A CASE STUDY OF THE UTILIZATION OF AN IBM 7090 COMPUTER IN A MAJOR OIL COMPANY

A Thesis

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by

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To my wife, Lois, gratitude is due for the countless hours of assistance and encouragement.

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CHAPTER I

INTRODUCTION

During the past twenty years, there have been few scientific or industrial developments which have received as much publicity as the electronic computer. Computers involve a new and fascinating method of manipulating data which has resulted in a more efficient and more up-to-date aid in problem solving for science and industry when compared to the manual manipulation of similar data.

Since problem solving is the primary function of a computer, efforts must be exerted to show a definite place in industry for this equipment and the answers derived from it.

Time is extremely important in our present day business world. In our present day industry, there exists a constant and increasing need for fast, dependable solutions to problems which engineers, technicians, and management are faced with in their daily work routines. In many instances, difficulties have been encountered when converting time saved into money saved. Money saved usually means more than time saved to those parties concerned with the finances of a firm. To delve into the aspect of money saved involves a tedious time consuming project which, in many instances, has biased

or inconclusive findings. In this area the computer and the satellite equipment used with it begin to show great dividends.

Generally speaking, the computer is considered a tool used in research. The problems that would take several man years to solve can now be solved in only a few minutes on the computer. One important aspect must be remembered, the computer cannot think nor rationalize as the human mind is capable of doing. In fact, the computer is an absolute idiot without a program which is a step-by-step written procedure describing the problem in the language of a computer. The program that is supplied to a computer is a product of the human mind. Thus, the industrial firm that has the facilities of a computer must also possess the human talent that can program and operate the equipment in a computer center.

Numerous comments are heard daily expressing fears or praise for the computer. In our present day society, man should be conditioning himself for this fast moving pace and learning how to cope with the results or reports generated through computer application. This conditioning will include further learning in order that a better understanding of what a computer is and what it can do will enhance man's confidence in a computer.

Management personnel must be conditioned to handle the results that computer centers process from raw data. Stock inventories, vouchers, and payrolls, which are fed from field offices into computer centers are examples of computer prepared reports which management personnel must handle.[1] This conditioning could include tours through a computer center, reading of related literature, or specialized training covering the input and output of computer prepared information.

Modern computers, no matter how large and complex they might be, are nothing more than simple-minded electronic devices. The large scale computer does nothing more than take up floor space; however, when activated by teams of highly skilled people, the computer can solve difficult problems involving 229,000 additions, or subtractions, or 39,500 multiplications, or 32,700 divisions in a single second.[2] This information was current as of February, 1961. During the month of April, 1964, International Business Machines made a public announcement concerning the development and eventual sale of a computer which will be of greater speed and efficiency than any other computer currently being used.

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[1]E. W. Jenkins, "Push Button Oil Production," The Oil and Gas Journal, 56:89, March, 1958.

[2]Bruce Roseblatt, "Electronics, the Company, and You," The Standard Oiler, February, 1961, p. 3.

The information presented in this study is based on the use of a 7090 computer and peripheral equipment in a Computer Center located in Ponca City, Oklahoma. This Computer Center is owned and operated by Continental Oil Company.

I. PROBLEM

Statement of the problem. Two major problems are explored in this study, one concerns the conversion from manual to computer utilization for solving the everyday problems of business and industry; the other pertains to the time saved by various departments using a computer facility.

The first problem concerns the adaptation of a repetitious problem previously solved through the aid of a slide rule and/or a desk calculator to a computer. There are various areas and aspects to consider when trying to program a workable problem for the computer. Therefore, this is one of the areas that will be covered in the study.

The second problem is to explore the aspect of time saved on the job when solving problems through the use of a computer and/or other peripheral equipment used in conjunction with the problem solving computer.

Importance of the study. The use of a computer center is considered an innovation by industrial as well as

non-industrial companies in recent years. In essence, very little detailed information concerning the actual use of a computer center is available for the student to use in classroom work, or for management personnel to consider in the installation of a computer center.

The study is designed to provide pertinent information about a computer center which will aid students in their classroom work and be of assistance to management personnel who are interested in an actual EDP situation that benefited an oil company.

Portions of this study may provide a basis for investigation into similar EDP facilities operated by other business firms.

Recommendations will be based on actual situations encountered by the company personnel selected for this study.

Limitations of the study. This study is limited to the centralized computer facilities of a major oil producing and distributing company. This study includes an analysis of the following six departments: (1) Pipeline, (2) Controller, (3) Purchasing, (4) Production, (5) Research and Development, and (6) Manufacturing.

The six departments were selected because they make extensive use of the center and show definite benefits derived from the use of the center's facilities and personnel.

This study was not intended to include all minor sections of the departments considered or other departments in the oil company. There are other departments that use the center on a lesser scale. It was felt by the investigator that there would be no significant improvement of data through a complete analysis of computer utilization.

The investigator limited the gathering of data for the study to the home office of the company in Ponca City, Oklahoma.

II. DEFINITIONS OF TERMS USED

Feasibility study. Is to appraise specifically the economics of a computer application to determine whether a computer should be acquired or not.[3]

Computer. Is in general terms, a group of interdependent units or devices all directed to manipulate facts and figures by mathematical means.[4]

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[3]Frank Wallace, et. al., Appraising the Economics of Electronic Computers (New York: Controllership Foundation, Inc., 1956), p. 23.

[4]M. Lloyd Edwards, "The Effect of Automation on Accounting Jobs" (unpublished doctoral dissertation, The University of Oklahoma, Norman, 1959), p. 183.

Input. The feeding of data into the computer.[5]

Output. The results from the computer after the computations are completed.[6]

EDP. The abbreviation of Electronic Data Processing.

Bugs. Is slang terminology meaning coding errors in a program.

IBM. The abbreviation of International Business Machines Corporation.

Conoco. The abbreviation and product brand name of Continental Oil Company.

Program. Is the list of instructions which the computer must follow in order to solve any given problem.[7]

Man-day. Involves the efforts exerted by one person when accomplishing his daily work routine in a standard eight hour work day. The terms man-week, man-month, and man-year

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[5]Clarence B. Randall, Sally W. Weimer, and Maynard S. Greenfield, Systems and Procedures for Automated Accounting (Cincinnati: Southwestern Publishing Company, 1962, p. 196.

[6]Ibid.

[7]Ibid., p. 195.

were used in this study in conjunction with the extension of the term man-day involving similar meaning.

Programmer. Is an individual who is responsible for the thorough analysis or definition of the problem, for the broad flow charting or system design of the computer solution, for the coding or preparation of the specific machine instructions to carry out the solution and verification of the set of instructions or programs for accuracy and inclusiveness.[8]

Peripheral equipment. Is the equipment used for getting data ready to put into the computer by sorting, rearranging, or reproducing, and for translating the punched cards received from the computer into pages of printed reports. This equipment is usually not directly connected to the computer.[9]

7090. Is a large and powerful IBM computer system capable of doing millions of calculations in a few moments.[10]

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[8] Ibid., p. 51.

[9] Edward J. Laurie, Computers and How They Work (Cincinnati: Southwestern Publishing Company, 1963), p. 15.

[10] Ibid., p. 38.

III. METHOD OF PROCEDURE

The procedure for completing this study involved the use of the William Allen White Library facilities located in Emporia, Kansas, and the library facilities of Continental Oil Company located in Houston, Texas, and Ponca City, Oklahoma. In addition to the information acquired from the libraries, the investigator interviewed various managers and supervisors to collect data relevant to this study. The following steps were involved:

1. An extensive review of published literature in the field of computer centers and their usage was made to gain the necessary background information about management and other personnel using the computer output to save time, and the adaptation of problem to a computer.

2. Letters were written and phone calls were made to responsible persons to get their permission to conduct this study in the company selected.

3. A tentative schedule for the collection of data was prepared and presented to the professor who was the author's major advisor on this study.

4. The schedule was then tested with a responsible individual in the computer center. After this test the questions were considered adequate for the gathering of data. The schedule was then duplicated for use and appears in Appendix A.

5. Several trips were made to Ponca City, Oklahoma, where the author interviewed the various managers and supervisors in the departments selected for this study. Some of the interviews were recorded on a portable tape recorder and later transcribed on the schedules. Otherwise, the responses were recorded on the schedule during the interview.

6. After each interview with a manager or supervisor, a brief summary of the interview was written to remind the author of information discussed, and not necessarily listed on the interview schedule.

7. The information discovered in the literature and collected by means of the interview schedule was summarized, interpreted, and compared.

8. The final step in this study involved presentation of the data, summarization of findings, and the development of specific conclusions and recommendations.

In Chapter II of this study, a review of literature relative to (1) why a feasibility study is necessary; (2) benefits derived from the use of computer; and (3) reactions of management to the use of computer output is presented.

The information obtained from the interviews was compiled as Chapter III of this study. The data compiled in Chapter III was then analyzed and presented in Chapter IV.

Chapter V includes a summary of the study, conclusions, and recommendations. Each person who was interviewed was sent a personal letter thanking him for his cooperation and a copy of the conclusions and recommendations was included with the letter.

CHAPTER II

BACKGROUND FOR THIS STUDY AS REVEALED IN CURRENT LITERATURE

A review of related literature, such as is commonly presented in a Master's thesis could not be adequately developed as part of this study. The area which was investigated is unique in that it concerns a relatively new phase in industry, one in which no significant prior research has been conducted relating directly to this area of study.

After having exhausted selected sources of information, the author reached the conclusion that an inadequate source of information was available for presentation in this study. Therefore, an attempt is made in Chapter II not to review past research but to present general background information relevant to this study. To prepare the reader of this study, the author will present various factors of concern in a centralized computer operation: why a feasibility study is necessary; benefits derived from the use of a computer; and reaction of management toward the use of computer output.

I. WHY A FEASIBILITY STUDY IS NECESSARY

Every day, man is faced with the question or reply of WHY. To develop a suitable response, it is sometimes neces-

sary to exert considerable time and effort to present a suitable and acceptable reply to this question of WHY.

Such is the responsibility of the individuals who conduct a feasibility study. They are attempting to present information to parties concerned. The feasibility study is an orderly, systematic, usually written, justification for the proposed equipment expenditure. The expenditure can be justified only if it (1) reduces clerical costs, or (2) provides needed management control information.[11]

In some instances, clerical costs are not necessarily reduced by the proposal, but additional information can be prepared and presented to management, thus enabling these responsible people to make wiser decisions.

The feasibility team is usually made up of middle management employees selected from the various departments within a company. This team has the responsibility of analyzing the existing procedures and recommending to management the feasibility of converting the present as well as proposed procedures to a computer.[12] One of the most difficult decisions for management is to determine whether or not computer facilities should be acquired. Management must analyze

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[11] M. B. Levitt, "Whys and Wherefores of the Mechanization Proposal," Systems and Procedures Journal, 14: 12-13, November-December, 1963.

[12] Ibid.

the recommendations that were made looking for flaws that might not be obvious to the untrained eye. Therefore, it is necessary to get all of the facts which aid management in making wise decisions.

The objective, then, of a feasibility study is to appraise specifically the economics of a computer application, to determine whether a computer should be acquired.

The computer team assumes a heavy responsibility. It is important to select the team carefully and to see that it is properly trained. In many instances, this detailed study will require about one year. It is doubtful that the study can be completed in most companies on a sound basis in much less time than a year. On the other hand, it seems desirable for the study not to run longer than one year. If it does, executives tend to lose interest in the project. Therefore, many man-years will be invested in this study.

The number of men on the computer feasibility team will vary from one company to another. Typical computer teams range from two to six members. Some of the factors which influence the decision on the size of the team are as follows:

1. Size of the company.
2. Geographic concentration or dispersion of operational functions to be studied.
3. Number of functions to be studied for possible computer application.

4. Functional range of applications to be studied (i.e., are all of the procedures concentrated in accounting or do the procedures cover a wide area involving, for example, sales, manufacturing, and engineering?)[13]

One of the primary purposes of a feasibility study is to define the major data applications of a department, and then to determine the type of data processing system most suitable for these applications. An additional objective of the study is to provide an up-to-date analysis or present manual data processing procedures in order that improvements in this area can be realized, in addition to any improvements possible from electronic data processing.

II. BENEFITS DERIVED FROM THE USE OF A COMPUTER

The high rate of speed at which a computer is capable of manipulating information is one of the primary benefits derived from computer applications. A significant project undertaken by Standard Oil Company was the operation of a 40,000 barrels-per-day fluid catalytic cracker. The primary problem was to determine what set of conditions (such as temperature, flow rates, and pressures) would most nearly bring the desired quality and quantity results in a refinery operation. Conditions change so rapidly, in refinery

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[13]Wallace, op. cit., pp. 23-24.

operations, that it is sometimes impossible for the optimum control settings to be figured manually in time to be of value in solving the problems at hand.[14]

The job of evaluating and preparing the program for a 7090 Data Processing system to do the arithmetic was assigned to a team of specialists. The specialists included operators, operating supervisors, process engineers, computer experts, and design engineers.

As a result of this project, the computer calculates, in less than one minute, the control settings recommended for the most profitable operation of the fluid catalytic crackers.[15] The investigator has observed similar calculations prepared manually involving as much as one hour of one engineer's time.

The previous situation points out how a computer not only saves time in computing mathematical problems, but also aids in obtaining an optimum operation which means dollars earned as well as time saved.

In the field of pipeline transportation, man is constantly faced with decisions concerning how much to move, when to move, and in what sequence the fluid is to be moved.

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[14]Rosenblatt, op. cit., p. 4.

[15]Loc. cit.

The pipeline industry is presently experiencing a major breakthrough. Giant multiproduct lines are now becoming a necessity as transportation costs go up and as the major producers expand their markets outside of old boundaries to compete in a larger market. The pipeline industry is faced with the problems of transporting more products to more places in shorter periods of time than ever before.

As more and more products, more and more brands, and more and more companies become involved, the complexity increases with the number of products involved. With twenty products to be transported in a pipeline the time of injection of each product into the pipeline requires two quintillion, four hundred thirty quadrillion decisions.[16] These figures readily portray the importance of using high speed computers to manipulate the information that has been programmed in order that men in responsible positions will have the needed information on which to base their decisions pertaining to pipeline transportation.

During the year 1961, Phillips Petroleum Company installed a 7090 system in their computer center at Bartlesville, Oklahoma. This new system replaced a 709 system which was slower and did not have the memory capacity of the 7090.

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[16] Dan B. McDevitt, "Automation Revolution in Pipeline," The Oil and Gas Journal, 61:119, March, 1963.

The primary reason for installing the 7090 was that the 709 could not keep up with the work load that Phillips personnel placed upon the old system. Much of the information now available to Phillips management and operating departments through the new 7090 would be almost impossible to obtain using manual calculations.

An example of computer aid is assisting in the analysis and design of gas gathering networks which transport natural gas from well heads to gasoline plants. As new wells are drilled and gas loads increase, and later, as well pressures decline, it is necessary to revise these gathering systems. By analyzing the systems on the computer it is possible to obtain cheaper and better designs.[17]

When the feasibility team is making a computer installation study or considering the purchase of additional equipment, they must always keep in mind the concept of benefits for the company derived from their recommendations.

III. REACTIONS OF MANAGEMENT TO COMPUTER OUTPUT

Man is constantly reacting toward the good and bad points of his private life and of his life in the business

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[17] Gene Hill, "And Now...The 7090," Philnews, 24:18, June, 1961.

world. The reactions of management personnel who use computer output as an aid in decision making is presented in the following comments.

There is constant reference to the question, "are all of the bugs out of the program?" These bugs, usually being human errors, are almost always screened out before the final output is delivered to the respective managers. Therefore, when the manager receives the computer output, he may rest assured that if there is an error, it will undoubtedly be a human error.

A malfunction in a computer is similar to having a clerk off from work due to illness. One knows he is not on the job and that the reason is illness. The same thing happens with a computer. If it is sick, certain indicators are brought to the attention of the machine operators and supervisors who, in turn, either correct the malfunction or have a maintenance technician correct the situation.

Being assured that the output is correct is of prime importance to the manager. The output of a computer system gives management more facts, with a high degree of analysis upon which to base major decisions, and is available more rapidly.[18]

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[18] Ibid., p. 19.

Management personnel are facing the resistance to change. It is human nature to rely upon what has worked in the past. In the dynamic world of management, an enlightened manager, who by his efforts has assured himself of the validity of proposed new techniques, can be of inestimable value to the company. Confidence in his judgment and respect for his past decisions will help to convince his people of the need and possibilities of computer output.[19]

The manager must be humble enough, to recognize his lack of understanding of computers. However, the progressive individual, if willing, must spend extra time in learning these new techniques. This additional knowledge will give him a feeling of the relative speeds of inputs, outputs, and processing; what a monitor system can do; and the indescribable chaotic battleground of de-bugging. He has to brace himself with the courage to see his technicians fail--and to protect them from thoughtless criticism.[20]

While adjusting to the use of computer output, the manager must always keep in mind the importance of possessing a basic understanding of EDP capabilities and limitations.

