	2.400	2.818	2.458	2.694	2.635
Statistical quality control in production management	2.875	2.471	2.813	3.000	2.600	2.133	2.818	2.500	2.722	2.667
Statistical surveillance of repetitive process.	2.917	2.588	2.813	3.000	2.800	2.333	2.818	2.750	2.694	2.708
Control charts of variables	2.875	2.647	2.875	3.000	2.700	2.200	3.000	2.583	2.736	2.698
Control charts of attributes.	2.833	2.706	2.875	3.000	2.700	2.400	3.000	2.625	2.778	2.740
Statistical analysis--time series data.	2.792	2.647	2.813	3.000	2.500	2.600	2.818	2.625	2.736	2.708
Forecasting and marketing research. . .	1.917	2.294	2.750	3.000	2.900	2.667	2.636	2.542	2.681	2.646

See Table XIX for details concerning columnar headings.

these topics merits the recommendation that they be included within the statistical courses made available to the business applications programmer.

Forecasting of future events and marketing research were important topics to programmers of business applications. These topics were rated in the frequency range between 1.6 and 2.5.

In many cases a programmer is employed by a firm which also employs a permanent statistician. As a result, the statistical knowledge which the programmer is expected to master is rather general. It is doubtful, however, that the introductory course in statistics that is offered in most business curricula could provide an adequate amount of general statistical knowledge for business applications programmers.

The statistical courses that should be a part of the education of the business programmer should stress the areas of elementary number usage techniques, probability theory, principles and methods of scientific sampling, and correlation and analysis of variances. The programmer should also encounter learning experiences through business problems that involve statistical quality control relating to production and management functions, forecasting of future occurrences, and marketing research. An advanced statistics course should logically include these learning experiences.

Frequency of Occurrence of Mathematical Topics

The fact that mathematical topics are important to the programmer is established by the data presented in Table XXVIII. The concepts of notation concerning subscripts, factorials, and superscripts were important to programming activities. The actual functioning of a

TABLE XXVIII

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF MATHEMATICAL TOPICS IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Mathematical Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
The concepts of notation (subscripts, factorials, etc.)	2.208	2.353	2.125	3.000	2.300	1.667	1.909	2.042	1.764	2.104
The number systems (base 10, binary and octal, rational and irrational, powers and roots, etc.)	1.750	1.887	2.125	3.000	2.100	1.333	1.600	1.667	1.819	1.781
Basic symbolic logic (statements, deductive and inductive logic, conjunction and disjunction, truth tables, arguments, etc.)	1.917	1.706	2.313	3.000	2.400	1.667	1.727	1.750	1.875	1.844
Sets and Boolean expressions (intersection and union, Boolean algebra)	2.708	2.471	2.688	3.000	2.600	2.533	2.636	2.458	2.611	2.573
Equations and inequations	2.208	2.059	2.125	3.000	1.800	2.133	1.818	1.875	2.292	2.188
Functions and their graphs	2.792	2.529	2.750	3.000	2.400	2.133	2.364	2.292	2.556	2.490
Linear functions	2.875	2.588	2.500	3.000	2.500	2.533	2.364	2.333	2.667	2.583
Non-linear functions	2.833	2.529	2.500	3.000	2.500	2.667	2.636	2.375	2.681	2.656
Exponential functions	2.917	2.588	2.500	3.000	2.600	2.667	2.636	2.375	2.750	2.594
Trigonometric functions	2.875	2.765	2.500	3.000	2.600	2.667	2.636	2.458	2.750	2.677
Basic probability theory (concepts, permutations and combinations)	2.625	2.353	2.500	3.000	2.400	2.467	2.545	2.167	2.583	2.479
Vectors and matrices (matrix algebra and applications)	2.792	2.471	2.625	3.000	2.400	2.467	2.545	2.375	2.264	2.281
Basic operations research techniques	2.875	2.412	2.688	3.000	2.800	2.533	2.727	2.542	2.708	2.657
Iterative process--the alogrithm	2.833	2.529	2.688	3.000	2.800	2.533	2.727	2.542	2.708	2.656
Mathematical models	2.792	2.471	2.688	3.000	2.600	2.867	2.818	2.500	2.750	2.688
Linear programming	2.708	2.529	2.688	3.000	2.500	2.333	2.727	2.417	2.625	2.573

TABLE XXVIII (Continued)

Mathematical Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Introduction to differential and integral calculus	3.000	2.706	2.750	3.000	2.700	2.667	2.626	2.650	2.764	2.729
The derivative	3.000	2.706	2.750	3.000	2.700	2.667	2.818	2.750	2.778	2.771
Maxima and minima	3.000	2.647	2.750	3.000	2.700	2.600	2.818	2.708	2.764	2.750
Definite and indefinite integral	3.000	2.706	2.750	3.000	2.700	2.800	2.727	2.750	2.792	2.781
Advanced calculus	2.958	2.824	2.938	3.000	2.900	2.800	2.909	2.958	2.833	2.865
Differential equations	3.000	2.765	2.875	3.000	2.700	2.800	2.818	2.833	2.819	2.823

See Table XIX for details concerning columnar headings.

computer is built around the number systems; therefore, the base 10 number system, binary and octal, rational and irrational numbers, and powers and roots must be mastered by a programmer of business applications. It seems reasonable to recommend that the mathematics courses offered the business applications programmer include: (1) concepts of notations and (2) different number systems.

