1958

Automation in accounting through electronic data processing

John Edward Traylor

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AUTOMATION IN ACCOUNTING
THROUGH ELECTRONIC DATA PROCESSING

A Thesis
Presented to
the Faculty of the School of Business Administration
The University of Richmond

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Business Administration

by
John Edward Traylor
June 1958
PREFACE

The giant computers no longer rank as a laboratory curiosity or a frightening science fiction robot to business and industry. Businessmen, hard-pressed for clerical help, have adopted automatic help in accounting offices and wherever else the flow of data is straight-line in nature such as to permit machine intelligence to supplement, or even replace, human intelligence.

This thesis is an effort to describe the economics and appraise the effectiveness of the applications of Electronic Data Processing to accounting functions. It is the writer's desire to avoid discussion of many of the technicalities associated with automation, and to explain what an Electronic Data Processor will do rather than how the processor works.

Public accounting firms have experienced an evolution in recording accounting data. As a result auditors have become concerned about the problems that arise through the use of Electronic Data Processing equipment because of the absence of conventional data and ways of tracing back to original documents. Many audit procedures will not be affected by automation but in other cases it will be necessary to revamp the existing auditing procedures. Several possible solutions for auditing under conditions created by automation in accounting are examined in Chapter IV.
Some of yesterday's promises of machine utilization have been developed into reality today. A summary is made of some of the latest innovations and a brief glance is cast into the future.

In preparing this thesis I am indebted to many people — too numerous to mention here. Specifically I wish to acknowledge the assistance of Forrest Mills and Louis Aprahamian of the Richmond Division of Remington Rand, Edward Smithson of the Richmond Division of the International Business Machine Corporation, Dr. T. C. Sanders of the University of Richmond, and many others that have given me aid in unfolding this subject of automation.

Finally, I am especially indebted to my wife, Margaret, for her encouragement and tireless efforts in typing this thesis.

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CHAPTER I

INTRODUCTION

What is Automation and Electronic Data Processing?

Although we encounter the words automation and electronics on frequent occasions, little do we know of them. The public probably comes into its closest contact with these million-dollar words through the medium of cartoons where gigantic pieces of equipment are displayed in the process of making earth-shaking decisions.

The term automation is a coined word and has two claimants. The Vice President of Manufacturing in the Ford Motor Company of America and John Diebold, a young Harvard Business School graduate and the author of a book on automation, thought up the term simultaneously and independently some ten or fifteen years ago.¹ Mr. Diebold justified his choice of the word because of the awkwardness of the word "automatization" and because of his weak spelling. Therefore, the word was shortened by two syllables and thereafter referred to as "automation."

The original frame of reference emphasized manufacturing operations. Automation as applied to manufacturing is

¹David O. Woodbury, Let Erma Do It, p. 5.
the accomplishment of uninterrupted motion that transforms materials through a series of processes into a predetermined state while maintaining desired qualities without human intervention.² From the manufacturer's viewpoint, the most important reason of using automation in the factory is to increase the uniformity and speed with which materials are produced.

As applied to accounting and office procedures, automation is the execution of clerical functions to keep management supplied with up-to-date information about sales, inventory, production and financial developments in a way that insures accuracy, speed, and economy. It might be said that the function of automation in accounting is to provide an accurate and rapid way of producing financial statements so that management will have knowledge of current operations. Some of the functions of automatic machines are:

1. Reading
2. Checking
3. Coding
4. Duplicating
5. Filing
6. Arranging

²Paul Einzig, The Economic Consequences of Automation, p. 17.
7. Sorting  
8. Posting  
9. Searching  
10. Comparing  
11. Counting  
12. Computing  
13. Listing  
14. Summarizing  
15. Printing  
16. Document writing

There is a close association between mechanization, electronic data processing and automation and they are frequently used synonymously. Therefore, an effort must be made to distinguish each term. In mechanization there is need for hand operations between various, separate machine operations, whereas in automation data are automatically transferred or fed from machine to machine. The same functions are required of both automation and mechanization to produce a given end result. For example, in mechanization data are processed through different machines such as sorters to arrange cards, collators to bring different decks of cards together under a controlled plan, and calculators to do the arithmetic required in any given procedure. In electronic

3International Business Machines, Machine Functions, p. 3.
data processing arranging and calculating are accomplished completely within the confines of the machine.

In automation, mechanical devices are held responsible for their own behavior. Machines have been endowed with limited powers of discretion and the ability to evaluate results. With intricate electronic sensing devices for comparison, automated machines can carry out the logical steps of a process in order, making certain that each step is performed correctly before going to the next. It might be said, then, that automation is the mechanization of judgement. When the ultimate in automation has been accomplished, human judgement is essential only in judging the validity of the results.