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[19]Alfred L. Baumann, Jr., "Managing An Expanding Horizon," Data Processing, 4:13, September, 1962.

[20]Ibid., p. 14.

During this period of adjustment, the manager should observe the following "10 commandments:"[21]

1. Know the capabilities and limitations of your computer installations.
2. Have a staff capable of keeping the command current concerning new concepts and equipment.
3. Know what managerial, organizational, and technical experts are available to advise you on matters concerning electronic data processing policies and procedures.
4. Conduct periodic reviews of your organization to determine if new areas can be automated.
5. Obtain from your data processing manager only the amount of detailed information necessary for decision making.
6. Insure that you don't develop a stereotyped approach to all data processing problems.
7. Realize that electronic data processing is not the cure-all for all organizational problems.
8. Recognize that feasibility studies which reveal that adoption of electronic data processing is not practical may also reveal where improvements in the existing system can be made.
9. Remember that it is seldom possible to include new areas in electronic data processing without having a consequent effect on other organizational elements.
10. Never try to use computers for jobs which people can do better, and never become disillusioned with electronic data processing when occasional failures occur.

Observing the preceding "10 Commandments" should be of considerable aid to the manager. The manager will not have to learn great volumes of technical information about EDP. At the same time, he can still learn enough about EDP to

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[21] Jesse H. Martin, "The EDP '10 Commandments' for Executives," Data Processing, 4:46-48, September, 1962.

assist him in his everyday contact with computer output and computer personnel.

In the future, the manager who understands the basic concepts of EDP, and who is able to apply them to his business, will be the manager who rises to the top in the business world.[22]

The following chapters will be devoted to the presentation and interpretation of data relevent to this study. This data reflects reactions of personnel, interviewed by the author, toward the operation and utilization of computer facilities, thus making it possible to gain some insight into the aspects relevant to assisting management personnel as they travel the complex roads of the business world.

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[22] Ibid., p. 48.

CHAPTER III

COLLECTION OF DATA

This chapter contains a comprehensive description of the operation of a computer center and how six departments use the facilities. The primary method used in developing the following information was the case study method. An attempt was made to interview the managers and supervisors in the six departments that are using the computer facilities extensively or have had some contact with the computer output as an aid in their daily work routines.

The collection of data involved personal interviews conducted by the investigator with managerial and supervisory personnel who were working directly in the computer center or using the facilities on a limited basis. Each interview was scheduled by means of a telephone conversation either between the investigator and the person to be interviewed or between Mr. W. M. McGee, Manager of the Central Computer Department, and the person to be interviewed. During these telephone conversations, a brief explanation of the project was made, and the general area of questioning was relayed to the person to be interviewed. The interview time, date, and location was at the convenience of the interviewee. Before any trips were made to Ponca City, the author contacted Mr. McGee

either by letter or telephone to assure the author that there had been no changes made in the interview appointments. Each interview was conducted in the privacy of the interviewee's office.

The managers and supervisors who were interviewed were either working on or with a computer application or using computer output as an aid in their work routines. This type of contact with computer information more than qualified these men to be included in this study.

To assure uniformity in the collection of data, each interview was conducted with the aid of an interview schedule and a tape recorder. The schedule included both general and specific questions to insure maximum collection of data relevant to the study. The time used in interviewing varied from thirty minutes to one hour. In some instances the interviewee went into great detail explaining a problem that was being solved with the aid of the computer.

I. LOCATION AND DESCRIPTION OF THE COMPUTER CENTER

At a cost of approximately $775,000.00, Continental Oil Company located and built a new central computer department in Ponca City, Oklahoma. The computer center features a brick construction with cast stone trim and contains 32,000 square feet of machine and office space, allowing room for a staff of 200 employees to work in the building.

The pictures and explanations found on pages 26 through 35 will best describe the computer center and equipment.

The decision to initiate a computer feasibility study is often a tremendous undertaking for management. Some feasibility studies involve many years of preparation at a considerable cost; such was the situation of Continental Oil Company.

During the year 1952, the potential use of computers in Conoco was being discussed. At that time, no commercial computers were available that would meet the needs of various departments in Conoco. In June, 1953, Conoco decided to construct a computer to meet their specific need and called it CONAC. After a period of time, it was decided that CONAC was not a successful venture. In March, 1956, CONAC was replaced by an IBM 650 computer.

On September 16, 1959, individuals from top level management and specialists were designated to investigate the following aspects of Continental's computer facilities and develop a feasibility study showing the need for additional computer facilities:[23]

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[23]Refer to Appendix B.

FIGURE 1

EXTERIOR VIEW OF CONTINENTAL OIL COMPANY'S CENTRAL COMPUTER BUILDING LOCATED IN PONCA CITY, OKLAHOMA

FIGURE 2

THE FLOOR IS ELEVATED TO ALLOW WORK ROOM FOR THE INSTALLATION OF ELECTRICAL WIRING WHICH LINKS THE VARIOUS PIECES OF EQUIPMENT TOGETHER

FIGURE 3

PROTECTIVE COVERING ON EQUIPMENT PRIOR TO INSTALLATION.
IT IS VERY IMPORTANT TO KEEP THE EQUIPMENT
CLEAN AND DUST FREE AT ALL TIMES.

FIGURE 4

TECHNICIANS INSPECTING THE 7090 MEMORY UNIT PRIOR TO OFFICIAL OPERATION OF THE COMPUTER

FIGURE 5

TECHNICIANS INSPECTING AND TESTING THE IBM 7090
PRIOR TO ACTUAL OPERATION

FIGURE 6

THE COMPUTER ROOM. IN THE FOREGROUND IS THE IBM 7090 CONSOLE, ON THE LEFT IS AN IBM 407 ACCOUNTING MACHINE, AND IN THE BACKGROUND ARE IBM 729 MAGNETIC TAPE UNITS.

FIGURE 7

ADJUSTING A REEL OF MAGNETIC TAPE ON THE
IBM 729 MAGNETIC TAPE UNIT

FIGURE 8

MAGNETIC TAPE BEING REMOVED FROM LIBRARY SHELVES
FOR COMPUTER APPLICATION

FIGURE 9

KEY PUNCH OPERATOR PREPARING CARDS ON
THE IBM CARD PUNCH MACHINE

FIGURE 10

REMOVING PUNCHED CARDS FROM
THE IBM 084 SORTER

1. Potential applications of computer usage.
2. EDP equipment that would be adaptable to present and future needs.
3. Organization required should Continental elect to install a centralized computer.

To facilitate acquiring this information, the study group developed three classes of basic information:

1. Information about other oil companies computer usage and organization.
2. Information about computers and manufacturers.
3. Information about Continental's potential computer applications.

A feasibility study was presented to the Data Processing and Advanced Instrumentation Methods Sub-committee of the Coordination Committee after a thorough investigation. The cost was approximately $50,000.00 and four man-years of effort, to determine potential computer applications in Continental Oil Company, and to consider possible EDP equipment necessary to implement a program for computer use in the company.

In the feasibility study the following recommendations were made:

1. Authorization of employment of 51 people to complete the staff of the proposed center.
2. Authorization of a building for computer and personnel with construction to begin at the earliest possible date.
3. Authorization of furniture and fixtures for personnel required.
4. Implementation of organization to organize the computer program. This should be done at the same time the computer is ordered so that adequate preparation can be made prior to receipt of the computer in 18 months.

5. Placement of order for an IBM 7090 computer and peripheral equipment for delivery in 18 months.

These recommendations were reviewed by the Data Processing and Advanced Instrumentation Methods Sub-committee of the Coordination Committee who in turn made decisions and recommendations that eventually resulted in the realization of a central computer department for Continental Oil Company.

The preliminary work of the feasibility study group, made it possible for top level management personnel to make an educated-and-well-informed decision on acquiring new computer facilities.

The computer center has in operation the following equipment:

Item No.	Description	Quantity
1	IBM 10 Card Punch	1
2	IBM 24 Card Punch	4
3	IBM 26 Print Card Punch	19
4	IBM 56 Verifier	11
5	IBM 83 Sorter	5
6	IBM 84 Sorter	2
7	IBM 88 Collator	3
8	IBM 402 Alphabetic Accounting Machine	2
9	IBM 407 Alphabetic Accounting Machine	1
10	IBM 419 Numeric Accounting Machine	4
11	IBM 514 Reproducer	4
12	IBM 557 Alphabetic Interpreter	1
13	IBM 711 Card Reader	1
14	IBM 716 Printer	1
15	IBM 729 Magnetic Tape Unit	15

Item No.	Description	Quantity
16	IBM 1401 Processing Unit	3
17	IBM 1402 Card Read Punch	3
18	IBM 1403 Printer	3
19	IBM 7090, 32K Storage, two channel, 12 tape drive system	1

The rental of this equipment costs Conoco approximately $90,000.00 per month, based on a 177 hour month.

II. PRESENTATION OF INTERVIEWS

For the purpose of this study, the individuals interviewed were referred to by letter. In some instances, it was a specific request that names be withheld. Therefore, the investigator felt that to comply with this request and to be consistent, all individuals interviewed should be referred to in this manner.

The information presented in the various interviews was based upon responses to questions originally recorded on the interview schedule which is reproduced in Appendix A. Therefore, all responses are the interviewee's reactions toward specific questions asked by the investigator.

The Pipeline Department

Interview Number 1. The General Manager Administrative A was exceedingly cooperative when answering the questions that were asked of him. It was his understanding that the pipeline department received a periodic report showing the

amount of time that their department had used the computer, but there was no actual monetary charge for the use of the computer facilities.

When considering the aspect of savings in time and money, the pipeline department has no set method of determining these factors at the present time. Management has discovered that the company is realizing an indirect savings in these factors through the use of computer facilities. In the future it is anticipated that a formula will be developed to make comparisons of manually prepared reports against computer prepared reports. The manager was convinced that savings, which could be measured, were definitely determinable in operation expenses.

The computer center, which is usually considered a service organization, makes it difficult to place a dollar value on the services received from this department. Granted, the computer saves a certain number of man hours in preparing reports, but there are other fringe benefits to consider. These fringe benefits include advice on programming, critiques on EDP, and various other aspects upon which it is difficult to place dollar values.

An example of computer problem application that is definitely of benefit to the pipeline department is the scheduling of product movements through pipelines to various geographic locations. Through the aid of a computer, the

Chief Scheduler is now able to plan a dispatching schedule involving two or more products in approximately half the time it once took him manually. This schedule would include the various products to be transported, time of departure, pumping rate, rate of injection, and approximate interphase arrival time at the various destinations. Through this type of scheduling, the person in charge of planning the schedule is enabled to prepare a more realistic schedule, thus eliminating a considerable amount of guess work.

When using computer output, man is usually wondering if there is an unseen mechanical error in the information he is using. According to Mr. A there are very few, if any, mechanical errors encountered. Errors that are encountered can usually be traced back to a human error in the original program. These errors are many times the result of a programmer's misunderstanding of what is involved in the particular problem. Therefore, it is essential that a programmer understand what the department expects and what is involved in the problem being programmed.

To gain a better explanation of how personnel are trained to program and use the facilities in the computer center plus the extent of systems control, Manager A recommended that the investigator discuss this with the person who is in charge of programming for the pipeline department.

There are various factors to consider when a specific problem is being analyzed for potential computer application. Mr. A discussed one point extensively, this being the question of "whether the program is to be used once or continuously?" If the problem is one that can be solved on the computer more than one time, this is a good indication that the time and effort exerted in the original programming can be a justifiable expense. But, if the problem can be worked out manually and is to be used only once or twice, management takes a dim view of personnel exerting their efforts on such a problem for computer application. Usually the cost of doing the problem manually one time only is cheaper than using EDP equipment to solve the problem.

As an aid in programming problems applicable to the pipeline department, Mr. A said that management and supervisory personnel assign such problems to the person in charge of pipeline computer programs; and this person and his staff, in turn, analyze the problem and write the program for computer application. Mr. A did not have any definite figures on the time involved to adapt a problem to the computer.

The question was asked, "after a problem is adapted to the computer, how is the time saved used by the employee affected by this savings in time?" Mr. A made the following comment on this question: The computer is relieving personnel of daily routine and repetitious work, thus giving the

employee additional time to evaluate and analyze the more critical problems that were previously processed with less attention. This extra time has, therefore, resulted in a more detailed and better evaluation of the problem, which in turn enables management to feel assured that the subordinate has had sufficient time to prepare and submit dependable information to management.

At the present time, Mr. A feels that management is definitely satisfied with the reports that are derived through the aid of the computer. The computer output has resulted in faster and more sophisticated information which has enabled the manager to make a faster and better informed decision. Mr. A stated that when management fully realizes the capabilities of the computer installation, there will be a definite change in management's respect for the human preparation and mechanical output of computer information.

According to Mr. A, the pipeline is more functional in the field of economics studies consisting of proposed pipeline expansion programs. To determine a pay-out period and other aspects in a study, many man hours of complicated mathematical manipulations are involved. Problems of this type can be programmed and run through the computer in less time than when prepared manually. With the aid of computer application, a certain amount of confusion is decreased when

compiling basic information, thus resulting in a smoother operating department.

Mr. A had some definite viewpoints or reactions to the utilization of computer facilities. He felt that the computer is a dynamic addition in aiding management to cope with the modern complexities of the business world. He also pointed out the fact that speed is of the utmost importance to the manager who needs up-dated information to make his decisions. Without rapid computer output, management would be at a definite disadvantage in the present day world of high level decision making that is necessary to operate big business.

Interview Number 2. Mr. B is the Senior Computer Analyst for the pipeline department, located in the engineering section of this department. Mr. B devoted a considerable amount of time to this interview and the investigator benefited greatly in learning basic computer terminology and techniques.

At the present this department receives a periodic report listing the amount of computer time that has been utilized by the pipeline department at no monetary charge for this service.

While discussing the aspect of the way in which savings in time and money are determined through computer

usage, Mr. B showed the way in which he uses a rule-of-thumb formula that can be applied to various problems when a savings in money is desired to prove the monetary rewards realized through the use of computer problem solving. This formula is as follows:

	Benefits (estimated)	$ Z
minus	Running cost (computer time)	Y per run
	Monetary benefits per run	Z

(or)

Runs per year equal P

Total annual monetary benefits equal P(Z)

This formula is not used by all firms or departments using computer facilities, but is a tool or aid that Mr. B uses when such information is asked for.

While discussing savings in time, Mr. B stated that there is a basic turn-around time involved in the use of the computer which is approximately three hours. To process an average routine problem the following information shows the amount of actual computer time and waiting time:

Data Input--1401--Tape--7090--Tape--1401--Printed Output

1 minute 70 seconds 1 minute

This shows that three minutes and ten seconds is actually used from input to output on the computer. The remaining two hours and fifty-six minutes and fifty seconds is waiting time. This does not mean that Mr. B or one of his

assistants is spending three hours processing a problem, but is the time used by computer center personnel to process the raw data through the 7090 computer and return the output data to Mr. B. This example brings to light how much time can now be utilized by staff personnel in devoting time saved to other pressing problems instead of toiling with a repetitious problem that would take from two hours to four hours to solve.

Mr. B considers the computer center as a service organization. The computer center is in a central location with a competent staff to maintain and operate the equipment. The personnel on the staff of the computer center act as consultants to all departments which need their help; considering these factors the computer center is a definite service organization.

Mr. B then stated that, in his opinion, monetary savings derived from computer usage were primarily capital investment savings. An example of this would be the decision to purchase thin-walled pipe rather than heavy-walled pipe as the result of the computer being able to determine hydraulic tolerances more accurately than if the same calculations had been prepared manually. Various projects that he has worked on involved the preparation of economic studies showing whether it was advisable to continue or discontinue the project. By programming a simulated example of a project

being considered, it was possible to run this type of program through the computer; the output would show the most optimum or economical solution to the problem. In using this output, the company has been able to spend less capital investment money on various projects than might have been spent unnecessarily if the problem had been solved manually.

For an example of problem solving with computer aid, Mr. B presented the following example. There is at the present time a pipeline that begins at Ponca City, Oklahoma, and extends to the area of Oklahoma City, Oklahoma; Wichita Falls, Texas; and Grapevine, Texas. Through this pipeline various petroleum products (fluids) are transported. To transport these products, it is necessary to schedule their movement from one geographic location to another. To prepare a schedule and know that it is workable has always been a challenge and time consuming job for the scheduler. The scheduler can now prepare a schedule and check the mechanics of his problem on the computer in sixty seconds. However, before this savings in time could be realized, it took approximately four man-months to program this problem. By using the computer, the scheduler is now able to decrease his time on this type of problem and devote more time to other scheduling problems with which he is constantly confronted. Mr. B has the opinion that the computer is one of the greatest benefits or tools that a scheduler can have at his disposal.

In a brief explanation of errors encountered in computer output, Mr. B stated that in his five years of experience of working with computers, he had encountered mechanical errors only twice. It is his opinion, however, that one out of five programs run through the computer has a human error in the output, but these errors will be corrected by the programmer, and the end result is an error-free report.

