AN ECONOMIC APPROACH TO OFFICE AUTOMATION

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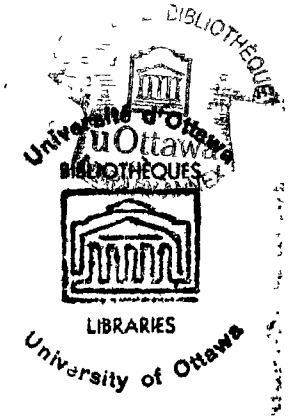

Ottawa, Canada, 1960

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INTRODUCTION

As an adjunct to the production process, automation has contributed to more elaborate and more precise production scheduling with obvious economies through labour saving devices, lower inventory holdings and speeding up of production, all of which contribute toward a rising productivity in production. But what of the office? What inroads has automation made into the office? Can automation effect economies in clerical work processes? Can automation contribute to rising clerical productivity? These are basic considerations on the effects of office rather than factory automation which are of vital concern to the company economist.

Much has been said on the problems of introducing automation into an organization and much fear has been expressed over the development of giant "brains" which are able to displace large numbers of clerks from their jobs. The problem therefore facing a firm in introducing office automation is to determine what benefits may accrue to the firm and to balance these benefits against any resulting diseconomies. These are economic considerations which should be assessed in an approach to automation.

Many articles and numerous books have been written about automation in the office but, mostly, the approach

has been of a technical nature particularly in considering electronic computers. This approach may have been taken because of the fact that early computer applications were engineering and military applications rather than business management problems and since automation is often associated with an electronic computer, then by nature all automation considerations have been in light of technical applications.

It has only been within the last few years that computers have been developed for business type applications rather than for scientific or engineering type applications. Even yet, there is considerable divergence between the needs of the business man and the capability of the systems being designed by computer manufacturers; however, with careful analysis of business requirements, then possibly this divergence will be narrowed. The economist is in a position to determine the computing needs of business and to relay these needs to the computer manufacturers so that better equipment will be developed for handling business applications.

Perhaps in establishing an economic approach to automation, it would be well to understand the responsibilities of the company economist. Short term considerations in the distribution of available resources are the responsibility of accountants, sales personnel and production researches; however, the long term considerations in establishing optimum combinations of productive factors involving huge capi-

tal expenditures and in determining the effects of outside influencing factors such as population growth, monetary and fiscal policies, market trends and social values are the responsibility of the company economist. The economist's value is of paramount importance in assessing social and economic repercussions of company policies. Big business has a significant effect on our economic life and changes in company policy without regard to possible social effects can jeopardize the position of a company socially and ultimately financially; therefore, there is a real need for a long term assessment of the effects of company policies.

The economist performs his function by measuring the efficiency of paper-work processing, of forms control procedures, of filing systems, of office staff proficiency and in selecting potential automation areas and assessing the need for further mechanization of clerical processes. The manner of accomplishing the economist's work is through the system survey, the application study and in continued operations analysis.

In scope, this thesis will firstly elaborate on the meanings of technical terms used and then explain the system survey and application study in detail. The last chapter will establish the economic considerations which should be given extensive thought when any firm is thinking of mechanizing its data processing function.

CHAPTER I

AUTOMATION TERMINOLOGY

An understanding of the effects of automating business data must necessarily be preceded by some definitions of the technical jargon which has developed with automation; therefore, some of the commonly used technical terms will firstly be explained.

Automation

Most authorities are agreed that automation is the continuous processing of production rather than processing by intermittent batches. The term has been synonymously associated with the production process; however, of recent years the concept of automation has been extended to include the automatic processing of business data. Automation is a technological development resulting from improvements in the production process and in supporting data processing operations and administrative procedures.

Mechanizing data flow processes leads one to consider whether the advanced stage of mechanization experienced on the production line is distinct from the developing mechanization of office procedures, or whether these spheres of business organization are interrelated. It is evident that the production line cannot operate without management policy Management lays out the limits within which the various

phases of production will operate such that minor decisions may be made at lower echelon of management without bothering top management with the details. Variations within these limits will not normally cause serious dislocations in other interdependent phases of the production line; however, exceptions may cause serious dislocations and bottlenecks and it is these exceptions which must be quickly and accurately relayed to higher levels of management. Without the use of mechanized and integrated data flow, the transmission of this vital information to higher echelons of management may be impeded. This process may be speeded up by the introduction of business data processing or office automation. Therefore, it seems that production line mechanization or factory automation is dependent upon and interrelated with data flow mechanization or office automation. The production line cannot be separated from management and office automation lessens the communication barriers.

Data Processing Concepts

Data or information processing is a concept of office work which involves the collection of information, the repetitive performance of simple clerical tasks, the analysis and evaluation of such assembled facts and the distribution of the results from the gathering and analyses functions. Data may be defined as any type of statistics such as hours worked, inventory-in-process and jobs on hand, which are used

in a firm's decision making process. Integrated data processing (IDP) is a system of paper work flow designed such that business data originated in one department serves its primary function, and additionally, as a by-product, provides data for other departments without further duplicate origination of this data. Data are raised mindful of the paper-work flow interrelationships existing among sections and with the aim of reducing duplicated procedures. The system as a whole is the prime concern when designing the origination and flow of paper work.

Automatic data processing (ADP) is defined by Moore Business Forms Ltd. as "the continuous and integrated operation of data processing using automatic machines".[1] ADP works on the principle of capturing data at the source of origination as a result of human to machine transformation, processing data through a series of machines including the decision-making function to various levels of management for action, and allowing for the feed-back of any decisions or criteria which may affect the predetermined limitations imposed upon the automatic process. The entire process is automatic without human intervention. The process must be integrated so that the data originally captured in mechanical form are processed mechanically to serve all subsequent

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1 Moore Business Forms Ltd., Automated Data Processing, Montreal, p. 53.

applications without manual intervention. Three general classes of equipment are used in ADP:[2]

1. Common and or native language machines where humans originate data.
2. Electrical communications equipment operating on an automatic basis.
3. Electronic business computers with large rapid-access memories.

Common or native language machines may be defined as the numerous office machines such as desk calculators, typewriters, billing and posting machines, which are able to activate one another through interconnecting cables and wires or through the use of a common mechanical device such as punched paper tape, magnetic tape or punched cards.

> A common language allows machines to interact. This interaction makes possible a flow of office work in which form human translation of information is minimized... Successful use of the common-language idea implies an integration of office work tasks. Initial handling of information must be compatible with subsequent information handling activities. For this reason we find the term integrated data processing, or IDP, used to describe application of the common language idea. IDP is the final step toward more effective control and faster managerial action.[3]

Electrical communications equipment is the teletype and printer equipment, telegraph, telephone lines and

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2 R. Hunt Brown, Office Automation, New York, Automation Consultants Inc., 1959, p. 207.

3 Howard S. Levin, Office Work and Automation, New York, John Wiley and Sons Inc., 1956, p. 19.

terminal equipment which are used to process data and which may be linked into one another by use of common language devices to process data from one operation to another without human intervention.

Electronic data processing (EDP) is the manipulation of and processing of information through a series of electronic and electrical equipments. The hub of an EDP installation is the electronic computer and the various types of electronic equipment used by the computer to bring data into the computer or to carry data out from the computer for further processing on electric accounting machines or for producing printed management reports. An EDP installation constitutes more than just the electronics equipment connected with the computer and its controlled input and output equipment. The electric accounting machines (EAM) that are used to prepare input cards from the original source data for the computer may be considered as part of an EDP installation even though these types of equipment are not necessarily electronic. EDP is semi-automatic data processing in that manual intervention and handling of data are required. Instantaneous or completely automatic data processing would be obtained by coordinating the operations of an entire IDP system such that complete processing of business data would be on electrical and electronics equipment without manual intervention, except in the initial capturing of source data

in mechanical form and in providing the printed progress reports in the final output phase. In such a system, the EDP installation would be considered the hub or core of the IDP system where the decision-making and record keeping functions are performed for the entire automated business data system.

The Electronic Computer

Electronic computers are used in the office to process a large volume of statistics or data with relatively little arithmetic manipulation; therefore, "the term electronic computer may prove something of a misnomer when business applications are considered."[4] Consequently, in using the term "computer" in respect of a business type application, we imply that the electronic computer is primarily used as a data processor and not as a computer in the technical sense.

The term "electronic computer" is sometimes used to imply an entire EDP installation; however, the electronic computer itself comprises five basic functional units:

1. Input devices such as magnetic tape units or card readers.
2. Output devices such as card readers, magnetic tape units and high speed printers.
3. Storage or memory.
4. Arithmetic and logical unit.

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4 Ibid., p. 47.

5. A control unit or control panel which, operating under the direction of a program, activates the other functional units of the computer.

A schematic diagram illustrating the relationship of these units is illustrated in Figure 1.

The "brain" of the computer may be considered as the arithmetic and logical unit where the manipulation of data occurs and logical decisions are processed. With business data processing, there is actually little arithmetic manipulation of data as compared to the file posting functions; therefore, the logical unit of the business computer is relatively small in capacity compared to that of an analogue computer. The memory unit is the temporary storage place for data which are waiting for logical processing. Data are transferred between memory and the arithmetic unit in the process of doing clerical operations. The input and output units bring the data in from and out to external sources. Most computers normally use magnetic tape units as input and output devices because card readers, card punches and high speed printers are rather slow. The supervisory control or console unit may be used for intervening in the internal processing of the computer and may be used to simulate what the program itself is doing in the way of operating the computer. The control unit is normally used for correcting errors which may result from the processing.

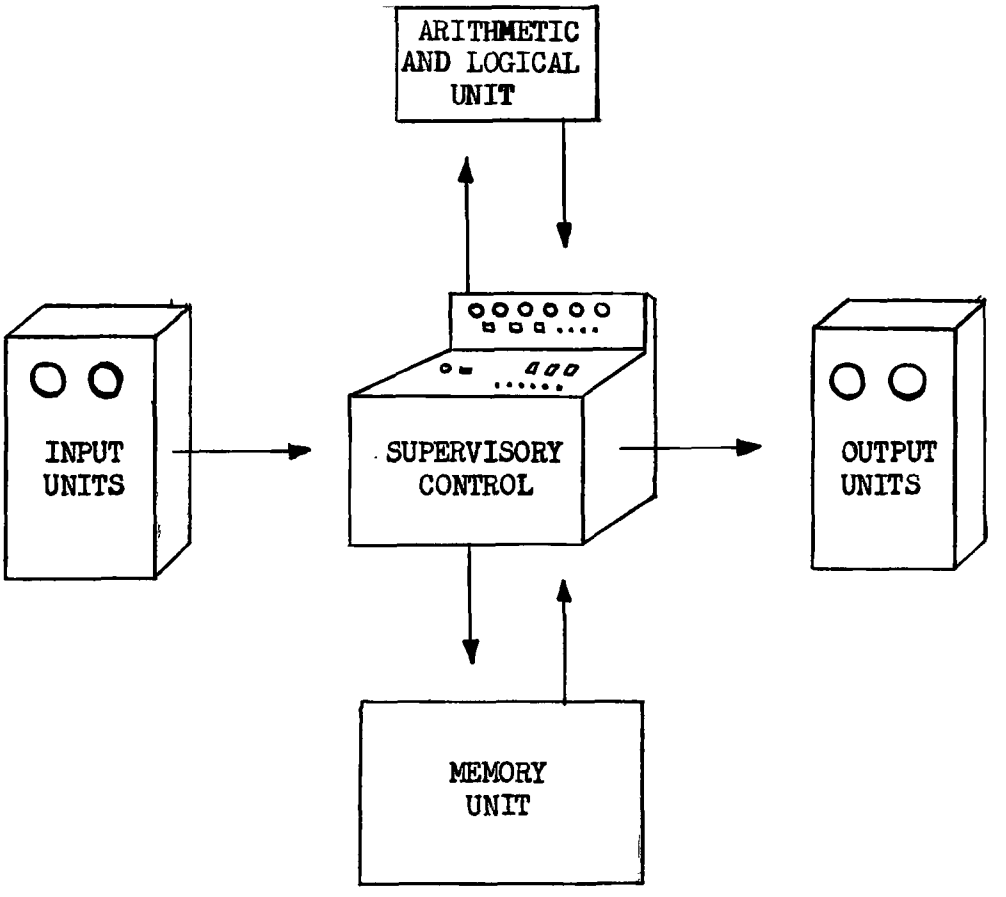

Figure 1. The Functional Parts of a Computer

Electronic computers may be classified according to the type of computation that they perform:

1. An analogue type computer functions by measuring the performance of an event in continuous quantities, making analogies to prescribed operating limits and computing variables for controlling and correcting further operations. An example of such a computer would be a self-guided missile.
2. A digital type computer functions by counting and recording, in discrete numbers, the performances of an event, making comparisons of quantities against accepted standards of performance and processing those items which meet established levels. Digital computers are concerned with counting and recording rather than in measuring and drawing analogies. An example of a digital computer would be any common desk calculator.

Analogue computers are primarily involved with scientific measurements and extensive calculations according to complex formulae with a small volume of input data and are therefore not particularly suited to business type applications. Digital computers, on the other hand, are designed for performing repetitive tasks such as sorting, transcribing and filing with a relatively large volume of data and so are

particularly suited to processing of business data. Digital computers are additionally valuable to business in possessing the ability to select alternative methods of processing based upon comparisons of the transactions being processed.

Digital electronic computers may further be subdivided into special and general purpose machines. Special purpose machines are designed to handle business type applications peculiar to one organization. Because they are restricted in use to the applications that they were designed for, special purpose machines are rather expensive since the benefits of mass production can not be gained in their manufacture. Such machines were quite common in the early history of digital computers because of a lack of knowledge on the part of computer manufacturers as to what characteristics were required of a machine for general application. As knowledge of business data processing requirements has developed, the computer manufacturers have been able to build machines which have general purpose application and thus gain the benefits of mass production.

General purpose digital electronic computers may be further subdivided according to the volume or the capacity they possess for processing data. They may be classed as small, medium or large scale computers. Several criteria are involved in assessing the capacity of a computing system: the size of internal storage used, the amount of equipment

directly controlled by the computer (on-line equipment) and processing speed of the system. All of these criteria are reflected in the rental or purchase price; therefore, cost is commonly accepted as the basic criterion. The capacity of an electronic computing system may costwise be determined as follows:

1. A small scale system may be purchased for less than $50,000.00.
2. A medium scale system costs between $50,000.00 and $500,000.00.
3. A large scale system costs more than $500,000.00.

CHAPTER II

THE SYSTEM SURVEY

1.- THE NEED FOR A SYSTEM SURVEY

What is a System?

A system is an orderly arrangement of interrelated functions so organized as to achieve the purpose for its inception in the most efficient manner. In a business system, management is concerned with organizing an optimum combination of the factors of production. Achieving this optimum depends upon organizing a management structure which will provide data on the costs, actions and interactions of the factors of production separately and upon one another. In order to obtain progressive knowledge of production interactions and to assess these factors in light of production developments, management must establish an efficient data handling and data processing system.

Datum collected in a comprehensive manner may serve many functions. It can tell management how close functional departments are operating to their budget forecasts. It can tell the production manager whether production is meeting planned target dates, whether supply feed-in lines are holding up production or whether in-process inventories

are out of proportion to what estimated production requires. It can tell the sales manager what current market changes have developed so that he can more precisely determine optimum combinations of sales and advertising effort. It can tell the purchasing department the types and quantities of materials needed, the best combination of purchasing items within budgetary limits and how to schedule delivery dates.

A well-developed data system may therefore be a critical management tool. However, such a system does just not happen, it does not develop without foresight and planning. It is developed through an objective system design program and requires the concerted efforts of personnel skilled in the science of management. Such a group of specialists may be organized as a separate management advisory group and their function is the development of efficient procedures throughout the entire business organization.

Besides the need for such a management team in the initial establishment of an optimum control system, there is a continuing requirement for them in the consideration of computer applications, in the critical analysis of accounting practices, in the continuous assessment of clerical efficiency and in the progressive evaluation of information flow.

The Purpose of a Survey

Management's function as performed by the system's group will be to establish and maintain an optimum coordination and control system. Their basic approach will be a critical analysis of the present organization which may be attained through a system survey. Such a survey should be an unbiased and fair appraisal of the working efficiency of the present system and not the designing of procedures to speed up an existing system. The survey group should also consider long term benefit and aim to establish a data processing system which will reflect the over-all, long term requirements of the organization. Because of the dynamic elements within a business enterprise, an optimum system may never be reached and if reached may soon become obsolete; therefore, the system's group should continually reevaluate and redesign the data system in aiming at a theoretical optimum in combining production factors.

There have been indications that a substantial portion of savings attributed to automation have actually been as a result of the benefits gained from an extensive system survey that preceded automation rather than as a result of further mechanization. Properly conducted studies can start a chain reaction of cost consciousness and desire for eliminating inefficient and duplicated procedures;

therefore, management should investigate clerical processes regardless of whether or not it is contemplating automation. Should a firm be contemplating automation, then the system survey is an exacting tool for determining the appropriateness and usefulness of suggested applications.

Conception of an Application

The requirement for a computer application may be conceived at top management level as the result of a desire to keep abreast with the technological developments of company X, or as a result of having been high pressured into thinking that such a requirement exists. The idea for installing a computer may also originate at lower echelons of management where delays in processing business data and the inability to meet target dates point out the need for better techniques of keeping up with the demands of an expanding organization.

Computer manufacturers are in business to sell equipment and make profits. Their primary concern is in the expansion of their own organization and not necessarily with the best interests of the firm in which they are attempting to install equipment. Their salesmen may therefore become overly exuberant with selling of their product and may often mislead top management into thinking that their computer is capable of doing marvelous and miraculous operations far beyond its capabilities. Any electronic

computer is merely a machine, a faster machine then we have experienced in the history of business organizations; however, its limitations should not be overlooked. When a possible application is conceived, management should be prepared to carry out a thorough analytical study of the merits of automating such an application. If the business has not developed an IDP system, then a system-wide survey should precede any application feasibility or economic study.

Management should not be led into automating one portion of a system without regard to the overall business requirements. Lacking top management support and without an integrated systems approach, an incompatible data processing system could result - incompatible in the sense that one portion of the business may become extensively automated while another portion of the business cannot provide the data for or use the data from the automated portion in an entirely satisfactory manner. This is tantamount to breaking up a potentially automatic production line with manual processes which slow down and unnecessarily impede the automatic processes. This approach may also be likened to the harnessing of a horse to a plow while the seeding and harvesting is done with tractors. Such an approach may result in lowering rather than raising of productivity.