Electronic data processing is simply the means for accomplishing automation. The basic differences between mechanization and electronic data processing are the speed, economy, and accuracy with which data can be handled. Electronic data processing equipment does essentially the same thing or performs the same function as a manually operated procedure. Common office machines perform one or more of the basic functions; recording is performed by the typewriter, recording and summarizing by the adding machine, and summarizing and calculating are done by the desk calculator. Office per-

---

4David O. Woodbury, Let Erma Do It, p. 6.
sonnel serve as a conveyor and control system to combine all of the major functions and, in a sense, add up to an integrated data processing system. Electronic communication and control between these machine function is the latest and the most advanced stage in the evolution of data processing.

Can Machines Think?

Referring back to the preceding page and the statement, "when the ultimate in automation is accomplished human judgement is essential only in judging the validity of the results", it must be remembered that a machine's inability to think or reason precludes any possibility of its originating information. Bits of information are plugged into the machine through a process called "programming." In programming, human intelligence is translated into machine intelligence. It is necessary to set up the operating instructions which the machine must follow, reducing each problem to a series of very simple steps. Questions must be devised that can be answered by yes and no and mathematical problems must be broken down into binary language.

When a thorough job of programming is done, machines can be made to exercise a degree of human intelligence. However, the computer's genuineness lies in the genius of the

5John Diebold, Automation, p. 28.
men who perform the complicated step of programming, rather than the machines themselves. Machines cannot think as men can. They are merely tools or robots through which man's work is accomplished more rapidly, economically, and effectively. In summarizing, these tools can:

1. Learn what you tell them.
2. Apply the instructions when needed.
3. Read and remember numbers.
4. Add, subtract, multiply, divide, and round off.
5. Look up numbers in tables.
6. Look at a result, and make a choice.
7. Do long chains of these operations one after another.
8. Write out an answer.
9. Make sure the answer is right.
10. Know that one problem is finished, and turn to another.
11. Determine most of their own instructions.
12. Work unattended.

The Need for Automation

As business grows more and more complicated and intricate, management has greater need for up-to-date information. Through mechanization and automation this information becomes available to management with greater accuracy, speed, and economy. Increased production, competition, diversification of products, employment, and government regulations have all increased the volume of records, reports, and analysis. In the present-day world a single purchase or sale can create a flood of paperwork.

The processing of a single customer's order involves:

6Edmund C. Berkeley, Giant Brains, p. 7.
1. Editing
2. Credit Information
3. Verification of specifications
4. Pricing
5. Inclusion of the order in sales
6. Financial and production planning statistics
7. Assignment of the products from factory or finished stock
8. Pulling of the material from factory stock
9. Packaging
10. Shipping
11. Invoicing

In addition to the creation of this paper flood somebody has to perform the functions of filing, comparing, transmitting, evaluation, and correcting.

In the not too distant years the processes of keeping business records were performed manually. All accounting data were recorded on large ledger paper, after being manually processed from source data by a large staff of clerks. These data were then manually posted to the general ledger and financial statements. Many machines have been created to alleviate this mass of paper work but have been far too inadequate to effectively free countless people from a manual form of slavery. "One dollar out of every eight, being spent on United States goods and service is now being
paid to men and women who, in their daily work, produce nothing more intrinsically useful than marks on a piece of paper." In order to reduce the task of posting and account control, bookkeeping machines were introduced. Shortly thereafter tabulating systems or machine methods were developed. Now electronic equipment is used to a limited degree to accomplish all the functions of the prior innovations in machines but with a much greater rate of speed and through the elimination of many intermediate processing steps. A machine that possesses a form of mind is a welcomed relief in many intricate businesses.

Modern industry has developed a system of checks and counter checks in order to account for all transactions involved in an accounting period, which is the very heart of accounting. It might be said that while we are obtaining this information necessary for decisions, companies are losing thousand of sales because of untimely data. Herein lie the needs for electronic data processing. Time is the greatest obstacle to planning and control functions of business and industry. Absence of timely reports may cause management to push production up when it should be leveling off or to build up inventories when inventory reduction is desired.

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CHAPTER II

FACTS AND FALLACIES IN ESTABLISHING AN ELECTRONIC DATA PROCESSOR

Criteria for Pre-Installation

The primary consideration in installing an Electronic Data Processor is the reduction of administration costs. However, there are many other tangible and intangible factors that should be considered before reaching a decision. Tangible savings result through: the minimization of personnel turnovers, reduction of labor force, consolidation of clerical operations, and maximum utilization of costly floor space.

Intangible savings are more difficult to measure. Some of these intangible savings result through: informative reporting, timely reports, and more efficient and effective methods and procedures. It is generally accepted that the intangibles will always add to savings.