There are various means of educating personnel in the use and operation of computer information and equipment. At the present time Mr. B has integrated the following procedure when training his assistants:

1. Two days orientation course conducted in the computer center.[24]
2. One week course in Fortran language programming.
3. Three months solving academic and actual problems.

At this point the assistant has become quite familiar with his work and should now be able to do the following:

1. Define and flow chart a problem.
2. Be able to consider which problem is applicable to the computer.
3. Realize the time savings and convenience received in problem solving through the use of a computer.

This procedure of training programmers must be followed closely to develop a competent person in this type of work.

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[24]See Appendix C.

The method of checking the correctness of a program is usually the responsibility of a Systems Control Group in the computer center. Mr. B does not depend on this group as much as other department personnel do. He has his problems programmed in such a manner that at various check points the computer will know, through programmed instruction, the reliability of the answer that is being printed. This system of programming is a common practice in the work routine of a person trained in the field of computer programming. If there is an error, the machine will either stop or print out certain instructions that will help to correct or find the error in the problem.

Prior to computer application, there are certain factors to consider when a problem is presented to a programmer for preparation. Mr. B listed the following points that he considers important when such a situation confronts him:

1. Does the problem have a feasible solution?
2. Will there be an improvement in present operating conditions?
3. Is the solution to this problem a step closer to the solution of a bigger problem?

These three steps are considered very important when considering a problem for computer application. Mr. B felt that they were self-explanatory, and that it would not be necessary to discuss them any further. Those persons responsible for programming problems for the computer include Mr. B, his assistants, and sometimes programmers in the computer center.

There is no definite answer to how much time is involved in programming a problem for the computer. The reader must remember that time saved is not realized in the programming. Any time saved is realized after the problem has been programmed and put into operation. The example presented previously, concerning scheduling of products transported through pipelines, involved four man-months of time and effort. At other times a programmer may spend only a few hours preparing a program.

After a problem has been programmed for the computer, there usually results extra work time to be utilized by various personnel in the department. How is this extra time utilized? The primary result is a reallocation of time to other problems. Or, sometimes it may be necessary to transfer employees to other departments or to different geographic locations. These transfers are usually the result of a computer application that eliminates a full man eight hours per day. The company does not lay-off personnel because a computer application has replaced the employee. It is a system of transferring employees to areas where their talents are needed that prevents any computer caused lay-offs.

The reports presented to management, which are the result of computer output, have been more than satisfactorily received. One factor that must be mentioned is that

management, in many instances, is receiving more information than is actually needed. Mr. B did not elaborate upon this statement. To consider the area of whether the computer analyst department is more functional through the use of a computer, was not relevant in this interview.

Mr. B had some personal reactions to the utilization of computer facilities. He stated that, as in the use of all previous inventions, the computer is a complex but competent tool which aids management personnel to make the company a more profitable organization. There is also a great demand for personnel who understand the potentialities of EDP and the type of problems that are applicable to a computer. The reader must remember that the computer should be used to solve the type of problems it was designed to solve. The computer is not a toy to be played with or a status symbol for an organization; it should be looked upon as a tool with which various problems may be solved faster and more efficiently.

Interview Number 3. Mr. C is the Supervisor of Oil Movements for the Pipeline Department. He has many responsibilities relevant to crude oil trading, tariffs, and oil field depletions. The primary interest that Mr. C has in the computer is the data output.

The question concerning monetary charges for the use of computer facilities was considered not relevant with this interviewee.

To explain how savings in time and money are realized, as the result of computer usage, Mr. C gave the following example which concerns savings in time. Each month he receives from the computer center a tabulation of crude oil that has been transported from various oilfield leases. Prior to the time that this report was prepared by the computer, Mr. C prepared the report manually. Through the aid of the computer, this man now realizes a savings in time of at least two days per month.

There was no doubt in Mr. C's mind but that the computer center is considered a service organization.

Through the use of the computer in developing economic studies, there results a definite indirect savings in operating expenses. Many times an economic study will show how a certain operation may be performed with less manpower. This, then, results in a savings in salaries.

There was an emphatic answer of yes to the question of "is it difficult to place a dollar value on the services received from the computer center?" Mr. C said there are many intangibles realized from the computer and services rendered by the computer center personnel. To delve into this question would take a considerable amount of time.

An example of a problem application on the computer is the monthly Run Depletion Report. This report shows the amount of crude oil runs during the month and the balance of crude oil reserves at the end of the month. Using this report Mr. C is able to predict the amount of oil that will be available for future processing in Continental refineries. If it is necessary to purchase crude oil from other producers, then these purchases can be based on the Run Depletion Report.

While discussing whether a significant number of errors were encountered in the reports received through computer application, Mr. C commented that at the present time he had not received computer prepared reports containing significant errors. He is very well satisfied with the reports he uses that are prepared in the computer center. The training of personnel to use the computer facilities was not relevant in this interview. Also, the method of checking computer output for errors was not the responsibility of this interviewee.

To explain what the determining factors are when considering a problem for the computer, Mr. C said that the following three areas are of prime importance:

1. Size of the problem.
2. Is the problem repetitious?
3. How rapidly is the information needed?

The interviewee did not think it necessary to elaborate on these pointers.

The programming of a problem for Mr. C is the responsibility of the Senior Computer Analyst in the Pipeline Department. The analyst and Mr. C discuss the problem. During the discussion Mr. C explains what he expects in the output and clarifies any points that the analyst does not fully understand. After the problem has been fully discussed, the analyst then programs the problem for computer application.

When adapting a problem to the computer, the time involved varies. The Run Depletion Report, that was explained previously, involved approximately six man-days to program and work the "bugs" out of the program.

After a problem has been programmed for solving on the computer, Mr. C said that he has more time to devote to other important reports. The two reports which receive more of his attention than others are the Over and Short Report and Thruput Increases and Decreases Report. These reports are of importance only to Mr. C and his supervisors and will, therefore, not be developed any further in this study.

Mr. C is more than satisfied with the output received from the computer. He also feels that management as a whole is very well satisfied with the reports received via computer

application. To give an example, Mr. C explained that the Run Depletion Report was previously prepared manually once every six months. With the aid of the computer, he now receives the report monthly. By receiving this report on a monthly basis, Mr. C is now able to furnish his supervisors with a more complete and up-to-date report of oil depletions in the various geographic locations in which Continental Oil Company has invested money to produce crude oil.

In closing this interview, Mr. C wished to make the following comments on his personal reaction toward the use of a computer. Prior to the time that he became acquainted with the various aspects of computer input and output, it was his understanding that a person just took raw material and typed the information into the computer and out came the answer. He also felt that the computer was a cure-all for paper work. Now that he is better acquainted with what is involved to prepare the input for a computer, he is now more capable of evaluating and determining, to a certain extent, certain problems for solution on the computer. Mr. C was pleased to report that through the use of a computer, a considerable amount of problem solving drudgery has now been eliminated from his work routine.

The Purchasing Department

Interview Number 4. Mr. D is the Assistant to the Manager of Purchasing in the Purchasing Department. It has been the responsibility of this man to help prepare the problem statement for a problem that is relevant to his department being programmed for computer application. By delving into the various aspects that are to be considered in a program, this gentleman has become acquainted with some of the workings of a computer and the computer language.

At the present time, the purchasing department is not receiving a direct monthly charge for the use of the computer and computer facilities. There is a possibility that in the future a detailed charge will be made against each department. This charge will then be considered an operating expense.

There has been no attempt, at the present time, to evaluate and determine any savings in time and money in the purchasing department as the result of using the computer facilities. The interviewee stated that when the savings are determined, they would surely reflect a definite savings in operating expenses.

During the interview, Mr. D stated that the computer center was definitely a service organization. The computer facilities and personnel in the center extend their services

to any department in the company that is presently programming a problem or anticipates adapting a problem to the computer.

Mr. D did not feel that it would be too difficult to evaluate and place a dollar value on the services received from the computer center. There are many intangible benefits on which it would be difficult to place a value. But after careful consideration, a reasonable amount of dollar savings could be determined.

An example of a problem application that is presently being programmed is the Forms Stock Control report. This report contains a listing of 2300 different vendors. These forms are in turn requisitioned by approximately 250 different departments and sections in the company. By utilizing the computer, a constant and more up-to-date inventory control will be maintained. This report will show the quantity of forms that have been printed by each vendor and the balance in stock. The report will thus enable the purchasing department to prepare a purchase order authorizing a specified vendor to print a certain quantity of forms before the inventory becomes too low. There have been very few errors encountered in the computer output. The errors that were encountered were man-made errors and were corrected before any decisions were made based on the information in the report.

The purchasing department has not developed a training program for personnel who are or will be working with computer applications. The purchasing personnel who are presently working with programming are being sent to computer orientation courses in the computer center to familiarize the individuals with computer applications and equipment.[25]

The purchasing department depends on personnel working in the computer center to maintain systems control on computer output of reports for the purchasing department.

Mr. D listed the following questions which he considers important when considering a problem for the computer.

1. Will the computer application decrease the buyers routine paper work?
2. Will the buyer have more time to negotiate the purchasing of supplies from the various vendors?
3. Will statistical information be available more readily to assist the buyer in making a decision on which vendor to purchase from?

If these three questions are answered in the affirmative, plus other considerations, then the problem being considered for computer application will probably be programmed and the output tested for reliability as an aid to the buyer.

When a problem is being programmed for the purchasing department, a considerable amount of time and effort is

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[25]See Appendix C.

exerted by both purchasing and computer center personnel. At the present time, there is no one in the purchasing department who is fully trained and qualified to do programming. Therefore, the problem is presented by a representative of the purchasing department to a qualified programmer in the computer center. The problem is discussed in great detail and the programmer then has the responsibility of programming the problem. Mr. D gave an example of the amount of time that is involved when adapting a problem to the computer. A problem that is presently being programmed involved two man-weeks to define and present the problem by the purchasing department to the programmer. After the problem was defined and presented to the programmer, there were five man-months involved in writing the program and adapting the problem to the computer. Mr. D explained that there is no definite time limit involved when a computer application is being prepared unless it is a critical problem and has high priority.

After a problem has been adapted to the computer, there are definite indications of how various employees are affected. For example, a buyer has more time to negotiate the purchasing of materials from various vendors. Prior to the utilization of the computer a buyer would spend a considerable amount of time doing routine manual processing of requisitions that can now be done with the aid of the computer. This time savings

permits the buyer to utilize more adequately his buying knowledge and skills.

Management has been more than satisfied with the reports that are derived through the use of the computer. An example was given of the Drilling Mud Report that is used by the purchasing department. The report is now more legible, accurate, and up to date than when the report was being done manually. The report now enables the purchasing department personnel to analyze the information more rapidly and thoroughly.

Mr. D stated that in the period of time that the purchasing department has been using the computer, there has been no attempt to analyze and determine in what way this department is more functional as the result of computer usage.

The reactions that Mr. D had toward the computer were varied and are as follows:

1. The computer is an effective tool and aid to the department and management in doing and solving daily problems in this department.
2. The computer is an expensive tool for any company, but the benefits, both tangible and intangible, are unlimited.
3. The ability to calculate difficult problems and prepare statistical information through the computer is of tremendous aid to this department.
4. Management should be aware that the computer is a tool that is to be used wisely and not to be used for some menial task.
5. Mr. D has no apprehensions or fears that his job will be replaced by the computer.

The Controller Department

Interview Number 5. Mr. E is an analyst for the Controller Department, and his office is located in the computer center building.

At the present time, the Controller Department is not charged for the use of the computer. A monthly report is prepared and submitted to the Controller listing the amount of time the computer was used in problem application for this department.

There is, at the present time, some difficulty in determining the savings in time and money through the use of the computer, especially on a new problem application. By delving into old records and routines, it is possible to determine the approximate amount of time which was used to prepare a report manually. By taking the manually prepared time factor, and comparing it with the time in which a computer can prepare the same report, a reasonable comparison can be made in showing time saved with the aid of the computer.

The controller department personnel considers the computer center a service organization. Mr. E did not elaborate any further on this part of the interview.

While discussing the question of whether savings are considered capital investment or operating savings, Mr. E stated that any dollar savings resulting from computer output

would, in most instances, be a savings in operating expenses. He could not think of any instance where a savings in capital investments could be shown for the controller's department.

There is at the present time some difficulty in placing a dollar value on the services received from the computer center. In some instances, information was prepared manually in twenty hours and is now being prepared in five hours with the aid of the computer; a dollar value can be placed on this savings. In other instances, a problem being considered for computer application might result in the discontinuing of the report. The discontinuing of a report many times is the result of asking various persons why the report is necessary, or who initiated the request for such a report and when. When these questions are answered, there are occasions when it is realized that the report is unnecessary and is then discontinued. This, then, results in a time savings for the person or persons who were preparing the report manually.

Mr. E gave the following example of a problem application on the computer that was originally prepared manually. The Gross Volume Calculations problem concerns the measurement of gas that is measured on recording charts at the well-site. The overall problem is to determine (1) How much gas was purchased? (2) How much does Continental owe for this gas? and (3) To whom does Continental owe this money? When this problem was being solved manually, there was

a definite problem in totaling all gas received in the field and at the gasoline processing plant. By feeding into the computer the information derived from the gas measuring charts, a report is now prepared in approximately twenty minutes. This report is a listing of all the gas purchased or consumed in each district owned or operated by Continental Oil Company. When this report was being prepared manually, there were six people working on the problem for approximately ten days. Thus meaning approximately sixty man days were used to prepare the report.

According to Mr. E, there have been very few, if any, mechanical errors encountered in the output of the 7090. The only mechanical error that was discussed concerned errors that were the result of a damaged magnetic tape and when this occurs the error is easily found. The primary cause of errors, in computer output, are caused by human errors in the original programming. These human errors are gradually eliminated as the programmer becomes better informed and educated in the field of computer programming.

There are various ways in which new personnel are trained to work with the computer input and output. Usually, the new personnel attend orientation classes in the computer center where they learn various aspects of computer operation

and programming.[26] Mr. E received his training in programming at Oklahoma University. He enrolled in six hours of computer programming course work while working on his Master's degree in Business Administration. In addition to his college training, he did programming work on the 650 computer prior to the installation of the present 7090 system.

The extent of systems control varies in the computer center. In many cases, the programmer knows in advance what the final total will equal. Therefore, if the programmed problem is broken down into small segments, the small segments must add up to 100 per cent or whatever the known total is. If the output does not total the predetermined amount, then the programmer must re-evaluate the problem and find the error which is usually found to be a human error.

There are various determining factors involved when considering a problem for computer application. Two important factors to consider are: the size of the problem, and whether the information generated will result in a new and more useful report. There are numerous other factors involved, but Mr. E felt that these two were more important.

The programming of large, complex problems for the controller department is done primarily by programmers

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[26]See Appendix C.

employed in the computer center. The short programs are prepared by Mr. E.

There are too many variables encountered to establish any time limit on the adapting of a problem to the computer. In some instances, a problem is programmed in three months time, and sometimes many years are involved in preparation of a suitable program. There is at the present time, no rule-of-thumb to determine the amount of time that will be involved to program a problem for computer application.

Mr. E has the opinion that it is difficult to determine how employees use the extra time that is generated through computer applications. In many instances, a computer application will result in saving ten men four hours of work in a specified period of time. Usually, the four hours savings per man will result in more time being applied to problems not concerned with computer applications. This results in a better prepared and analyzed solution. In essence, it can be said that usually a job is not eliminated as the result of computer application, but results in a more specialized type job because the routine work has been decreased or sometimes eliminated. When a job is eliminated, the person is usually transferred to another job in the same department or to another department where his talents and ability can be utilized for the benefit of Conoco. Conoco

management has the philosophy that a man will not be released from Continental's payroll as the result of computer application.

There are varied opinions on the subject of whether management is or is not better satisfied with computer prepared reports versus manually prepared reports. Mr. E is of the opinion that computer prepared reports have been well received by management personnel. For example, Conoco has numerous oil leases that need constant observation from the operational point of view. The reading of a report, which shows the operational information concerning every lease that Conoco has, would involve a considerable amount of time. Therefore, a predetermined plus or minus percentage limit can be programmed into the problem which, in turn, will result in the printing out of only those leases that are affected by this limit. Those leases that are listed on the report are the ones that need management's attention, and those leases that are operating within the predetermined limits do not need his attention. Management personnel consider this type of sophisticated report of great benefit to them in terms of time saved doing routine paper work and reading the various reports relevant to areas which are considered their responsibility.

Mr. E found it difficult to give an adequate explanation of how the controller department is more functional as the

result of computer applications. One point that was made clear involves the expansion of a problem that has been programmed for the computer. When it is necessary to increase the size of the original program, this does not result in the computer being overworked, which is possible if a man were solving the problem. In other words, a problem may be increased in size without increasing the size of the computer. On the other hand, if man were solving the problem, this would undoubtedly result in the hiring of additional manpower to handle the additional work in the controller's department. There is considerable flexibility to grow without the need of additional manpower which results in additional time to work on problems that are not considered adequate for the computer.