Trouble Areas

Management must not underestimate the troubles that

could develop from favouring immediate implementation of automatic data processing without regards to the overall system requirements. Experience shows us that such a building block type of approach will result in an inefficient system which may prove quite incapable of doing as good a job as the old system, and may very easily result in scrapping the automated system and reverting to the old system. Mr. John Diebold, a New York automation consultant, has in his experiences seen just such disastrous results.[1]

Regardless of where the requirement for a computer application may have originated, the same initial approach should be taken by management i.e. to undertake a thorough and extensive system survey of all data processing functions followed by a detailed application analysis study. The intent of the system survey should not be, as many firms consider, "trying to find an application for a computer",[2] but rather to assess the entire organization with a view to improving clerical efficiency, reducing duplication of work effort and speeding up processing of management decision-making data. The system survey should be an economic appraisal of the efficiency of an existing system. Suggested improvements may not necessarily mean the installation of a computer but rather

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1 John Diebold, "Bringing Management to Electronic Data Processing", Ideas for Management, 1959, pp. 103-117.

2 John Diebold, "False Starts in Office Automation", The Management Review, July 1957, p. 84.

may result in refinements to the present system. Very often the economic benefits from reorganization or even minor system readjustments may more than justify the costs of a comprehensive survey without introducing any further mechanization.

2.- ORGANIZING THE SURVEY

Character of Analysis

An analysis project must be thorough, it must be comprehensive and it should determine economies for the over-all system rather than for any particular aspect of the system. The survey team should adopt the IDP concept in its approach to analysis of a system. Recommendations for automating any particular operation should be on the basis that such a development will primarily contribute to the efficiency of the over-all data processing system, and as a by-product, raise the processing efficiency of the particular operation.

Synonymous with the integrated approach to system analysis and synthesis is a need to assess the contribution of each phase of operations to the over-all scheme of data processing. There is a reason for the existence of each stage of processing data within an organization, and each of these operations possesses characteristics which influence one another. It is these interdependent relationships which determine the character of information flow. Should these interacting functions be determined, then the responsibilities

of each stage toward the total system become clear and a pattern of data processing can be established. With possession of such an intimate knowledge of the system, the survey groups are then in a position to assess the economic feasibility of automating portions of the system.

Scope of Analysis

In organizing for a system survey, the intent and scope of the analysis must be precisely determined. The survey objectives and the areas in which the survey is to operate must be established. Should the intent of the survey be a comprehensive system analysis, then inevitably departmental lines of communication will be crossed; and since the survey will be making recommendation on the efficiency of operations, then departmental influence upon the survey team must be eliminated. This is accomplished by placing the team at a proper level of management reporting. For a system-wide survey, the team must be responsible to and report only to a senior level of management and probably to a vice-president. However, should the intent of the survey be the analysis of an operating department, then since the analysis and recommendations will reflect only upon the department concerned, the level of survey reporting should be to the manager of that particular department.

Having established the operational relationship of the survey team to management, the manager to whom the team will

report may then specifically lay out the scope of the problem to be analysed, and the frequency with which progress of the survey team will be reported. If the scope of analysis is system wide, then the processing of data throughout all operational units will have to be charted. The analysis will establish a functional relationship of processing data from one operational unit to another and will graphically portray the interrelationships in processing data of one unit upon another. However, should the scope of analysis be limited to one operating department, then interdepartment functional relationships of processing data will have to be ignored and the character of the survey will be narrowed toward assessing the level of working efficiency within the particular department.

Composition of the Survey Team

The survey team may be composed of people within the organization, a mixture of company personnel and consultants or entirely of management consultants. The advantages of including company personnel are that a knowledge and understanding of company policy and operations will form a basis for the work of the team and that continuity in implementing survey recommendations will be accomplished. The work of the survey team will have internal support of middle management, because recommendations will be coming from company orientated personnel. Additionally, the use of company personnel

ensures that problems experienced at the working level will be adequately understood in the deliberations of the survey, and that survey recommendations will reflect difficulties of implementing new procedures at the working level. The use of consultants, on the other hand, has the advantage of bringing in a fresh approach to the studies. Such an unbiased approach may result in recommendations to faulty or inefficient company policy which may be easily overlooked by and accepted as a matter of fact by company personnel. Furthermore, the consultant brings experience from a wide range of businesses within the industry and may have a better appreciation of the pitfalls in implementing automation than would company personnel.

The foremost consideration of whether consultants are desirable is usually the cost of their services. Should management decide to provide the experience which could be procured from a firm of consultants from resources within the organization, then we should look at the costs of providing such services in assessing whether consultant services are more expensive. To provide such valuable experience, management would have to internally transfer personnel to a systems group. There would be considerable expense incurred in the loss of services of the individuals from their normal jobs and in the training of people to succeed them. Additionally, there would be considerable expense entailed in educating the

systems people to current technologies in automation equipment and it would be impossible for company personnel to gain a first hand knowledge or experience of installing automation equipment systems. Management would have to accept the diseconomies which would result from implementing a system lacking such knowledge; therefore, considering that their services are required only for a short time and that additional training time is not required for special assignments, consultant services become profitable regardless of how exorbitant their charges may appear.

For the initial analysis of a problem, management is faced with the building up of an experienced systems group. If the firm is large, then there will be a continuing need for experienced systems people to keep current with developing techniques of automation and in the changing pattern of the firm's competitive characteristics. However, for an initial system analysis, an extensive automation knowledge may not be available within the company's resources. To acquire this experience from computer manufacturers leaves management open to the pitfalls of acquiring a system biased in design toward using equipment of that particular computer manufacturer. Additionally, computer manufacturers will certainly not advise procurement of another manufacturer's equipment and they are less likely to advise that no requirement exists for installing electronic computing equipment. This impartial advice

may however be gained from utilizing the services of professional automation consultants.

Since the intent of a system survey isprimarily one of determining the economies and extent of automation, and because the system study is a continuing economic analysis of the operating efficiency of an organization, then of necessity the team must include the services of an economist. The economist should preferably have an intimate knowledge of company policy and the operational functions of the company. He should be able to provide a professional analysis of the trends in costs of production. If the firm is experiencing a long-term trend of increasing costs, then careful consideration would be given to whether the firm is in an industry which is experiencing decreasing returns. Should this be the case, then the benefits of cheaper and more efficient clerical operations as a result of automation may only result in a temporary alleviation of the effects from increasing costs. On the other hand, if the costs are rising as a result of clerical pressures, then the utilization of automation may give the company a competitive advantage in having access to more profits for capital investment in further innovations or plant expansion. Whatever the characteristics of the factors of production will prove to be, and whatever the results of the survey will be, the economist will provide an important contribution in assessing the economics of implementing more extensive office automation.

Tools of Analysis

Of paramount importance to the survey analyst, is the type of equipment which is available to him in the performance of his duties. A system survey, just like any job, requires reference material and tools and one such useful equipment is an adequate reference library. Reference material should consist of a wide selection of literature on systems and procedures subjects, on data processing topics and on the latest techniques and technological developments in office automation. Additionally, in keeping current with developing systems techniques, the analyst should avail himself of the professional conferences and courses that are held from time to time.[3]

Because the analyst is a synthesizer of systems, he is the company expert in realizing the overall company implications and in understanding the operations of a new system. He is therefore responsible for developing company policy. The systems man formulates the criteria which management uses in establishing company policy and he then devises means of carrying that policy to the working level. The dissemination of such policy is usually in the form of statements which are

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[3] In this regard, the Systems and Procedures Association of America has as its dedicated purpose the establishment of the systems profession as a functional tool of management. Annual meetings of analysts in the systems profession are sponsored by this organization and the results printed in a publication entitled Ideas for Management. Participation in the deliberationsof just such an association will provide the systems analyst with a useful source of current techniques in his profession.

bound into a manuel. This manual then becomes the basis for operations in all data processing units as it enumerates the work processes, the details of data information flow and the duties of individuals within each processing unit. Instructions within the manual are explicit enough that a minimum of supervision is required in directing employees. The procedures are standardized from one processing unit to another, from one business function to another and from one production unit to another. They are standardized so that personnel can be transferred from one unit to another and become orientated to the new unit without disruption. Making one processing unit compatible to another through standard operating procedures makes it easier to implement new procedures and to orientate new personnel into a system. Because of their generalized nature and because of their standardized techniques, the procedures manuals are an inevitable outcome of the system survey. Their production is the direct responsibility of the systems group and may therefore be considered as another tool of the systems group.

Perhaps one of the most important techniques in the systems profession is the method by which an existing and a proposed information flow system may be presented. This function is accomplished by the technique of flow charting using symbols which have developed standard meanings through common usage. By combining these symbols into various pat-

terns on a flow chart, the system as it operates may be easily portrayed in graphical form. This graphical analysis may then be used for further analysis and understanding in synthesizing a new system. Procedure flow charting is a simple method of diagraming production processes and of diagnosing business problems in locating trouble areas and in working out possible solutions. The methods chart, as illustrated in Figure 2, is a more detailed chart than the procedures flow chart. The methods chart illustrates every physical operation performed on a process whereas a procedures chart leaves out the extreme detail of what occurs at each stage of processing data. The analyst will require both types of charts in summarizing his findings: the procedures chart will be used to show unfamiliar personnel what processes occur within an office or organization, the methods chart will be used by the analyst in analyzing the operations which comprise each process.

In selecting flow diagraming techniques and symbols, the economist has a wide variety to chose from; however, he should be sceptical of accepting those symbols and techniques which are quickly endorsed and recommended by computer manufacturers. By using the techniques and symbols suggested by a computer manufacturer, a company place themselves in the position of becoming prejudiced to the use of that particular manufacturer's equipment. Familiarity breeds a prejudice

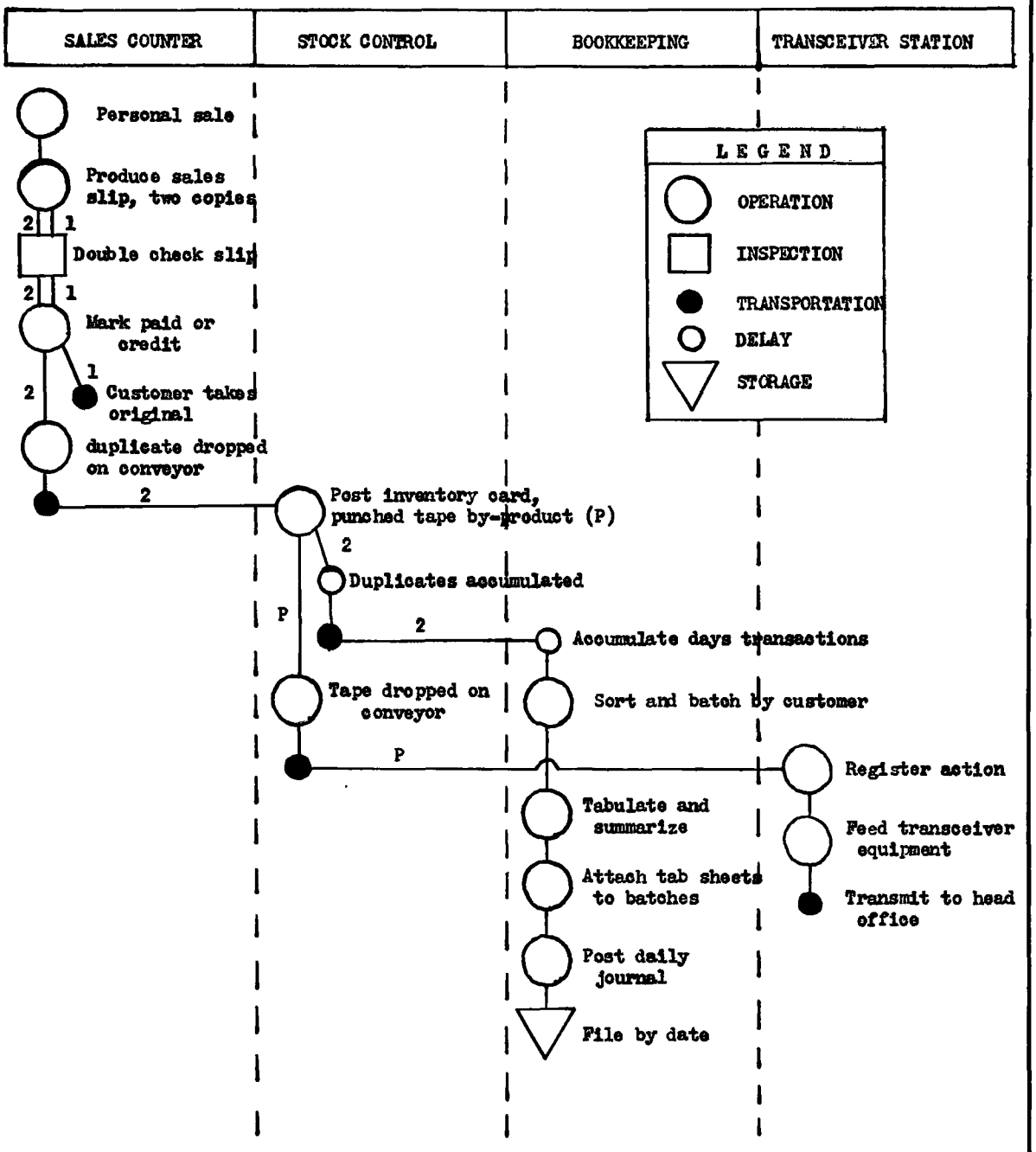

Figure 2. Methods Chart of a Hypothetical Sales Procedure

which the systems man cannot afford to develop. The analyst should remain unbiased and should not be enticed into indirectly becoming a computer manufacturer's spokesman. Just as he should develop his own opinions on the extent and type of automation equipment required by the company, so should the economist also develop his own charting techniques and symbols. If any standardization of charting techniques is desired, then those techniques which are generally accepted in the systems profession and which are presented at various systems symposiums should be adopted.

3.- CONDUCTING THE SURVEY

System Review

A good system review is thorough and comprehensive. It will analyze every data processing operation performed within the organization and establish the interlocking relationships that exist between data processing units. Basically, the system survey may be considered as a fact finding survey.

In reviewing the present system of processing data, the survey will attempt to establish the sources and characteristics of data that are used iwthin the organization, the format of data origination, the methods used for processing data and procedures which duplicate one another. The survey will also establish the basic files that are used for recording and filing data, the characteristics of information held in these

files, and will determine information that is being unnecessarily filed and other information which may be lacking in the files. Filing systems in each data processing unit throughout the firm will be assessed in this manner, and further, each processing unit will be critically analyzed to substantiate its place in the flow of information. Characteristics such as continuous processing, batched processing, mechanized processing, required manual operations and volume and types of data will be established for each processing unit. Additionally, the analyst will determine information which is added to or deleted from the data flow, and will attempt to establish the decisions made on data flowing through each unit as a result of the information at hand, and the decisions that cannot be made because of missing data or which are beyond the decision making ability of each processing unit.

The analysts must be continually looking for areas of potential improvement in the processing of data. Such areas will be noted in the light of data needed elsewhere in the organization as pointed out by the survey, and in light of technologies and knowledge available to the analyst. Such factors which may improve data processing efficiency are:

1. Deficiencies observed in the processing of data.
2. Techniques of processing data which are not being used.
3. Technologies in processing data.
4. The duplication of processing procedures.

Potential improvement areas, particularly those which may use more extensive mechanization, are those processes which possess a high volume of data processing, a preponderance of monotonous, repetitive and routine clerical routines and processes high in cost and in operation time. The examination of data processing stages in light of existing automation technology will point up segments of the system which may be subject of individual automation. Such areas are known as applications and their consideration may imply the need for an EDP feasibility study. On observing such areas, the systems analyst may make a preliminary survey of available computing equipments. Such a survey will provide the information upon which to recommend further study as being desirable in an application area.

In assessing the efficiency with which productive factors are combined, the analysts should appraise the relation of labour costs to production costs so as to establish areas which are out of proportion to the average ratio experienced throughout the firm. In areas where productivity is low, extensive analysis will determine whether automation will correct the high rate of labour costs. Such areas may be synonymous with the potential improvement areas pointed up by previous analysis. In addition, an analysis of the distribution and employment of capital will indicate whether capital is being efficiently employed. Again, such areas as may point

up an inefficient utilization of capital may prove to be potential improvement areas subject of further automation, or they may also point up an over-utilization of automation equipment and indicate that some mechanization may be eliminated.

The Mechanization Level

Information, in flowing through an organization, goes through a variety of operations each of which represents a delay in the data flow. These data operations or processes involve one or more clerical tasks that need be performed on the data. Such clerical tasks as may interrupt the flow of data may be classified as follows:

1. Creating - originating, selecting alternatives, signalling exceptional conditions.
2. Classifying - sorting, inspecting, editing, merging.
3. Computing - calculating.
4. Reproducing - writing, transcribing, listing, posting, recording.
5. Transporting - moving paperwork from one place to another.
6. Filing - searching, delay, storage.
7. Controlling - supervising, auditing.

Since these clerical operations may be performed either manually or through varying degrees of mechanization to that of complete automaticity, then each data process may

be assessed in light of the degree of mechanization involved. A summary of such assessments will indicate those processes which have more or less mechanization than the general level of office automation. In assessing the mechanization level of each process, the guiding principle is that only those operations in the direct flow of data will be assessed. Operations supplementary to the data flow such as the requisitioning of stationery, the writing of letters and the cleaning of offices, although affecting general office efficiency, do not reflect directly on the efficiency of processing management data; therefore, such operations will not be the subject of mechanization scrutiny, but will comprise a separate study in assessing clerical efficiency as a prerequisite to obtaining optimum utilization of automation.

In attempting to establish the degree of automation at each data flow process, the system developed by Professor James R. Bright for assessing the level of factory automation may serve as an excellent basis.[4] Professor Bright lists three fundamental qualities or dimensions of assessing the degree of mechanization and automatic control:

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[4] James R. Bright, "Does Automation Raise Skill Requirements?", Harvard Business Review, July-August 1958, Vol.36, No. 4, pp. 85-98. In his article, Professor Bright discusses the physical and mental efforts, educational and training requirementsof skilled and unskilled workers at jobs experiencing varying degrees of factory automation; however, the same concept may be applied with respect to office workers in experiencing varying degrees of office automation in the performance of their duties.

1. Level of mechanization - the degree of mechanical accomplishment by which a given production action or operation is performed.
2. Span of mechanization - the extent to which mechanization spreads across a sequence of production events.
3. Penetration - the extent to which secondary and tertiary production tasks such as lubrication, adjustments and repair are mechanized.