Basic symbolic logic involving statements, deductive and inductive reasoning, conjunction and disjunction, truth tables and arguments were frequently encountered by business applications programmers. The frequency ratings within the range of 1.6 to 2.5 for these topics may be interpreted to mean that it is desirable to include these topics in the content of the mathematics courses designed for business programmers.

The ratings between 1.6 and 2.5 given to equations and inequations, sets and Boolean expressions, and functions and their graphs prove the usefulness of these fields of mathematics. An understanding of the applications involved in matrix algebra was also necessary for the business applications programmer. Matrix algebra was rated with a frequency of occurrence of 2.264 by all non-key programmers. Operations research techniques involving linear programming, mathematical models, and iterations are gaining a place of importance in the business applications problems of the programmers. As these topics in the mathematics area were rated within the "recommended" frequency range, it would be desirable to include them in the content of mathematics courses offered for business applications programmers.

Topics in calculus and differential equations were rated above 2.5 by programmers. This rating indicates that knowledge of calculus

and differential equations is not essential to the success of the practicing business applications programmer.

Several courses in the field of mathematics would apparently be necessary in the education of a business programmer. The spiral learning pattern involved in the learning of mathematics would imply the need for more than a basic mathematics course. The mathematics courses should involve problems which require a working knowledge of the different number systems, basic symbolic logic, and sets and Boolean expressions. The courses should, in addition, develop the ability to solve equations and inequations and to understand functions and their graphs. Matrix algebra which includes mathematical applications concerning vectors and matrices should provide a foundation for the learning of basic operations research techniques which involve iterations, mathematical models, and linear programs.

Frequency of Occurrence of Marketing and Economic Topics

Tables XXIX and XXX reveal that many topics in the fields of marketing and economics are relatively unimportant in the work of the business applications programmer. It should be noted, however, that the areas of principles of marketing, distribution management, marketing research, and economic principles of production all have ratings in the range from 1.6 to 2.5.

The ratings given to topics in marketing and economics may be interpreted to mean that survey courses in these two areas would be desirable in a curriculum for business applications programmers.

TABLE XXIX

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF MARKETING TOPICS IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Marketing Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Principles of marketing	2.798	2.529	2.875	3.000	2.900	3.000	2.273	2.500	2.764	2.698
Retail management	2.875	2.765	3.000	3.000	3.000	3.000	2.273	2.750	2.833	2.813
Distribution management	2.875	2.588	2.938	3.000	2.000	2.933	2.364	2.542	2.833	2.771
Sales management	2.833	2.765	2.938	3.000	2.900	3.000	2.364	2.708	2.791	2.771
Advertising management	2.875	2.765	3.000	3.000	3.000	3.000	2.727	2.833	2.875	2.865
Marketing research	2.833	2.706	3.000	2.500	2.800	3.000	2.455	2.500	2.347	2.385
Advertising copy and layout	2.833	2.765	3.000	3.000	3.000	3.000	2.818	2.792	2.889	2.865

See Table XIX for details concerning columnar headings.

TABLE XXX

WEIGHTED AVERAGE FREQUENCY OF OCCURRENCE OF ECONOMICS TOPICS IN THE WORK OF BUSINESS APPLICATIONS PROGRAMMERS

Economics Topics	B&F	M&D	SG&EI	UTIL	INS	FED G	PETR	KEY P	N-KEY	ALL
Economic principles of production	2.875	2.588	2.875	3.000	2.800	2.733	2.636	2.583	2.778	2.729
Economic principles of consumption	2.692	2.825	3.000	3.000	3.000	2.600	2.818	2.933	2.778	2.729
Economic principles of distribution of wealth	2.692	2.824	3.000	3.000	3.000	3.000	2.727	2.917	2.861	2.875
Price determination	2.823	2.706	2.875	3.000	3.000	2.867	2.636	2.750	2.792	2.781
Allocation of resources	2.692	2.706	2.750	3.000	3.000	2.667	2.727	2.667	2.861	2.813
Market structure in the private sector of the economy	2.958	2.824	2.938	3.000	3.000	2.867	2.818	2.875	2.889	2.886
Modern currency and its place in a financial organization	2.667	2.882	2.938	3.000	3.000	3.000	3.000	2.833	2.861	2.854
Banking and credit and its place in a financial organization	2.458	2.824	2.938	3.000	3.000	2.867	3.000	2.798	2.792	2.771
Causes for period of prosperity in a business	2.583	2.824	2.813	3.000	3.000	2.867	2.909	2.875	2.792	2.813
Causes for period of depression in a business	2.583	2.824	2.938	3.000	3.000	2.875	2.909	2.875	2.806	2.823
Determinants of national income and distribution	2.708	2.882	3.000	3.000	3.000	2.867	2.909	2.875	2.792	2.802
Problems of underdeveloped areas	2.708	2.882	3.000	3.000	3.000	2.867	3.000	2.917	2.847	2.854
History of public utilities	2.583	2.882	3.000	3.000	3.000	2.867	3.000	2.917	2.847	2.865
Relation of public utilities to the community	2.667	2.824	2.875	3.000	3.000	2.867	3.000	2.875	2.833	2.854

See Table XIX for details concerning columnar headings.

CHAPTER VIII

CURRICULUM RECOMMENDATIONS FOR BUSINESS APPLICATIONS PROGRAMMERS AT CENTRAL STATE COLLEGE, BASED ON THE ANALYSIS OF DATA

The recommendations concerning the development of a four-year curriculum for programmers of business applications may be based upon the analysis of the data of this study and related literature.