The personal reactions of Mr. E toward the use of the computer facilities are as follows: (1) helping people work out a problem on the computer, which otherwise might have been impossible to prepare manually, creates a deep sense of personal satisfaction; (2) he is using the computer to solve problems for his department and also helping other people solve problems from their departments; eventually, he gets a broader perspective of the company and how it functions. These reactions create a feeling of actually knowing and understanding how Conoco operates.

The Production Department

Interview Number 6. Mr. F is a Senior Analyst for the Production Department, and his office is located in the computer center.

At the present time the production department is not charged for the use of the computer and other computer center facilities. There is a monthly report which shows the amount of time the computer was used for production department reports. This department uses the 7090 for approximately twenty hours per month which is a small amount of time when compared to other departments.

To determine the amount of savings in time and money, as the result of computer application, an analysis of the time used to prepare the report manually is made and a dollar value is placed on man hours expended preparing the report. Then a comparison can be made between computer time and manually prepared time which will show the savings in time and money.

The computer center is considered a service organization. Mr. F did not elaborate on this any further.

While discussing whether savings were operating or capital investment savings, Mr. F stated that the use of the 7090, as an aid in problem solving, results in a definite savings in operating expenses.

There is, at the present time, some difficulty in placing a dollar value on services received from the computer center. There are so many intangible benefits received from the center, Mr. P said, that it was almost impossible to say that these benefits were worth so many dollars to the production department.

An example of a problem application on the 7090 for this department is the Well Status Report. This report includes a listing of all oil wells owned or partly owned by Conoco. This report is broken down into five parts which are as follows: (1) a detailed oil well status report which shows each oil well completion, whether the oil well is pumping, flowing, or shut-in; (2) a summary of oil wells production which is used by the accounting department in clearing district overhead and operating expenses; (3) a shut-in well report which informs the manager of the wells that have been shut-in, the date the shut-in occurred, and the reason why the well was shut-in; (4) a drilling report is prepared which shows the drilling time on a new well; and (5) a summary report is prepared listing each district and the number of wells in the respective districts. Prior to the time these reports were prepared on the 7090, only the first report was used. The manual preparation of this report required approximately two man days in each of the thirty-

one districts or sixty-two man-days. Now, with the aid of the 7090, all five reports are prepared in thirty to forty minutes time each month. This savings in time has resulted in approximately $15,000.00 savings per year.

According to Mr. F there have been no errors in the computer output that can be classified as mechanical errors. Errors that are encountered in the output are usually the result of human errors in the programming or other information that was incorrect before the programmer received the new information for computer input data.

The training of an individual, who is to do programming work for the production department, is usually the responsibility of the personnel who conduct EDP classes in the center. The time involved for training varies and depends on the individual's weak points in EDP.

To facilitate a systems control of computer output is the responsibility of a nine member staff which is supervised by Mr. F. A member of the staff will scrutinize the output, checking for errors in the final totals or for indications of errors at various check points in the output. After a report is considered correct, the report is then forwarded to the department manager or supervisor who needs the information.

There are two major determining factors, according to Mr. F, when considering a problem for computer application.

The first factor involves the complexity of mathematical calculations or manipulations which are necessary in solving the problem. The second factor to consider is the volume of data to be analyzed before a final conclusion is made in the report. These two major factors, complexity and volume of data, included with other small factors result in the decision whether a problem will or will not be programmed for computer application.

The responsibility of programming problems for the 7090, which are relevant to the production department, is the responsibility of Mr. F and his nine member staff. There are instances when other technicians are called upon to furnish pertinent information to supplement the programming of highly technical problems.

To establish a formula or rule-of-thumb for time involved in adapting a problem to the computer is an almost impossible task. In some instances, a programmer might prepare a problem in two days, and sometimes as much as six months time will be used in the preparation of a problem. Therefore, Mr. F has no definite answer for this area of the study.

Mr. F was asked the question, "After a problem has been programmed for computer application, how does the savings in time affect these employees who were originally preparing

the same problem manually?" In some instances, a complete man or position is eliminated. When this occurs, the employee is either transferred to another section in the production department, or he might be transferred to another department where his talents may be utilized. It is the policy of Conoco that a person will not be relieved of his or her job because of computer applications. There are other instances where the computer might relieve an individual of only a portion of his daily work load. When this occurs, the individual usually absorbs additional work, and he also has additional time to analyze other data more closely which results in reports better organized and prepared.

Management's reaction toward computer prepared reports has been more than satisfactory in the production department. The information is considered to represent a more sophisticated presentation of data whereby management personnel have been enabled to scrutinize the data more easily and to make a better informed decision based on the sophistication and accuracy of these reports.

The production department has become more functional through the use of computer applications because of additional information which can be made available to the interested parties in a short period of time. Prior to the use of computer output, there occurred unnecessary periods of delay in

receiving information which definitely hindered the decision making of people in responsible positions.

One of the primary reactions which Mr. F has toward the utilization of computer facilities is the realization that he and his staff are capable of developing pertinent data which are of unlimited value to responsible people in the production department. This ability to aid management leaves Mr. F with a feeling of pride and satisfaction in his work and his staff.

The Manufacturing Department

Interview Number 7. Mr. G is the Chief Process Economics Analyst for the Manufacturing Department. His responsibilities are varied, but primarily he and his staff are responsible for developing the computer input data which results in the output data used to facilitate the operation of the two oil refineries located in Ponca City, Oklahoma, and Lake Charles, Louisiana.

In reply to the question of how the manufacturing department is charged for the use of the computer facilities, Mr. G explained that his department received a monthly report showing the amount of computer time used to solve problems for the manufacturing department. The manufacturing department has not been charged directly for the use of the computer.

This department has had considerable difficulty in calculating the savings in time and money as a result of computer applications. Most of the savings are considered hidden savings. One area in which a savings in cost may be determined is the pricing of jet fuel to the purchaser. Most of the jet fuel is sold on a bid basis. When submitting a bid to sell jet fuel, Conoco must sell the fuel at a price low enough to be granted the contract, but still at a profit-making price. There are numerous incremental expenses which must be accurately determined. With the aid of the computer these expenses have been more accurately calculated than if done manually. By using this accuracy, the persons responsible for submitting a bid price for selling jet fuel have been enabled to underbid competitors and thus increase the sales of Conoco jet fuel.

The computer center is definitely considered a service organization.

Most of the savings accrued from computer applications have been considered savings in operating expenses. In some instances, there have been limited savings in capital investments as the result of the computer executing a more exacting calculation of the rate of return on an investment. To establish a dollar value for the services received from the computer center would be difficult. But, when the computer

center service is restricted to the running of a program on the computer, then a dollar value is determinable. If the Conoco computer center did not exist, the manufacturing department computer applications would be solved on a computer which was owned and operated by another business firm. The expense of using the computer facilities of an outside business firm are determinable. Therefore, a dollar value can be placed on the computer time when used by the manufacturing department.

An example of a problem application on the computer, which was previously prepared manually, is the scheduling of refinery operations. Each month the manufacturing and marketing departments submit their respective supply and demand reports. These reports, plus the maintenance schedules and potential inventory problems, are programmed for computer application. The computer then prepares a report showing the optimum operation for a refinery. This report is then discussed in great detail with various persons responsible for the refinery operation. During these discussions, there is an exchange of ideas concerning the plan of operations and the financial aspects which are involved in producing products for distribution by the marketing department. If there are any corrections to be made, the programmers alter the computer input accordingly, and a new optimum operations report is then prepared on the computer.

The training of personnel to work with the programming of manufacturing problems is strictly on-the-job training. An engineer is selected who shows potential for this type of work. He then works with a qualified programmer on simple problems which he can easily comprehend. As he progresses, his work load increases; and after a certain period of time, he is considered capable of working with and programming the more complicated problems.

Systems control, sometimes referred to as checking the correctness of computer output, is the responsibility of various programmers in the manufacturing department. These personnel check the computer output for reasonableness. This is a hand checking process which will undoubtedly not be replaced by a machine.

Various factors are taken into consideration when a problem is submitted for possible computer application. When Mr. G is confronted with a new problem for computer application, the following factors receive considerable attention: does the problem warrant the time and effort which is necessary to prepare a problem for computer application, and to what extent is the computer capable of preparing the report better than if prepared manually.

The responsibility of programming computer problem applications for the manufacturing department rests upon Mr. G and his nine member staff of engineers and technicians.

Time involved in programming problems is an ever-changing factor. A person cannot say or determine the exact amount of time which will be involved in programming a problem. The programming of refinery simulation and optimum operations involved approximately four calendar years or twenty-five man-years of effort. Other programs might involve only two days of effort for preparation and running on the computer.

After a problem has been adapted for computer preparation, there then exists in some instance extra time for certain employees to absorb into their daily work load. In the manufacturing department, due to computer applications, there have resulted additional work loads for certain personnel. The computer applications require the raw material to be more detailed and specific than when the problems were being solved manually. Therefore, engineers and technicians are now required to submit information which has been analyzed in greater detail than previously. This detailed analysis has resulted in a greater demand on the engineer's and technician's time rather than a lessening of their work loads.

Because the computer now prepares reports which are considered sophisticated and in greater detail than those previously provided, management has been quite pleased with the results. Management personnel are now enabled to view

the facts, which are relevant to their responsibilities in the manufacturing department, in a broader scope.

The manufacturing department has become more functional in many ways through the use of the 7090 computer. Engineers, who are now using the computer as a tool with which to solve problems pertaining to their work, can now work with problems much greater in scope and complexity than without the aid of the computer. The answers to problems and decisions made based on computer output have resulted in smoother and more economical organization operations. These examples are but two of the many ways this department has become more functional with the aid of the computer.

Mr. G had various reactions concerning the utilization of the computer facilities, but he considered the following examples more important than any other reaction he might have. In the first place, when man uses a computer intelligently there then exists a tremendous potential in the computer output for the benefit of Conoco. In the second place, man must be careful in using the computer correctly. Sometimes, man uses the computer to solve menial problems which should be solved manually. This is definitely a waste of computer time. In other instances, man uses the computer to solve a complex problem when he does not fully understand the complexity of a program. When this occurs, the computer output is accepted as fact, and due to a possible error in the

individual's program, the results are incorrect, and the individual does not realize there is an error. Therefore, unnecessary and incompetent use of the computer should be eliminated as soon as possible in the respective departments.

The Research and Development Department

Interview Number 8. Mr. H is the Research Group leader of the Production Research Division in Research and Development located in Ponca City, Oklahoma. This gentleman was also a member of the feasibility team which recommended the acquisition of the 7090 computer facilities that are described in this study.

The Research and Development Department is not directly charged for the use of the computer and other facilities in the computer center. Mr. H informed the investigator that all expenses incurred by his department, related to computer usage, are borne by Continental Oil Company.

Savings in time and money as the result of computer usage are very difficult to determine. When the original computer feasibility study was being prepared, various estimates were presented in the study relevant to time and money savings on various projects. These estimates are still the basis for determining any savings when this information is needed.

The computer center is definitely considered a service organization. The equipment and staff in the center are there to aid and assist other departments in solving the large or small, complex or routine, problems confronting respective department personnel.

Savings in operations expenses and capital investments as the result of computer usage in the Research Department have been very difficult to determine. There has been no definite attempt to determine whether savings are more prominent in operating expenses or capital investments.

When considering errors in the computer output, Mr. H had the opinion that usually any errors encountered in the computer output were definitely human errors. He had complete faith in the reliability of computer output being free of machine errors.

The training of personnel in this department for computer programming involves on-the-job training and classroom training in the computer center. Many of the new engineers have received some formal programming education in the college or university from which they have graduated. The classroom training conducted in the computer center covers various phases of computer input and output.[27] This classroom

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[27]See Appendix C.

training coordinated with on-the-job training usually involves approximately six months time before the individual is qualified to handle various problems for computer application.

Systems control is primarily the responsibility of the personnel in this department. The individual or team members who programmed the problem scrutinize the output data for errors, and if there exist any errors, the program is corrected, and a corrected report is prepared on the computer delivered to the interested parties.

Various factors are taken into consideration when a proposed problem is considered for computer application. One factor concerns the amount of manpower time saved through computer application. The question is asked whether the computer is capable of preparing data faster and more efficiently than man. If the answer is negative, a manual system will be utilized. Another factor considered relates to the possibility of preparing studies which were previously considered impossible or impractical to prepare manually. If both of the factors are considered in the affirmative, then usually the problem is programmed for computer application.

The responsibility of problem programming for this department has been, and presently is, the responsibility of Mr. H and his staff of five engineers. These men work as individuals or teams, depending upon the size of a problem, when programming a problem. The programming time varies from

fifteen minutes to a calendar year. There has not been a rule-of-thumb developed which will determine the amount of time necessary to program a new problem.

After a problem is adapted to the computer, there usually results a time savings for various individuals. Most of the engineers in this department use the extra time to solve other more important problems. The engineer has more time to analyze a problem and develop a more complete and intelligent program.

In reply to the question "is management better satisfied with computer prepared reports than manually prepared reports?" Mr. H stated that to the best of his knowledge, management personnel are pleased with the computer prepared data. Management now receives information which now enables them to gain a broader outlook on the situation and possible alternative solutions that were not available when the data was prepared manually.

When asked the question, "what is your personal reaction toward the use of computer facilities?" Mr. H stated that he was definitely in favor of using the computer. The computer is a tool which aids his group in doing a better job on complicated problems. The problem of determining oil reservoir performance was always a complicated and dynamic problem when prepared manually. With the aid of the 7090 computer, this problem is now analyzed and reports are

prepared without the difficulty previously encountered when prepared manually.

The result of using the computer as an aid in problem solving has definitely made this department more functional. It is without question that any problem which confronts Mr. H and his staff must be solved with the aid of the computer. In essence, this department did not exist and presently could not function as a group without the aid of a computer when solving complex problems. Prior to the installation of the 7090 computer, the engineers attempted to solve problems of this nature with a slide rule and calculating machines.

Chapter IV will contain an analysis of the interviews presented in this chapter.

CHAPTER IV

ANALYSIS OF THE DATA

The purpose of this chapter is to provide an analysis of the data reported in Chapter III. In presenting this material, it is assumed that opinions of managerial and supervisory personnel interviewed are representative of the opinions of other persons in their respective departments within Continental Oil Company.

In Chapter II the investigator listed two problems which were to be considered in this study. One problem concerned the amount of time necessary for conversion from manual to computer utilization for solving the everyday problems of business and industry; the other pertained to the determining of time saved by various departments using a computer facility.

Conversion from manual operation to computer operation. The conversion from manual to computer utilization for solving the everyday problems of business and industry constitutes, in many instances, a considerable amount of time and effort. This was the situation which the interviewees in this study had experienced as well as the members of the feasibility study group.

In all instances, the interviewee expounded on the great length of time expended before a problem could be considered ready for computer application. Nevertheless, there were instances in which a routine problem could be programmed in a matter of a few minutes or hours.

Much of the conversion time also involved training personnel to be competent programmers. This usually involved extensive on-the-job training or classroom training conducted by personnel in the computer center.

After a problem was converted from manual preparation to computer preparation, there then existed a sophisticated report which, in many instances, the manager or supervisor receiving the report did not fully comprehend because of the magnitude of the information which he possessed.

When a problem has been prepared for computer application, there then exists the problem of errors in the initial output data. This constitutes another time consuming job for the programmer. For it is then necessary to closely scrutinize the output data to determine the area where the error occurred in the original program. Many of these errors are the results of the programmer not fully understanding the nature of complexities of the raw data.

Various factors concerning whether a problem should be considered for computer application were presented by the interviewees. The factors most frequently presented concerned

the size and frequency of a problem. In some instances, a difficult problem being solved manually involved many hours of manpower using a slide rule and/or a desk calculator. It was also noted that the resulting answer of these calculations might not achieve the desired accuracy. In other instances, the problem was not considered extremely difficult to solve manually. However, because it was a repetitious problem involving many hours to solve and prepare in report form manual methods were in many instances impractical. These two factors result in ideal situations for computer application.

The responsibility of converting a manually prepared report to a computer prepared report was that of personnel in five of the six departments represented in this study. Only one department did not have qualified personnel trained to program problems at the time of this study. The interviewee representing this one department stated that one person from his department had been attending classroom lectures for training in computer programming. But, in the meantime, this department was depending upon personnel in the computer center to program any and all problems which were being considered for computer application.

At the time of conversion from manually prepared to computer prepared reports, there was no formal training program for personnel who were selected to work in the computer

center or in other departments as programmers. Most or all of the training these individuals received was accomplished through on-the-job training. In some instances, certain individuals would attend classes conducted by the manufacturer of the equipment installed in the computer center. Usually, any additional formal training was administered to those persons who showed a definite need for such training. When considering individuals for positions in the computer center, it appears that a series of tests ought to be administered to measure the individual's aptitude in this area of employment prior to his assignment as a programmer.

Reactions toward the utilization of a computer to aid the interviewee and their respective departments in solving problems were varied yet consistent. One frequent response was that the interviewee felt he was forced to think more thoroughly and rapidly now that the computer was being used. Thus, resulting in a better knowledge of the problem, and in many instances, a broader perspective of the operations of his department.