In our analysis we are particularly concerned with the first two qualities, but the third, penetration, for reasons explained will not be considered in assessing the mechanization level.

The first portion of our analysis will deal with establishing the level of mechanization of each phase of data processing or each interruption in the processing of information. This level is contrived by using the gauge indicated in Figure 3. Each data process in the office is charted in detail and, by referring to the gauge, each process may have a mechanization level assigned. This mechanization level reflects the amount of mechanical or electronic equipments used in performing the clerical task. The established level may then be noted on the procedure flow chart beside its respective process.

In reviewing the procedures and methods charts, the analyst is able to project the mechanization level of succes-

DATA PROCESSING CATEGORY	PROCESSING CHARACTERISTICS	MECHANIZATION LEVEL DETERMINATE	LEVEL NO.
automatic	mechanical activation of successive processes	automatic starting, processing, and feedback control	12
		mechanical starting, automatic processing, common language feedback control	11
		common language, activated, programmed processing	10
		common language activated processing and feedback	9
semi-automatic	manual activation of successive processes	common language processing control, manual feedback	8
		creative processing, computational characteristics	7
		mechanical processing, reproducing characteristics	6
		hand operated, mechanical data feed control, manual performance checking	5
	independent processes	hand operated, mechanical processing	4
		hand operated machine, computational characteristics	3
manual		hand operated machine, reproducing characteristics	2
		manually performed	1

Figure 3. The Mechanization Level Gauge

sive interdependent processes on a chart called the mechanization profile.[5] The mechanization profile illustrated by Figure 4 will graphically portray the span of mechanization in an autonomous office and through a succession of office. In analyzing the mechanization profile of each office and of successive offices, four aspects of automation are considered:

1. Establishing the average level of mechanization throughout the organization.
2. Determining those phases of data processing which fall below the average level. In this regard, an assessment will be made of the desirability of bringing the mechanization in these areas up to the general average level.
3. Detecting those phases of data processing which exceed the average level. In this regard, an assessment will be made of the economics of such an excess of mechanization as contributing an optimum utilization of automation equipments.
4. Estimating the profitability of raising the average level of automation.

The average organization-wide level of mechanization may easily be determined by a cursory examination of the

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5 Adapted from James R. Bright, "The Operating Characteristics of the Highly Automatic Factory", Ideas for Management, 1959, pp. 139-146, by kind permission of the author.

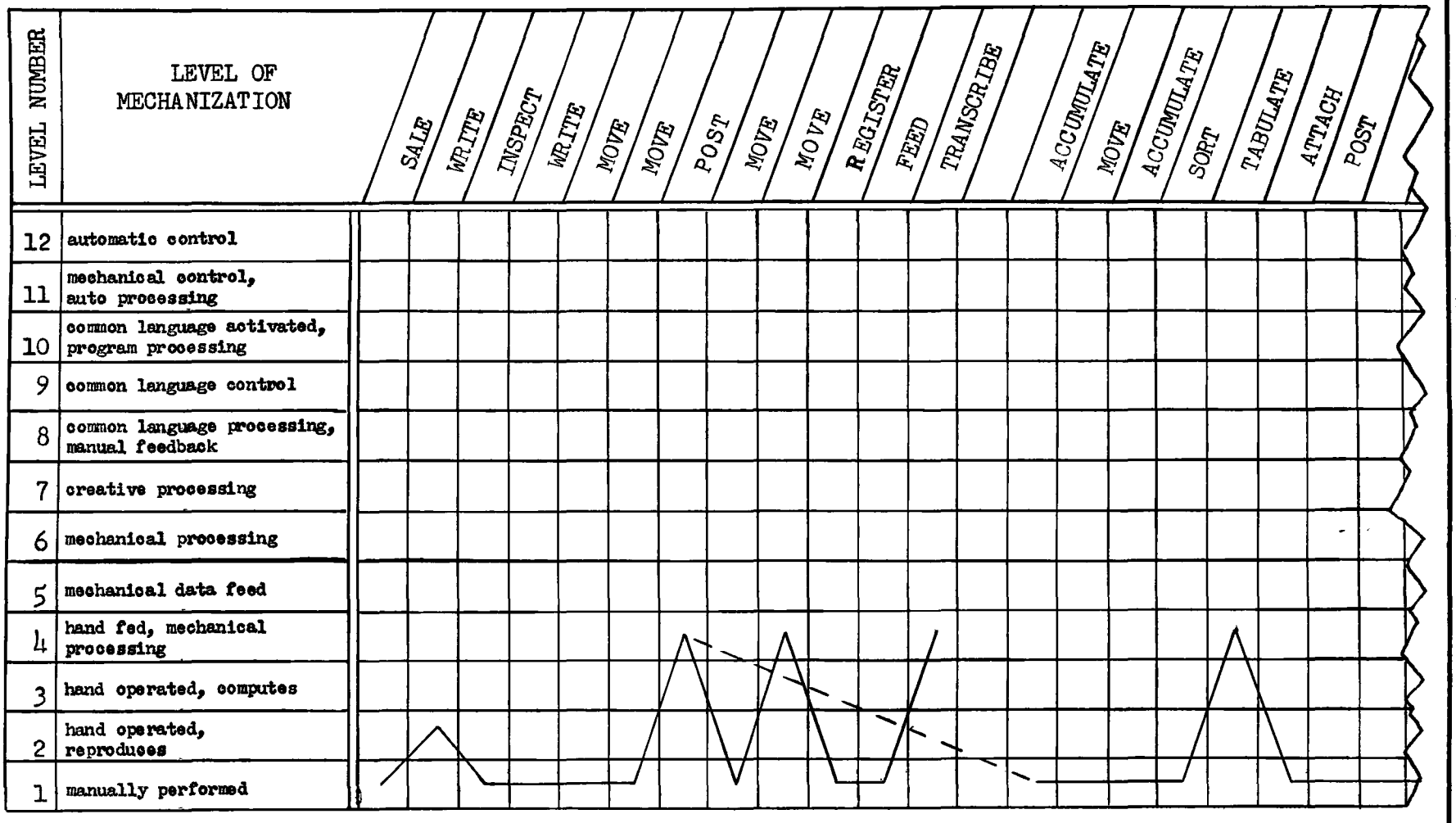

Figure 4. Mechanization Profile-Sales Office Procedures.

mechanization profile chart. The concentration of level scatter will tend to form or follow a normal curve distribution about one particular level. The level thereby indicated may be accepted as the existing average level of mechanization used for subsequent analysis. In the example illustrated in Figure 4, the scatter of events centralize about level 1, manually performed processes, with wide random variations up to level 4. Such a case, although theoretical, could in fact occur and such random scattering of mechanization could be substantiated by a need for speeding up excessively slow manual processes. Figure 4, it may be noted, is a mechanization profile of the methods chart portrayed in Figure 2.

Such an analytical tool as the mechanization profile will give the analyst a means by which he can readily spot potential bottle-neck areas and areas where the greatest potential exists for further mechanization. Keeping in mind the principle that a chain is as weak as its weakest link, so in an analogous manner, the chain of data processing is as weak as the lowest level of mechanization. It is these below average areas which impede and slow down the flow of management data; therefore, the analyst should assess the economics of speeding up these areas through more automation. The analyst should assess present operating costs and assess the prospective mechanization costs for bringing these areas up to the average level of mechanization; then he may balance these costs against the intangible delay costs resulting from these

areas being below average. The economic feasibility of implementing further automation into the lower than average automation areas may then be determined.

Some data processing areas may prove to possess excess mechanization and these areas may contribute more expense and more perplexing administrative problems than recognized. Such areas should be the subject of intense scrutiny with the purpose of lowering the degree of mechanization unless such automation is warranted through the type of operation involved or through prospects of raising the general level of mechanization up to these particular levels. In any event, the analyst must critically analyse the reasons for and substantiate these areas possessing automation above the general level experienced throughout the organization.

The last consideration of the analyst in reviewing the mechanization profile chart should be an assessment of raising the general level of mechanization. In establishing the criteria for this recommendation, the analyst will have to cost the elements in raising the mechanization level of each process up to a predetermined average level or to several obviously practicable levels. The analyst may then determine that general level which would be most appropriate for the organization. In this analysis, he will be guided by the need for accurate and current management data. The intangible benefits of speeding up the data flow process will bear a strong influence upon his decisions. He may find that there are some

stages of data process flow which are not capable of having their level of mechanization raised, but levels of the remaining processes should be raised regardless as there may be extenuating circumstances that require one or more areas to be below the average mechanization level. However, if such conditions arise then the extenuating circumstances should be explained in detail.

On the basis of his findings, the analyst may then make recommendations for automation implementation which will accompany the survey report. Because the mechanization profile chart may change as a result of these recommendations, then a revised profile chart reflecting the recommended automation must be submitted with the analyst's report. The "before and after" profile charts will present management with a useful tool in understanding the extent of automation used in and required by the company.

4.- ASSESSING THE FINDINGS

Analysis of Findings

After completing the system survey, the study group will thoroughly examine their findings and establish recommendations for improving clerical efficiency and for implementing further automation. The procedures and methods flow charts and supplementary notes produced during the survey will provide the basis for this critical analysis. Findings and

recommendations may be translated into costs and savings and presented graphically in a table, as in Figure 5. Figure 5 depicts the costs and savings resulting from recommendations for increasing clerical efficiency, for the raising of low mechanization areas and from raising the general level of office automation. This table also represents these statistics as ratios which provide a quick appreciation of the recommendations.

As indicated previously, the potential savings to be realized from the recommendations for improving clerical efficiency may more than offset the cost of the system survey. Savings which may result from work simplification programs, from improved office layouts, from revised forms control procedures and from simplified records keeping may be termed the reorganization benefits. These benefits will also include the relinquishing of some automation equipments in over-mechanized areas. In the management presentation, a distinction should be drawn between reorganization benefits and those benefits which may be realized from implementing further automation. Management should not be presented with findings which cloud up the real sources of savings. Half-truths should not be used to credit the savings from improved clerical efficiency as benefits derived from implementing further automation. In this respect, the economist must recognize personal bias toward particular equipments and fairly discount such prejudices in presenting the true sources of

OPERATION	REORGANIZATION		LEVELLING OF MECHANIZATION		RAISING GENERAL MECHANIZATION LEVEL		COSTS/SAVINGS RATIOS		
	COSTS	SAVINGS	COSTS	SAVINGS	COSTS	SAVINGS	RE-ORGANIZATION	LEVELLING OF MECHAN.	RAISING MECH. LEVEL
TANGIBLES									
Personnel -									
Records -									
Conversion (amortize)									
- displacements									
- re-location									
- equipments									
- training									
Tangible Totals									
INTANGIBLES									
Improved mngt control									
Competitive position									
Faster service									
Error reduction									
Clerical efficiency									
Employee benefits									
Flexibility									
Intangible Totals									
TOTALS									

Figure 5. Costs and Savings Comparison Chart

benefits. A fair presentation of benefits may well prevent management from being led into extensive and unwarranted automation programs which could result in chaos and eventual revision to traditionally established methods with substantial capital losses. Quite often an organization may reclaim the system survey costs as a result of implementing work simplification programs; however, the same cannot always be said as a result of implementing further mechanization.

After distinguishing potential reorganization savings, the economist may then focus his attention on the lower than average mechanization areas. These areas may be quickly determined from a cursory glance through the mechanization profile charts. The economist can then cost further mechanization in those areas in raising them to the average level of mechanization. Such cost estimates should be supplemented with notes of equipments recommended for these areas. Savings resulting from levelling of low mechanization areas should, besides the obvious tangible benefits, also include the potential intangible benefits to be gained from speeding up of the data flow.

The survey group should next consolidate their findings and recommendations by charting revised mechanization profile charts. These charts will reflect the mechanization of data flow as it would stand should reorganization and levelling recommendations alone be implemented.

The survey group may now consider raising the general mechanization level. The revised profile charts are scrutinized with a view to raising the level of mechanization from the revised plateau and not from the existing level. Recommentations for raising the general level will be in addition to the levelling recommendations. Raising of the general level may involve procurement of common office calculating and tabulating equipments, or it may involve procurement of small or medium scale digital electronic computing equipments for particular processing units. However, the findings may also indicate the need for centralizing the flow of business data under control of a large scale EDP installation. In such a case, potential application areas in priority of requirement will be established. Additionally, recommendations should include those manufacturer's equipments which might be considered by an application study group. Should knowledge of suitable equipments be lacking, the survey group may then recommend a requirement for such technological education. This additional training will be directed towards the people who will be making the application feasibility study.

Short-Term Considerations

Short-term considerations in the building of an IDP system are primarily concerned with the selection of application areas which would substantiate the need for EDP equipment in providing immediate tangible benefits. A company

may require an EDP installation as the basis for building of an IDP system and selecting applications, which can substantiate immediate EDP installation put a company a long way towards inception of an integrated system. The selection of application areas in light of this reasoning would therefore require substantiation by direct dollar savings. Experience from many operating EDP installations seems to justify this approach. A survey of 82 companies with EDP installations which had mechanized 274 applications indicated the following reasons for accepting applications:[6]

1. Reduced costs - 155 reasons
2. Reduced man power - 127 reasons
3. Improved administrative effectiveness - 122 reasons
4. Improved management control reporting - 89 reasons

The results from implementation indicated substantial success in most applications. Of a total of 253 expressed opinions, 129 rated implementation results as excellent and 101 rated results as good. It appears, therefore, that reduced operating costs are the primary reason for accepting applications and that these costs may be considered as sufficient justification toward taking a step into using EDP equipment.

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[6] During 1958 the Research Committee of the Empire State Chapter of the Systems and Procedures Association conducted an independent questionnaire survey of Association members. Of the 281 replies received, 82 organizations reported applications in service which involved a total of 203 computers. Results of the survey were published by the Association in a pamphlet entitled Computer Use Report.

Direct savings from the installation of computing equipment are of course difficult to precisely determine. Changing business conditions and changing dollar values that occur between the time that application studies are undertaken and the time that successful implementation is effected provide different comparison bases. The intervening period may last four or five years, and during this time there may be a substantial change in the combination of production factors which would jeopardize the use of good cost bases. Savings, particularly in the reduction of personnel, are difficult to accurately determine. Normal personnel turnover and an expanding business will account for much of the potential costs reduction which could otherwise be obtained; however, without having experienced them, it is difficult for a firm to estimate what these costs would have been with precise accuracy. The results of the survey presented in the Computer Use Report can be subject of critical analysis in this respect. The survey was carried out by means of a questionnaire which, in the first instance, leaves the findings subject to personal views and estimates. Additionally, statistics were summarized only from voluntary replies which bias the results in favor of companies who voluntarily participated in the survey. A random sampling approach was therefore not accomplished. The error of bias may have been further compounded by virtue of the fact that only an approximate

15 percent of total in service computers were represented in the survey replies.

It is possible that the results of the survey carried out by the Empire State Chapter may reflect more the opinions of what companies would wish their computer applications to represent than in fact what has actually been accomplished. Most companies will not openly admit to clerical manpower reduction, nor will they accomplish such savings even if possible because of adverse public opinion and because of strong union pressures in protecting labour. The fact that clerical cost savings are elusive and difficult to prove is born out by the results of a personal survey undertaken by a New York firm of management consultants of eleven companies primarily engaged in manufacturing.[7] The findings of this survey were that EDP users were reluctant to quote exact dollar savings attributable to the use of computing equipment. However, potential benefit areas could be generalized as follows:

1. Clerical cost reductions are most likely in high volume processing and where previous business experience dictated extensive decentralization of routine clerical work.
2. Control type applications, and particularly inventory control, provide outstanding rewards.

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[7] Lybrand, Ross Bros. and Montgomery, Survey of Benefits Resulting from the use of Electronic Data Processing Equipment, Management Services Research and Consulting Division of Lybrand, Ross Bros. and Montgomery, New York, May 1959, p. 8.

3. The adoption of exception reporting provides a more powerful tool for screening reports.
4. Budgeting limits which prevented older less automated systems from providing timely reports are eliminated.

Perhaps one of the most lucrative potential costs reduction areas is in the achieving of lower average costs of production through volume expansion. The costs of electronic computers, unlike variable clerical costs, decrease as a portion of total product costs as business expansion is accomplished. Computer operations can cater to an increased workload with the same amount of personnel and with a slight increase in fixed machine costs. The variable costs of a large clerical staff are converted to the fixed costs of computing equipment and any increased activity will result in substantial benefits.

Long-run Considerations

In the long term, perhaps, a firm will attempt to obtain a lion's share of the market. Accomplishing this objective requires a constant knowledge of market conditions, of production characteristics, of supplier's problems, of management techniques and of many such variable factors each of which affects a firm's capacity to produce but in an interrelated manner. In attempting to achieve optimum production, to obtain maximum returns from investments with a least cost combination of production factors, a firm must constantly

juggle these variables and this demands knowledge of such proportions as to be beyond human capacity to digest and control. Such a system of business control, a management control system, must make allowances for the dynamic elements that are present in an organization. Continuous adjusting of production factors is required in attempting to approximate an optimum system; however, experimentation with actual business control would be expensive. The only logical alternative is to simulate actual operating conditions in a business model and experiment on the model with varying combinations of production factors. Business model experimentation requires simulating a close approximation of the many variable factors and therefore presupposes an accurate and well-developed integrated data collection system. It requires constant appraisal of developing conditions and simultaneous adjustment of other dependent factors.

Such business model experimentation will involve more research and development time than allowed for the system survey and should constitute a permanent aspect of management control; therefore, should the analyst consider that the long-run interests of the company would profitablt be served by such experimentation, then appropriate recommendations can be made in the survey report.

The Survey Report

The type of survey report will be determined by the

manner in which the survey was organized and conducted. Generally, the report will dwell on four subjects:

1. Purpose of the survey.
2. Summary of current procedures.
3. Costs-savings comparisons.
4. Recommendations.

Purpose of the survey - an outline of the responsibilities and duties assigned the survey will suffice as an introduction. This statement will outline the composition of the survey team, the extent to which the company was surveyed, the man-hours and expenses consumed and how the survey was accomplished. A statement should also summarize the competitive position of the company within the industry, and the industry trend in sharing of the gross national product. Determining the long-term prospects for company development and for industry development will reflect on the capital which may be directed toward the development of automation within the organization, and such investment opportunities will bear directly on the extent to which recommendations may be fulfilled; therefore, such prospects must firstly be established.