The second part of the problem of this study was to develop a suggested four-year curriculum for Central State College. Such a curriculum should provide for enough student choice of courses to make it democratically sound; yet, it should be rigid enough to produce competent employees for business applications programming occupations. At the same time, the curriculum must adhere to the philosophy and requirements that are basic to all curricula at Central State College.

Philosophy Governing Curricula at Central State College

The philosophy behind all four-year curricula at Central State College is that each pattern should include a group of general education courses. The courses in the general education area are predetermined and almost standard for any degree, regardless of the major emphasis.

A second part of each curriculum is identified as specialized education. In the general education segment, the courses are foundational and general in nature. In the specialized education segment, advanced courses receive major emphasis.

The purpose of the studies in the general education is to acquaint the student with the social, scientific, and cultural inheritance. It is believed that the student's experience and development in these vital areas will assure the establishment of a background which will contribute much to a successful, satisfactory, and responsible adult life and provide an avenue for his understanding of and intelligent participation in a democratic society. The student's studies in the general education segment provide a basis for the successful pursuit of the advanced and professional studies in the specialized education segment of his curriculum.[1]

General Education Recommendations

The delimitations of this study emphasized the fact that a curriculum designed for Central State College must conform to the established degree patterns. A four-year curriculum leading to a degree may take either of two patterns: (1) It may include at least 50 credit hours of general education with one major area of subject matter specialization and two 18-credit-hour minor areas of subject matter specialization; or, (2) it may include 50 credit hours of general education with two major areas of subject matter specialization.

The pattern involving two minor areas of specialization is recommended for programmers of business applications because that pattern could provide a general business background with breadth in accounting, mathematics and statistics.

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[1] Central State College Bulletin (Vol. 52, No. 5, November, 1963), p. 1.

The general education segment of the curriculum for business applications programmers at Central State College should be based upon the following recommendation:

> The general education content of a curriculum for programmers of business applications should be basically the same as that for other business majors. An effort should be made to include as many courses as possible in the fields of written and oral communications, psychology, economics, and mathematics.

Courses that must be included in the 50 credit hours of the general education pattern of a degree curriculum at Central State College are selected from several divisions: (1) Language Arts, (2) Social Science, (3) Health and Physical Education, (4) Science, (5) Humanities, and (6) Mathematics, Psychology, Foreign Language, Fine Arts, or Practical Arts. The courses from these areas that are recommended for the business applications programmer are analyzed in the following sections.

Language Arts. In order to meet the minimum college requirement for language arts, at least eight credit hours must be earned in the fields of grammar, composition, and speech. The catalogue descriptions of the three courses that should ordinarily be taken by the business applications programmer to satisfy the language arts requirement are:

> English 103, English Grammar and Composition. Review of the principles of grammar and basic mechanics for effective use of the English language, both written and oral, with emphasis on writing as required for successful college study and adult life. Study of specimens from literature. Standard first course for freshmen.
>
> English 113, English Grammar and Composition. Continuation of English 103 with a greater emphasis on composition on a higher level.

> Speech 103, Fundamentals of Speech. Elements of speech and principles of effective speaking in everyday social relationships as well as in oral reading and public address.[2]

Social Science. At least nine credit hours in the field of social science are required by Central State College. In order to comply with legislative requirements, three hours of government and three hours of American history should be included. A three-semester-hour course in Economics is recommended for business applications programmers because it should help build a foundation for further specialized courses in the curriculum. The catalogue descriptions of the social science courses that are recommended for the prospective business applications programmer are:

> History 223a, History of the United States to 1865. A survey with emphasis on the political, social, and economic development of the United States to the end of the Civil War; or
>
> History 223b, History of the United States Since 1865. Continuation of History 223a.
>
> Government 103, American National Government. Origin, structure and functions of the national government.
>
> Economics 203, Principles of Economics. Fundamental economic principles appearing in production, consumption, and distribution of wealth; selected problems in applied economics.[3]

Health and Physical Education. Four credit hours of physical activity courses and two credit hours of personal health must be completed to comply with the minimum college requirement in Health and Physical Education. The catalogue description of the personal health course is:

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[2]Ibid., p. 155.

[3]Ibid., p. 170.

> Health 102, Personal Health. A survey of habits and practices which affect personal healthy living.[4]

Science. The general education segment of each curriculum must contain two four-credit-hour courses from the field of science to satisfy the minimum college requirements. One course must be in biological science and the other in physical science. The two courses at Central State College which are recommended are listed below.

> Biology 104, General Biology. The outstanding discoveries and generalizations in the field of biology, with particular attention to the cell and heredity. Lecture and laboratory.
>
> General Science 104, General Physical Science. A lecture-demonstration course designed to assist students to interpret their physical environment. A study of important topics in astronomy, chemistry, geology, and physics.[5]

Humanities. At least five credit hours in humanities are required to meet the general college requirement in that area. The course recommended is:

> Humanities 105, General Humanities. Study of significant ideas of Western man as manifested in the arts, philosophy and religion.[6]

Mathematics, Psychology, Foreign Language, Fine Arts, or Practical Arts. Courses from each of the areas of mathematics, psychology, foreign language, fine arts, and practical arts are not likely to be essential in the education of the programmer. The catalogue for Central State College emphasizes the point that the general education segment of any curriculum must include one or more courses amounting to at least five credit hours and including at least two of the five areas. The

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[4]Ibid., p. 150.

[5]Ibid., p. 168.