Time factor. The evaluation of time saved in solving problems with a computer, and how this savings in time is used by personnel affected by computer applications, was and is sometimes difficult to determine.

Usually, after a problem has been programmed and run on the computer, there then results extra time for certain personnel to devote to their other work. In most instances, according to the interviewees, this extra time permits personnel to devote more time to problems which previously were inadequately handled.

Infrequently, there have been situations where a computer application has completely eliminated a man. When this occurs, the individual is offered a job with the same department in another geographic location, or a transfer to a different department where his talents will be utilized to their greatest capacity. It is definitely the policy of Continental Oil Company that computer applications will not result in the termination of any employee.

Management has been very well satisfied with the rapidity of problem solution from the computer. This rapid output of data has enabled the managers and supervisors to make decisions, and see the results of their decisions more readily. The data received from computer output has been prepared in a manner which has saved the managers unlimited reading time. Prior to computer applications, the managers and supervisors would spend considerably more time analyzing manually prepared data than they use in reading computer prepared data.

The question of whether savings in time, through computer application, results in savings of operating expenses or capital investment is always being asked by responsible people. The personnel represented in this study all agreed, except one, that savings in time usually meant a savings in operating expenses. The savings in operating expenses were considered the result of decreased manpower needs for the particular area affected by computer application. The other individual was of the opinion that savings through computer application would directly reflect a savings in capital investment. This opinion was based on economic studies concerning the expansion of existing facilities. In these economic studies, a program is prepared, which, when fed into the computer, will point out optimum sizes of piping and pressures which, when compared to vendors material specifications, the necessary materials might be purchased at a lower cost than when such studies were prepared manually. When such studies are prepared on the computer, there is greater accuracy than when prepared manually.

After the involved and tedious efforts of programming are completed, there then results the much sought after savings of employees work time on the problem which has been programmed. The example was presented in Chapter III by Mr. B concerning the amount of time used by the scheduler in checking the correctness of his proposed schedule for

transporting petroleum fluids through pipelines. The scheduler is now capable of checking his schedule on the computer for accuracy in a matter of seconds. Prior to using the computer a matter of hours were involved in checking the accuracy manually. It was such examples that the interviewees presented to the investigator.

The interviewees consistently made an effort to explain another factor relevant to this area of the study. There is constantly the problem of showing how all persons affected by a computer application use their extra time. Usually, these people receive additional work to take the place of the work they previously did which has been prepared for computer application. In these instances, the interviewees were of the opinion that a computer application did not necessarily result in a decrease in the work load of certain employees. In most instances, there results an increased work load on the individuals.

I. SUMMARY

In this chapter information based on the data collected and presented in Chapter III was analyzed and summarized to reveal the findings. To facilitate the presentation of the data collected concerning the six departments represented in the study, this chapter was divided into two parts with information relevant to the amount of time

necessary for conversion from manual preparation to computer utilization for solving the everyday problems of the company represented; and the second part presented information which pertained to the determination of time saved by the various departments using a computer facility.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to explore the conversion from manually prepared information to computer utilization for solving the everyday problems of selected departments in Continental Oil Company and how personnel in these departments used the time saved or work now being prepared by the 7090 computer.

This study was based on information obtained from books, periodicals, and interviews with managerial and supervisory personnel employed by Continental Oil Company located in Ponca City, Oklahoma.

The various reactions of the persons interviewed by the investigator concerning the utilization of a computer and time saved was presented in this study. The information gathered is summarized below:

According to an article written by M. B. Levitt[28] concerning the expenditure of huge sums of money for a computer, a computer can be justified only if it (1) reduces

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[28]Levitt, loc. cit.

clerical costs, or (2) provides needed management control information. In some instances, clerical costs are not necessarily reduced; but additional information can be prepared and presented to management, thus enabling these responsible people to make wiser decisions. Such was the case in this study.

Before a computer is acquired, a complete and thorough feasibility study must be conducted to assure the economics of acquiring such an expensive tool.

One of the primary benefits derived from computer application is the high rate of speed at which a computer can manipulate information.

The manager must realize that electronic data processing is not the cure-all for all organizational problems, and should realize that computers can never do the jobs which people can do better. The manager should not become disillusioned with electronic data processing when occasional failures occur. In the future, the manager who understands the basic concepts of EDP and who is able to apply them to his business, will be the manager who rises to the top in the business world.

While interviewing various managerial and supervisory personnel, the investigator discovered that these interviewees were acutely aware of the time needed to convert from manual to computer prepared data. In some instances certain

individuals were amazed at the complexities of programming a problem for computer application. Various factors were presented relevant to considering a problem for computer application. The primary factor considered to be of significant importance was the size and frequency of the problem. Just because a problem is repetitious did not mean it was necessary to convert from manual to computer prepared output data. One frequent response expressed by the interviewee was that these managers and supervisors were now forced to think more thoroughly and rapidly when using computer output data for decision making.

Those persons affected by computer application usually are relieved of one particular phase of their work, but this work has been replaced by new work or more time to devote to other phases of their daily work routine. By devoting more time to other phases of their daily work routine, personnel are now capable of making better analyses and improved data for management.

There have been few instances where an individual position has been completely eliminated as the result of a computer application. In those instances where a position was eliminated, the individual was either transferred to a different geographic location in the same department or offered a position in a different department where his talents might be fully utilized. It has been the policy of

Continental Oil Company that no employee will be terminated as the result of computer applications.

Management and supervisory personnel have been very well satisfied with the computer being used as an aid in problem solving. The computer prepared data has enabled these persons to make decisions quicker and realize the results of their decisions more readily.

II. CONCLUSIONS

After the analysis and interpretation of the data obtained for this study, the following conclusions were made:

1. Management is aware of and is yet concerned about the length of time necessary to program a problem for computer application.

2. Management is pleased with computer prepared data to aid them in their decision making.

3. The size and frequency of a problem are important factors to consider when a problem is proposed for computer application.

4. Management and supervisory personnel are now forced to think more rapidly and thoroughly when using computer output data to facilitate their decision making.

5. The computer does not necessarily decrease an individual's work-load. Usually the work-load increases.

6. Individuals affected by computer applications have, in some instances, more time to devote to other more important problems which results in better analyzed-and-prepared data.

7. Competent personnel must be selected and trained to program problems for computer application.

8. Most of the errors encountered in the computer output data are human errors.

9. Continental Oil Company protects individuals from employment termination as the result of computer applications.

10. A well-prepared feasibility study is of utmost importance when considering the acquisition of a computer.

III. RECOMMENDATIONS

From the information presented in this study and the interviews with the personnel in departments of Continental Oil Company selected from this study, the following recommendations were made:

1. This study should be expanded to include other oil companies for the purpose of making comparisons.

2. Management and supervisory personnel should be subjected to limited classroom training or familiarization with programming and computer facilities.

3. Programmers should be selected by formal aptitude testing.

4. Companies considering the acquisition of a computer read this study and consult with personnel in Continental Oil Company to ascertain the various problems encountered in the acquisition and operation of a computer center.

5. This study be used as a teaching aid in college classroom work relevant to electronic data processing.

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APPENDIX A

Interview Schedule

Name_____

Title_____

Department_____

Is your department charged monthly for the use of the Computer Center?

Yes_____

No_____

How are savings in time and money determined?

_____

_____

Is the Computer Center considered a service organization?

Yes_____

No_____

Discuss_____

_____

Are savings considered "operating" or "capital investment" savings?

Operating_____

Capital Investment_____

Discuss_____

_____

Is it difficult to place a dollar value on the services received from the Computer Center?

Yes_____

No_____

Discuss_____

_____

Example of problem application and comparison of computer prepared versus manual prepared report. _____

_____

Is there a significant number of errors encountered in the output of a computer?

Yes_____

No_____

Discuss_____

_____

Method of training personnel for the various jobs and positions in the "Center."_____

_____

What is the extent of System Control (checking the correctness of machine calculations) maintained in the "Center?"

_____

_____

_____

What are the determining factors when considering a problem for the computer?_____

_____

Who is responsible for programming your problem?_____

_____

How much time is involved in adapting a problem to the computer?_____

_____

After a problem is adapted to the computer how is the time saved used by the employee affected by this time saving?_____

_____

Is management better satisfied with the reports that are derived from the computer?

Yes_____

No_____

Discuss_____

_____

In what way is your department more functional as the result of using the computer as an aid to problem solving?_____

_____

What is your personal reaction toward the utilization and of computer facilities?_____

_____

Would you like to receive a copy of the summary, conclusions and recommendations?

Yes_____

No_____

APPENDIX B

Computer Feasibility Study

This feasibility study is not in its entirety because, in some instances, the data was considered classified and not for public use.

CONTINENTAL OIL COMPANY
COMPUTER FEASIBILITY STUDY

SUMMARY AND RECOMMENDATIONS

A Computer Study Group was appointed at the request of the Data Processing and Advanced Instrumentation Methods Sub-Committee of the Coordination Committee. The Study Group was to determine potential computer applications in Continental Oil Company and to consider machinery and organization necessary to implement a program for effective computer use in the Company. This report presents the findings of the Study Group.

Continental presently has 26 people, representing an annual salary of approximately $200,000, engaged in computer work. The Company has two computers--a Bendix G-15 used exclusively by Exploration Research and an IBM 650 used for data processing (40 per cent) and technical (60 per cent) applications. Conac, the computer built by Continental, is unreliable and is not considered for further use in Continental's computer program.

The Study Group visited 21 other integrated oil companies and 9 computer manufacturers to obtain information about computers and their usage.

A survey of all departments and regions of Continental has resulted in a list of 120 potential computer applications which should be analyzed and, if economical, programmed and processed on a computer. As estimated by the operating departments, the potential gross values of the applications range from a minimum of $9,600,000 to a maximum of $15,800,000 per year. The survey also included estimated analysis and programming effort and required computer hours. The Study Group has scheduled programming and machine usage to attain full value from the applications as early as possible. Some of the values will be realized through outside machine rental in 1960 and 1961. With receipt of a computer about mid-1961, benefits will increase and should reach full value for the listed applications by 1965.

Eight different computers (or computer combinations) were evaluated assuming 50 per cent, 75 per cent, and 100 per cent of the potential values estimated by the operating departments and also 50 per cent, 100 per cent, and 150 per cent of the estimated machine time requirements.

Organization and provision for adequate personnel is fully as important as machinery selection. It is estimated that 77 people will be required to handle the listed applications. Of these, 26 are now engaged in this activity in the Company. This will require hiring 51 new people. Of the

total of 77 people, it is anticipated 22 will be located in operating departments as analysts. Of the 51 new personnel, it is felt that 28 will need to come from outside the Company and 23 should be transferred from within the Company with replacements presumably hired for them.

The Study Group has concluded that Continental's needs are best met by a single large computer rather than by separate computers in different departments and regions. The logical location for a computer is in Ponca City, since the largest indicated users are located there. Controller's, Manufacturing, Pipe Line, Production (currently done by Production Research), and Research and Development cover the major portion of listed applications.

The computer and central computer function will require 10,000 to 11,000 square feet of floor space. It is essential that this area be convenient to the tabulating groups because of the problem of transportation of punched cards. This space can be converted in the existing main office building for approximately $90,000, with an additional expenditure of approximately $251,000 for office space for the displaced personnel, making a total cost of about $341,000. A new building connected to the main office building to house the computer and personnel will cost an estimated $322,000.

Furniture and fixtures and contingency items are estimated at $109,500, making a total investment of $431,500 based on construction of a new computer building.

The Study Group recommends leasing of an IBM 7090 computer and peripheral equipment at $901,800 annually. Personnel costs are approximately $809,000; and other operating costs, $237,400 per year, making the total annual operating costs $1,948,200.

The Study Group recommends that Continental expand its computer activities. To accomplish the full potential of applications listed by the operating departments, the following steps are necessary:

1. Authorization of employment of 51 people during the next two years.
2. Authorization of a building for computer and personnel with construction to begin at the earliest possible date.
3. Authorization of furniture and fixtures for personnel required.
4. Implementation of organization to accomplish the computer program. This should be done at the same time the computer is ordered so that adequate preparation can be made prior to receipt in 18 months.
5. Placement of order for an IBM 7090 computer and peripheral equipment, for delivery in 18 months.

DISCUSSION

The potential use of computers in Continental Oil Company was discussed starting around 1952. At that time, no commercial computers that would meet our needs were available; therefore, in June of 1953, it was decided that we would

construct a computer to our specifications. Unfortunately, this machine--Conac--has not proved successful. The unreliability of the machine is such that its utility is estimated to no more than equal the out-of-pocket costs of operation and maintenance.

Conac was planned as a special-purpose, technical computer so a need was felt for a computer for data processing, economic studies, and general engineering applications. An IBM 650 computer was placed on tentative order in October of 1953 and was finally approved in October, 1955. The 650 was installed in March, 1956. This machine was used an average of 220 hours per month. In April, 1959, a new IBM 650 was obtained to replace the one installed in 1956. This new machine was equipped with automatic floating point and other features making it faster and more versatile for technical applications. The 650 is now utilized about 300 hours per month (almost two full shifts) and has shown a sharp increase in technical applications since installation. This computer is used about 40 per cent for data processing and 60 per cent for technical applications.

The Exploration Research Division had need for considerable calculating capacity and in May, 1957, ordered and installed a Bendix G-15 computer to handle exploration analysis work. This computer is utilized approximately 620

hours per month, which is very close to maximum usable time. In addition, Exploration Research uses Conac 50 to 60 hours per month to supplement the G-15. As stated previously, use of Conac is not satisfactory, but is "stop-gap" until additional reliable computer time is available.

In the past, some companies have ordered computers for delivery before they had done adequate preparation and without assignment of sufficient personnel for analysis and programming. As a result, their early experience has reflected inefficient usage. The techniques of computer usage and the range of sizes of computing equipment have advanced rapidly in a very few years. Today, a company should be able to select machinery having a better knowledge of preparation and personnel requirements. Applications developed by other companies, and programs written by users and manufacturers assist in avoiding long periods of ineffective use.

Many departments in the Company are expending considerable effort in the use of computers to save time and increase the effectiveness of their work. Twenty-four engineers and analysts and two machine operators, representing an annual salary of approximately $200,000, are now engaged in this effort. The work of these engineers and analysts has yielded programmed applications that cannot be handled by our present computers. This resulted in an expenditure of $6,000

for outside machine rental in 1959 and will require an estimated expenditure of $100,000 in 1960. Also, many problems that are computer applications cannot be analyzed or run because of insufficient personnel.

A group was designated on September 16, 1959, to investigate the following aspects of Continental's computer program:

1. Potential applications of computer usage.
2. Machinery that would be adaptable to needs.
3. Organization required should Continental elect to install a centralized computer.

The Study Group has compiled and evaluated data to cover the three aspects listed above including other related cost items, and hereby presents this information.

BASIC DATA

To satisfy the charges to the Study Group, three classes of basic information were required:

1. Information about other oil companies' computer usage and organization.
2. Information about computers and manufacturers.
3. Information about Continental's potential computer applications.

Outside-Company Survey. There is a considerable amount of information published in trade journals and by computer manufacturers as to the usage of computers by the military as well as by industry. The Study Group found that such information was general in nature. The Group surveyed 21

integrated oil companies to obtain specific information about computers installed, computers on order, applications, and organization. The information gathered in the survey is presented in Appendix A. In addition to the tabulated data, much good was obtained by the Study Group in the personal discussions with representatives of these companies.

In general, the survey revealed that there are three basic types of companies with respect to location of the computer function:

1. Holding companies and independent subsidiaries each having their own computer functions.
2. Integrated oil companies with geographically decentralized computer functions such as R&D and Manufacturing.
3. Integrated companies with geographically centralized computer functions.

In every company surveyed, the computer effort was initiated in the Controller's Department as an outgrowth of tabulating work performed by this department.

In the case of the holding companies, this function has remained in the Controller's Department since they remain the principal user; however, in most instances there are some technical applications performed on these machines. Independent subsidiaries of these holding companies are generally in the second or third groups listed above.

Many of the companies with geographically decentralized functions have multiple machine centers. For example, Ohio

Oil Company has a computer for Research and Development in Denver, one for Manufacturing in Robinson, and one for other users which is located in the Controller's Department in Findlay. In this company, the computers located in the Controller's Department are used for applications from Production, Pipe Line, and other departments located geographically with the Controller's Department. In general, the computers are under the supervision and control of the department where the machines are located.

In the case of companies where major departments are centrally located, plans vary. In many cases, the computers are in the Controller's Department and are used for both data processing and technical applications. Most companies have established a centralized service group for analysis and programming aid to user departments. Two companies have organized separate computer departments. Phillips has a strong, closed-shop central group reporting to a senior officer. Imperial (Standard Oil Company, New Jersey) has a centralized open-shop service group reporting to a senior officer. Closed-shop implies that a computer group does all analysis, programming, and machine operation. Open-shop implies analysis and programming done by each department, with a computer group operating machines and giving assistance in programming efforts if requested by the departments.