Summary of current procedures - a general statement should indicate the nature of operations considered during the survey. The data processing system as it presently operates will be flow charted generally, in the form of procedures charts, and in detail in the form of methods charts. The

procedure flow charts will accompany the report and these will reflect, for each data process, the volumes and frequency of data processed, the estimated average cost of processing transactions, the types of clerical operations performed and the measured level of mechanization in each process. The charts will also be cross referred to presently used forms, samples of which will accompany the report. In a more general nature, the report will assess the level of clerical work efficiency existing in each office, with an indication of the overall clerical efficiency and the ratio of clerical occurrence of errors. Additionally, serious shortcomings of the present system and recurring bottleneck areas will be indicated.

Costs-savings comparisons - an economic analysis of the benefits to be realized from reorganization as a result of the survey recommendations, of the benefits to be realized from raising the mechanization level of individual processes and of the benefits to be gained from raising the general level of mechanization as summarized in Figure 5. A narrative summary will indicate the advantages and disadvantages to reorganization and to raising the general level of mechanization. A summary explanation of intangibles should also be given.

Recommendations - the recommendations should be clear and precise. Management do not want to go searching through detail in order to establish what has been recommended;

therefore, a precise and clear statement of what has been recommended will be required. This statement should cover the following points:

1. A statement indicating the areas that immediately require and do substantiate further mechanization in order to bring them in line with the company average level of mechanization.
2. An affirmation of requirements for raising the general level of automation and the means of raising this level. Should the company not wish to pursue a program of further mechanization, then alternative procedures for meeting increasing demands upon the data processing system should be outlined.
3. A statement of the long-term automation requirements of the organization and also an indication of trends within the industry. A skeleton IDP system proposed for the company may be submitted. This skeleton should indicate where data may be captured in mechanical form, what processing functions will be performed, intervening manual procedures that are required and the benefits that may be realized.
4. An outline of any work simplification program which may be recommended. Since no work simplification project is worthwhile unless continuously appraised by management, then a working plan to effect this principle must be outlined. This may be accomplished by

establishing a permanent systems group which will continuously analyze clerical and data processing efficiency.

5. An assessment of the applications worthy of conversion to EDP and the priority with which they should be considered. This applications assessment should broadly outline each proposed application indicating how it will operate, the extent of electronics equipment to be used and a statement of its expected accomplishments.
6. A summary of the implications and the effects of further mechanization upon the workers, upon management and upon the organization.
7. An analysis of the long-term prospects of integrating, both vertically and horizontally, the framework of the company IDP system with that of other companies with which the company is associated.

CHAPTER III

THE APPLICATION STUDY

1.- Organizing an Application Study

The Study Objective

The application study is an economic appraisal of automating a pre-selected project or application. This study complements and supplements the system survey analysis; therefore, to accomplish continuity and to effectively utilize human resources, members from the system survey team should be represented in the application study group.

Many times this study project is referred to as a feasibility study which implies the analysis of a requirement for a particular type of automation equipment; however, the study should be directed toward the economics of automating a selected application rather than trying to justify pre-selected equipment, otherwise the study will fall into the trap of looking for an area in which to justify the prematurely selected equipment. This study will therefore determine the feasibility of automation for a pre-selected application area and should extensive automation appear warranted, then the computer feasibility analysis will follow in step.

Management are responsible for specifying the general confines of the application analysis, of elaborating on

problems which infringe upon other applications and of determining the character of study group organization. On the basis of this study requirements then, the composition of the study group will be determined.

The Application Study Group

The best efforts of an application study can be attained when analysis progress is an individual rather than a committee group responsibility. The committee approach to analysis lends itself to considerable discussion with little substantial progress in the analyses of application details; therefore, the study group should be organized so that one individual is entirely responsible for the study group's progress and this person should preferably report to a high level of management.

Much of the work done by the study group and the recommendations which will be implemented therefrom, will have organizational wide repercussions; so the study group should have the backing of top management. With this backing, the analysts are in a position to transgress departmental authority, tu cut across company red tape and to recommend desired changes to company policy. Without this top level support, and without the organizational structure to lend weight to their studies and recommendations, the analysis group will be intimidated by and dominated by departmental line supervisors. The synthesis of a new system would then reflect the

particular desires of department managers rather than the best interests of the over-all organization. The dominant personalities of department managers may not necessarily reflect the best interests of the company in attaining an optimum management control system; therefore, top management support is required where the application area encompasses more than one department.

Because of the continuity required in passing from the application study phase into the implementation phase, members of the EDP installation who will be responsible for developing in detail and implementing the application should be represented in the study group just as soon as it is realized that the application will justify the use of EDP equipment. Having been with the study group throughout the entire application analysis, the EDP analysts will be well versed in the intricate details of the system and will be well qualified for implementing the system onto electronic computing equipment.

In determining the composition of the study group, perhaps management should consider using the services of consulting firms much as was done in the initial system survey. Much technical knowledge of electronic computing equipment and much experience in the knowledge of potential trouble areas may be gained by adding the resources of a consulting firm to the application study group. However, management

should not be confident that all their problems can easily be answered by assigning complete responsibility to consulting firms. Consulting firms do not possess the detailed operating knowledge of the particular organization which experience may only be attained from company personnel. The knowledge of company policy and operating techniques may be found in a well organized systems and procedures group, and a good combination of experience and computer technologies can be attained by adding the consultants in the form of advisors to the survey group.

With or without the services of a consultant, members of the study group should become familiar with the latest developments in computer technology. This technology may be gained through attendance at the various computer manufacturer's training schools, through numerous seminars sponsored by management organizations, through numerous trade journal articles and publications and through active participation in systems seminars and conventions. A goodly number of university sponsored courses are becoming available throughout Canada and the United States which supply an ever increasing knowledge in this field. Furthermore, members of the application study group should be familiar with the firm's long term policy and should be knowledgeable in combining factors of production in an optimum manner. The group must therefore possess the professional services of a company economist.

Having availed themselves of personnel who appreciate and can interpret long term company policy, management are in a position to constitute the application study group and assign responsibilities. By further sponsoring these individuals in active membership in one or more systems associations, management will assure their firm of possessing the latest electronic computing techniques and will furthermore be constantly abreast of continuing management developments.

Phasing of Operations

Commencement of the application study may not in all cases be distinguishable from completion of the system survey. The two studies have overlapping functions which makes them in some cases almost as one continuous study and presumably the personnel involved may be the same. There may in some cases, however, be a complete demarcation of the two studies particularly if the application study is one of series of such inquiries carried out as time permits subsequent to the system survey. The phasing of these studies in relation to the system survey and the subsequent application development and conversion phases may be graphically illustrated as in Figure 6.

A knowledge of the overlapping functions existing between phases may be more easily understood by a look at Figure 6. Figure 6a portrays the time phasing of the system survey in relation to the subsequent phases, while Figure 6b

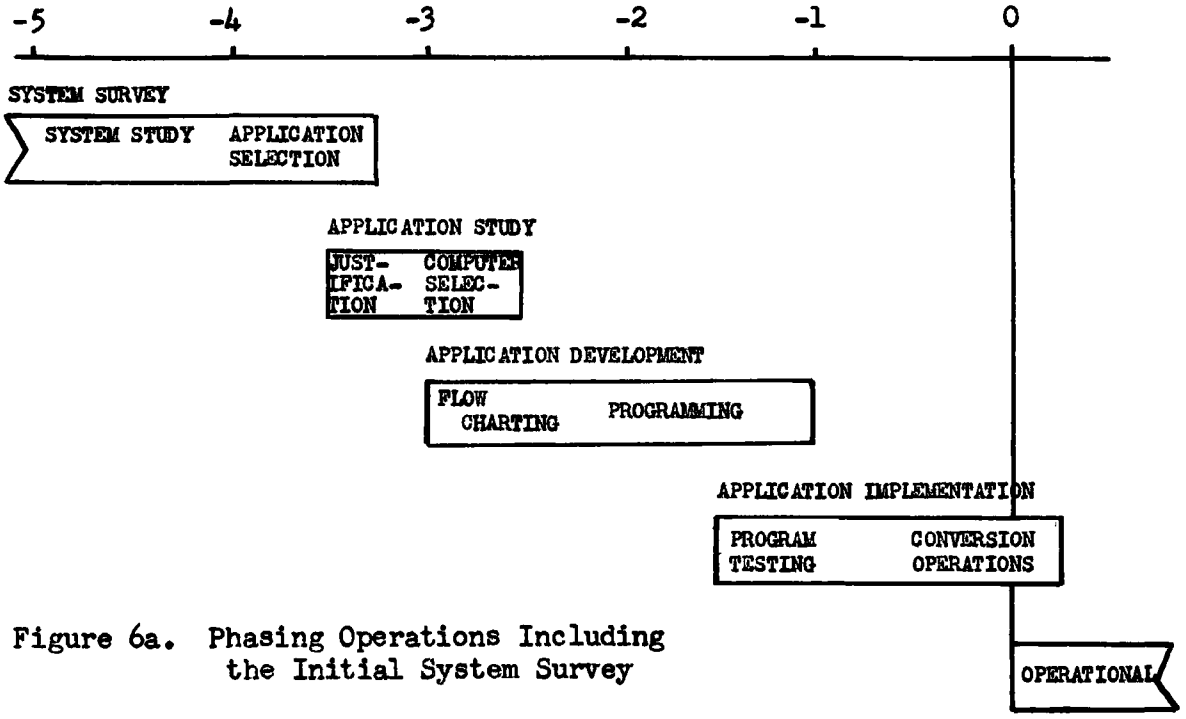

Figure 6a. Phasing Operations Including the Initial System Survey

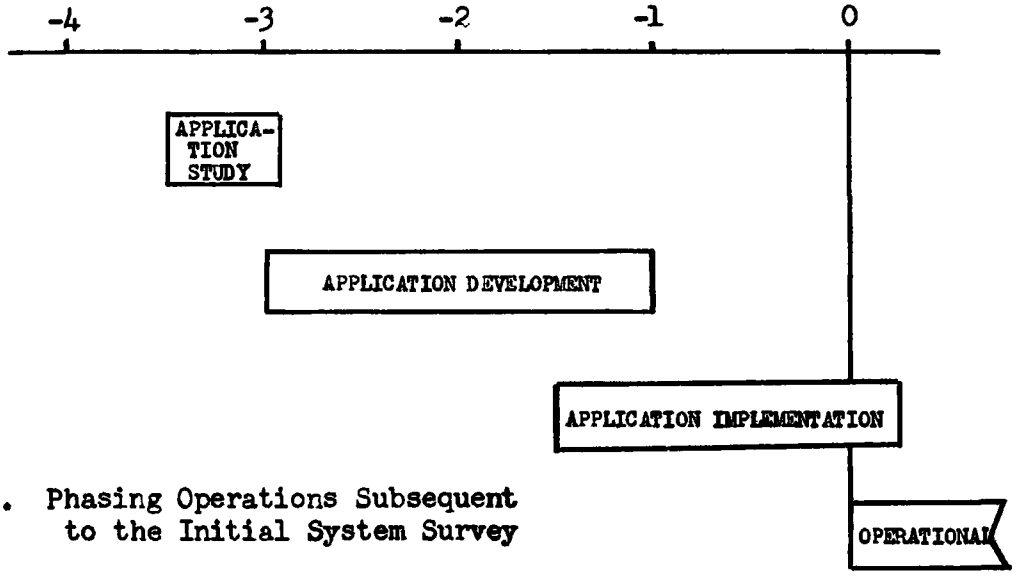

Figure 6b. Phasing Operations Subsequent to the Initial System Survey

Figure 6. Phasing In of an EDP Application

shows subsequent phases development independently of the system survey. Considering Figure 6a, the application study in a large firm and covering a large scale digital computer application will probably consume the better part of a year with up to three months at the start of the study overlapping with the tail end of the system survey. Application study personnel may be drawn into the final deliberations of the system survey so that continuity and understanding will be maintained in going from one phase to the next. The latter six months of the application study is spent on computer selection which may be overlapped with a separate pursuit into the detailed development of the application subsequent to its being justified for installing on electronic computing equipment. The computer selection inquiry may be considered as a study independent of the application justification or the application development; however, since it will be pursued by the application study group, then it is considered as a continuing portion of the justification study. Simultaneously with the computer selection inquiry, however, may be the establishment of an organization to pursue the detailed development of the application. Personnel assigned to the development program will have been drawn into the justification study at an early date so as to gain an intricate knowledge of the application parameters and will be able to independently proceed with detailed application development with little direction from

management. After application development has got under way, then the analysts responsible for programming and implementation will be drawn into the details of application development so as to provide continuity and understanding between these phases. Because programming and testing operations will be carried out simultaneously, then a demarcation between the development and implementation phases cannot be drawn; therefore, Figure 6 portrays these two phases as overlapping one another. Subsequent to the implementation phase, other overlapping will occur when operations get under way and when there are still programs which require testing and debugging.

Figure 6b is a repetition of Figure 6a with the exception that the time spent on the systems survey is not included, and also, the second part of the application justification phase, i.e. the computer selection portion, is not included. The time phasing of operations illustrated in Figure 6b will apply to those applications considered subsequent to the system survey and for which available computing capacity exists. However, should subsequent applications be considered which require additional capacity, then again the computer selection portion of the application study phase will be included and will overlap somewhat with the development phase.

From the phasing of operations illustrated in Figure 6, it is evident that an organization must be flexible in assign-

ing personnel from one phase to another, and in ensuring that personnel in phases which are interdependent have preliminary knowledge from the preceding phase by having been drawn into the deliberations of the previous phase. Maintaining continuity between phases requires considerable organizational planning and foresight which contributes to minimizing the length of time taken from the initial system survey until an application is operational. The minimum time to cover all phases will be in the order of five years, and should an organization lack foresight in maintaining continuity from one phase to another, then this time may be extended up to six and one half years.

Manner of Analysis

An application area will have been selected for potential automating because it fits well and will contribute to an over-all scheme of organization. However, the application in its present form may not possess certain characteristics which are required by an integrated data system. These discrepant areas, unless cleared up, may cause extensive damage to the integrated data system; therefore, they must be pinpointed and rectified so that the new application will reflect corrective procedures. In the determination of these areas, and as a starting point for developing a new system, the study group should work from the findings of a system survey and from the statement of application expectations which

form the basis for organization of an application study. They should also understand what the application is expected to contribute so that they may design an application which can easily be integrated into the planned data system.

Working from the charts developed as a result of the system survey, the study group will firstly document the present application flow. Should the system survey have not thoroughly documented data flow of the application, then the group may have to do a survey of the particular application along the lines of the procedures outlined in the preceding chapter. The documentation produced will be in the form of an application flow chart with supporting statistics on data characteristics, and with attached samples of forms presently used. A sample application flow chart which lays out the detailed procedures involved in a typical counter sale with subsequent paperwork documentation is illustrated in Figure 7.

A careful analysis of the present application documentation will point out procedures in which substantial improvement can be made and the group may then develop a proposed application flow which will reflect improved processing efficiency in the discrepant areas. In synthesizing data flow in the form of a redesigned application flow chart, the group will establish the characteristics of basic files required in the new system and the characteristics of data which flows into and out of the system, for it is upon the

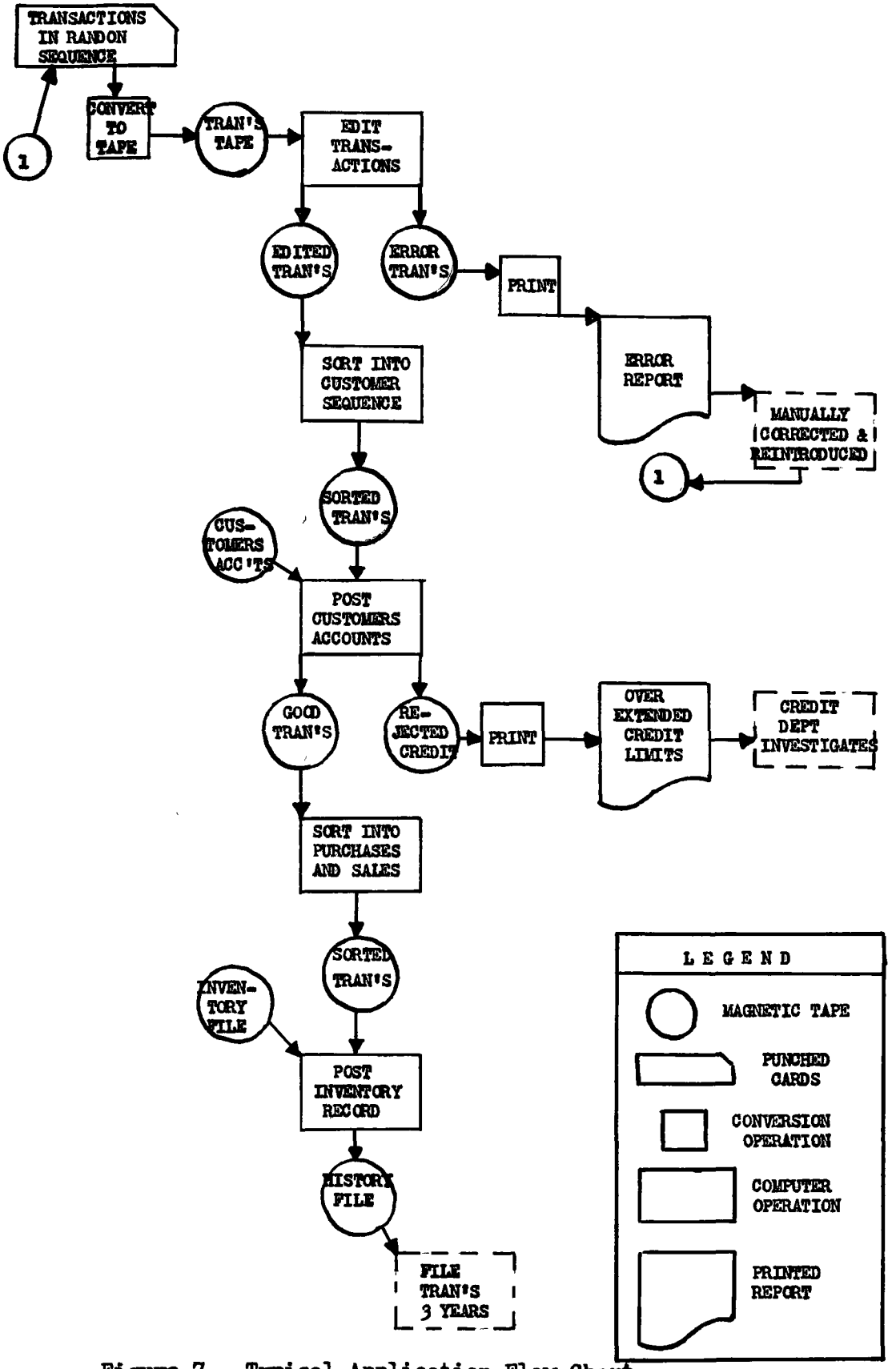

Figure 7. Typical Application Flow Chart

establishment of these data characteristics that the EDP staff will develop the detailed procedures for implementation. In designing this application flow, an attempt should be made to accurately establish the decision criteria that will be simulated on the automation equipment. These criteria will be normal management decisions which may be assumed by the EDP system and which form an integral part of the application area. As a supplement to the redesigned application flow chart will be samples of redesigned forms and notes on the redesigned procedures and on the organizational structure which will be required in implementing the new application.