[6]Ibid., p. 157.

most logical areas to consider for the business applications programmer are mathematics and psychology. Courses from these two areas could logically serve as a foundation for further learning experiences. The two courses that are recommended are:

> Mathematics 165, College Algebra and Trigonometry. A combined course of plane trigonometry and advanced algebra including basic concepts of function, logarithmic and exponential functions, trigonometric functions on the real numbers as well as functions of angles, complex numbers, solutions of linear equations using simple matrix manipulations, determinants, binomial theorem, permutations and combinations, mathematical inductions, and inverse trigonometric functions.[7]

> Psychology 203, General Psychology. The basic facts and principles of the mental activity of human beings; a critical study and evaluation of modern psychological theories.[8]

Electives. The prospective programmer should choose from the general education areas enough courses to account for a minimum total of 50 credit hours of general education.

Specialized Education Recommendations

The specialized segment of the curricula confines the study of the student largely to one or more selected fields. These fields are developed through more advanced courses as majors and minors. As a rule, these fields of concentration will have been selected by the student during the sophomore year, and some of the introductory courses will have been completed while the student is completing the general education segment of his curriculum. The more concentrated work comes at the specialized education level.

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[7]Ibid., p. 162.

[8]Ibid., p. 148.

It is the aim of Central State College through the organization of its specialized education program to make it possible for the student, through a series of progressively advanced studies, to achieve relative thoroughness in these more limited areas by the end of his four-year course.[9]

The specialized sector of the curriculum for business applications programmers should consist of one 38-credit-hour major area and two 18-credit-hour minor areas of specialization. The courses recommended in the major area represent the fields of accounting, mathematics, statistics, and written communications. They should help to develop the background needed to carry out computer science functions. These courses should be followed by courses in computer science which incorporate the student's background of business with actual business applications utilizing computing machinery.

The first minor area of specialization should consist of accounting courses designed to acquaint the student with topics such as interpreting and analyzing financial data, the funds flow statement, and techniques of reporting using percentages and ratios. Other topics that should be included in these accounting courses are break-even chart construction and interpretation, analysis and understanding of cost accounting variances, management reporting dealing with relevant, future, and differential cost factors, and income tax accounting for the individual and business concern.

The second minor area of specialization should include basic courses in several areas of a general business nature. These courses should

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[9]Ibid., p. 1.

represent the fields of marketing, management, business law, finance, and communications.

The specialized courses which are recommended for inclusion in the specialized sector of the curriculum for business programmers are analyzed in this section. These specialized courses fall within six general activity areas which are basic to the daily job activities of the business applications programmer. These activity areas are: (1) Communication Skills, (2) Accounting, (3) Mathematics, (4) Miscellaneous Business, (5) Computer Science, and (6) Human Relations.

Communication Skills. The fact that many programmers program applications for firms which have multiple departments within their structures portrays the presence of communication problems that programmers are likely to encounter. In addition to the three foundation courses in English, two more concentrated and specialized courses in the field of communications could help properly prepare the programmer for problems he may encounter. Two courses recommended are:

> Business Practices 313a, Business Communications. The essential qualities of business writing; composition of sales letters and response; application letters.
>
> Business Practices 313b, Report Writing. A study of the procedures and methods of gathering, assembling of business, information, and the writing of business reports.[10]

Accounting. Accounting courses offered at Central State College which are recommended for inclusion in a programming curriculum and which are related to the accounting duties of the programmer are:

> Accounting 213, Accounting I. An introductory course in gathering, recording, and using financial data of a business.

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[10]Ibid., p. 145.

Accounting 223, Accounting II. A continuation of Accounting 213 with increased emphasis upon the interpretation and use of accounting data; partnership and corporation accounts.

Accounting 333a, Income Tax Accounting. Accounting for income tax requirements, federal and state; tax forms; income tax problems; preparations of returns.

Accounting 343a, Cost Accounting. Elementary principles of cost accounting. Internal records of manufacturing business. Process and job lot cost accounting.

Accounting 343b, Cost Accounting. Advanced principles of cost accounting. Problems dealing with by-products, estimated and standard costs, budgets, and cost analysis.[11]

Appropriate elective courses should be selected to complete the first minor area of specialization.

Mathematics. An analysis of the mathematics courses offered at Central State College reveals that the courses in mathematics that are listed below include many of the topics that are important to the business applications programmer.

Mathematics 333, Matrix Algebra. Elementary operations in matrix algebra, determinants, inverse of matrix, rank and equivalence, linear equations and linear dependence, vector spaces and linear transformations, characteristics equations of a matrix bilinear quadratic, and Hermition forms.

Mathematics 382a, Modern Algebra I. Number theory, equivalence, congruences, Boolean algebra, group theory, rings, integral domains, and fields.[12]

In addition, a course which would emphasize operations research techniques is desirable.

Miscellaneous Business. Business courses that are general in nature and that could provide a broad background of business principles and tools are described below. These courses should comprise the content of the second minor area of specialization.

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[11]Ibid., p. 145.

[12]Ibid., p. 163.

Marketing 383, Principles of Marketing. A survey of the field of distribution. A study of the place of the cooperative, the chain store, and the jobber in the chain distribution.

Management 393, Principles of Management. An introductory management course dealing with the fundamental principles of management such as planning, organizing, actuating and controlling the fundamental processes.

Business Practices 363, Business Statistics. Principles of statistics, methods of collection and tabulation of data, average construction in the use of index numbers.

Business Law 303a, Business Law. Introductory course dealing primarily with the legal principles of contracts, negotiable instruments, agency and employment.[13]

An advanced course in statistics should be made available. One course in statistics would not likely offer enough learning experiences to adequately prepare the programmer of business applications. In addition, a course concerning the principles of finance is recommended for the prospective programmer. This course is considered to be an essential for a broad business background.