Manufacturers' Survey. The Study Group considered computer manufacturers and decided there was a maximum of nine having potentially the size and quality of computers that should be considered for Continental's use. Arrangements were made for members of the Study Group to visit the factories of these manufacturers and to obtain pertinent information about the manufacturer and the computers produced. In addition, information was obtained from representatives of Royal-McBee Corporation on their computer. This information is contained in Appendix B. The nine companies visited are:

1. Bendix
2. Burroughs
3. Control Data Corporation
4. International Business Machines
5. Minneapolis-Honeywell
6. National Cash Register
7. Philco
8. Radio Corporation of America
9. Sperry Rand Corporation (Remington Rand)

The Study Group ranked the computers of each of these companies by size and rated them according to memory capacity and speed.

Continental's Potential Computer Applications. Before any evaluation of equipment could be made, it was necessary to determine as well as possible the potential computer applications within the Company. Each department, region, or function head was contacted and the purpose of the study explained to him. He was asked to designate a "working

contact" with whom the Study Group could meet and work out a list of potential applications. In addition to listing the applications, the department was asked to estimate the potential values of their applications to the Company. With the aid of the Study Group members, analysis and programming time and probable machine computing time were estimated. These applications were compiled by departments and a copy of each department's list of applications was sent to the department head and to the "working contact" to be verified. After corrections were made, the list, consisting of 120 applications, was recompiled.

From the above compilation of projects, the Study Group charted analysis and programming effort, machine time, and potential values for a 10-year period giving consideration to machine delivery time (18 months) and time for analysis and programming.

MACHINERY

The first step in defining cases to be evaluated was to select machinery to be considered. The following aspects of the problem were given consideration by the Study Group:

1. Centralized computer center vs. multiple machines located in departments.
2. Possibility of gradual increase in computing capacity.
3. Lease vs. purchase of computers.
4. Delivery and preparation time.
5. Computers which merited detailed consideration.

Centralized Computer Center Vs. Multiple Departmental Machines. We are entering what might be called the second generation of computing machines. Not only has size and speed been increased tremendously, but most new models coming on the market use solid-state components (transistorized). There is now a wide range of sizes and speeds of machines for consideration.

Many departments would prefer to obtain their own computer, utilizing it to fulfill their own needs. There are some serious detriments in this approach to attain the most effective computer effort. The following are examples of problems encountered with multiple departmental machines:

1. The Manufacturing Department needs a computer with 32,000 words of memory to handle some of their more complex problems. Any computer with 32,000 words of memory has high speeds such that the Manufacturing Department cannot utilize the machine full time.

2. Research and Development has a wide range of applications with regard to memory requirements. Exploration Research has a group of applications that could utilize a high-speed, small memory, relatively low cost computer; however, if this is done, R&D has other applications which require a larger memory but they cannot fully utilize such a large machine. To avoid overlooking any possibility, the

Study Group evaluated one case (Case IV) which would provide a small-memory machine for Exploration Research and another machine for the remainder of the Company, plus some outside rental.

3. Controller's Department can justify a computer similar to the IBM 650; however, if this is done any machine selected for the remainder of the Company would have excess time. Several combinations of machines, both with and without outside rental, have been evaluated to judge whether one machine, basically for data processing, and another machine, basically for technical applications, with planned full-time use of both, would provide an economical solution.

It should be noted that the costs of computers do not increase as fast as the memory and speed provided by the larger machines. After considering multiple departmental machines, the Study Group concurs with Price Waterhouse and Company in their report "Business Experience with Electronic Computers" prepared this year (1959) for the Controller's Institute Research Foundation, Incorporated. This study stated, "In most instances, where there are several major departmental users of the equipment, an attempt is made to establish a service center to serve all departments." The major users in Continental, as indicated by the survey, are: Controller's, Manufacturing, Pipe Line, Production (currently handled by Production Research), and Research and Development.

These groups are all located in Ponca City, making a centralized computer service center very desirable.

There is one situation in the Company where small computers may be justified on a departmental basis. The three regional marketing accounting offices (Fort Worth, Denver, and Kansas City) may each justify a small computer if they remain decentralized. Many companies justify larger machines for a centralized marketing accounting operation. It was not felt that the possible centralization of this effort should be made a part of this study; however, it should be pointed out that machinery recommended by the Study Group is compatible with machinery now used and planned for these regional offices and also the IBM 7090 will handle the increased load if this operation should be centralized in the future.

Possibility of Gradual Increase in a Computing Capacity. From the survey of potential applications in Continental, it is apparent that the departments have sufficient problems to utilize a large computer. After scheduling analysis and programming by quarters for each year, the Study Group concludes that a large machine is more economical than a small one by the time delivery can be attained.

There are several reasons why a gradual increase of computing capacity is not desirable:

1. Program techniques and language are not the same for different computers. Although efforts are made to use programs for a smaller machine with a larger machine, the results are not satisfactory. Changes in machines always involve considerable manpower for conversion of existing programs.

2. Analysts and programmers trained in the techniques and language of one machine must have additional training if machines are changed. This results in higher costs and in low efficiency following machine changes.

3. Smaller machines cost more per unit of calculation. It is often cheaper to lease a larger machine and run it less than one shift than to have a smaller machine and run it over one shift. For example, an IBM 7090 is 6.3 times as fast as an IBM 704 and costs only about 1.6 times as much. If an IBM 704 were used two shifts per day five days a week, it would be as cheap to lease an IBM 7090 even though it would be used only about 2 1/2 hours per day.

An alternative to changing the machinery as use is increased is to rent time from service centers or other companies on larger computers. Several of the cases evaluated were selected so this alternative could be evaluated even though there are many disadvantages to extensive use of outside machine rental:

1. Hourly rental charges are usually 1.5 times full-time lease costs converted to an hourly basis.
2. It is doubtful that some applications will be worked if they must be done on machines at remote locations. Card transportation for high-card volume applications would be very impractical.
3. Programs, tape files, card files, etc. would be split between the programming center and one or more machine locations. It would be difficult to make program changes and maintain up-to-date programs.
4. Personnel transportation and assignment between the programming center and machine centers would be added expense and difficult to schedule satisfactorily for efficient use of personnel.
5. Programming effort might need to be diversified between several different types of machines because of limited rental time available on a particular type.

Lease Vs. Purchase of Computers. All suppliers surveyed will either lease or sell their computer equipment. Rather than have a sub-case for both lease and purchase for all cases evaluated, the Study Group made a separate evaluation of lease vs. purchase of equipment. The rate of return on the purchase price of the equipment varies from about 6 per cent when used one shift to a maximum of 15 per cent when used three shifts, seven days a week. The rate of return for the recommended case would be less than 6 per cent. Because of the rapid obsolescence of computers and particularly of components and attachments, the rates of return are not adequate to justify purhcase as compared to lease; therefore, all cases evaluated are based on leasing.

Delivery and Preparation Time. Most of the machines considered in this study range from six months to eighteen months delivery. Based on experience of other companies and unanimous opinion of manufacturers, it requires from one to two years to prepare for a large-size computer. This preparation includes building, personnel, and programming effort. The Study Group feels that eighteen months' preparation time is adequate, based on personnel, building, etc. recommended.

Designation of Machinery Cases. The Study Group considered computers of manufacturers covered by the Manufacturers' Survey previously discussed, and considering all factors, selected the following cases for further evaluation:

Case I - IBM 7090
Case II - IBM 7070 with outside rental
Case III - IBM 704 and IBM 7070
Case IV - IBM 7070 and Minimum Bendix G-20 with outside rental
Case V - Bendix G-20
Case VI - IBM 650 and Bendix G-15 with outside rental
Case VII - Philco S-2000
Case VIII - Honeywell H-800

There are several computers which were eliminated at this stage of this study because the Study Group did not feel they warranted further consideration. Of the medium-large and large machines listed in Appendix B, the following machines were eliminated for the reasons given:

1. Burroughs 220, IBM 705 III, NCR 304, and RCA 501 were all eliminated because they were not attractive enough in price and capability to warrant further consideration over the IBM 7070.

2. Control Data Corporation 1604 - apparently a good machine, but manufactured by a small company formed by a group of former Sperry engineers. The new company is now in a law suit with Sperry over patents and designs. The machine has no users now and no orders from oil companies. This makes programming exchange and information sharing almost nil.

3. IBM 709 - not competitive on price for the computing capacity with the smaller IBM 7070 or the larger IBM 7090, Philco S-2000, etc.

4. Remington Rand 1102S or 1105 - not competitive on price for the computing capacity with the IBM 704 or the larger IBM 7090, Philco S-2000, etc.

5. Remington Rand LARC - too large and expensive for indicated work load.

It should be noted that the IBM 1401 is used as peripheral equipment for the larger IBM computers as a more economical arrangement than separate card, tape, and printing equipment.

BUILDING

Ponca City is the logical location for a computing center for Continental because the heaviest computer users are located at Ponca City.

Approximately 5,000 square feet of useable area is required to house a large-scale computer, magnetic tape, and card storage area, a small quantity of peripheral equipment, and a supervisor's office. In addition to the computer area, the administrative, and analysis and programming effort will need 5,000 to 6,000 square feet for office space. (The total space requirements are equivalent to 60 per cent to 65 per cent of one floor of the main Ponca City office building.)

Since all office space in Ponca City is now fully utilized, new space will have to be provided. This can be either a new building to house the computer or a new building to provide floor space displaced by the computer activity.

For the computer to be of any practical use to the Controller's Department, it must be located in the same building or connected by an all-weather passage to the same building which houses the Controller's punched-card installations. Transporting large volumes of punched cards from one building to another in inclement weather would render the cards almost useless. At the same time, the Controller's punched-card installations must be convenient to the manual

accounting groups. This leaves the main office building or an addition to the main office building as the only practical locations.

Special raised flooring for the computer area is required because of the many cables interconnected between the various units of the computer. The electrical, air conditioning, and humidity control requirements are many times greater than for normal office areas.

While there is sufficient total area on any floor of the main office building (by displacing other offices) to house the computer, the floor plan would not permit a desirable computer installation. In addition, displacing offices and equipment in the main office building would likely create reduced efficiency over a considerable period of time. Engineering estimates are $100,000 for remodeling the existing building and $250,000 to build a new building for displaced personnel.

After discussing this problem with the Engineering Department, they prepared preliminary drawings and estimated construction costs for a proposed elevated computer building. It would be located directly south of and connected by passageways to the main office building. It is designed to accommodate the computer and the central computer organization.

Construction costs are estimated at $322,000. The plans and costs provide for sufficient structural strength to support two future additional floors to the building.

Although this plan is not the only possibility, the committee believes it is desirable in that it more adequately fills the needs than any other alternate studied.

PERSONNEL

To evaluate each of the machinery plans outlined in the previous section, it was necessary to determine the personnel required for each and to estimate resulting annual salary expense. The Study Group determined that it would require basically the following personnel to carry out a computer program to handle the listed applications:

Administrative (Including Secretaries)	13
Analysis and Programming - Departmental	22
Central Group	24
Machine Operations (Including Scheduling, Key Punch and Librarian)	10
Departmental Representatives	8
Total	77

This number varies between cases depending on shifts operated, amount of machinery, and amount of outside rental where travel time is required. The number of people for each case is shown in the case summaries.

There are 26 full-time people engaged in computer work in the Company located organizationally as follows:

Process Engineering	6
Exploration Research	2
Production Research	5
Central Research - (Math Section)	7
Controller's - Office Methods	3
Controller's - 650 Machine Operations	2
Coordinating and Planning	1
Total	26

In addition, a number of people in these and other departments have spent part time on computer efforts but because of the difficulty of isolating the actual time, these have been ignored in our accounting for people.

It is anticipated that the 7 people in the Mathematics Section and 2 computer operators would be transferred to the computer group, leaving 17 analysts and programmers in operating departments. It is anticipated that 5 additional analysts and programmers will be added in operating departments, making a total of 22.

The central group is assumed to have a total of 24 analysts and programmers. With the 7 from the Mathematics Section, there would remain 17 as required new hires. Twenty-nine of the 31 people in administration, machine operations, and departmental representatives would be, in effect, new hires since any transferred into the group would presumably

be replaced except the two operators from the Controller's Department.

A summary of personnel requirements would be as follows:

	Operating departments	Computer group
Present Personnel	26	0
Transfer of Math Section	- 7	+ 7
Transfer of Machine Operators	- 2	+ 2
New Hires	5	46
Total	22	55

Of the 51 "new hires," 5 for the operating departments and 23 for the central group would probably be hired from outside the Company directly into the computer group. The remaining 23 in the central group should be transferred from within the Company and presumably would be replaced in their former positions by hiring from outside.

	Inter-department transfers	Outside hires
Administration - Supervisory	5	3
Secretarial	1	4
Analysts and Programmers	6	11
Machine Operations	3	5
Departmental Representatives	8	-
Operating Departments' Analysts	-	5
Total	23	28

ORGANIZATION

Although the number of people to perform the necessary work can be estimated, the Study Group feels that organization

and a clear understanding of functions and relationships is essential to a successful computer effort. The Study Group, therefore, wishes to present some of the concepts formed through its survey of other companies and through its familiarity with the recommended equipment and the programming techniques and methods connected therewith.

There are many forms or types of organization to be found in the oil industry, but there are four basic ones that warrant discussion:

1. Multiple decentralized machine locations with administration by each department or function where the machines are located.
2. Centralized service center under administration of one of the user departments.
3. Centralized service center under separate computer department.
4. Centralized independent computer department.

Multiple Decentralized Machines. This plan has been previously discussed. It provides a workable plan where certain major users of computing equipment are widely located geographically. For example, a research and development group with major computer requirements that is remotely located from the remainder of the company may justify their own computer. In Continental's case, this is not believed to be a desirable arrangement at this time because the major users of the computer are all located in Ponca City. It is possible in the future that improved smaller machines or changes in operation

will warrant computers at such locations as Lake Charles or others. These machines may be a combination automatic process control and calculating machine.

Centralized Service Center Under User Department. The connotation of "service center" as used in this discussion implies that the group provides computing services but does not dictate to user departments what applications shall be programmed or run on the computer. It is the concept of the Study Group that such a service center would have the following basic functions:

1. Supervise and operate the computer
2. Furnish analysis and programming assistance as follows:
   a. Specialized mathematical talent to assist departments in analysis and programming efforts.
   b. Analysis and programming assistance for those groups that are not able to justify full-time personnel within their own group.
   c. Analysis and programming assistance to supplement departmental analysts when work load exceeds capabilities of full-time staff.
   d. Establish and administer programming standards for maximum effective use of computers.
3. Do basic mathematical research
4. To educate and furnish liaison between computer center and user departments.

Machine operation includes, as a minimum, machine operators, a librarian for card and tape files, and key punch operators. The key punch operators would not replace or duplicate the key punch operators now in the Controller's Department. It is anticipated this group would be required

to punch basic programming instructions for the computer and data cards for scientific problems.

Analysis and programming assistance and mathematical research would be performed by a group of mathematicians and analysts of two functional classifications: data processing and technical. The technical group would have two functional subdivisions: scientific and operations research. The administration of these personnel should be such that research effort is carried out along with the assistance in analysis and programming efforts.

It is anticipated that departments which can justify and desire their own analysts and programmers on a full-time basis will do so and the central group will perform the functions as outlined above. For purposes of this study, it has been estimated that there will be 22 analysts and programmers in operating departments and 24 in the central group.

If proper programming techniques are not used by all programmers, considerable machine time can be wasted. Problems can be programmed in a number of ways, and it is necessary to have certain standards to take advantage of techniques for using minimum machine time for each application. The computer group is the logical place for establishing and administering these standards.

Education and liaison are two functions that are becoming more important all the time. The recommended computer is a major piece of equipment. Its use requires more than a surface knowledge of programming and problem-solving techniques. Education should be planned and carried out, and this requires people. It is felt that this function can best be coordinated and carried out by the people in the computer group.

Although we have many people in the company with knowledge of computers, the majority of our people have insufficient knowledge for most effective use of computers and interpretation of the results of computer applications. It is the feeling of the Study Group that personnel should be assigned to act as liaison between departments and the computer group. This group would assist in education activities and would serve as liaison with all departments. These people would be educated and utilized for a length of time sufficient for them to be of maximum assistance in both determining potential applications and interpreting computer results for their departments. It is anticipated that such an assignment would be ideal training for future administrative and supervisory personnel based on estimated increasing use of computers in data processing, technical problems and business decision situations.

Centralized Service Center Under Separate Computer Department. Internal organization would be the same as discussed above; however, instead of reporting to a user department, the group would be a separate department.

The survey reflects that the computer effort should be a major one with an investment of about $430,000 and an annual expenditure of about $2,000,000 for machine rental, personnel, and other expenses. Of the $2,000,000 annual costs, approximately $1,750,000 will be in machine rental and service center personnel and expense. This is a major undertaking and should require full-time supervision and administration of a high-level, capable person.

Although any number of organizational arrangements can be made to work if all people have the proper attitude toward the function, a smoother and more effective effort may result if it is obvious to everyone that the center has equal responsibility to all user departments both in machine use and in programming assistance. Such a department would operate within established policies on priorities, etc.