In their perambulations, the analysts will undoubtedly be faced with the problem of whether the data relationships substantiate the need for centralizing the flow of data into an EDP installation. Should it appear that centralization of data flow is necessary, then the analyst may consider whether there should be a synonymous centralization of operations. As management becomes more capable in handling a complex business through the simplification of data flow as a result of installing an EDP system, then there may be strong arguments for centralizing the operating functions; however, the arguments still exist that decentralization of operations brings management closer to the worker, gains the advantages of small community benefits, and that electronic computing methods will provide a more powerful method of disseminating

management data such that decentralization of functions will be favoured. There may be considerable advantages to be gained in either respect and some of the considerations will be discussed in a subsequent chapter.

2.- EVALUATING THE APPLICATION

Economic Evaluation

Having an appreciation of the present and of the proposed application parameters and data flow characteristics, the study group may proceed to justify the economic worth of adding more automation. The proposed application may be computer feasible but may not economically justify added mechanization; therefore, a comprehensive economic appraisal must follow. This assessment should consider the total contributions to be gained from the proposed application and carefully weigh these benefit against the shortcomings of the present system, because it must be realized that electronic computers are not the only answers to organizational problems and may in fact present further problems.

The study group should not be hastened into performing a quick application evaluation. Top management may have been sold on the idea that the application under study is obviously computer feasible and should therefore be quickly implemented without realizing the full implications. Top management exuberance must be held in check until a thorough appraisal of the application has been accomplished.

Frequently, applications are suggested which may be quickly implemented onto an EDP system. They may be presented along with the arguments that getting a computer and installing these applications quickly will reap benefits which will pay for the costs of installing EDP equipment and then further applications, which utilize remaining unused capacity, will constitute the icing on the cake and will provide pure profit. This approach, however, disregards the basic fact that such an easily implemented application may not necessarily reap as much investment returns in the long run than would some less attractive applications. The real benefits may not be so easily realized; furthermore, there may be extensive intangible dislocations which would preclude rushing into the automation business. The pressure of unions for higher wages shorter annual working hours, guaranteed annual wages, and restrictive displacement benefits limit the direct dollar savings that may be realized from implementing computing methods. It is easy to state that a computer will displace one hundred clerks; however, the practical limitations of the demands of a good economic system for worker security will erase many of the direct savings which would otherwise have been realized. Most companies, in implementing further automation, have adopted the policy of reducing personnel through normal employee turnover and attrition, and through absorbing displaced personnel in other departments of the company without reducing their take home pay. A thorough economic evaluation will

discover these indirect dislocations. For the purposes of this chapter, the direct costs and savings will be considered while the indirect effects upon the worker, upon management and upon the company will be considered in a subsequent chapter.

The results of application analysis may indicate a requirement for more automation, however, it may just as easily recommend that sufficient mechanization already exists within the application and may recommend alternate data processing methods. The importance of automation costs must not be underestimated at this stage for analysis of the Computer Use Survey[1] indicates that of the 28.9 percent of all applications rejected, some 79 percent are rejected during application analysis. A summary of the opinions indicates that applications are accepted primarily for their contribution to costs reductions; therefore, the significance of the study as an economic analysis is apparent. The study should thereby pursue a comprehensive costs-savings comparison analysis.

In a costs-savings analysis, particular emphasis should be given to the direct savings attributable to further mechanization. Direct savings are those displaceable costs which can be reduced or eliminated as a result of increased mechanization. The economic evaluation appraises the amount

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[1] Systems and Procedure Association, Computer Use Survey, Empire State Chapter of S.P.A., 1958.

of direct savings with respect to the costs of automation in the proposed system; therefore, the cost justification should eliminate any savings which may result from a recommended reorganization. Although the comparison will consider only direct costs and savings, intangible benefit should not be completely ignored. If the displaceable costs of the present system exceed the cost of the proposed electronic computing system, then conversion to the new methods are more than cost justified, however, "if the displaceable costs are approximately equal to, or even less than, the costs of the mechanized system, it might still be a wise decision to install the electronic equipment, based upon better reporting and the other intangible benefits".[2] Intangible benefits may provide the deciding criteria as to automating an application or selecting alternate methods for increasing data processing efficiency.

While synthesizing an application, an economist should cost the application development, programming, debugging and conversion operations; because, however justifiable the application may seem to be in terms of its contribution to an integrated flow system, and regardless of the obvious savings that may be realized, there still remains a long, arduous and expensive task of developing and implementing the application. The time and expense of the two subsequent phases should not

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[2] Neal J. Dean, "Is Automation for You?", Office Executive, January 1958, p. 26.

be under-estimated. The analysis phase is a small portion of the expense involved. The most expense lies in converting an application onto an EDP system,[3] and these costs may preclude any further analysis.

Degree of Automation

The application analysis should promptly determine whether and to what extent the application is computer feasible. This does not imply economic but rather computer practicability. A preliminary assessment of data volume and savings potential will indicate whether to proceed any further with the computer feasibility analysis. If the volume processing appears to small, or if the potential savings appear insignificant, then further study would be a waste of time as the most significant savings may have been realized from the increased efficiency gained as a result of the system survey. It might be interesting to note what the opinions were on rejection of applications as established by the questionnaire published in the Computer Survey Report.[4] The opinions for rejections showed:

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[3] The development and implementation phases require more personnel and chew up expensive computer time in program testing and debugging operations. These phases require more technical knowledge of computer characteristics than required in the system survey and application study phases. Much literature has been written on these phases. A good reference in this respect is Richard G. Canning, Installing Electronic Data Processing Systems, John Wiley and Sons, Inc., New York, 1957, XII - 193 p.

[4] S.P.A., Computer Use Survey, p. 3.

1. Volume of data too small - 96 reasons
2. Too costly - 92 reasons
3. No time savings - 53 reasons
4. Routine has too many exceptions - 35 reasons
5. Lack of reference to account history - 17 reasons
6. Inadequate input-output equipment - 10 reasons

From this questionnaire summary then, it would appear that volume data and potential savings are an important factor in the early rejection of applications.

Should the analysis indicate that the application is not computer feasible, then the study should determine alternate methods of performing the application. Assuming that an application had some merit in being presented in the first place, then there may be potential savings in other processing methods.

Some applications may warrant partial mechanization. When such applications are perceived, then the study group may consider the use of service bureaus in handling part time, peak load requirements and the application may be automated to the extent of catering to such peak loads. Service bureaus are small data processing centres which computer manufacturers are establishing for the purpose of renting computers on a part-time basis. Service bureaus provide the capacity for applications which may not be completely computer feasible but which, because of spasmodic demands, may require

partial electronic computing. Generally, there are four categories of users who can benefit by using service bureaus:[5]

1. Firms with a volume of paperwork that does not economically justify their own machine installation.
2. Firms with a sufficient volume of work to support an installation but who may want to pre-analyze the economics of such an installation.
3. Companies preparing for an installation of their own who wish to pre-test their programs and procedures during the installation period.
4. Organizations with their own installation who find it expedient and economical to use service bureau facilities for special reports, to eliminate peak loan operations, or for selected repetitive applications.

Another alternate processing method which may be considered is the use semi-automatic electric accounting machines (EAM). Punched card equipment is often used as an intervening step toward implementation of an electronic computing system, and no EDP installation can operate without the back-up of an EAM operation in preparing data for the computer on punched cards, for pre-editing of transactions, for converting data into magnetic tape and in performing similar functions with the output from an EDP installation. Therefore, utilizing

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[5] O. M. Scott, "A Look at Service Bureaus", Punched Card Data Processing, May-June, 1959, p. 18.

EAM will bring partial mechanization into an application, and above all, provide the application with one step toward the time when potential savings and data volume will substantiate conversion to an electronic computing system.

The analyst may also consider the amount of mechanization that an application requires is contributing to the build-up of an IDP system. Perhaps the application in itself will not substantiate EDP; however, it may form an integral part of an IDP system without which the over-all system could not operate unless the particular application is automated. The application may provide the synthesis for an EDP system, it may be required to substantiate additional computer capacity, or it may be required in levelling out the mechanization in an existing highly automated system. Whatever reason it was perceived, the analysts should assess the contribution that the application will make to the firm's over-all data flow system.

Implementation Problems

Developing an application for EDP has extensive implications which are not readily discernible. Some of these considerations which the analyst should dwell on are: the effects of data flow centralization upon the company organization, the relocation of plants and equipment in installing large scale electronics equipment and the changing clerical responsibilities as a result of more extensive mechanized clerical

procedures. The company organization and structure may change to the extent that old timers find it foreign and incomprehensible; therefore, a comprehensive executive and employee educational program will need be developed. There will be doubt in the minds of the workers as to how they fit into the new system, as to whether they will have to retrain themselves to learn the new technology in order to keep a job with the firm, or possibly that their job might be eliminated altogether. These doubts can be diminished through an educational program.

Possibly, the analyst should also consider the effects upon the firm's competitive position within the industry. Presumably the raising of productivity as a result of implementing an electronics system will give the company a competitive advantage; however, this might not be the whole case. The firm may be facing competition where there are a number of producers of a similar product and where the price and production policies of one firm cannot be varied too much for fear of reprisal from other firms. Furthermore, any competitive advantage which may have been gained from implementing current technologies may not be realized over the long-term period. Assuming free entry into the industry, other firms presently engaged in the industry may also adopt the latest technical developments and align themselves competitively again with the company leading in implementing the latest

computer technologies. Therefore, any advantages in extra profits to be gained from implementing the latest computing techniques may only be short lived and may not be sufficient to cover the huge sums of money required for developing and implementing such a complicated system. The economist should therefore establish the competitive advantages to be gained and precisely evaluate the economic benefits which may accrue to the company, to the management organization and to the worker.

3.- THE EQUIPMENT REQUIREMENTS

Required Application Capacity

The application analysis should come up with a precise determination of mechanization requirements. This involves assessing the volume of data flow, the frequency of data requirements and the size and other characteristics of the data being manipulated. Having furnished themselves with required data characteristics, the study group may then determine what type of electronic computer appears most appropriate to the application.

An assessment of the volume, frequency and costs of processing data will indicate whether a small, medium or large capacity electronic computing system is required. A look at the calculation of requirements will determine whether a digital or an analogue computer is required. Since most

of the business man's needs in data processing are for simulating clerical-type operations, then the probability is that digital processing equipment is required. This discussion will therefore be limited to the consideration of digital equipment.

The size of capacity is determined by the characteristics of the data being processed. In any organization, the use of small capacity EDP will normally be limited to the processing of low volume data within the confines of individual offices, or to the computation of simple problems in the locale where the problems originate. Small scale capacity may also be substantiated by the need for raising the level of mechanization of individual offices so as to speed up the flow of data and contribute to the overall efficiency of an IDP system. Medium and large scale capacity, on the other hand, are justified on the basis of volume data processing, frequent repetitive clerical operations and an ever increasing need for simulating management decision-making criteria. Medium and large scale capacity may also form the hub or core of an IDP system.

The decision as to whether medium or large scale capacity is required will depend upon the degree of flexibility required in operations, the volume and speed of manipulating data, the extent of automaticity required and the validity of or reliability of the processing function. Medium scale capacity which normally uses punched cards native language media

is relatively inflexible to volume increases compared to large scale systems which utilize magnetic tapes native language media. Furthermore, medium scale capacity usually requires considerable manual intervention; therefore, it is limited with respect to the simulation of management decisions and of controlling the automatic flow of data within an IDP system.

Large-scale capacity, on the other hand, may have predetermined management criteria programmed into the operations of the computer which will control the flow of data within an IDP system with a minimum of manual in tervention. Furthermore, it is flexible to the extent that its capacity may be increased considerably without any additional planning or staff. Additionally, reliability is immune to volume increases; whereas, with medium scale capacity, where additional personnel are required for increased activity, the degree of reliability varies inversely to the amount of extra planning and personnel required. Large scale capacity may also process variable lengths of files, whereas medium scale capacity is usually restricted to the processing of fixed length files. This negative aspect of medium scale capacity may, however, be somewhat overcome by developing technologies of in-line electronic accounting and processing in random rather than sequential fashion, which techniques are being developed as auxiliary equipment to both medium and large scale capacity systems.

Perhaps analogous to the scale of capacity required would be the extent of supporting electrical communications systems that are required. If the intent of the application is the processing of data without regards to an IDP, then there will probably be little requirement for tying in the functions of the computer with the processing requirements of the system. However, if the intent of the application is such that the EDP operations will form an integral part of an IDP system, then the requirements concerning telecommunication facilities will need to be determined and the available facilities may in turn reflect on the types of electronic computing equipment that would technically warrant consideration. The extent of participation of the application within an IDP system may therefore have a direct bearing on the scale of capacity required and the types of computing equipment that may be considered.

Additionally, there would be little merit in considering equipment that is not compatible with the present data processing operations; therefore, an assessment must be made of the present processing characteristics. If a semi-automatic data processing system has been carefully built up over the years, then records and functions will reflect the characteristics of equipment used. Implementing an application which disregards existing records and equipments may result in considerable confusion and considerable incompatibility. The existing equipment, however, should not dictate

the type of electronic equipment selected for the application.

Existing Capacity

At this stage of analysis, when the size and character of required capacity has been established, the study group should determine whether sufficient unused capacity exists within the firm to handle the proposed application.

Most computer manufacturers, in renting their equipment, will charge less for second and third shift operations than for the primary shift; therefore, unless a full three shifts are operating, considerable economies can be gained by utilizing such unused capacity. Even if the equipment has been purchased, increased returns on investment can be realized by bringing such unused capacity into play and thereby spreading fixed operating costs over a larger volume of production.

Unused capacity may be stated in hours of mainframe time. By comparing the unused mainframe time against the required application mainframe time, and allowing for a normal increase in application activity as well as present applications activity over a long term period, then it may be determined whether sufficient unused capacity is available for the proposed application. Should sufficient capacity be available, then the study group may promptly wind up their survey in the form of a report. However, should additional capacity be required, then the group may submit an interim findings report

and proceed with economic justification for a particular type of manufacturer's equipment.

4.- COMPUTER JUSTIFICATION

Desirable Characteristics

What does the economist look for in justifying the selection of particular computing equipment? Perhaps there are several desirable characteristics which should be considered in narrowing down the selection of equipments.

Primarily, of course, the analyst is concerned with building of a compatible IDP system and implementing electronic computing equipment which will not endanger a compatible integrated relationship but which will increase the facility with which data is processed. Therefore, a most important characteristic is that electronic computing equipment be adaptable to the building of an IDP system. Adaptability may be assessed on the ease with which the computing equipment may be installed and the ease with which conversion operations may take place. Perhaps also, adaptability may be assessed on the compatibility of the electronics equipment to other applications which may be considered in the future.

Regardless of how economically justified a particular equipment may appear and regardless of how adaptable the equipment may be, it might still prove to be a most expensive "white elephant" unless it possesses a high degree of

reliability. The more mechanized that procedures become, then the more dependable a firm becomes upon a high degree of machine reliability. A car which is broken down one tenth of the time because of repairs may not be too inconvenient to the average individual; however, to a taxi driver such lost time may prove disastrous because of lost business. Consequently, reliability will depend upon how much a firm's production is geared to good machine performance. In a preliminary survey phase, the analysts may assess the reliability of computing equipment through an analysis of the maintenance and servicing facilities that are available for each type of equipment. An assessment should be taken of the calibre of person required to maintain the equipment, the availability of repairs, the ease of access to the computing equipment for maintenance purposes and the relative complexity of the equipment which needs to be maintained. Having availed themselves of the various characteristics which determine reliability, the analysts may then establish a ratio of performance time versus down times for each type of equipment and thereby point up the equipments which may prove most reliable.

Many EDP equipments are justified on the basis that they are extremely flexible to production volume increases. As the scale of operations of an organization increases, so the capability of the computer increases without a proportionate increase in performance costs as would be experienced

with manual methods. Furthermore, sudden production volume changes may be easily handled without the inconvenience and costliness of hiring extra clerical help. As a result, the ability with which each computing equipment is able to adjust to and handle peak loads and gradually increasing scales of production should be assessed. There is little need in installing computing equipment which will just handle the average work load experienced today, whereas a year later the capacity may prove to be more than inadequate. The costs which may have been justified in the initial installation may more than be offset by the additional installation costs of more capacity at a later date or the business which may be lost in not being able to expand operations to meet demand. Because electronic computing equipment constitutes a major capital expenditure, then its investment must be considered in light of the long run operating policies of the company. Possibly another consideration with regard to flexibility is the degree to which the computing equipment is able to assimilate the developing technologies in input and output equipments, i.e. the particular equipments which read or process data into and out of a computing system. Since most computing equipments possess high processing speeds and relatively slow input and output devices, then there remains potentially lucrative areas in the development of faster input and output devices. Computing equipment should be flexible enough to

handle any faster input and output equipments which may be designed in the ensuring years.

It may be characteristic in many firms that once top management have become interested in electronics equipment, they will after a few months wonder why the equipments have not been selected, installed and operating. Quite often there exuberance may have to be held in check when they are not thoroughly aware of the implications of installing electronics equipment; however, at the same time, the analyst cannot disregard the availability of electronic computing equipment. As delivery time is delayed, the more obsolete becomes the originally conceived application for which the electronics equipment was procured; so in evaluating the capability of equipments, the analysts should assess how readily the equipments may be available and the facility with which the installation may proceed.

Much sales literature stresses computing equipment's speed as being one of the basic criteria of a good computing system; however, in building an adequate data processing system, there is little use in having one portion of the system operate at microsecond speeds when the remaining part of the system operates at milli-second speeds. The faster the speed of the computing equipment, the higher will be the price of the system and the greater will be the risk of lower reliability. The desirability for speed should therefore be judged

in light of the processing speed requirements of the remainder of the IDP system. Furthermore, most business type applications are characteristic of volume data processing with relatively little manipulation of data; so there is no real requirement for speed other than in the minds of computer manufacturers.