It cannot be stated that a computer can perform a given operation more economically than an alternative means without making a detailed comparison of all cost. J. P. Stevens and Company states that if the said comparison reveals a profit, or merely breaks even with the present system, it is nevertheless advisable to adopt the new system.\(^1\)

In sequential order, the questions asked by many

\(^1\)Robert J. Bruce, "Factors in Entering the Electronics Field," Proceedings of the Second Annual American Management Association Conference, p. 3.
companies planning the possible future application of a computer may be summarized as follows:

1. What will the study cost and is management prepared to invest the capital?
2. Is a competent systems staff available and how much will it cost?
3. Is management prepared to accept a new concept in record keeping?
4. What will the new system accomplish?
5. On what basis will hardware be selected?
6. What are the installation problems?

What Will the Study Cost, and Is Management Prepared To Invest the Capital?

These are questions foremost in the eyes of management. Obviously this is dependent upon the scope of the business. If there is existing mechanization, it may serve to reduce the study time required by 50 percent or more.\(^2\)

The objective of such a study is to appraise the economics of a computer application to determine whether or not a computer should be installed. Such a study, in addition to appraising the readiness to enter automation, will indicate whether a company is getting maximum utility from its present system.

Does Management Have Access to Competent Staff Members?

Does management have access to competent staff members who will be capable of positions in a highly technical field? Training personnel for Electronic Data Processing involves substantial cost. These people will include programmers, operators, supervisors, etc.

The extent of the training problem is roughly proportional to the size of the computer and the proficiency of the men trained. Formal courses may be given, but experience is essential for personnel to learn the techniques in manipulating the machines. This training is both time consuming and costly. Typical cost are noted in the tables on the following pages. Consideration should also be directed to the fact that many of the costs such as original programming and preparation cost are of a non-recurring nature.

Is Management Prepared for this Concept of Electronic Data Processing?

It is difficult to impress upon some companies the importance of Electronic Data Processing as a cost reducer and a contributor to more efficient operations. Management frequently justifies postponement of Electronic Data Processing installation on the ground that future improvements in electronics will render existing machine functions obsolete. Another common fallacy in postponement is the anticipation
### TYPICAL PERSONNEL COSTS TO OPERATE A COMPUTER

(In thousands of dollars per year)

<table>
<thead>
<tr>
<th></th>
<th>Medium-scale computer</th>
<th>Large-scale computer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One-shift operation</td>
<td>Two-shift operation</td>
</tr>
<tr>
<td>Administrative supervisor</td>
<td>1</td>
<td>$12</td>
</tr>
<tr>
<td>Chief operator</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Operator</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Tape clerk</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Programmer</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td><strong>Tape librarian</strong></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Data control clerk</strong></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Production clerk</strong></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6</td>
<td>40</td>
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</table>

<table>
<thead>
<tr>
<th>Maintenance (if not contracted):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
</tr>
<tr>
<td>Technician</td>
</tr>
</tbody>
</table>

**Total (including maintenance)**

<table>
<thead>
<tr>
<th></th>
<th>One-shift operation</th>
<th>Two-shift operation</th>
<th>Three-shift operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----</td>
<td>------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>$55</td>
<td>10</td>
<td>$65</td>
</tr>
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*Frank Wallace, *Appraising the Economics of Electronic Computers*, p. 66.*
## TYPICAL ELECTRONIC COMPUTER ANNUAL OPERATING COSTS

(In thousands of dollars)

<table>
<thead>
<tr>
<th>Type of cost</th>
<th>Medium-scale computer</th>
<th>Large-scale computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory and conversion costs (five-year amortization):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer site preparation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium-scale - $15,000 ____________________________</td>
<td>$3 $3 $3 $3 $3 $3</td>
<td>$30 $30 $30 $30 $30 $30</td>
</tr>
<tr>
<td>Large-scale - $150,000 ____________________________</td>
<td>$3 $3 $3 $3 $3 $3</td>
<td>$30 $30 $30 $30 $30 $30</td>
</tr>
<tr>
<td>Program preparation and data conversion cost:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium-scale - $55,000 ____________________________</td>
<td>$11 $11 $11 $11 $11</td>
<td>$70 $70 $70 $70 $70 $70</td>
</tr>
<tr>
<td>Large-scale - $350,000 ____________________________</td>
<td>$11 $11 $11 $11 $11</td>
<td>$70 $70 $70 $70 $70 $70</td>
</tr>
<tr>
<td>Equipment costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rental ___________________________________________</td>
<td>96 144 192</td>
<td>360 540 720</td>
</tr>
<tr>
<td>Amortization of purchase price - five-year basis:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium-scale cost - $250,000 _______________________</td>
<td>- 50 - 50 - 50 - 50</td>
<td>- 250 - 250 - 250 - 250</td>
</tr>
<tr>
<td>Large-scale cost - $1,250,000 _____________________</td>
<td>- 10 - 10 - 10 - 10</td>
<td>- 50 - 50 - 50 - 50</td>
</tr>
<tr>
<td>Interest on investment (4%) ________________________</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment maintenance - supplied by manufacturer under rental - under purchase assuming contract with manufacturer ____________________________</td>
<td>- 58 - 74 - 91</td>
<td>- 90 - 125 - 175</td>
</tr>
<tr>
<td>Personnel costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming and computer operation</td>
<td>40 40 44 44 49 49</td>
<td>79 79 98 98 118 118</td>
</tr>
<tr>
<td>Physical and data media costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space rental, power, supplies, etc. ---</td>
<td>8 8 8 8 8 8</td>
<td>30 30 30 30 30 30</td>
</tr>
<tr>
<td>Total annual costs (five-year amortization of purchased equipment)</td>
<td>$158 $180 $210 $200 $263 $222</td>
<td>$569 $599 $768 $653 $968 $723</td>
</tr>
<tr>
<td>Revised annual costs based on ten-year amortization of purchased equipment -----</td>
<td>$158 $155 $210 $175 $263 $192</td>
<td>$569 $474 $768 $528 $968 $598</td>
</tr>
</tbody>
</table>