Centralized Independent Computer Department. This type of organization implies that a computer group will handle all analysis, programming, and machine operation on a "closed-shop" basis. The group either initiates, or has referred to it, problems with potential computer application.

The group proceeds on analysis, programming, and computing on an independent basis. When this is complete, they forward the answers to the operating department concerned.

The theory of such a department is that analysts and programmers as well as computing machinery can be utilized more efficiently when under sole supervision of the computer group.

The obvious objections to such a plan are that the talents of operating personnel are not utilized adequately in problem solution and in many cases normal prerogatives of the operating departments are taken away. This does not lead to full cooperation. In the opinion of the Study Group, this type of organization will not attain the maximum value from computers. There is only one company, Phillips Petroleum Company, which has an organization of this type.

ECONOMICS

As discussed in the "Machinery" section of this report, eight basic cases were selected for evaluation:

Case I	-	IBM 7090
Case II	-	IBM 7070 with outside rental
Case III	-	IBM 704 and IBM 7070
Case IV	-	IBM 7070 with Minimum Bendix G-20 with outside rental
Case V	-	Bendix G-20
Case VI	-	IBM 650 and Bendix G-15 with outside rental
Case VII	-	Philco S-2000
Case VIII	-	Honeywell H-800

Although some of the applications listed by the operating departments have greater potential value to the Company than others, the Study Group felt that each was worthy of analysis for computer application. It was decided that each case considered should provide personnel and machinery to accomplish the entire program.

It was recognized by the Study Group that the potential value is an estimate by the operating departments and might be somewhat in error. For this reason, it was decided that the economics of the project should not only be determined for 100 per cent of the value of these estimates, which is the most probable, but for lesser values in order to better judge the degree of risk. The Study Group, therefore, evaluated each case for 75 per cent of the estimated value and also for 50 per cent. The 100 per cent value is the mean of the minimum and maximum values obtained in the survey.

It is extremely difficult to estimate computer hours required until applications are actually programmed. In order to be sure how either increases or decreases in machine time requirements would affect the conclusion, each case was evaluated for 100 per cent, 50 per cent, and 150 per cent of the estimated machine hours.

The following is a detailed discussion of each of the cases in the order eliminated from consideration by the Study Group:

Case III - IBM 704 and 7070 - This case was selected as a logical one to provide one machine primarily for technical problems (IBM 704) and another machine primarily for data processing (IBM 7070). This case ranked at the bottom for all variations of value and machine hours. The primary reason for this low rating is that the IBM 704 is expensive for its computing capacity, and the IBM 7070 and 704 were both operated full time to meet the requirements.

Case II - IBM 7070 with outside rental - This case was selected because the 7070 is a decimal machine designed primarily for data processing. The 7070 has a maximum of 10,000 words of memory. This means that many problems such as refinery simulation must be done with outside rental. This case ranked seventh of the eight cases for 100 per cent of estimated value and 100 per cent of estimated hours. The 7070 ranked low economically because it is capable of handling only about 35 per cent of the total load and the remainder was considered to be done with outside rental.

Case VI - IBM 650 and Bendix G-15 with outside rental - This case is based on leasing only the machines we now have and doing the remainder of the work on an outside rental basis. This case ranks second on a basis of 50 per cent of estimated hours but only sixth at 100 per cent of estimated hours. There are many of the listed applications which cannot be performed satisfactorily with outside rental because of possible delays. Under this plan, approximately 97 per cent of the total applications would have to be run at service centers.

Case IV - IBM 7070 and Minimum Bendix G-20 with outside rental - This case uses a minimum G-20 with 4,000 words of memory for Exploration Research and the IBM 7070 for data processing and technical applications which its 10,000-word memory and speed will accommodate. After using the 7070 full time, it is still necessary to use outside rental for many applications including all those with large memory requirements. This case ranks third, fifth, and fifth at 50 per cent, 100 per cent, and 150 per cent of estimated machine hours.

Case VIII - Honeywell H-800 - This case was included because it appeared to be an economical machine with capacity to handle all applications. Although the

machine has been announced, it has not as yet been manufactured. It ranks fourth, third, and fourth at 50 per cent, 100 per cent, and 150 per cent of estimated hours, respectively. The Study Group feels that the fact it has not been manufactured makes it less attractive than others at this time. The H-800 is actually only about $4,000 per year more attractive than the IBM 7090 before consideration of manufacturer's aid in service, programming, etc.

Case V - Bendix G-20 - This case is based on a G-20 which is large enough and fast enough to handle all applications. This computer has not officially been announced by Bendix, but has been generally discussed by them with potential users. The specifications of the machine appear good but they have been changed many times in discussions with sales representatives. This machine has the same objections as the H-800 but because it ranks first, first, and third at 50 per cent, 100 per cent, and 150 per cent of estimated hours, respectively, it is ranked above the H-800 by the Study Group.

The two machines which remain most attractive are the IBM 7090 and the Philco S-2000. The Philco S-2000 has two attractive features compared to the IBM 7090: it has a 48-

bit word length, and it has the capability of being converted to a much faster machine at nominal cost.

Offsetting the $42,000 per year advantage of the Philco S-2000 over the IBM 7090 are the additional factors of service and programming assistance given by IBM.

IBM places two highly qualified programming consultants at the location of each of their large systems in addition to maintenance personnel. The added assistance of these people over the direct programming assistance understood to be given on the S-2000 is estimated at $15,000 per year.

IBM is recognized as the leader in the computer field. As can be seen from the summary of computers in the oil industry, most of the machines in the industry are IBM machines. There are 29 IBM 7090's in operation and on order, 6 of them in the oil industry. There are only 10 S-2000's in operation and on order, and none of these is in the oil industry. There is a user organization for both the S-2000 and 7090. Through these organizations, program libraries are formed and programs of general usage are undertaken on a cooperative basis. The additional number of participants of the IBM 7090 users in the group is estimated to be worth $80,000 per year to Continental in programming assistance above that of the S-2000 user group.

RELATIVE COMPUTER EFFORT IN THE OIL INDUSTRY

(Includes only companies visited by the Study Group)

Company	Ranked by Computer Effort*	Ranked by Assets (1958)
Standard Oil Co. (N.J.)	1	1
Standard Oil Co. (Indiana)	2	5
Socony Mobil Oil Co.	3	3
Shell Oil Company	4	7
Gulf Oil Corporation	5	2
Standard Oil Co. of Calif.	6	6
Texaco, Incorporated	7	4
Phillips Petroleum Company	8	8
Monsanto Chemical Company (Lion Oil)	9	14
Standard Oil Co. (Ohio)	10	20
Pure Oil Company	11	17
Ohio Oil Company	12	19
Cities Service Co.	13	10
Atlantic Refining Company	14	12
Union Oil Co. of California	15	13
Sinclair Oil Corporation	16	9
Continental Oil Company	17	15
Sunray Mid-Continent Oil Co.	18	16
Richfield Oil Corporation	19	18
Tidewater Oil Company	20	11
Skelly Oil Company	21	21
Kerr McGee Oil Industries, Incorporated	22	22

*This is a composite ranking by the Study Group, based on computers now in service and manpower devoted to computer effort.

APPENDIX C

The Central Computer Department Training Program

THE CENTRAL COMPUTER DEPARTMENT TRAINING PROGRAM

I. Introduction

To fully develop and utilize the potential of inexperienced personnel, the Central Computer Department has established a training program as outlined in this booklet. Although this program is primarily designed for the college graduate with no computer experience, it can be equally effective when used for personnel being transferred from other areas of the company.

The intent of the training program is to educate an individual who can be used in any one of the several functional areas of the department. The program is designed as a tool for internal training and no attempt has been made to expand it beyond the department.

The length of the program has been made variable so that each trainee is allowed to proceed at the best rate. Since the aptitude and ability of trainees will vary, the total time of the program will also vary. A counseling and reviewing session will be held at the completion of Sections II-B, II-C, II-E, and II-F. This program is designed to last not less than 9 1/2 months nor more than 17 1/2 months.

II. Training Areas

A. Orientation

Objective: To give the student a general knowledge of the Central Computer Department and its role in the operation of Continental Oil Company. To familiarize the student with the physical layout of the department and to introduce the student to the department personnel.

Outline:

1. History of Continental Oil Company.
2. History of Central Computer Department.
3. Function of Central Computer Department.
4. The organization of Central Computer Department.

5. What the training assignment is and what is expected.
6. Tour of facilities.
7. Benefits orientation.

Time Required: 2 Days

Instructor: Supervising Analyst-Systems Design Division
Supervising Analyst-Applications Development Division

B. Operations

1. Electronic Accounting Machines

a. Concepts

Objective: To give the student a conceptual understanding of the use and value of unit record equipment. To further introduce the basic items required with the unit record equipment such as cards, continuous forms, etc.

Outline:

1. The Unit Record - Tab Card
   a. History - Size and significance - One-key stroking produces many reports.
   b. Hollerith Code.
   c. Card columns and fields.
   d. Master and detail data and balance forward data files.
   e. All-purpose and special-purpose card designs.
      (1) Mark Sense
      (2) Continuous Card Forms

2. The General Procedure Flow - Demonstrate Flow Charting
   a. Master records - Set up and maintenance.
   b. Detail current data - From source document to machine language.
   c. Data rearranged for processing - Sorting (numeric and alphabetic).
   d. Current data cards matched up with descriptive masters - Collator.
   e. Descriptive information copied from masters to data cards - Gangpunching.

f. Descriptive masters separated from data cards - Sorter.
g. Current data arranged in report sequence.
h. Current data combined with balance forward cards.
i. Report heading master's merged with above accounting entries.
j. Report preparation and updated balance forward created.
k. New balance forward tabulated for balancing to control totals.

3. The Unit Record "Program" - The Control Panel
   a. Character recognition via punched holes.
      (1) Timing importance
   b. Counter accumulation.
   c. Recognition of code change from card to card - Zero and blank problem.
   d. Recognition of debit and credit entries - Selectors.
   e. Detail printing of information in each card (listing).
   f. Group printing of summation of multiple cards (Tabulating).
   g. Minor, intermediate, and major control breaks.
   h. Difference between 419, 402, and 407 accounting machines.
      (1) Alphabetic
      (2) MLP (Multiple Line Print)
      (3) Crossfooting
   i. Summary punching on certain class of total.
      (1) Summarizing of indicative codes - Only what is controlled.
      (2) Summarizing of debit and credit indications.
   j. Editing on an accounting machine - zero elimination.
   k. The carriage - its control and function.
   l. The storage units in an accounting machine.
   m. The emitting of characters.

4. The Printed Report - Continuous Forms - $6,300 per Month
   a. Stock Paper
   b. Carbonization for multiple copies
   c. Custom-made forms

5. The Wired Program Calculator
   a. Storage Limitations
   b. Decision Limitations
   c. Speed
   d. Results punched in input card

6. Set Up Time - A Major Time Consumer
   a. Selection and threading the form.
   b. Carriage tape selection and mounting.
   c. Switch settings.
   d. Control panel - wiring - mounting.
   e. Editing
   f. Accuracy check with test deck.

Time Required: 1/2 Day

Instructor: Director - Operations Division

b. Keypunch and Verifier

Objective: To teach the student the basic operations of keypunch and verification of source data and to give an orientation of the operations of the keypunch section.

Outline:

1. The machine
   a. General operations
   b. Program card
   c. Keyboard

2. Source documents
   a. Correct method of writing source.
   b. Coding for M.I.P. standards.

3. Control of work
   a. Checking in of vouchers, programs, etc.
   b. First drawer, training drawer, other.
   c. Passing from keypunch to verifier.
   d. Errors from verifier to keypunch.
   e. Work not finished at end of day.

4. Priority and workloads
   a. Regular fixed daily jobs.
   b. Other "red ball" jobs.
   c. Relations of keypunch and verifier on "red ball" jobs.
   d. High-priority jobs on accounting closing requirements.
   e. Use of machines, re-printing and non-printing.

Time Required: 1/2 Day

Instructor: Supervisor - Keypunch Section

c. Sorter and Interpreter

Objective: To familiarize the student with the operations and uses of sorters and interpreters and to allow for actual on-the-job training.

Outline:

083 Sorter

1. Description of machine and functions
   a. Handling and feeding of cards.
   b. Chute blades and pockets, pocket stops.
   c. Starting and stopping.
   d. Selection switches and sorter suppression.
   e. Changing card columns.

2. Numeric Sorting
   a. Description of sorting principle.
   b. Explanation of minor, inter, major field sorting.
   c. Block sorting - use of sorting needles - sight checking.
   d. Actual sorting - production jobs available

3. Alphabetic Sorting
   a. Use of alphabetic sorting switch.
   b. Difference in numeric and alphabetic sorting.
   c. Explanation of blank columns in sorting field.
   d. Actual sorting.

4. Select sorting and sorting suppression
   a. Rejection of certain numbers.
   b. Grouping of numbers using sorting suppression.

5. Other
   a. Handling and storing large groups of cards.
   b. Correction of jams.

<u>084 Sorter</u>

1. Basic difference between 083 and 084.
2. Actual sorting on the 084.

<u>557 Interpreter</u>

1. Description of machine and functions
   a. Feeding of cards.
   b. Starting and stopping.
   c. Principle of control panel.
   d. Multi-line print.

2. Wiring of control panel
   a. Limitation of printing positions.
   b. Wire simple control panel.
   c. Changing of panels.

3. Production interpreting
   a. Interpret cards from "In" box.

4. Other
   a. How to change ribbon.
   b. How to correct jam.

Time Required: 1/2 Day

Instructor: Unit Supervisor - Tabulating Section

d. Reproducers and Collators

<u>Objective</u>: To familiarize the student with the functions of reproducers and collators and to provide on-the-job training using these machines.

Outline:

514 Reproducer

1. Description of Machine and Functions
   a. Feeding of cards.
   b. Starting and stopping.
   c. Connection with 402, 419, or 407 summary punching.

2. Wiring of Control Panel
   a. Gangpunching - sight verifying.
   b. Reproducing and verifying.
   c. Interspersed gangpunch and verifying.
   d. Emit zero or "X".

3. Production Work
   a. Reproduce and gangpunch cards from "In" box.
   b. Correction of jams.

088 Collator

1. Description of Machine and Functions
   a. Feeding of cards.
   b. Starting and stopping.
   c. Output pockets.

2. Wiring of Control Panel
   a. Check sequence
   b. Merge
   c. Match-merge
   d. Match

3. Production Work
   a. Wire panel and complete available current job.
   b. Correction of error lights or jams.

e. Tabulators

Objective: To familiarize the student with the functions of the various tabulating machines and to provide on-the-job training using these machines.

402 Accounting Machine

1. Machine Operations
   a. Main line switch, start, stop and final total keys.
   b. Card feed.
   c. Forms feed and platen.
   d. Carriage tape.
   e. Set-up change and other switches.
   f. Control panel changes.
   g. Read brushes.
   h. Hammerlock and hammersplit levers.

2. Wiring Control Panel
   a. Minor, inter, and major control.
   b. List numeric and alpha printing.
   c. Adding one counter.

3. Punching Carriage Tape
   a. One-punch and twelve-punch.
   b. Cut tape for simple overflow.

4. Explain summary punch principles

5. Correct card jam

407 Accounting Machine

1. Basic difference between 402 and 407.
2. Correct card jams.

Time Required: 1/2 Day

Instructor: Unit Supervisor - Tabulating Section

f. Basic Machine Operations/Functional Wiring

Objective: To give the student detailed instruction in the wiring and operation of EAM equipment.

Outline: The student is sent to an IBM branch office for this five-day course.

g. Card 1401 - Combining EAM Function

Objective: To allow the student to become familiar with the operation of the Card 1401 and to gain a concept of the utilization of the machine.

Outline:

1. Physical Descriptions and Properties of the Units
   a. 1401 - 4K
      (1) Power on - Power off.
      (2) Sense switches on and off.
      (3) Console readings.
   b. 1402 - 800 c.p.m., 250 c.p.m., S.P.
      (1) Start - Stop - Load.
      (2) Card feed - read and punch.
      (3) Output pockets.
   c. 1403 - 600 l.p.m.
      (1) Start - Stop.
      (2) Carriage tape.
      (3) Adjust forms technique.

2. Software
   a. Programs
      (1) Filing and numbering system.
      (2) Single instructions card - condensed deck.
      (3) Core dump program
      (4) Control cards General Ledger - GOSI list.
   b. Instructions - Run Book
      (1) Need of detail instructions.

3. Production Runs
   a. Job card and data.
   b. Set-up - Correct forms and cards.
   c. Log of job - Start and stop.
   d. Load program - data.
   e. Priority handling.

4. Versatility of the 1401
   a. Ease of calculation.
   b. Summary punching in input.
   c. Summary punching in output.
   d. Pocket selections.

e. Various types of printed forms.
f. Machine-printed code sheets.
g. Print control.
h. Music

Time Required: 1 Day

Instructor: Unit Supervisor - Tabulating Section

B-2. Computer Concepts

Objective: To give the student the basic conceptual understanding of the requirement for computing equipment as well as the concept of stored programming and various hardware functions.