Perhaps, the least important consideration of all characteristics in evaluating equipment is price. Many manufacturers spend a tremendous amount of money in research and design of highly reliable equipments. On the surface, such highly reliable and well designed systems may appear too expensive, but in the performance that may be gained by the installation perhaps the costs may eventually prove to be more than reasonably priced.

Rating of Computer Characteristics

Before comparing the economies to be gained from individual computer systems, it may be well to eliminate those systems which are undesirable with respect to their general characteristics. The usefulness of any computing system is a reflection of the several previously mentioned interrelated and desirable characteristics. A table of these characteristics may be established in descending order of preference, and a set of values may be assigned each characteristic so as to reflect its particular importance to a firm. The most

desirable equipment will then be that assigned the highest point score. Table I reflects this value assignment system.

The computing systems designated as A, B, and C have no significance toward any particular manufacturer as they are merely examples to illustrate the relationship between the characteristics of computing systems. In constructing Table I and particularly in establishing the value ranges, the following considerations were made:

1. The characteristics were listed in descending order of preference as discussed earlier, and the value ranges were established so as to reflect this order.
2. Most computing equipments will reflect a high degree of adaptability because of the development of special equipments which will convert native language media from one to another. However, in order to accomplish such a conversion of data, additional planning and additional equipment is required; therefore, a range of values is required to reflect this inconvenience.
3. The value range for reliability is established fairly wide so as to reflect the degree of maintenance required and the degree of satisfaction that present users experience in the use of their equipments. Perhaps, also, the value assigned reliability will reflect the time and investments which each computer manufacture has spent on developing their particular equipments.

TABLE I

Evaluation of Computer Characteristics

Characteristics	Value Range	Electronic Computing Systems A	B	C
Adaptability	0 - 15	15	12	10
Reliability	0 - 12	10	8	6
Flexibility	5 - 10	10	10	7
Availability	5 - 7	7	7	5
Speed	3 - 5	5	6	3
Price	0 - 7	3	7	6
Totals	13 - 56	50	50	37

4. The bottom range of values for flexibility is considered as not less than a value of five because, regardless of the system used, there is always available a certain amount of flexibility. A system may be utilized 100 percent of the time; however, additional flexibility may always be attained through purging existing applications of inefficient runs and converting these inefficient or less desirable applications to semi-automatic or manual methods. Most computer runs possess inefficient operations and process undesirable or infrequently used data. Purging the computer runs of this undesirable data requires fairly extensive investments in program analysis, and for this reason, computer users may be reluctant to avail themselves of this potential flexibility.
5. The range of values assigned to availability is fairly restrictive because investments in a large scale computing system and delivery of any of these equipments must be considered in the long run period. Regardless of whether the equipments may be available within 18 months or whether delivery may be delayed up to three years, the long run policy of the company will determine the use to which computing equipments will be implemented and manufacturer's delivery dates may not be substantially reflected in company policy.

6. The speed characteristic range has been established quite narrow because the internal processing speed of an electronic computer, as indicated earlier, does not determine productivity as much as does the input and output equipment; therefore, this range has been so established that any value assigned speed will not bear strongly on the over-all computer assessment.
7. Price, alone, will not necessarily justify computing equipment; however, because management must endorse long term capital expenditure projects, then this characteristic has been given a range which will reflect such a major decision and yet subordinate it in effect to the other characteristics.

An analysis of Table I indicates that computers A and B are equally and highly desirable systems, while computer C may be rejected at this stage because of its relatively low value assignment. Since both computers A and B have the same value assignment, they may therefore both be given more careful consideration. Possibly at this stage of analysis, since either system is desirable, then the only distinghishing characteristic which need be more closely examined is the price of the respective equipments.

Cost Analysis

Having narrowed the selection to equally desirable systems in terms of operating characteristics, a discerning

cost analysis will select the most economically desirable computing equipment. The object of an economic evaluation is to select the range of equipment which will provide the firm with the greatest returns on investment in the long run period. Costs, therefore, provide the basis on which to assess the most appropriate equipment.

Carefully maintained electronic computing equipment may have a useful economic life of 15 or 20 years. Technical developments, however, may produce more desirable equipment within a period of five years; therefore, a long term period of ten years is generally used in computing average costs of production and rate-of-returns on investments.

The economist should firstly establish the long term average costs of production which each equally desirable equipment will produce. This analysis proceeds by selecting a representative work load[6] which reflects costs incurred by

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[6] County of Los Angeles, County Assessor, Evaluation of Bids for an Electronic Data Processing System for Property Assessment and Tax Collection Work and Recommendation of Award to DATAmatic Corporation, Los Angeles 15, California, May 7, 1957. The approach taken by the county was to submit a typical and representative problem of a major application along with specific questions to various computer manufacturers who would assess the time and costs of processing on their respective equipments. Specifically required machine characteristics and equipment complement were enumerated. Having laid out the specifications for a representative workload, and having had the computer manufacturers program and cost the problem on their equipments, the analysts were in a position to compare and analyse proposals and bids. Considerations were also given to intangibles such as programming ease and flexibility. Thus an economic evaluation was

depreciation, power, spares requirements, maintenance, preparation and personnel. Upon this basis, the total costs incurred in meeting maximum production over the long run period are calculated. The long term period is particularly important in this analysis. What may appear to be the lowest average costs of production equipment in the short run may turn out to be one of the highest average costs machines in the long run because of an inflexibility to handle all the applications expected for conversion over a period of ten years. The equipment must possess sufficient flexibility to meet the long term workload requirements, otherwise considerable other costs such as loss of market and increased manual costs may be incurred. The lowest average costs of production machine thus presents one criterion which the economist may present in the survey report.

The economist should secondly establish the out-of-pocket expenses which would be incurred for each range of

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possible on the basis of the costs of processing a representative workload. The county approach may not however be suitable to every application analyses. Not all variable criteria of an application may be adequately simulated in a representative problem and therefore bids may sometimes be misleading. Perhaps, however, such an approach may almost always be justified in its usefulness in orientating company personnel into the particular characteristics of each line of computing equipment. This educational value may be a pre-requisite to a knowledgeable analysis of various computing systems.

equipment over the long run period. Average annual operating costs may then be summarized as illustrated in Table II. These statistics present a second selection criterion.

Next, the economist should present management with a means for comparing the returns on investments expected from computing equipment against returns expected from other capital expenditure projects such as advertising, plant expansion and product improvement. From the statistics summarized in Table II, the economist may calculate the pay back period, i.e. the length of time it will take to recuperate out-of-pocket expenses. The displaceable costs eliminated by implementing EDP equipment will be used in this analysis and a price tag may be assigned intangible benefits in this respect. On the basis of these statistics, the economist may further establish the effective rate of return on investments. These calculated decision criteria will then neatly summarize the results of equipment costing and will present management with sufficient data to select the most economically desirable line of equipment.

Economists, who are costing electronic equipment, should possess considerable knowledge of computer characteristics so that they may effectively evaluate manufacturer's bids. Some bids may be out of proportion to others because of a wrong interpretation on the part of a computer manufacturer as to what specific machine requirements are desired;

Table II

Summary of Annual Computer Expenditures

Computer: Manufacturer	Company A		Company B	
Model	AX		BXY	
Purchase Price	$2,500,000		$1,500,000	
	Rental - Purchase		Rental - Purchase	
Preparation Costs:				
Preliminary analysis & planning	$100,000	$100,000	$100,000	$100,000
Development & programming	250,000	250,000	225,000	225,000
Installation & conversion	150,000	150,000	125,000	125,000
Total	500,000	500,000	450,000	450,000
Capital Expenditures:				
Building - new or alterations	$350,000	$350,000	$350,000	$350,000
Building services	200,000	200,000	200,000	200,000
Total	550,000	550,000	550,000	550,000
Annual Operating Costs:				
Building maintenance	$ 50,000	$ 50,000	$ 50,000	$ 50,000
Depreciation: (straight line)				
Purchased equipment	-	250,000	-	150,000
Preparation costs	50,000	50,000	45,000	45,000
Capital expenditure	55,000	55,000	55,000	55,000
Interest loss 5% of Purchase Price)	-	125,000	-	75,000
Rental (incl. maintenance)	560,000	-	330,000	-
Equipment maintenance	incl.above	50,000	incl.above	60,000
Personnel	200,000	200,000	200,000	200,000
Average annual operating costs	915,000	780,000	680,000	635,000

therefore, evaluation of bids should be done with extreme care and with a knowledge of computing equipment.

In assessing bids, the analysts should fairly determine when quotations have been made for machine characteristics which are beyond the pre-established requirements, and should accordingly adjust such bids so as to bring the characteristics into the acceptable limits. Each range of computing equipment is different in many respects. One computing system may be more automatic, more electronically complex than other types of equipment depending on the particular computer manufacturer's design. Because every line of computing equipment is physically different, the respective bids must therefore be analyzed and weighted according to the required characteristics and valued accordingly.[7] Guiding the analysts in their bids assessments, will be the ease with which the various computing equipments meet the several desirable characteristics: adaptability, reliability, flexibility, availability, speed, and price.

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[7] William D. Bell in his article "How to Evaluate Control System Bids", Control Engineering, December, 1957, p.87, explains the many pitfalls which one may fall into in assessing bids on complex control systems. He lists a number of factors which may be discounted in assessing bids and by which a prospective purchaser may bring diverse pieces of equipment onto a common denominator for fair appraisal of bids. This system of assessing bids may quite adequately be used in assessing electronic computing equipment and will complement and supplement the County of Los Angeles approach.

5.- THE APPLICATION STUDY REPORT

General

The manner of reporting analyses findings will more or less follow the course taken by the application study. Periodic progress reports will be required to substantiate that analyses progress is being directed along the lines expected of the survey. Consequently, the study group's coordinator will be required to report progress to the manager to whom he is held responsible. The frequency and extent of the progress report will depend upon the coverage and prominence of the application under study.

Progress reports are an informal means of communicating the course of action being followed by the analyses; however, documentation of a more permanent nature will be required to substantiate findings and recommendations. The permanent documentation will comprise an application study report. Since top management may be interested in an early indication of whether the application is computer feasible, then a fairly comprehensive report will need to be submitted at that time. If sufficient unused computing capacity is available within the firm for implementing the application, then a complete report may be submitted and the firm may swing into the development phase. However, should additional or new capacity be required then the application study will have to select appropriate additional capacity and make recommendations

accordingly. In this case, the report will be submitted in two parts; the first part to justify the application for implementation onto a computing system and for recommending the use of any available capacity, and the second part for investigating potentially desirable equipments and recommending the specific type of additional or new capacity required for the application. The complete report, whether in one or two parts, should be extensive in coverage, comprehensive in understanding and concise in explanation.

Part 1

The first part of the report will substantiate implementation of the application onto an electronic computing system. The following subjects will be covered in this portion of the report:

1. Narrative
2. Application justification
3. Equipment requirements
4. Potential problem areas
5. Recommendations

The narrative will indicate the intent for organizing the applications study and will high light the extent of the investigations. It will further outline the composition of the study group, their terms of reference and the level of management reporting. It will recapitulate the characteristics and products of the company, outline the present data

processing system, summarize the available equipments and state the long term policy of the firm with respect to development of data processing. Additionally, the narrative will sketch the manner in which the proposed application will fit into long term policy with respect to the development of an IDP system.

The justification portion will outline present operations, alternate processus that were considered, characteristics of the proposed application, an economic evaluation of the application and the requirements for implementation such as the required organization and time phasing details. A summary of present operations should detail the characteristics of source data and of decision criteria, forms and procedures structure, the usefulness of existing files and the shortcomings or obvious omissions of the present system. Application flow charts and supporting documentation are carried as appendices. An outline of the proposed system will indicate those forms and procedures which may be eliminated, required organization changes, how obvious shortcomings have been overcome and a summary of the tangible and intangible benefits.

An outline of equipment requirements should firstly summarize the firm's present capacity and the extent of capacity utilization. Application requirements can then be compared against unused capacity to determine whether additional or new capacity is required. Should unused capacity fall

short of the mechanization requirements, then the group may outline the types of equipment considered useful for the application and the size of capacity required.

The report should not under-estimate the time and difficulties which may be encountered in preparing the application for and implementing the application onto an EDP system; therefore, an indication should be given of the time, expense and personnel which will be required in programming and conversion operations. Additionally, a comprehensive statement should be given of the required supporting electrical communications equipments and the phasing in requirements of these equipments. The report may further indicate potential company dislocations such as employee retraining and orientation, employee displacements, plant relocation requirements and organizational changes.

The recommendations will pinpoint the capacity required, the extent to which available capacity may be used, the amount of additional capacity that is required, continuing analysis requirements and implementation procedures.

Part 2

The second part of the report will be prepared only for investigations pursued in selecting equipments for new capacity. The second part will therefore supplement the first part of the report, and will consist of a short narrative indicating the equipment selected, a justification for the

equipment selected and recommendations with respect to procuring and installing equipment. The narrative will summarize the capacities and types of equipments considered, the manner of analysis, the basis for selection and the recommended equipment.

The computer justification portion will indicate the characteristics used for evaluation and provide an economic evaluation of each range of equipment. A cost analysis of equally desirable equipments will justify the selection of a particular computing system. If a typical sample problem had been submitted to various computer manufacturers, then the results of their submissions and bids will be analyzed and such analysis will constitute a significant contribution in the report. This portion of the report should also present a comprehensive and concise outline of the benefits to be gained from implementing further mechanization supported by a costs-savings comparison.

The recommendations portion should concisely enumerate the line of computing equipment selected, the supplementary auxiliary equipment required, whether to rent or buy with supporting cost documentation, the suggested time phasing of equipment installation and a carefully planned conversion schedule which will illustrate the phasing out of the old application in conjunction with phasing in of the new application and its equipments.

CHAPTER IV

ORGANIZATIONAL EFFECTS

1.- EFFECTS UPON COMPANY ORGANIZATION

Size of Organization

With the expanding use and application of office automation, more firms are becoming concerned with introducing this technology into their data processing structure. Early automation history indicates that considerations for automating data processing functions were restricted to large firms because of the huge capital investments required. However, with development of general purpose digital computing equipment, a wider range of equipment capacity, and the establishment of service bureaus for part-time rental of electronic computing equipment, smaller firms are now able to make use of considerable office automation.

In order to develop integrated system of processing data, a firm will have to consider the steady use of a central digital computing unit. This involves the installation of a small, medium or large capacity machine capable of simulating management decisions in the automatic computation, transcribing, filing and passing of data. Installations of such equipment will entail large capital investments. As indicated in Chapter 3, there are enormous capital outlays

in building requirements, programming costs, conversion costs and in depreciation or rental costs; therefore, these costs will determine the size of organization that could consider developing an automated, integrated data flow system.

Perhaps some indication of the size of organization that could justify an automated data processing system utilizing a large capacity electronic computer may be determined. Assuming that a firm would experience displaceable costs of 15 percent of total gross revenues and fixed operating annual costs of $750,000.00 as a result of installing a large scale electronic computor, then the firm's total gross revenue would have to exceed $5,000,000.00 annually before reaching the break-even point where additionally incurred expenses are covered by the reduction in displaceable costs.[1] Intangible benefits may warrant lowering of the $750,000.00 break-even point; however, for the purposes of this discussion such benefits will be ignored. In this analysis, the manufacturing firms in Canada who report production statistics to the Dominion Bureau of Statistics will be

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[1] This will vary considerably between firms. A firm with a high ratio of fixed to variable costs will have a much lower percentage of gross sales which would be subject of displaceable costs, whereas with a high ratio of variable labour costs in comparison to fixed investment costs, a firm would experience a higher potential for displaceable costs and therefore would require much lower gross revenues in order to reach the break-even point.

considered.[2] The number of manufacturing firms experiencing total gross revenues exceeding $5,000,000.00 annually from 1939 to 1956 are indicated in Table III. In the 18 years for which statistics are shown, firm with annual turnover exceeding $5 million have averaged an increase of 30 firms per year. On a percentage basis, the average increase in number of firms over the preceding year is 15 percent as compared with the total manufacturing establishment increases of only 2 per cent. Therefore, it would seem that considerable scope exists within the Canadian economy for installation of large scale EDP equipment and that this scope is increasing year by year.

The increasing potential for large scale EDP installations may be further substantiated by a look at the cumulative production distributed by size of manufacturing establishment, where size is determined by annual gross value of production, as illustrated in Figure 8. In this chart, the impact of large firms in taking an increasingly larger portion of total manufacturing production is even more strikingly evident. However, manufacturing production is only part of

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2 There is a notable lack of production statistics in Canada; reporting of production is on a voluntary basis and useful statistics thus attained are only within the manufacturing industries. Even within the manufacturing industries some bias of statistics results because of reporting only from firms employing 15 persons or more; therefore, most of the small industries production statistics are not included.

Table III

Number of Manufacturing Establishments
by Gross Value of Products

Year	Gross Turnover $5 million annually or larger			Total Establishments Reporting	
	Number of Establishments	Increase Over Preceding Year	Percent Increase Over Preceding Year	Number of Establishments	Percent Increase Over Preceding Year
1939	81			24800	
40	123	42	52	25513	3
41	198	75	61	26293	3
42	278	80	40	27862	6
43	281	3	1	27652	-1
44	287	6	2	28483	3
45	266	-21	-8	29050	2
46	259	-7	-3	31249	8
47	346	-13	34	32734	5
48	381	35	10	34134	4
49	421	40	10	35792	5
1950	470	49	12	35942	0
51	568	98	21	37021	3
52	558	-10	-2	37929	2
53	592	34	6	38107	0
54	567	-25	-4	38028	0
55	628	61	11	38182	0
56	695	67	11	37428	-2
Averages:		30	15		2

Source: Canada, Dominion Bureau of Statistics, Canada Year Books 1943-1959 incl.