*Frank Wallace, Appraising the Economics of Electronic Computers, p. 62.*
of lower installation cost in the future. Few companies can afford to abandon developments that materially affect their operations. If any systems or procedural deficiency exists management should take the necessary steps to alleviate the problem immediately.

It is an erroneous assumption to think that the postponement of Electronic Data Processing to a future time would result in economy. If all the considerations have been carefully resolved; and it is determined that such a system will be efficient, effective, and result in savings, the company should not hesitate in hope of a future reduction of cost. For each day of postponement the company will be losing profits and its competitive position in the market situation.

What Will the New System Accomplish?

In order to develop the accomplishments of Electronic Data Processing equipment it is necessary to explore the possible benefits that electronic computers offer. The distinguishing accomplishments are: cost reduction, flexibility and accuracy. These three benefits are discussed below:

a. Reduction of Cost

The evaluation and appraisal of Electronic Data Processing equipment are no different, essentially, from those
needed in the purchase of other equipment. It is necessary to compare the cost of new equipment processing in relation to the cost of existing methods and procedures. In most installations, emphasis has been on reduction in clerical costs. The main accomplishment of Electronic Data Processing is in the reduction of cost through speed, versatility, and reliability. This is the producing more accurately and rapidly of that which is essential for management in the effective and efficient operation of a business. Ten specific and direct quotations from top management executives who have surveyed the results of Electronic Data Processing in their respective organization are:

1. Issues credit faster than any system we've ever seen.
2. Helps us to maintain a better-balanced inventory.
3. Has resulted in fewer back orders than ever before.
4. Has greatly reduced customer claims.
5. We now have greater personnel control.
6. We now get more significant and accurate data from lower operating levels.
7. Now we can pinpoint responsibility and make adjustments quicker.
8. We now have and can maintain a more balanced plant work-load.
9. The interaction between sales, production, and inventory is more clearly understood and related to over-all operations by all our management team.
10. It is now possible to base individual decisions
upon their forecast effects on the over-all operations of this company.\(^3\)

b. **Flexibility**

The flexibility and the versatility of Electronic Data Processing are unprecedented in the field of business. One of the main advantages of Electronic Data Processing is that input-output devices are highly susceptible to low-cost specific applications. Businesses have been handling payrolls, personnel records, sales analyses, manufacturing control, cost distribution, and inventory records through Electronic Data Processing since 1954-1955.

Is the computer versatile enough to produce all the required information at the time and in the form desirable? By producing a more timely and informative report that prevents a wrong decision Electronic Data Processors may make savings amounting to thousands of dollars in very short order. According to the American Management Association, electronics offers a tremendous benefit since it is a simple matter to expand an Electronic Data Processor to meet new growth situations.

c. **Accuracy**

Accuracy and reliability are key features to consider when planning to purchase an electronic computer. Most manufacturers have many built-in checks to insure that information is accurately read, processed, transferred, and recorded within the system.

Electronic Data Processors' accuracy and reliability have been utilized by large merchandising companies which are obligated to handle hundreds of changes a day in pending orders. Unless the exact status of a particular order is known when the modification comes in, the result is likely to be a shipment of a part to the wrong place at the wrong time. The cost of such incorrect shipments in terms of time loss alone, can be substantial; hence, the profitability of accuracy.