Computer Science. No specialized courses in business computer science are offered at Central State College. It is recommended that at least four courses of this nature be added to insure adequate training for the programmer. The computer science courses should be designed to develop a technical background. They should develop an acquaintance with the many pieces of machinery connected with the computer, provide opportunities to program a number of business applications, and encourage first-hand associations with actual business programming problems. A description of the four courses might be:

Introduction to Unit Record Equipment and the Field of Electronic Data Processing. Designed to acquaint the student

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[13]Ibid., p. 145.

Designed to acquaint the student with the functions and operations of unit record equipment and the role unit record equipment and electronic digital computers play in modern business.

Techniques of Computer Programming. Designed to acquaint the student with the basic functions and operations of the electronic digital computer and begin to formulate within the student the ability to write programmed instructions that would activate the computer into solving business problems.

Systems and Procedures of Business Applications. Includes adequate discussions of many applications in the business world that are subject to being mechanized and the systems and procedures most adequate for mechanizing them. An amount of flow charting and some programming would be expected.

Practicum. Ties together the techniques of programming and systems and procedures designing and applies them to actual business problem solving. Each student would be expected to study a definite business application for a going concern, write a program that would mechanize that application, and run it successfully on a computer.

Human Relations. A prospective programmer could choose a number of psychology and/or sociology courses that would help him develop an understanding of human relations; however, the course described below is specifically suggested:

> Sociology 223, Social Psychology. An integration of sociology and psychology stressing personality development of the individual growing out of contact with his fellow beings; social adjustment and social controls.[14]

Electives. A prospective programmer should elect additional courses to complete the total of 124 credit hours required for a degree.

Outline of Courses at Central State College Which Should Logically be the Content of a Curriculum for Business Applications Programmers

On pages 140 and 141 are summaries of the courses at Central State College which are recommended for inclusion in a curriculum for

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[14]Ibid., p. 173.

business applications programmers. On page 140 these courses are listed according to the level at which it is recommended that they be taken by the student. It should be noted that the freshman and sophomore years contain all of the general education courses plus a small number of specialized education courses which provide a foundation for more specialized courses in the junior and senior years.

On page 141 the courses that are recommended are classified according to whether or not their selection for inclusion in the curriculum for business applications programmers is supported by the findings of this investigation.

As the curriculum is planned to meet all academic requirements for a bachelor's degree, the general education segment necessarily includes some courses that are not supported by specific findings of the study. All prescriptions for the major and minor areas of the curriculum are supported by findings of the study.

CURRICULUM OUTLINE FOR BUSINESS APPLICATIONS PROGRAMMERS

Freshman Year

First Semester	Second Semester
Engl. 103, Grammar & Composition	Engl. 113, Grammar & Composition
Gov't 103, American National Government	Hist. 223a, U. S. History to 1865 or Hist. 223b, U. S. History Since 1865
Humanities 204, General Humanities	Health & Physical Educ., 1 cr. hour
Health & Physical Educ., 1 cr. hr.	Gen. Sci. 104, General Physical Sci.
Biology 104, General Biology	Psychology 203, General Psychology
	Health 102, Personal Health
Total . . . . . 16 hours	Total. . . . . 16 hours

Sophomore Year

First Semester	Second Semester
Speech 103, Fundamentals of Speech	Math. 165, College Algebra and Trigonometry
Econ. 203, Principles of Economics	Acctg. 223, Accounting II
Acctg. 213, Accounting I	Mktg. 383, Principles of Marketing
Health & Physical Educ., 1 cr. hr.	Health & Physical Educ., 1 cr. hour
Sociology 223, Social Psychology	Bus. Law 303a, Business Law
Elective, 3 hours	
Total . . . . . 16 hours	Total. . . . . 15 hours

Junior Year

First Semester	Second Semester
Math. 382a, Modern Algebra	Math. 333, Matrix Algebra
Acctg. 343a, Cost Accounting	Acctg. 343b, Advanced Cost Acctg.
Acctg. 333a, Income Tax Accounting	Bus. Practices 313a, Business Communications
Mgmt. 393, Principles of Management	Bus. Practices 363, Business Statistics
Introduction to Data Processing, 3 hours	Techniques of Programming, 3 hours
Elective, 2 hours	
Total . . . . . 16 hours	Total. . . . . 15 hours

Senior Year

Bus. Practices 313b, Report Writing	Practicum, 3 hours
Operations Research, 3 hours	Elective, 12 hours (Accounting, Mathematics and/or Computer Science)
Systems and Procedures, 3 hours	
Elective, 6 hours (Accounting and/or Mathematics)	
Total . . . . . 15 hours	Total. . . . . 15 hours