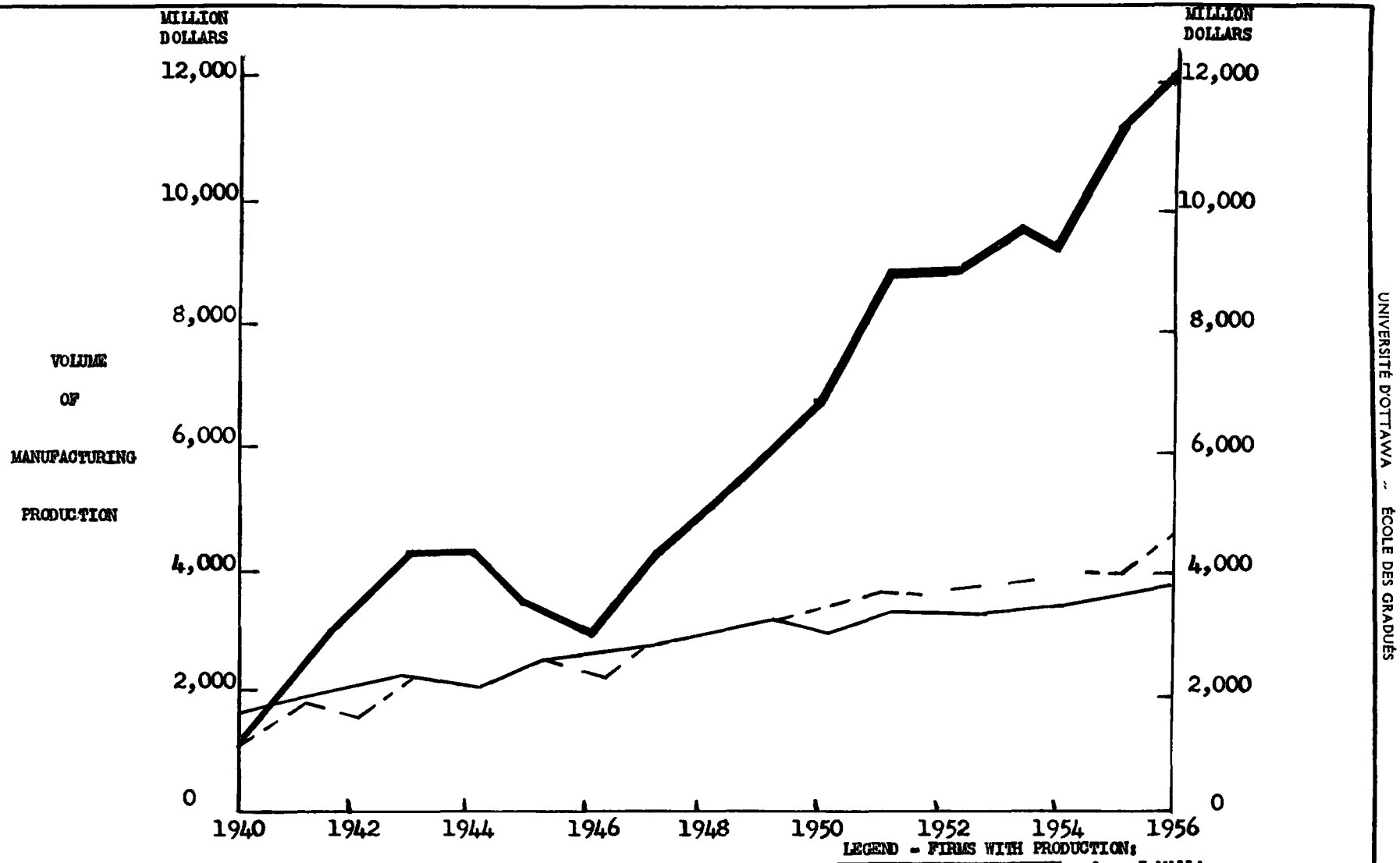

Figure 8. Sharing of Total Manufacturing Production by Size of Firm

Source: D.B.S., Canada Year Books 1943-1959 incl.

the gross domestic production. Statistics[3] for the years 1939 to 1958 indicate that manufacturing production as a portion of gross domestic production at factor cost has fluctuated between 24.6 percent and 31.8 percent with a constant fluctuation about an arithmetic mean average of 28.3 percent. During these 20 years, manufacturing has not shown any significant change in sharing of the total gross domestic product. Should the swing of production in other industries show a pattern as indicated by the manufacturing industries toward large firms, there will be tremendous possibilities for large scale EDP installations in future years. However, such a potential may not be in such proportions as indicated by this reasoning, because much of the remaining 71.7 percent of domestic production is taken up by the agricultural, extractive and service industries which industries by their nature could not utilize as much office automation as could the manufacturing industries.

Capitalization Requirements

The expanding use of office automation may result in an increasing requirement for capitalization on the part of firms. As more investments are tied up in capital equipment, then larger depreciation and obsolescence reserves are required; therefore, the more a firm is forced into using office

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[3] Canada, D.B.S., National Accounts Income and Expenditures, 1926-56 and 1958, Table 21.

automation, the more rigid their capitalization structure becomes. Other factors are however also contributing to a growing capitalization requirement. The stronger demands of unions for a greater share in the distribution of income requires larger welfare reserves. The trend toward larger firms means more production facilities, a search for new market areas, dispersal of production functions into frontier market areas, a greater clerical work force and a more elaborate management structure, all of which contribute to demands for increased capitalization.

These mounting capitalization demands may have a tendency toward extending the forecast period of a firm. This relationship can be graphically illustrated as in Figure 9. In this chart, curve CC represents the average costs of production which are normally experienced prior to implementation of an EDP system. Curve KK, on the other hand, includes the costs of curve CC plus the additional costs incurred as a result of implementing EDP equipment and of increased union demands less the displaceable costs eliminated as a result of implementing electronic computing equipment. These additional costs are: training costs, programming and implementation costs, management incentive costs, production reserve and depreciation costs, increased workers severance benefits and guaranteed annual wage clauses.

Curve MM reflects a degree of uncertainty costs which

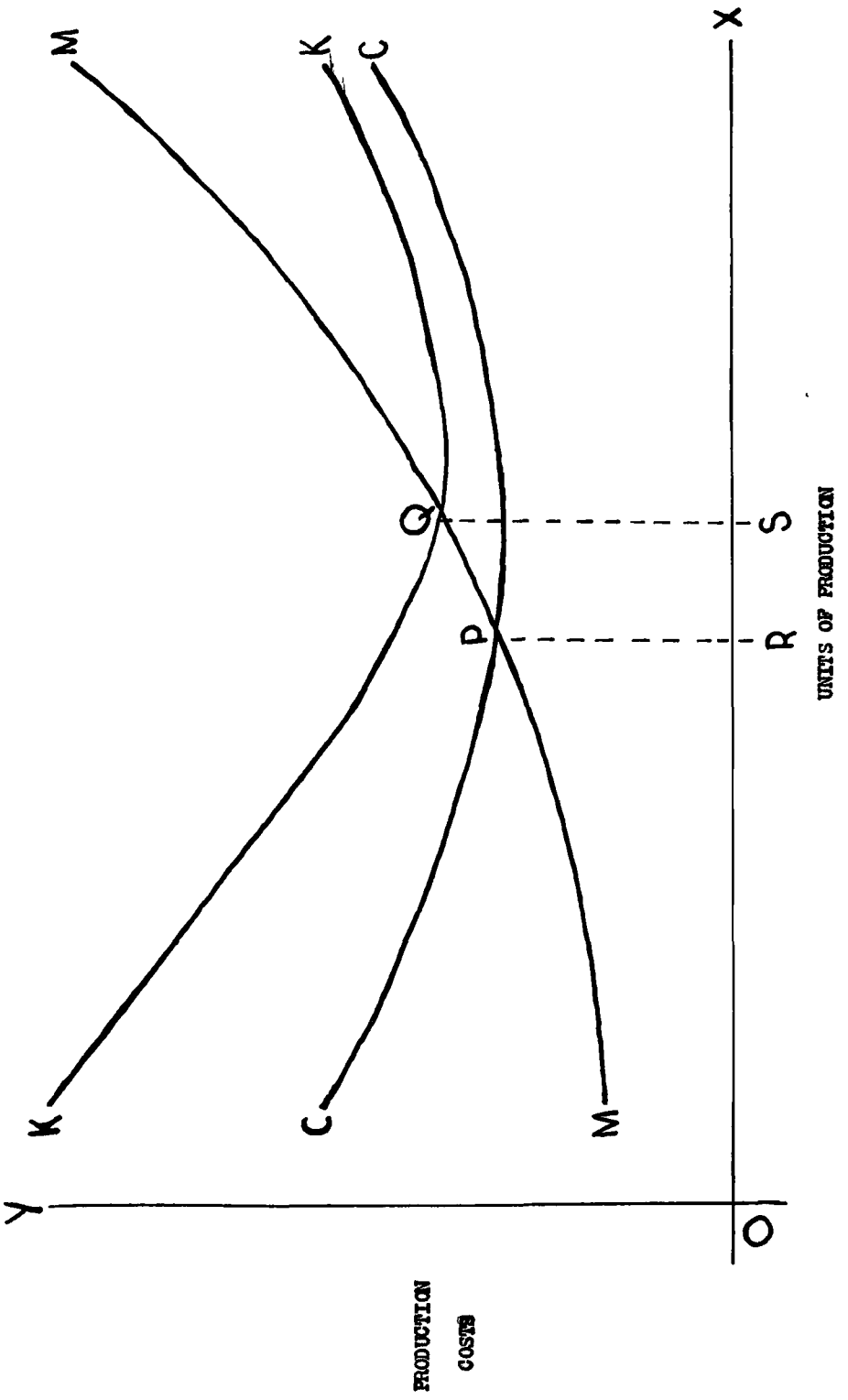

Figure 9. Determination of a Firm's Forecast Period

face a firm in expanding production over the long-term period. These costs reflect what it would cost the firm should it error in estimating the type of product design and experience obsolete product costs or should it lose some share of the market through not automating; therefore, curve MM reflects changing consumers demands, changing product designs, uncertain availability of raw materials, automation obsolescence costs and changing fiscal and monetary policies. As the length of the forecast period is extended, then more risks are assumed by the firm and therefore uncertainty costs will mount at an increasing rate.

Normally a firm would plan for OR amount of production prior to the installation of electronics equipment; but as additional costs are incurred and increased capitalization is required, the firm must extend the forecast period to allow for increased production RS and extend production to OS. The effect upon the firm is a tighter and more precise planning of expenditures, of production research and of purchasing. Increased demands are placed upon the management function. A larger firm is required because of the demands for increased capitalization and the increasing specialized functions facing management. The net effect is the amalgamation of smaller enterprises into larger organizations, plowing back of profits into an organization so as to build up larger reserves and absorption of more market demand by the larger firms.

The more expansive application of office automation will also affect the production process. The switch from variable to fixed clerical costs and the increasing union demands for welfare benefits will result in a steadier rate of production. The greater a firm has investments in capital equipment and the more a firm is penalized for laying off workers during slack production periods, then the greater is the incentive for a firm to even out its flow of production. The same situation will exist when considering production expansion as a result of increased demand. A firm must plan for the day when the increased demand falls off and must therefore think twice before expanding production too quickly. The firm must, however, still be flexible to market conditions and perhaps even more flexible than ever before, because a delay in switching production from one design to another means a far greater amount of obsolete production. The greater a firm becomes mechanized, then the more quickly they must respond to market conditions in order to minimize obsolete production. Since obsolete production is a mounting factor in the long term planning of an organization, firms will probably be less inclined to induce a change in market demand toward new products. There may be a switch in the amount of advertising from new products toward expounding the advantages and qualities of presently produced goods.

With increasing demands upon the capitalization of a

firm, business faces a narrowing profit margin and so a challenge exists to increase productivity so as to forestall closing of this gap. A firm is being constantly pressed to increase productivity and must therefore spend larger sums in research and development in looking for new techniques of production. Perhaps, the expanding application of office automation may help to bridge the gap between increasing costs and levelling out of production returns. The challenge to the firm, in attempting to maintain their profit margin, will probably have the long term effect of evening out production and this will in turn have dampening effects upon business cycles.

Intercompany Business Relationships

The business relationships which companies experience with one another will change as a result of automating office procedures. In vertically integrated organizations, there will be an increasing incentive for automating the passing of data from one organization to another. It is highly desirable that the data processing systems of each organization be made compatible. Economy is the key note in integrating functions on a vertical base, and one of the key areas in which extensive economies can be achieved is in eliminating procedures that are duplicated between firms particularly in the recording and processing of paper work. This will entail the standardization of forms and procedures, combining the job analyses and systems research functions, sharing of computer time

between companies and considerable other closely correlated functions.

A horizontally integrated business relationship involves numerous individualistic companies, each possessing distinctly unique data processing systems which have developed over the years in the light of the particular requirements within each organization. Additionally, the functions of each company have little in common with one another other than the common ownership control. Data processing functions from one company to another will therefore not have as much in common as would companies combined in a vertical relationship. Attempts to integrate such individualistic data processing systems may then achieve less usefulness than in retaining multiple autonomous units even if considerable duplication of administrative processes does exist. The fact is evident that there is not the problem of overlapping, similar operations in horizontal integrated units as there would be in vertical integration where processes are successive and interdependent in nature; therefore, optimum economies in the paperwork flow function may be obtained by retaining separate data processing units using smaller capacity EDP installations.

Firms are furthermore involved with communications of data with businesses outside any integrated business relationships and with government agencies. A skeleton of manual procedures will therefore always be required in effecting

such business dealings. In considering automation, therefore, an organization will need to look outside its own immediate operating problems and consider the structure of business relationships experienced with other firms. This means closer business ties and a lessening of the firms autonomy within the business world. Firms will become even more dependent upon one another and will need even closer and more precise working relationships.

Department Autonomy

As an organization adopts an IDP system, department functions in respect of data processing will become less autonomous. Departments will develop an increasingly closer relationship to one another as members of one whole system instead of a combination of individual autonomous entities. Unit managers will in effect lose control of their data processing design functions and will be relegated more to supervision and administration. This is not to imply, however, that their responsibilities will diminish. Experience indicates that many organizations have administrative problems which they do not have time to consider. As more menial data processing tasks are assumed by automation, then more time will be available for supervisors to explore these long forgotten administrative problems. Therefore, although he loses autonomy in some respects, the departmental manager gains more responsibility in other respects.

2.- THE DECENTRALIZATION PROBLEM

Conflicting statements have been made concerning the effects of office automation upon decentralization of business. Some statements claim that office automation assists in decentralization while other statements give the opposite conclusions. Perhaps these conflicting opinions are a question of semantics or a misunderstanding of terms; therefore, it may be wise to establish what we are referring to when we talk of decentralization. We must look at those functions of an organization which are subject of the decentralization controversy.

The Operations Function

The primary function of any company is production. An organization is established for producing and selling a product or service. Operations in support of this primary function are those which are necessary for maintaining a coordinated complex of production facilities. Such functions are the coordinating and controlling, and the record keeping and servicing functions.

Centralization of production depends primarily upon the advantages to be gained from mass production, location to markets, location to labour supplies, location to power resources and cheaper land facilities. These are factors which concern the dispersal of an organization in order to achieve production economies and these are factors which are greatly

influenced by the effects of factory automation but to a much lesser extent by office automation. As labour saving devices are more extensively used within an organization and a higher ratio of capital investments to gross sales is experienced, a company will show a gradual shift from variable to fixed costs. The increasing ratio of fixed costs will provide a firm with more incentive to achieve economies in production; therefore, as more factory automation creeps into an organization, there is an increasing incentive to physically disperse the operations function.

The Controlling Function

Parallel to the physical dispersion of production is the increasing importance of responsibility and authority. Should physically dispersed production units be self-autonomous operating units? This problem concerns the delegation of responsibility and authority without forfeiting centralized planning and control.

A complex organization may have the functions of coordination, control and planning effectively split into two management levels - top management and middle management. Middle management may be assigned the short term operating responsibilities of purchasing, warehousing, sales, production, and budgeting. They are responsible for combining the available factors of production in such a way as to achieve a least cost combination of production in the short term period and

also for analyzing market conditions and designing compensating production and sales policies. The controlling function at middle management level involves possessing a current knowledge of operating conditions and being in a position to have their decisions effectively instituted.

As an organization grows in complexity and size, more of the operating responsibilities may be delegated to middle management. The greater this delegation to subordinate management, the more encouragement will be given toward management specialization. Specialization is enhanced by short communication lines. The farther an executive specialist is removed in a communication sense from his source of management data, then the more difficult his task becomes in assuming management functions within operating limits; therefore, the closer must be to the operating functions. As this communication barrier is decreased through raising the level of office automation, then more effective management control may be established. By encouraging management specialization and being open minded with respect to developing management techniques, top management assure themselves of more time in exercising their responsibilities of planning and control.

Operating departments are normally dependent upon one another for ideas and statistics which are communicated by means of reports or on a personal basis. Distance and time are factors which slow up the communication of such matters.

Ideas are best transferred by personal contact; however, statistical data such as current operating statistics, warehousing statistics and sales progress may just as easily be transferred by mechanical means. This is the area in which office automation may assist the decentralization of functions which previously had been in close proximity because of a lack of communication facilities. Therefore, it would seem that automation will contribute to decentralization of those staff functions which are not dependent upon one another for verbal or personal communication.

Record Keeping

One aspect of an organization which is common between departments and which may be classed as a service to the firm's primary function is the record keeping function. This concerns the maintenance of statistical data so as to facilitate operations from one time period until another. Such a function is a necessary and costly expense of running an organization and becomes more expensive as the size of a firm increases. The mountain of paper work required to run an organization appears to increase at a more rapid pace than does the size of a firm; therefore, this is one critical area in which potential costs reductions may be accomplished. This is an area where office automation provides such an important potential for cost reduction.

A close look at the data processing functions of any

organization will point up numerous situations of handling data which are duplicated from one unit to another. The establishment of an IDP system will eliminate many of these areas of data duplication. Once data has been captured in a mechanical form as a necessary part of an IDP system, then it may be stored any place in the system. As long as operating departments have access to historical data in a reasonable amount of time, they are not concerned with where or how data are actually maintained. The techniques of office automation are such that record keeping can be maintained on a centralized basis in areas physically removed from the operating departments. Office automation, therefore, facilitates the separation of the record keeping and operating functions and contributes to decentralized operations under centralized planning and control.

3.- MANAGEMENT ASPECTS

Management Flexibility and Control

In implementing ADP into an organization, there will undoubtedly be organizational and management changes. The minds of management should be open and receptive to these changes. Management is a dynamic and exacting science and must be flexible to change.

Like any other factor of production, management is subject to innovations and new techniques. The techniques

of management were not of much concern to the 19th century individualistic entrepreneur. As organizations developed and became more complex and difficult of managing, however, the techniques of operating business became more complex. More variables of control were experienced and management developed into a combination of interdependent sciences such as control, financing, engineering and product research, all of which were gradually delegated to specialist officers. The effects of automation have been to add the techniques of systems and procedures development to the specialist functions. Implementing automation requires a precise and exacting data flow system development in order to obtain maximum utility from the installed equipments. This is a full-time job, one requiring knowledge and experience of available and developing electronics equipment and one requiring a dynamic interest in systems techniques. However, organizing a system and methods group so as to inject flexibility into the controlling function will not relieve management of their controlling responsibilities.