Errors in information appearing on Alcoa Aluminum sales orders have been reduced from 18 percent in 1953 to 4 percent in 1957 by electronic processing.4

Basis for Selecting "Hardware"

The term "hardware" is commonly used to denote Electronic Data Processing equipment. The "hardware" should be selected in order to perform all the proposed applications. In choosing the "hardware" it is necessary to weigh and evaluate the following:

a. Size of Computer

"The inherent capabilities of electronic equipment are more nearly measured by the size of the equipment's memory than by any other criterion."\textsuperscript{5} The essential difference in the size range of computers lies in capacity (memory) and in cost. The total operating cost of Electronic Data Processing equipment for one year varies from $4,000 to $75,000.\textsuperscript{6}

Electronic computers are justified only by volume of work. Just because a machine can accomplish a sequence of work ten times as fast as the present labor force, there is no conclusive indication of the practicality of computer installation. There are many tools to accommodate different office situations; the choice of which depends largely on the volume of work to be done. Electronic Data Processors are merely tools, appropriate for some jobs and inappropriate for others.

b. Speed, Versatility, and Reliability

Speed in many cases is of the essence; however, often times, it is over-emphasized. Many companies are not of


\textsuperscript{6}American Management Association, \textit{Establishing an Integrated Data Processing System}, p. 50.
sufficient size to make Electronic Data Processing justifiable. A super high speed mechanism (Electronic Data Processors) is not practical in a system that cannot adequately process the data input or output at a sufficient rate or volume to take advantage of the use of the computer.

To increase the flexibilities of Electronic Data Processing equipment, manufacturers have placed intensive emphasis on input-output methods. As pointed out in Appendix II, the input method is the form in which data are fed into the machine and the output method is the form of reproducing answers.

To provide for versatility Electronic Data Processors must be capable of accepting source data in a multiple number of forms. Such forms include tabulating cards, paper tape, magnetic tape, key punch (direct), and the typewriter.

The speed of input depends, in part, on speed of the typist or key punch operator. The typist turns out about ten characters a second and the key punch operator fifteen whereas punched cards and punched tapes produced on keyboard devices can be fed into the computer at speeds ranging from 150 to 600 characters a second.7 Magnetic tape has phenomenal speed as data can be read into or written out at 20,000 characters a second.8

8Ibid., p. 6.
Storage devices are equally important as input-output methods in selecting types of equipment. The speed of a storage device is measured by the time it takes the Electronic Data Processor to locate specific data. The speeds of the various storage units vary considerably:

1. A reel of magnetic tape can store up to four million characters. Access time can vary from one thousandth of a second to several minutes.

2. In the magnetic disc type storage, units have been devised in which access time is less than a second and capacity about six million characters.

3. The magnetic drum is a faster random access storage device, but has less capacity.

4. Magnetic cores have a fast access time - about a hundred thousandth of a second - but the capacity of core units is relatively low.9

The flexibility of an Electronic Data Processing depends a great deal on how the input and output methods and the storage devices work together.

Reliability is an important criterion in the selection of "hardware." It is noted on page of its importance in large businesses. The processing of a single customer's order involves scores of operations and through dozens of departments. Through the inherent accuracy of the machine, coupled with controls introduced by auditors, companies are assured of the reliability of Electronic Data Processing

9Ibid., p. 5.
equipment. The equipment cannot be guilty of fraud. It will only follow those instructions programmed into the machine.

The Human Side of Electronic Data Processing

A planned program of education is important from the standpoint of employees' morale and employees' willingness to cooperate in the new system of Electronic Data Processing.

First of all, the employees should be told why the initial study was being made and how they would be directly affected. The Pacific Mutual Life Insurance Company emphasized to its employee personnel that any job eliminated would be one of repetitive, monotonous tasks - that no employee would be a sacrificial lamb on the altar of electronic progress.

New devices are generally distrusted until they are known and understood. Almost from the beginning men fought against machines and in spite of the fact that their tasks were lightened, productivity multiplied, and standard of living elevated, men feared that machines would then eliminate bread as well as drudgery.

Robert T. Bruce made a statement regarding the human reaction to automation which seems characteristic of the average employee encountering automation.
Most of us dislike changes; we oppose them. Every improvement ever made was made reluctantly. Nothing new is considered practical or possible until someone with broader vision than our own does the thing that 'can't be done'; gets better results by methods that 'won't work.'

Electronic Data Processing places a premium on technical knowledge thus creating more jobs which are free of monotony and drudgery. It is estimated that employment in electronics will eventually exceed that in aircraft and the automotive industry.

It is generally accepted in a period of technological change, such as the one occurring in automation, that fewer jobs are created than vacancies filled. Thus automation could mean temporary but not mass unemployment. Fifteen years ago there were five million clerks - now there are approximately eight million. Surely, technology has contributed to this increase.

Certainly, the more challenging aspects of the new electronic methods will be human and not mechanical - the decrease in routine task; the new skills needed for the new jobs created; the growing importance of analysis, organization and planning; the increase in leisure time and how

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12 Ibid., p. 5.
it is used in short, fewer people doing things that machines can do and more people doing things that only people can do.13

Purchase or Rental of Electronic Data Processing Equipment

In the purchase of Electronic Data Processing equipment, as in the purchase of any other piece of office equipment, there is the question of whether to rent or to buy. Up until January 1, 1957, International Business Machines engaged in merely renting Electronic Data Processing equipment. Subsequently this company has been forced, by a 1952 judgement handed down by the Department of Justice, to allow customers the option to rent or buy.