SUMMARY OF CURRICULUM RECOMMENDATIONS FOR BUSINESS APPLICATIONS PROGRAMMERS

	Hours	
General Education courses supported by study:		
English 103, Grammar and Composition	3	
English 113, Grammar and Composition	3	
Speech 103, Fundamentals of Speech	3	
Economics 203, Principles of Economics	3	
Mathematics 165, College Algebra and Trigonometry	5	
Psychology 203, General Psychology	3	20
General Education courses not supported by study:		
History 223a, United States History to 1865 or History 223b, United States History Since 1865	3	
Government 103, American National Government	3	
Health 102, Personal Health	2	
Health and Physical Education--Activity	4	
Biology 104, General Biology	4	
General Science 104, General Physical Science	4	
Humanities 205, General Humanities	5	
Electives	7	32
Specialized Education courses supported by study for major concentration area:		
Accounting 213, Accounting I	3	
Mathematics 383a, Modern Algebra	3	
Mathematics 333, Matrix Algebra	3	
____, Operations Research Techniques	3	
Business Practices 363, Business Statistics	3	
Business Practices 313a, Business Communications	3	
____, Introduction to Unit Record Equipment and the Field of Electronic Data Processing	3	
____, Techniques of Computer Programming	3	
____, Systems and Procedures of Business Applications	3	
____, Practicum, 3 hours, and 8 hours electives	11	38
Specialized Education courses supported by study for minor concentration area in General Business:		
Marketing 383, Principles of Marketing	3	
Management 393, Principles of Management	3	
Business Practices 313b, Report Writing	3	
____, Advanced Business Statistics	3	
Business Law 303a, Business Law	3	
____, Finance	3	18
Specialized Education courses supported by study for minor concentration in Accounting:		
Accounting 223, Accounting II	3	
Accounting 343a, Cost Accounting	3	
Accounting 343b, Advanced Cost Accounting	3	
Accounting 333a, Income Tax Accounting & 6 hours electives	9	18
Total hours recommended		124

CHAPTER IX

CONCLUSIONS

History, in many cases, dictates future actions. In some cases future actions are also governed by that which seems theoretically ideal. In the case of curriculum development, however, it would seem logical to permit those factors that definitely exist to carry the bulk of the weight in determining curriculum content.

The conclusions in this section have an historical element as the basis of their formation; however, considering the future changes and complexities that are developing in the field of computer science and business applications programming, it would be wrong not to envision both current and future situations that should modify a curriculum. More detailed topics and specialized fields will develop within business applications programming as time progresses.

The first part of the problem of this study was to determine what factors should influence the content of a four-year curriculum in computer science with emphasis on business applications programming. It is the purpose of this section to summarize conclusions which served as the basis for the majority of the recommendations for curriculum content that were reported in Chapter VIII.

1. There is evidence that should encourage any interested individual to seek college training in order to become a business programmer. Eighty-three per cent of the 100 programmers interviewed had received

college training. The Hanke study supports the conclusion of this study in that 80 per cent of the programmers in Hanke's study had received some college training and close to one-half possessed a bachelor's degree.[1]

2. Apparently, employers of business programmers prefer an employee who possesses a degree in mathematics or business or a combination of mathematics and business. This conclusion is based on the fact that 64.04 per cent of the degrees possessed were in mathematics. A little more than 88 per cent of all bachelors' degrees held by the programmers involved in this study were in business or mathematics.

3. Accounting seems to be the first preference of employers for a major concentration in business.

4. The analysis of technical training seems to indicate that specialized training, closely associated with the computers involved, is inevitable for a newly employed programmer. It is clear that this specialized training is taken regardless of the amount of formal education an employee has experienced. There is doubt, therefore, that any curriculum for programmers will provide learning experiences that will train the programmer to the extent that he will be fully qualified to hold a programming position immediately following his graduation.

5. The technical learning experiences provided in a formal curriculum should be such that the future programmer will develop a well-rounded background concerning the field of data processing and a technical vocabulary which will enhance intelligent conversations regarding the use or operations of data processing equipment. The learning experiences should also provide for meaningful practice in writing programs which

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[1]Hanke, p. 36.

would solve a variety of practical business problems. These technical learning experiences should accelerate the progress of the programmer in his post-employment training programs.

6. The multiple number of departments with which the programmer must communicate indicates the importance of including within a formal curriculum for programmers learning experiences which will develop adequate communication skills. About one-half of the programmers interviewed performed programming functions for ten or more departments within their firms. Hanke ranks English and communications skills as fourth in the order of importance as recommended for inclusion in a training program by the programmers in his study. Employers of programmers indicate that the training of programmer applicants is deficient in English and communication skills.[2]

7. The relationship of the programmer with the multiple number of departments within his firm also suggests the need for learning experiences which would develop an understanding of sociological and psychological factors which influence human behavior.

8. The decisions made by programmers are closely related to the routine of the data processing department. The decisions the programmer makes and the management level with which the programmer associates himself imply the usefulness of a broad general business background. This viewpoint is further emphasized by the large number of programmers who have had major or minor concentrations in a field of business. General business fields are often related to the actual duties of the programmer.

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[2]Ibid., p. 76.

9. Programming activities involve accounting topics which are the subject matter content of a selected number of accounting courses. The accounting topics which a programmer encounters show the importance of accounting within a curriculum for business programmers; yet the topics are not inclusive enough to prove that a programmer must be an accounting major to be successful on the programming job. A prospective programmer could learn the properties of different accounting topics through taking six courses in accounting instead of the nine or ten that are normally required for a major concentration.

10. Many of the mathematical topics which are frequently encountered by the programmer are indicative of the content of advanced courses in a formal curriculum for mathematics. The topics which are encountered represent mathematical knowledge that would be essential to understand the composition of the computer and of mathematical knowledge which is necessary to solve many business problems. Knowledge of mathematics for knowledge's sake alone is not the objective of the business programmer. Formal mathematics courses should provide for the business programmer learning experiences directly related to solving practical business problems. The content of formal mathematics courses must be revised if these business problem learning experiences are to be provided.