Outline:

1. Why computers?
2. History of computers.
3. Computer components and storage devices.
4. Stored program concepts and examples.
5. Differences between computers and EAM.
6. How applications are chosen and why computers are used.
7. Review and explanation of terms.

Time Required: 1 Day

Instructor: Senior Analyst - Computing Standards
IBM Systems Engineer

B-3. Computer Operations

a. Messenger and Stock Room

Objective: To provide information concerning the use and availability of the messenger service. A familiarization with the content and activities of the stock room.

Outline:

1. Describe and demonstrate decollator and bursting jobs.

2. Paper size and weight tolerances with this equipment.
3. Turnaround capabilities of bursting job.
4. Familiarization with "rush" jobs and critical time periods.
5. Messenger function of "breaking-out" output.
6. On-line and off-lines delivery schedules.
7. A trip with messenger making normal run to Refinery, Exploration Research, Geophysical, and Production Research.
8. Review of available stock room supplies and description of stock paper sizes and plies available.

Time Required: 1/2 Day

Instructor: Assistant Director - Operations Division

b. Scheduling and Data Control

Objective: An introduction to the problems and duties of a data control unit.

Outline:

1. A look at voucher balancing, General Ledger account controls, and trial balance.
2. Run Books - Study of their makeup and use and documentation requirements to get run books in use.
3. Study of computer flow charts and their use with production jobs.
4. Financial closing and the emphasis of production jobs during this time span.
5. Normal turnaround scheduling and batching.
6. The job card - types, use, and relationship with the PIC card.
7. The route card and its use in Data Control.
8. Priority scheme - its dangers and values.
9. Long-shot scheduling.
10. Data Control's service as a communication link between computer clients and computer operations; who to telephone and types of questions we can answer.
11. The programmer present card and how it can be of value.

12. Assigning of program numbers and maintenance of report register.
13. Our accounting reports and types of statistics available from them.
14. The tranceiver (when in operation) - operational factors, and its use in application for Lake Charles Refinery.
15. Supplies cabinet in Julia's office showing supplies available.
16. Xerox - its use and some "do's and dont's".
17. Programmer's keypunches in Data Transmission Room and some do's and dont's.
18. Introduction to C.E.'s - familiarization with PM times.
19. Explanation of use time, machine rent figures, and overtime charge formulas.
20. Short explanation of closed-shop operating values.

Time Required: 2 Days

Instructor: Assistant Director - Operations Division

c. Librarian

Objective: To teach the various functions of the librarian and show how they are connected with the role of the Operations Division.

Outline:

1. Familiarization with physical design of tape and related supplies.
2. The "Save Tape" log and its application.
3. How "save tapes" are safeguarded and scratched.
4. How production tapes are saved, controlled, and scratched.
5. Library listings to programmers.
6. One and two-day "saves" and their usefulness.
7. Automatic external labeling, how developed and used.
8. Program tapes and card decks - how developed and controlled on production jobs.
9. Telephone service provided by librarian and types of assistance he can give.

10. How "save" input tapes are selected and returned to the library.
11. The Security Bank vault for important tapes and how programmers can use this service.

Time Required: 1 1/2 Days

Instructor: Assistant Director - Operations Division

d. 1401 and Dataplotter

Objective: An on-the-job training session on how to operate the 1401 and Dataplotter.

Outline:

1. Use of monitor - automatically from PIC records.
2. Types of peripheral jobs accomplished on 1401's.
3. 1403 Printer - operating principles.
4. 1402 Reader/Punch - operating principles.
5. 1401 CPU - operating principles with emphasis on console displays, etc.
6. Use of carriage tapes.
7. Definition of paper settings recommendations - left margin requirements showing normal location of print position 1.
8. Unpack operation and related turnaround difficulties.
9. Pure 1401 jobs and turnaround difficulties.
10. 729 vs. 7330's - emphasis on economy and speed differences.
11. Dataplotter - operating principles.
12. Tape handling.

Time Required: 3 Days

Instructor: Assistant Director - Operations Division

e. 7090

Objective: An on-the-job training session on how to operate the 7090 Computer.

Outline:

1. Description of components used in operating area, i.e., reader, printer, channel consoles, C.P.U. console, and tape drives.
2. A and B channel locations and explanations of unique operating principles on the channels.
3. Unit assignments of systems and various operating differences with each - FORTRAN, IBSYS, SIMI, PEST.
4. Start and control card use at the console, including dump options available. When we use these dumps, and when and how the programmer may ask for dumps.
5. Types of systems on-line prints.
6. Input-Output unit assignments, and unit assignments for special input and output.
7. Use of run books, labels, and save tapes in operating area.
8. Devote considerable time following console operator running job, and during the latter part of this time, actually help operator mount tapes, start job, and "take down" jobs.
9. Devote one evening with night operations in operation and scheduling.
10. Explanation of "Programmer Return" service at night.
11. Familiarization with operating differences at night, i.e., batching, length of runs, and production job scheduling.

Time Required: 5 Days

Instructor: Assistant Director - Operations Division

C. 1401 Programming

1. Flow Charting

Objective: To teach the purpose of flow charts and block diagrams, use of the diagramming template in preparing flow charts and block diagrams, and guide a practice session in preparing same.

Outline:

1. What is a flow chart; block diagram, with examples.
2. Reasons for preparing each.
3. Diagramming template.
4. Short exercises.
5. Larger exercise.

Time Required: 1/2 Day

Instructor: Senior Analyst, Computing Standards
IBM Systems Engineer

2. Decision Tables

Objective: To convey to the student the purpose and advantages in using decision tables, to illustrate the various forms and uses of decision tables, and to provide exercises in the creation and interpretation of decision tables.

Outline:

1. What is a decision table - examples.
2. Reason for using decision tables.
3. The decision table format.
4. Three types of tables.
5. Exercises in the use of decision tables.

Time Required: 1/2 Day

Instructor: Senior Analyst, Computing Standards
IBM Systems Engineer

3. Program Maintenance/Documentation

Objective: To inform the student how programs are maintained after the program has been implemented and the needs for good documentation.

Outline:

1. Where the Maintenance Library is located.
2. What is kept in the Maintenance Library.
3. Who has authorized access to the Library.
4. How and when a program change is requested.

5. When a program is ready for acceptance into the Maintenance Library.
6. What should be included in documentation.
7. How documentation is organized.

Time Required: 1/2 Day

Instructor: Senior Analyst - Program Maintenance Group

4. 1401 PEST Class

Objective: To give the student the knowledge which will enable him to block diagram and program the 1401 using PEST Symbolic Language. He should be able to handle straightforward jobs such as file updating, report writing, etc.

Outline:

1. Introduction to machine components.
2. Operational details of available instructions.
3. Practice problems coded in machine language.
4. Introduction and explanation of PEST symbolic programming.
5. Practice problems using PEST.
6. Introduction and uses of magnetic tape.
7. PEST Symbolic Language used with magnetic tape.
8. Practice problems using magnetic tape.
9. Final examination.

Time Required: 5 Days

Instructor: Senior Analyst - Computing Standards
IBM Systems Engineer

5. 1401 FARGO Class

Objective: To give the student necessary information to enable him to program the 1401 using FARGO. This would include the ability to make patches and to work without assistance on non-complex jobs.

Outline:

1. General explanation of FARGO and why it is used.
2. Detail explanation of FARGO Control Cards.

3. Practice problems using FARGO.
4. Explanation of patching, why and how used.
5. Practice problems with patching.
6. Case study using actual problem from machine room operations.

Time Required: 3 Days

Instructor: Senior Analyst - Computing Standards
IBM Systems Engineer

6. On-The-Job Training - 1401

Objective: To acquaint the trainee with peripheral processing equipment and techniques and to aid the trainee in equipping himself to become a 1401 programmer through a controlled on-the-job training program.

Outline:

1. Simple Peripheral Programming
2. Complex Peripheral Programming
3. 1401 Monitor
4. Maintenance of the Monitor
5. 1401 Program Library
6. Aid in Consulting
7. 1401 Programming Backlog

Time Required: 1-3 Months

Instructor: Senior Analyst - Computing Standards
Senior Analyst - Applications Development
Senior Analyst - Systems Design Division

D. 7090 Programming

1. Commercial Translator - SORT

Objective: To enable the student to design and program solutions using 7090 Commercial Translator language and to make effective use of 7090 Generalized SORT Program.

Outline:

1. Introduction to 7090.
2. Programming languages and where CT fits in.
3. Explanation of various phases of CT.
4. Detail presentation of CT forms and formats.
5. Practice problems using CT.
6. Necessary monitor operations needed for CT use.
7. Debugging facilities of CT.
8. CT case study and examination.
9. Description of 7090 SORT.
10. Why SORT and how it operates.
11. Detailed control card description.
12. Practice use of 7090 SORT.

Time Required: 2 Weeks

Instructor: Senior Analyst - Computing Standards
IBM Systems Engineer

2. FORTRAN

Objective: To teach the basic FORTRAN Language with reference to Conoco's operating environment. The student should, at the completion of two weeks' training, be able to code and set up a source program in pure FORTRAN for processing on the 7090. No reference will be made to symbolic coding, and a Computer Concepts Course will be sufficient for hardware considerations.

Outline:

1. Introduction to FORTRAN Notation
   a. Fixed and floating-point numbers.
   b. Constants, variables, and subscripts.
   c. Examples of FORTRAN statements, coding form, and general rules for punctuation.

2. Arithmetic Language
   a. Rules for forming arithmetic expressions.
   b. Arithmetic statements.
   c. Problems.

3. FORTRAN Subprograms
   a. Arithmetic statement function.
   b. Built-in functions.
   c. Function subprogram.
   d. Subroutine subprogram.
   e. Problems.

4. Input-Output
   a. Review of input-output media.
   b. Conversion of numeric data.
   c. FORMAT Specifications

Time Required: 2 Weeks

Instructor: Senior Analyst - Computing Standards
IBM Systems Engineer

Demonstrations: One class problem to be compiled and executed on the 7090.

3. 7090 Symbolic Programming

Objective: To familiarize the student with 7090 hardware devices and with 7090 symbolic coding. Emphasis is placed on the basic instructions required to write short subprograms; more instructions, class problems, and programming techniques will be added as class progress allows. A brief discussion of assemblers and loaders is included.

Outline:

1. Introduction
   a. Core storage and registers.
   b. Binary/Octal representation and conversion
   c. Instruction formats.

2. Symbolic Coding
   a. Arithmetic instructions.
   b. Elementary pseudo-operations for storage allocation, data generation.
   c. Control instructions.
   d. Index registers.
      (1) Looping and array manipulation.
      (2) Subroutine communications.
   e. Logical and masking instructions (Sense Indicators Optional).

3. Assemblers and Loaders
   a. Explanation of 2-pass assembly process.
   b. Functions of a loader.
      (1) Relocatable programs.

(2) Storage allocation and subprogram communications.
(3) Pseudo-operations related to the loader

4. Input-Output
   a. Discussion of magnetic tape hardware and data channel operations.
   b. Input-output instructions.
   c. Tape error recovery procedures.
   d. Discussion of channel trapping (optional).
   e. Discussion of random-access devices (optional).

Time Required: 2 Weeks

Instructor: Senior Analyst - Computing Standards
IBM Systems Engineer

Demonstration: One (or more) problem run on the 7090.

4. MONITORS

Objective: To develop an understanding of the role of monitoring systems in Conoco's operating environment and to teach monitoring concepts.

Outline:

1. Development of Monitoring Systems
   a. Effect of increasing computer speeds on useful time available.
   b. Throughput and turnaround considerations in computer work.

2. Monitoring Concepts
   a. Systems residence.
      (1) Description of systems tape.
      (2) Monitor control over subsystems.
   b. Batch processing.
   c. Monitor recovery from program failures.
   d. Symbolic tape assignment and inter-system communications.

3. Conoco's Operating System
   a. Batching and the 1401 Monitor.
   b. 7090 Monitors
      (1) FORTRAN Monitor
      (2) IBSYS Basic Monitor
      (3) IBJOB Job Monitor

Time Required: 1 Day

Instructor: Senior Analyst - Computing Standards
IBM Systems Engineer

Demonstrations: Observe 1401 and 7090 monitoring operations with explanations in terms of the class material.

5. On-The-Job Training - 7090

Objective: To familiarize the trainee with the responsibilities of the Computing Standards Section in regard to 7090 Program Systems Maintenance, consulting with programmers, maintaining standards, SHARE activities and equipment studies, and to provide the opportunity for the trainee to gain experience in 7090 programming.

Outline:

1. Acquaint the trainee with one or more systems. This will include a study of the Monitor, Compiler, Assembler, Loader, Library, and I/O routines. The choice of systems will depend on the classes taken.
2. Maintaining a system.
3. Programming Handbook and Standards.
4. Machine time accounting.
5. Manuals distribution.
6. SHARE - organization, meetings, library.
7. Aid in consulting (Programming errors, machine errors, etc.).
8. Familiarization with IBM Systems Engineer function.
9. Equipment studies.
10. Possibly writing a utility subroutine.

Time Required: 3-6 Months

Instructor: Senior Analyst - Computing Standards
Senior Analyst - Applications Development
Senior Analyst - Systems Design Division

E. Other Equipment

1. Data Transmission Equipment

Objective: To familiarize the student with the basic concepts of data flow and data manipulation.

Outline:

1. Discuss general block diagram.
2. Discuss communications mediums.
3. Discuss input/output mediums.
4. Discuss transmission speeds.
5. Discuss available equipment.
6. Discuss economics.
7. Computer switching.
8. Dataphone concept.

Time Required: 1 Day

Instructor: Equipment Standards Engineer

Demonstration: Demonstrate an operating system.

2. Data Origination Devices

Objective: To familiarize the student with data origination devices with which he may come in contact.

Outline:

1. Card punches.
2. Paper tape punches.
3. Analog-digital conversion (OSCAR).
4. Automatic gear.

Time Required: 1 Day

Instructor: Equipment Standards Engineer

Demonstrations:
1. Keypunch (will depend upon the experience of the student).
2. OSCAR

3. Disk Files

Objective: To familiarize the student with disk file concepts, speed, capacity, etc.

Outline:

1. Discuss fundamental concepts.
2. Speeds, capacity.
3. Compare disks with magnetic tape.
4. Costs.

Time Required: 2 Hours

Instructor: Equipment Standards Engineer

4. Dataplotter

Objective: To bring the student to a point where he can generate output tapes which can be read by the plotter.

Outline:

1. Brief description of analog-to-digital conversion logic.
2. Required format.
3. Scaling, parallax.
4. Commands.
5. Specifications.
6. Canned programs.

Time Required: 4 Hours

Instructor: Equipment Standards Engineer

Demonstrations:
1. Demonstrate use of controls.
2. Plot demonstration tape.

F. Systems Design

1. The Systems Organization

Objective: To give the student basic information about the location of the Systems staff in the

organization, its function and contribution to the corporate effort.

Outline:

1. Definition of terms.
2. Scope of activity or functions of the systems staff.
3. Contributions of Systems to the Organization.
4. The Systems staff.
5. Qualifications needed for successful Systems work.

Time Required: 1 Day

Instructor: Senior Analyst - Systems Design Division

2. The Systems Study

Objective: To explain and discuss the various phases of the complete systems study.

Outline:

1. Preparation
   a. Initiating the project.
   b. Criteria for selecting a project to be studied.
   c. Defining the problem.
   d. Defining the objectives.
   e. Determining the scope of the study.
   f. Defining the expectations.
   g. Format for preliminary proposal.

2. The Survey
   a. Preliminary planning and background development.
   b. Gathering facts.
   c. Recording the facts.
   d. Analyzing the facts.
   e. Reviewing the problem-definition after the analysis has been completed.
   f. Determining in complete detail the output or results needed to accomplish the objectives.

3. Synthesis
   a. Definitions of synthesis.
   b. Relationship of synthesis to the analysis step.
   c. Purpose of the synthesis step.
   d. Creative thinking as a part of the synthesis step.
   e. Testing for practicality of a solution.
   f. Evaluating alternative solutions comparatively.
   g. Amplifying the selected solution.

4. Report of the Survey
   a. Purpose of the report.
   b. Timing.
   c. Format of the report.
   d. Presenting the report.

5. Implementation
   a. Fixing responsibility.
   b. Preparing the workers for the change.
   c. Pre-installation systems work.
   d. Planning the installation.
   e. Preparing for the physical installation.
   f. Making the installation (starting the new system).

6. Basic Techniques
   a. Charts and charting
   b. Basic principles of forms design.
   c. Preparing the manual.

Time Required: 4 Days

Instructor: Senior Analyst - Systems Design Division

3. On-The-Job Training - Systems Design

Objective: To give the student practical experience in dealing with other departments while engaged in a systems study.

Outline:

1. Review of a short problem through analysis and design.

2. Analysis and review of a portion of an integrated data processing system.
3. Assignment to aid in the research of a portion of a design problem.
4. Assignment to coordinate with programmers during the programming of the designed problem in No. 3.
5. Writing complete problem statement.
6. Assist during implementation of system.

Time Required: 1-3 Months

Instructor: Senior Analyst - Systems Design