There are many considerations, both tangible and intangible, when considering purchasing of Electronic Data Processing equipment. The primary consideration in any procedural change is simply cost reduction. The economic result through various considerations:

Internal Evolution

There is always the possibility of internal evolution of a business such as decentralization. This has posed a major problem to users of Electronic Data Processing. Management now has a machine of such great capacity that it

creates a need for bringing information into a central point. This internal evolution limits the amount of work which may be economically assigned to Electronic Data Processing. Resale of such equipment results in substantial losses. International Business Machines, for example, accepts used equipment only on trade-ins for new equipment. The rental of equipment would partially resolve the evolution in business needs.

Technological Obsolescence

Closely associated with change in organization is the matter of technological obsolescence. A major new operation could render an old piece of equipment obsolete. Even though there is consolation that new innovations will accomplish the new jobs and existing jobs better, the cost could be prohibitive. On the other hand, rental does not place one in a decided flexible position to protection from obsolescence. "A change in computers would require another substantial outlay for programming and conversion to a new computer."  

Effect on Business Profits

The effect of purchasing or renting equipment on net

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15Ibid., p. 64.
income taxes should be carefully analysed. A rental expense deduction oftentimes exceeds the rate of depreciation or amortization of purchased equipment. This could be of major importance in that in periods of high income businesses are interested in immediate ways of offsetting incomes so as to lower taxes.

Conclusion

It is the viewpoint of Mr. Donald Niles, of the New York Federal Reserve Bank, that any business organization should formulate a financial policy with respect to the expected return on any capital investment. Irregardless of the supply of capital, a standard or criterion for measuring one investment against another can be weighed in terms of percent of return on investment.

Once the rate of return has been established, and assuming the funds are borrowed at that rate, it is necessary to determine the number of years that must pass before the cost of the machine, interest, principal, and maintenance charges is equal to the accumulated rental of the equipment. This point is commonly called the "break-even" point.

It is noted from the table on page 26 that the higher

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16Ibid., p. 29.
### PURCHASE VERSUS RENTAL OF DATA PROCESSING EQUIPMENT

<table>
<thead>
<tr>
<th>Future Age of Machine</th>
<th>Purchase Price</th>
<th>IBM Annual Maintenance</th>
<th>Balance Before Interest</th>
<th>Average Balance For Interest Calculation</th>
<th>Annual Balance After Interest</th>
<th>Accumulated Rent</th>
<th>Purchase Price + Interest + IBM Maintenance</th>
<th>Net Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>$28,628</td>
<td>$21,211</td>
<td>$20,189</td>
<td>$24,409</td>
<td>$1,465</td>
<td>$21,654</td>
<td>$10,560</td>
<td>32,214</td>
</tr>
<tr>
<td>7</td>
<td>$2,505</td>
<td>2,505</td>
<td>13,509</td>
<td>17,627</td>
<td>1,958</td>
<td>14,657</td>
<td>21,120</td>
<td>35,777</td>
</tr>
<tr>
<td>8</td>
<td>2,505</td>
<td>-</td>
<td>6,602</td>
<td>10,630</td>
<td>368</td>
<td>7,240</td>
<td>31,680</td>
<td>38,920</td>
</tr>
<tr>
<td>9</td>
<td>2,505</td>
<td>-</td>
<td>-</td>
<td>3,620*</td>
<td>199</td>
<td>-</td>
<td>42,240</td>
<td>41,624</td>
</tr>
</tbody>
</table>

*When the remaining balance in column 7 is less than the annual savings $8,055 (i.e. rent $10,560 - IBM maintenance $2,505) compute average balance as in column 5, but then divide the monthly savings $671.25 ($8,055 divided by 12) into the remaining balance in column 7 to obtain the number of months (to the nearest full month) for interest calculation.

(a) $2400 + 0 = 3620 (b) $2400 / 671.25 = 10.78 or 11 months

(c) 3620 x .055 = $199 interest

**Approximately one month's savings (671/671 = 99%), therefore break-even point is 3 years, 11 months.

the rate of return the longer the span of the break-even period. A typical appraisal as to whether to continue to rent or to purchase equipment is also noted in the table on page . Such a study is highly essential in determining whether to buy or rent.

Limitations of Electronic Data Processing

Economics

Some accounting operations can be done better by means other than electronic data processing. To be justifiable, a sufficient volume of transactions must exist. It is uneconomic to analyse, sort, and assemble certain types of data through electronic means. In many instances simpler processing units can do the job equally as effective. It must be remembered, however, that when an electronic computer can be applied to other uses, the volume does not have to be as great because of the process of "batching." Batching is simply the holding of any category of items to be processed by a computer so that sufficiently large numbers of them are accumulated to justify electronic processing.17

This process allows smaller businesses, where purchase or rent of Electronic Data Processing is not feasible, to take

advantage of the speed and economy through the use of service bureaus. Service bureaus, such as International Business Machine Corporation, Sperry Rand, Burroughs, as well as private agencies exist for companies with simple needs. Examples are: a job of data analysis, payroll work, or getting out of large numbers of dividend notices or checks.