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APPENDIX

INTERVIEW GUIDE FOR DEVELOPING MODEL CURRICULUM FOR PROGRAMMERS OF BUSINESS APPLICATIONS AT CENTRAL STATE COLLEGE

Name of Company_____ Type of Business_____
Address of Company_____
Name of Person Making Reply_____ Title or Position_____

PART A--EDUCATION OF RESPONDENT

1. How many years of college education have you completed? (Encircle appropriate year): None 1 2 3 4 5 6 7

2. Did you receive a degree? (Please check item) no__ yes__ What year?_____ From what institution did you receive your degree?

   _____

   What was your major area(s) of concentration?_____

   What was your 1st minor area?_____ 2nd minor area?_____

3. How many years of technical education did you complete other than your formal college education? (Encircle one) none 1 2 3 4 5 6

4. What was the source of your technical education? (Please check item) Independent Technical School___; Manufacturers Training School____; On-the-job Training___; Public Supported Institution___; Others: (Please specify)_____

PART B--PROGRAMMING ACTIVITIES

1. At what management level of your firm's organizational structure are you classified? (Please check item) Operative level___; Middle level___; Upper level___; Other___(Please specify)_____

2. How many separate departments are within your firm?___ Approximately how many of those departments bring to you business applications to be programmed?_____

3. Do you, as an individual, help to make management decisions? (Check one) yes__ no__. If yes, please give one example of a management decision you have helped to make._____

_____

_____

4. Are you working for a parent organization? (Check one) yes__ no__. If yes, how many subsidiaries does your firm have?_____

5. Does your office prepare standardized computer programs for subsidiary firm's business applications? (Check one) yes__ no__. If yes, approximately what percentage of those business programs are standardized?_____

6. Do your duties involve the use of standardized programs produced by some other firm or parent organization? (Check one) yes__ no__. If yes, approximately what percentage of your programs are standardized?_____

7. Do you study the work flow of each department before making a program for its business applications? (Check one) yes__ no__.

8. What phases of business have you had occasion to study in order to gain knowledge concerning the systems involved?_____

_____

_____

9. Approximately how long is each phase of your business operations studied before you attempt to design a computer program to accommodate that operation?_____

10. Are you ever responsible for operating a computer? (Check one) yes__ no__.

11. Are you responsible for preparing for management written reports based on data derived from computer operations? (Check one) yes__ no__.

PART C--CURRICULUM

Indicate the frequency of the occurrence of the topics which follow as they are involved in your performance of your duties as a programmer of business applications.

Use the following code to indicate the frequency with which each topic is involved in your work as a programmer:

1--Occurs frequently 2--Occurs infrequently 3--Never occurs

Topics That Might Occur	Frequency 1	2	3
Accounting.			
Basic accounting concepts			
The accrual concepts.			
The mechanics of accounting (accts., drs., crs., jrnls.). . .			
The mechanics of accounting (adj. & closing process).			
Accounting information for management's use			
Overall reporting and analysis using the funds flow technique			
Overall reporting and analysis using ratios and percentages			
Control by use of analysis of cost accounting variances . . .			
Direct labor variances.			
Direct material variances			
Overhead variances.			
Payroll accounting.			
Period planning and budgeting			
Break-even chart (construction and interpretation).			
Relevant costs (profit maximization).			
Future costs.			
Differential costs.			
Income tax accounting (individual and business)			
Fiduciary accounting (receiverships, trusts, estates)			
Municipal or governmental accounting principles			
Accounting for cash (petty cash and special cash funds) . . .			
Accounting for securities			
Permanent and Temporary Investments			
Listed and unlisted			
Marketable and nonmarketable.			
Other_____			
Accounting for receivables.			
Notes receivable.			
Trade customers' notes.			
Discounting notes			
Past-due notes.			
Accounts receivable (evaluating, aging)			
Assigned accounts			
Installment accounts.			
Consignment accounts.			
Capital stock subscriptions			
Intercompany accounts			
Advances to employees			
Accruals receivable			
Other_____			
Inventories			
Types of inventories (perpetual and periodic)			
Goods not possessed			
Goods in transit.			

Topics That Might Occur	Frequency 1	2	3
Goods pledged			
Basis of valuation			
Lower of cost or market			
Cost basis			
Retail method of valuation			
Gross profit method of valuation			
First-in, first-out			
Last-in, first-out			
Other _____			
Fixed assets			
Land, buildings, machinery and equipment			
Patterns, dies, drawings, and electrotypes			
Other _____			
Wasting assets			
Intangible assets			
Goodwill			
Patents			
Copyrights			
Trademarks			
Franchises			
Other _____			
Deferred items			
Deferred charges to operations			
Insurance			
Interest			
Discount on bonds			
Discount on capital stock			
Experimental expenses			
Organization expenses			
Advertising			
Other _____			
Deferred credits to income			
Interest			
Rent			
Installment sales			
Other _____			
Current liabilities			
Notes payable			
Accounts payable (trade and officers and employees)			
Dividends payable			
Merchandise received on consignment			
Contracts for future delivery			
Goods in transit			
Accruals payable			
Salaries and wages			
Interest			
Commissions			
Royalties			
Taxes			

Topics That Might Occur	Frequency 1	2	3
Contingent liabilities.			
Fixed liabilities			
Mortgages			
Bonds			
Classification.			
Recording bond issue.			
Amortization of bond premium and discount			
Methods of amortization			
Bond sinking fund			
Business Ownership.			
Sole proprietorship			
Partnership (formation, operation, disolution).			
Corporation			
Organization.			
Capital stock			
Treasury stock.			
No-par-value stock.			
Retained earnings			
Appropriated retained earnings.			
Other_____			
Statistics.			
The field of statistics			
Elementary number usage techniques.			
Probability (equally likely outcome).			
Principles involved in sampling			
Random selection in scientific sampling			
Standard error of the mean.			
The statement of reliability.			
Statistical inference			
Sampling methods.			
Bivariate data and regression analysis.			
Confidence intervals in regression analysis			
Regression analysis in economics and business			
Correlation and the analysis of variance.			
Analysis of variances: the one-way classification.			
Analysis of variances: the two-way classification.			
Statistical quality control in production and management.			
Statistical surveillance of repetitive process.			
Control charts of variables			
Control charts of attributes.			
Statistical analysis of time series data.			
Forecasting and marketing research.			
Management.			