The experience of many EDP installations indicates that one characteristic common to nearly every one is a lack of management control. John Diebold and Associates Inc., of New York, in a survey during the latter part of 1958 of some 200 EDP installations operating for six months or longer came up with some interesting observations. The results showed

"that we have been very loose and very sloppy in the management of data processing activities."[4] Recurring instances showed considerably higher operating cost than anticipated. Achievements in many cases did not approach the anticipated results. Mr. Diebold summarizes the basic reasons for installations not achieving the expected performances as lack of planning and imagination on the part of management.

Management control can be enhanced by extensive delegation of operational functions as the firm grows in size, by setting standards of performance in which subordinate management are expected to operate, and by removing themselves from operating details through adoption of the management by exception principle. Further, by adding automation for rapid processing of decision-making data, top management may effectively widen their span of control.

Integrated Data Processing Concept

In order to extract the greatest potential from a system, management should actively support an IDP approach to analysis and design. Unless such an approach is taken rather than a piece meal approach of automating one section at a time, then the chances are that an incompatible data system

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[4] John Diebold, "Bringing Management to Electronic Data Processing", Ideas for Management, The Systems and Procedures Association of America, Detroit, Michigan, 1959, p. 103.

will result. Physically separated data processing units will find that their procedures are not compatible with one another nor compatible with the central EDP unit. Such incompatible data systems are the result of misunderstanding by top management of the concept of IDP.

Any system being implemented should have been designed from the bottom up, rather than from the top down. Experience in many cases will indicate that when management decides on a system and thrusts it upon the data processing units without taking proper cognizance of processing limitationsof the scattered units, then incompatible situations will result. Such incompatible systems may be obviated, however, by management backing of an exacting and thorough analysis of the entire existing data flow system. With the knowledge gained from this analysis, the management planning group may then design a new system knowing very well what resulting effects there will be at field units level. Operating directives will reflect all the problems in the field and will make allowances for inconsistencies such as the procuring of additional or different types of equipment, retraining of personnel and revision of existing procedures. Then and only then will a truly integrated approach have been taken and a compatible system designed.

By accepting the IDP concept and actively supporting such an approach, top management can assure themselves that

an efficient data processing system will be designed. This approach will firstly eliminate those procedures which contribute nothing to the over-all system. This involves cleaning up the reporting system, producing and eliminating inactive files and duplicated procedures, improving the accuracy and speed of reporting , and realigning procedures to complement one another and support one another in the processing of data. Management must realize that a well designed system will reap benefits and present less obstacles even if it takes longer in developing. By designing an integrated system which benefits the organization as a whole, then the primary reasons for implementing automation, that of reducing costs and of providing more effective management data, will have better chances of success. Furthermore, an actively interested management will sew the seeds of inspired support throughout all levels of the organization. The new system will therefore be received by operating personnel more understandably and happily, and the greater will be the chances for its successful implementation.

Management Fears

Management's concern and reluctance toward office automation stems from the many problems encountered in equipment maintenance, the high installation costs, the time consuming installation period, the interim - period production disruptions, the specialized nature of automation equipment and the variety of machines to choose from.

Any maintenance breakdown of integrated office equipment may result in serious production set-backs, developing bottlenecks, tremendous losses in tied up inventories and delayed production schedules. The greater the degree of mechanization, the more dependent the data processing function and thus the production process is upon good maintenance. However, much of this fear may be dissipated by a high degree of preventative maintenance which may be carried out during the silent hours or during slack production periods.

The extensive installation period leaves management to shudder this phase of operations, and management should not be lulled into thinking their fears are unfounded, for as Mr. John Diebold states:

> Careful study of almost every major data - processing undertaking, the most successful as well as the failures, reveals a consistent under-estimation of the investment in time and in money that must precede office automation.[5]

The less thought, analysis and planning given during a survey phase, the more critical and extensive will be the problems encountered during the implementation phase. Unless the survey has been done, then the phase of implementing automation equipment will be severely handicapped by the need for going back over and designing a system which would be compatible to the equipment. Such back-tracking and redesigning

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[5] John Diebold, "False Starts in Office Automation", The Management Review, July 1957, p. 81.

of procedures may be a very lengthy, involved and costly process.

Production dislocations, retraining and relocation of personnel displaced as a result of automation, the many variable factors to be considered in installing such as new buildings, auxiliary installation and lighting equipment, all contribute to uneasiness amongst management personnel. The specialized nature of automation equipment may very well present further fears to management. This is like "putting all your eggs in one basket". The more specialized the equipment, the more dependent the firm becomes upon the manufacturer of the equipment to provide good maintenance and to provide the latest technological developments. The large variety of machines present management with further problems of deciding which equipment is more applicable and more dependable and which manufacturer is most apt to keep abreast of technological developments.

It seems evident that management's responsibilities and concern will be increased through automation. As variable clerical costs swing toward the fixed costs of capital expenditures incurred for automation, the more will the organization become dependent upon steady production, less loss of time through strikes, competitive advantages and less violent economic fluctuations. The firm must become more static and must prove itself less subject to swings in the

economy; therefore, management's responsibilities are increased in ensuring and developing an organization which will become less subject to the economic climate.

4.- SUPERVISORY STAFF

Effective Supervision

As the general level of office mechanization increases throughout an organization, there will be need for more effective and understanding supervision.

As more automation is introduced into office procedures, the greater will be the separation of the clerical staff from the in dividuality that has been characteristic of their close proximity to their work. Introduction of office automation implies a greater emphasis on integrated procedures; therefore, increased attention will be placed on the coordination of office procedures. Clerks will be required to work closer together as a team in a family relationship atmosphere rather than in the manner of individual work relationships. Supervision will require good leadership and more effective coordination of activities. Supervision will also become more difficult in being able to assess the productivity of individuals working together rather than apart on specific individual tasks.

As office functions become more closely coordinated because of integrated data requirements, then more precision will be expected of the supervisor in scheduling workloads

and in recommending corrective action in catering to peak loads.

Unless a method is established for allocating work effort, for distributing workloads, for evaluating clerical performance and for scheduling work and predicting work requirements, then effective supervision will not be possible and clerical efficiency will not be high. This problem may be somewhat solved by a suitable work measurement program; therefore, the supervisory staff will be required to determine methods for work simplification. The benefits to be gained by delving into the scientific aspects of supervision are evident. Some of these advantages are:

1. Individual productivity can be measured.
2. By having methods of measuring individual productivity, a base is provided for assigning tasks according to an individual's capability.
3. A base is provided upon which to recommend rewards in the manner of pay increases or promotions.
4. Total office productivity can be measured.
5. More accurate scheduling of the workload can be attained.

Capturing Data

An IDP system relies heavily upon the accuracy of data which enters the system. Once data has been captured in a mechanical form, very few errors occur so long as the

data are processed in a mechanical form; however, any errors existing in the data at the time of capturing in a mechanical form will be perpetuated throughout the various data processing stages. Therefore, there is an increasing responsibility placed upon the supervisory staff in ensuring that a minimum amount of errors enter the system. There must be more exacting requirements as to what enters the system, and more critical controls placed on the maintenance of a high degree of accuracy; so, there will be a greater need for more precise supervision in the area of capturing and collecting data for an IDP system utilizing automation equipment.

Coordination

In an integrated system, each phase of data processing is dependent upon one another in many respects: the standardization of forms and pro cedures between units, the compatibility of common language media between processing stages and the maintenance of coordinated schedules between stages in the processing of data. Because of this interdependency of operations, there is a need for closer coordination of activities between processing phases. This requires considerable planning and supervision in the analysis of methods of processing data and an increasing requirement for knowledge in the developing technologies within the field of office automation. Therefore, good supervision will require an extensive knowledge of data processing concepts, of developing techniques within the

field, and of a continual analysis of the system in light of these developing technologies so as to obtain and maintain an optimum utilization of equipments. Office supervision will require a more enlightened and educated person than required under less mechanized methods.

5.- GENERAL OFFICE STAFFS

Changing Job Content

Office automation equipment will perform monotonous and repetitive tasks more efficiently and accurately than by manual methods; so, there will be a tendency to reduce the number of tasks performed by manual methods as automation is introduced into the office. Because the simulation of office procedures by data processing equipment requires considerable planning and analysis, there will be a trend toward shifting of personnel from monotonous office jobs to the more creative work of designing and maintaining the automated system. There will be an evident shift in the job content of clerical staff from monotonous toward more creative work.

Because of this shift from manual operations, there will be changes in job classifications which will generally result in the upgrading of personnel. The clerical operations of running and filing can be readily adapted to office automation equipment; therefore, the clerks who do the running and filing functions will be released from their tasks and

will more than likely become schedulers. They will be responsible for the collection of data that goes into the system on a tighter schedule than required under manual processing methods. They will be responsible for maintaining the accuracy of the data that are collected. At the time, they will be responsible for disseminating the output data from the automation equipment, and ensuring that any feed-back information is brought back into the data processing system as expeditiously as possible. As schedulers, their work is more precise and more determinant of data processing efficiency than as runners or filing clerks.

The adoption of the management by exception principle will mean less correspondence of ideas between offices in the form of memorandum and letters. There will be less need for typists' services. However, there will be a greater requirement for translating data into a form acceptable by the data processing system. There will be a greater need for creating common and native language media which may be digested into the system. Therefore, typists will need to become more familiar with a greater variety of office equipment and with methods for preparing data as input to this variety of equipment. The nature of the typists' job will change from that of knowing only one machine to that of knowing and understanding the operations of a variety of office equipment.

The bookkeeping function of posting transactions to

ledgers may be easily simulated on office equipment much as are the filing operations. Therefore, there will be less requirement for the normal bookkeeping function of posting transactions, and a greater requirement for auditing in respect of the automatic posting and processing of operations. The bookkeeper's responsibilities will shift from the manual tasks of ledger posting to the more creative tasks of supervising operations and testing or sampling, much as an auditor would, the accuracy and content of mechanical processing of data.

The accountants will have their responsibilities shifted from the auditing and bookkeeping aspects more into the responsibilities of system analysts. The accountants will be required to continually analyse the measures of processing data, to analyze developing bottle-neck areas and to recommend remedial action, and to keep abreast of developing technologies so as to recommend further methods for increasing the level of office automation and of raising the efficiency of processing data.

Worker's Fears

The introduction of automation poses some real fears to the clerical staff. A clerk isprimarily concerned with his job. Is he going to be displayed by automatic equipment? Will he be required to learn new skills? Must he move to a new location? Will his job be down-graded? These and other

problems are of great concern to the clerk; however, his basic fear is one of the unknown.

The clerk's fear may also stem from the knowledge that he will become further removed from his identity to the processing of a particular function. As more automation is introduced into an organization, there will be a loss of individuality in relating personnel to specific office operations. Clerks will find themselves becoming a part of a team rather than individuals in relation to their work. As a data processing system becomes more automatic and integrated through utilization of automation equipment, the work of clerical personnel becomes more closely related to one another. More standardization of procedures is required so that clerks will become aware of functions performed in other offices and so that they may quickly be switched from one office to another so as to cater to fluctuating peak load requirements. The maintenance of a data processing system requires more than ever for people to know what each other is doing so as to eliminate duplication of effort and attain high processing efficiency.

Worker's fear may also result from erroneous knowledge that there is a one for one displacement of personnel as a result of the introduction of automatic equipment, i.e. if the automatic equipment is advertised as being able to replace ten clerks, then ten clerks will be displaced and will

lose their jobs. However, this one for one type of displacement does not in fact result. The introduction of automation may directly replace 10 clerks, but there are jobs created in other functions of the organization as a result of the improved management data and in other industries that support the automatic equipment. The industries that supply spares and parts to the computer manufacturers, the computer manufacturers themselves requiring personnel to produce the computing and automatic equipment, and the subsidiary industries that spring off as a result of this new production, all supply jobs where no jobs existed before as a result of the increased production of automatic equipment.

The worker's fears may therefore be unfounded. This fear could be considerably dissipated by a thorough employee educational program with respect to the implications of automation. Furthermore, considerable advance planning in devising means of easing the separation of displaced personnel may prevent an indignant strike. The more time that displaced persons have to look for new work and the greater their severance benefits in supporting them during a period of unemployment, the less disposed they will be toward fearing and rebelling against introduction of such an innovation as office automation.

Leisure Time

As the benefits of automation are felt through

increased clerical productivity, there may be a reduction in the number of hours that need be worked in accomplishing the same amount of work. This may result in a decrease in the numbers of personnel employed or an increase in the amount of leisure time available.

There will be a reduction in the number of clerical personnel employed unless these people are absorbed in more creative work, retrained and employed in other jobs, or a policy of working less hours is adopted so as to maintain the level of employment. The results will probably be a combination of all three. It has been shown that as automation is increased within an organization, there is a change in the job content of individuals more toward creative work and away from manual jobs. Experience has shown that the installation of office automation has not resulted in any significant lay off of personnel. Normal attrition has taken care of most of the personnel whose positions had been eliminated; however, company policy in most instances stresses the fact that personnel have been re-employed on other jobs and that the character of jobs themselves have resulted in gradual upgrading of personnel.

Another method of sharing the benefits of increased productivity in the form of less hours worked has in recent years been the target of union demands. The larger unions have gone on record as aiming toward the 30 hour week. As

these union demands become realized, there will be further union demands for less than a 30 hour week and the trend will continue. Consequently, there will need to be a continuing rise in productivity so as to offset the increasing amount of leisure time and still maintain or show improvement in the standard of living. In respect of clerical workers, office automation will help fill this gap.

Feelings have been stated that the more leisure time people have, then the more their time drags and the more likely they will become discontented with themselves, with their families, and with their work all of which reflects in the efficiency of their work. In order to maintain clerical productivity, an organization may therefore have a social obligation toward the employees in respect of this extra leisure time.

Perhaps this problem may be attacked by encouraging people to stay in school longer and raise their level of education. The benefits from such a program are evident. With the increasing shift of industry from primary to secondary, and then to tertiary industries, there is a developing requirement in the Canadian economy for more elaborate mechanization of industrial processes. There is a correspondingly increasing demand for more skilled management specialists. Such people will require higher levels of education than was required in the primary industries. Therefore, increasing

the length of time that people stay in school will provide a partial solution for the extra leisure time made available through introducing automation, and will at the same time provide the educational requirements for future methods and procedure specialists.

This same effect may be attained by allowing office workers to retire at an earlier age. As people become older, they develop hobbies and interests which consume more of their idle time than would happen in earlier years; therefore, they will want to devote more of their time toward these extra curricula activities. Such time could be created by allowing clerks to retire at an earlier age and thus release some of the pressure of potential unemployment which could result from increased use of office automation.

However, as more people become involved in leisure time, then more facilities will need be provided for stimulating and holding their interests in the form of recreation, cultural and educational facilities. Leisure time without these facilities will be meaningless and more disastrous than ever. Therefore, governments will also have to concern themselves with developing such facilities. It appears that governments as well as industry have an obligation toward office personnel as the economy experiences in creasing use of office automation.

SUMMARY AND CONCLUSIONS

Economics has a substantial part to play whenever a firm is considering mechanization of its clerical processes. Office automation involves the long term allocation of capital expenditures in seeking an optimum combination of productive factors. It is concerned with the administrative processes, the character of a firm's productivity development, the industry's expansion potential and organizational repercussions; all considerations of which involve basic economic analysis principles and therefore demand the services of a company economist.

Because of the varied and extensive repercussions which may result from its introduction, automation must be approached from a what-benefits-the-system attitude. All production factors must be considered in light of potential benefits; therefore, an initial approach should be a comprehensive assessment of an organization in order to establish the characteristics of present processes and to determine areas of potential improvement. These areas may then be given subsequent rigorous analysis to determine automation feasibility.

System and application surveys are basically an economic analysis of the efficiency of present and proposed operating procedures. In survey work an economist's deliberations

will be directed towards achieving a least cost combination of production factors in the long term period, and is influenced by a knowledge of factors outside the firm such as union demands and latest settlements, changing trade relationships, government policies and population growth. He may build these variables into an experimental business model and, by projecting each, establish a pattern of possible development characteristics from which he may assess the part that office automation might play in a firm's growth.

Within the firm, organizational and human problems will be of major concern to the economist. Union demands for increased severance benefits and guaranteed annual employment are changing the character of clerical costs from variable to fixed costs of production. Firms are therefore concerned with utilizing displaced labour resources in other positions and must provide allowances for retraining and relocating personnel displaced directly as the result of introducing office automation.

As the character of production costs switch from variable to fixed as a result of increasing capitalization requirements and union welfare demands, then the slope of the average costs curve will gradually decrease over the long run. A firm is thereby influenced into lengthening the production process and in establishing a longer forecast period, the cumulative net result of which will be a significant

dampening of seasonal fluctuations in business activity. Office automation will therefore contribute toward a more uniform and substantial rate of economic growth. However, the social upheavals caused by inadvertent and carelessly planned installation of office automation may more than offset any benefits which may accrue to a firm and may subsequently adversely effect a firm's development program; therefore, it behooves economists to study the full potential of mechanizing office procedures and to carefully analyze the social and economic implications.

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APPENDIX 1

ABSTRACT OF

An Economic Approach to Office Automation

Traditionally, the approach to office automation has been a scientific approach coupled with management indifference and reluctance to be involved in economic pre-implementation evaluation. The results are discouraged and disillusioned top management personnel, inefficient and costly electronic computing installations and occasional revisions to manual data processing methods. Such costly mistakes tie up large sums of capital and resources which could have been productively utilized if allocated to other worthy projects; therefore, an economic approach cannot be easily dismissed. In the long run, it is profits in terms of dollars which must vindicate such a major project.

The initial approach to automation is to take a good look at the efficiency with which the present data processing organization operates. On this factual basis, an economic appraisal can then determine potential areas or applications for mechanization and other areas in which overmechanization may exist. Simultaneously, other methods for increasing clerical efficiency, and thus data processing and organizational efficiency, can be delineated. This approach is taken through what is commonly called the system survey.

A more discerning and analytical evaluation must be taken of potential automation applications than time warrants during the system survey. This analysis, the application study, is carried out subsequent to the system survey and is done on pre-selected areas in order of required urgency. Other potential applications may of course be presented at any time and may be given priority by management. The phasing of and responsibilities for system analysis and application assessment are so inextricably similar that participants in these studies will in most cases be the same individuals.

Overshadowing the basic long term accounting considerations are the social and economic aspects of organizational changes and economic repercussions. The nature of a firm's organizational structure may be so radically altered as to offset any implementation benefits and preclude installing any office automation. The considerations for implementing office automation equipment are so entangled with a firm's economic potential as to demand discerning and continuous management analysis as performed by a group of specialists economic advisors. An approach to office automation must therefore, by necessity, basically be an economic approach.