Electronic Data Processing tends to be economical but it is unlikely to be so unless the flow of data is straight-line in nature, completely streamlined, utilizing machine intelligence rather than human intelligence.18

Cost

The costing of an electronic processor has been dwelt on quite extensively. In spite of the substantial cost incurred, both in the installation and maintenance cost, the writer is convinced of the savings of Electronic Data Processing equipment.

Personnel

There is a definite need for a staff or trained personnel, capable of handling positions of high caliber. Assuming the availability of such trained personnel there is the

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18Robert T. Bruce, "Electronic Equipment," Univac In the News, p. 4.
cost to consider. The analysis on page 12 notes some of the costs involved.

Must automation bring unemployment, is the question in the minds of the would-be replaced personnel. Although automation tends to reduce labor requirement for a business of an unchanged output, it tends to create employment in other parts of the economy. A more intense use of machinery may have the effect of rendering the now existing machines obsolete and thereby creating new jobs for persons in the manufacture of new machines. In taking a long range view, automation is likely to be accompanied by a progressive reduction of working hours or the much publicized "four-day workweek."

Internal Control and Auditing

One person on Electronic Data Processing machines integrates many functions which were originally separated in order to maintain an adequate internal control. Many specialists in machine accounting hold the view that the new techniques render many basic principles in accounting and auditing obsolete. The converse of this is true. Fraudulent manipulations can be made where data are processed electronically as well as under conventional accounting methods. This disadvantage can be mitigated by devising a proper system of accounting control as is pointed out in Chapter IV.
Inadequacy in Original Planning

Inadequacy in original planning is a lesson hard-learned by some companies. According to Consolidated Edison, "The length of time required to prepare for Electronic Data Processing is probably the biggest lesson we have learned from our experience so far." This company claims that one year's preparation does not allow sufficient time for training of personnel, system design, and inadequate programming.

Maintenance

When data processors are in successive use there is little time for maintenance without bringing the entire process to a halt. This is especially true when all the data processing is done within the confines of one machine. This argument can be answered, in part, by the fact that there are only a few moving parts subject to frictional or mechanical wear. The Eniac, the world's first electronic computer, is working just as efficiently and effectively as it did ten years ago.


20Frank Wallace, Appraising the Economics of Electronic Computers, p. 63.
CHAPTER III
APPLICATIONS OF ELECTRONIC DATA PROCESSORS TO ACCOUNTING

Electronic Data Processors have been applied successfully to a wide range of problems, both in the field of science and in business. Precisely, computers can perform two kinds of jobs: problem solving and data processing. The year 1954 marks evolution of Electronic Data Processing to the point of use in solving accounting-type problems through data processing.

Inventory

One of the biggest headaches for many business firms is their inventories. The amount of capital investment in inventory and its maintenance represents a large portion of a firm's assets. The cost of maintaining an inventory, alone, is as high as 25 percent of its value. Such cost includes obsolescence, interest or return on investment, and depreciation.

Management decisions in accounting for this inventory can mean the difference between a profitable operation and a loss on operation. Some of the analytical questions asked by management are: what is in stock?, is the quantity suf-

\footnote{International Business Machines Corporation, Inventory Control and Material Accounting, p. 8.}
sicient?, and what is the most economic quantity to order?

What is in Stock?

The inventory at the Hanford Atomic Products Operation is designed for a general supplies inventory containing about 20,000 items valued at approximately two million dollars and is comprised of a wide variety of items. Some of these items are paper clips, safety shoes, nuts and bolts, drums of soap, stainless steel and many others. The Hanford Atomic Products Operation is analogous to many business concerns. The problem is in keeping track of the inventory and in knowing where to locate desired items. In non-automated businesses where there are literally acres of inventory storage space, it may take an army of clerks to track down any given article of merchandise. It is highly essential for executives in sales departments to be accurately informed on what is immediately available for sale. In organizations with branch warehouses and stores, a manual means of supplying sales information is costly. Information, to be effective, is provided at the proper time in order to capitalize on a favorable situation. The great advantage of automation is timeliness.

The Sufficient Quantity

Electronic Data Processing machines can give top manage-

ment great aid in the field of inventory control. Most businesses, which have a large part of their assets represented by inventory, can justify the use of Electronic Data Processing machines through savings resulting from the reduction of its inventory through better control.\(^3\)

Stock Ordering

Reordering Point

In essence, the reordering point is a minimum inventory level to be maintained above planned requirements in order to prevent work stoppages, customer demands, etc. A reorder analysis, through Electronic Data Processing reports each item in the inventory when the balance on hand plus due-in, less quantity back-ordered is less than the lead time plus the safety factor multiplied by the average monthly usage.\(^4\)

When an order point has been reached an order is automatically initiated in the form of a purchase authorization card and contains all the significant item data, the economical order size, the manufacturing starting data, and the date the item must enter the stock.