Topics That Might Occur	Frequency 1	2	3
Mathematics			
The concepts of notation (subscripts, factorials, etc.)			
The number systems (base 10, binary and octal, rational and irrational, powers and roots, logarithms, etc.)			
Basic symbolic logic (statements, deductive and inductive logic, conjunction and disjunction, truth tables, arguments)			
Sets and Boolean expressions (intersection and union, Boolean algebra)			
Equations and inequations			
Functions and their graphs			
Linear functions			
Non-linear functions			
Exponential functions			
Trigonometric functions			
Basic probability theory (concepts, permutations and combinations)			
Vectors and matrices (matrix algebra and applications)			
Basic operations research techniques			
Iterative process--the alogrithm			
Mathematical models			
Linear programming			
Introduction to differential and integral calculus			
The derivative			
Maxima and minima			
Definite and indefinite integral			
Advanced calculus			
Differential equations			
Marketing			
Principles of marketing			
Retail management			
Distribution management			
Sales management			
Advertising management			
Marketing research			
Advertising copy and layout			
Economics			
Economic principles of production			
Economic principles of consumption			
Economic principles of distribution of wealth			
Price determination			
Allocation of resources			
Market structure in the private sector of the economy			

Topics That Might Occur	Frequency 1	2	3
Modern currency and its place in a financial organization . .			
Banking and credit and its place in a financial organization			
Causes for period of prosperity in a business			
Causes for period of depression in a business			
Principles underlying public expenditure, revenue and indebtedness.			
Determinants of national income and its distribution.			
Problems of underdeveloped areas.			
History of public utilities			
Relation of public utilities to the community			
Wage theories and practices			

Firms By Which Programmers Were Employed

Company Name	Key	Non-Key	Total
American General Life and Accident Insurance Co. Oklahoma City, Oklahoma	1	3	4
Anderson-Prichard Oil Company Oklahoma City, Oklahoma	1	0	1
Central State College Edmond, Oklahoma	1	0	1
Federal Aviation Agency Oklahoma City, Oklahoma	1	4	5
Fidelity National Bank Oklahoma City, Oklahoma	1	2	3
First National Bank and Trust Company Oklahoma City, Oklahoma	1	4	5
Fleming Company Oklahoma City, Oklahoma	1	0	1
General Electric Company Oklahoma City, Oklahoma	1	5	6
Globe Life Insurance Company Oklahoma City, Oklahoma	1	2	3
Humble Oil Company Tulsa, Oklahoma	1	4	5
Kerr-McGee Oil Company Oklahoma City, Oklahoma	1	1	2
Liberty National Bank Oklahoma City, Oklahoma	1	6	7
Local Federal Savings and Loan Association Oklahoma City, Oklahoma	1	1	2
National Bank of Tulsa Tulsa, Oklahoma	1	4	5
Oklahoma City Federal Savings and Loan Association, Oklahoma City, Oklahoma	1	1	2
Oklahoma Gas and Electric Company Oklahoma City, Oklahoma	1	1	2
Oklahoma State Highway Commission Oklahoma City, Oklahoma	1	4	5
Oklahoma Tax Commission Oklahoma City, Oklahoma	1	1	2
Oklahoma University Medical Center Oklahoma City, Oklahoma	1	3	4
Oklahoma Welfare Commission Oklahoma City, Oklahoma	1	3	4
Pan American Oil Company Oklahoma City, Oklahoma	1	3	4
Skelly Oil Company Tulsa, Oklahoma	1	3	4
Standard Life and Accident Insurance Company Oklahoma City, Oklahoma	1	2	3
Tinker Air Force Base Oklahoma City, Oklahoma	1	9	10
Western Electric Company Oklahoma City, Oklahoma	1	9	10

VITA

James B. Davis, Jr.

Candidate for the Degree of

Doctor of Education

Thesis: FACTORS WHICH SHOULD INFLUENCE A MODEL CURRICULUM FOR PROGRAMMERS OF BUSINESS APPLICATIONS

Major Field: Business Education

Biographical:

Personal Data: Born near Stratford, Oklahoma, April 5, 1933, the son of James B. and Annie G. Davis.

Education: Attended grade school in Roosevelt, Hobart, Verden, and Pioneer, Oklahoma; graduated from Chickasha High School, Chickasha, Oklahoma, in 1951; received the Bachelor of Science degree from the Oklahoma State University, with a major in Business Education, in May, 1956; received the Master of Science degree from the Oklahoma State University, with a major in Business Education, in August, 1958; completed requirements for the Doctor of Education degree in May, 1966.

Professional experience: Taught high school at Marshall, Oklahoma, during the school year 1957-1958; since 1958, have taught in the Business Education Department at Central State College, Edmond, Oklahoma.