\(^3\)International Business Machines Corporation, *Inventory Control and Material Accounting*, p. 48.

Economic Ordering Quantity

The economic lot of merchandise to purchase results in substantial savings in that it eliminates such excessive maintenance costs as interest, obsolescence, storage, etc. In addition, an economic lot of merchandise allows a business to capitalize on such decreasing costs as freight, discounts, and other procurement costs. A formula used in programming a computer for computing the economic quantity and in evaluating the cost of stock acquisition in relation to maintenance cost is:

\[
Q = \sqrt{\frac{2PY^*}{1 / I}}
\]

* where  
\( Q = \text{Economic Order Quantity} \)  
\( P = \text{Cost of Acquisition in dollars per replenishment cycle} \)  
\( Y = \text{Annual disbursement in dollars} \)  
\( I = \text{Carrying cost percent, per year} \)

In essence this formula allows a business to maintain its inventory at such a quantity as to minimize its investment. Where large purchases are considered, interest and storage charges, coupled with the danger of depreciation and obsolescence of the inventory, make it mandatory for management to use some means of determining economic ordering quantities. Manual methods are out-dated by the advantages

\( ^{5}\text{Idem.} \)
of high speed Electronic Data Processing machines with capacity for making decisions that are provided in machine programming. The tangible advantages for using Electronic Data Processing in inventory control can be summarized as follows:

1. Maximum return from investment in inventories.
2. Economic cost of production and efficient use of manpower.
3. Ability to meet emergency customer demands without delay.
4. Ability to take advantage of quantity discounts and savings in freight and drayage.

In establishing any phase of Electronic Data Processing it is necessary to match the expenses to be incurred against savings to be expected. As pointed out previously, only volume of transactions justifies automation.

Accounts Receivable

The function of the accounts receivable department is to keep the details of the relationships with customers. One can realize the importance of this function after realizing that approximately 90 percent of the nation's business is conducted on credit. The recording of credit transactions is predominant in relationship to total administrative costs.

Electronic Data Processing of Accounts Receivable is a by-product of the sales-accounting operation in that sales
cards and accounts receivable cards are merged into one operation. The advantages of applying Electronic Data Processing to accounts receivable can be summarized as follows:

1. Speed in the preparation of invoices.
2. Positive accuracy of all billing documents.
3. Definite assurance that product description and other data is consistent.
4. Accuracy in subsequent accounting and statistical reports.
5. Prompt processing of sales orders.
6. Prompt shipment of goods.
7. Current forwarding of invoices to customers.
8. Current posting to accounts receivable.
11. Improved appearance of all documents.
12. Accuracy of all documents produced.
13. Easier warehouse selection because of sequence of items on shipping orders.
14. Better routing of shipments through proper sequence of items and availability of data such as total weight or cubic content.
15. Fewer copies of documents because subsequent records can be produced directly from the cards instead of from additional invoice copies.
16. Economy of operation because of the elimination of numerous manual operations, proofreading and rewriting.
17. Promotion of better customer relations through
prompt processing of orders and improved appearance of documents.  

Plant and Equipment Accounting

All transactions affecting plant and equipment can be processed through electronic means. This includes the calculation of depreciation, new and used acquisitions, retirements, transfers, disposals, abandonments, and maintenance history. In addition a separate property card is maintained for each asset to include item identification number, description, location, acquisition data, retirement, annual depreciation, accumulated reserve, purchase price, book value, etc.

As in all applications, the use of an Electronic Data Processing machine will probably result in savings of time and permit management to utilize analytical treatment in relation to the job plant and equipment.

Accounts Payable

Two main functions in the accounts payable department are recording liabilities and distributing the expenditures to the proper account. Payables accounting offers problems, questions, and situations that can be handled in a fraction

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of the time required by manual methods through the use of a data processing system. As in all phases of accounting the volume of transactions is the criterion when considering the applicability of data processing techniques.

The advantages of processing accounts payable electronically may be summarized as: verification of accuracy, automatically written remittance statements, checks, analytical reports, classified and stored data files, and posting to accounts payable ledgers and subsidiary ledgers for discount and cash.

Sales

Sales accounting is the recording of information of sales and shipments of merchandise to consumers. Sales managers are interested in the various elements of sales such as: what was sold, cost of sales, who the customer is, who made the sales, geographical location of sales, and the extent of the profits.

The process of gathering sales data and summarizing it takes excessive time under old methods, and before management can exert proper control or corrective action the sales or inventory pattern may have changed. The figures obtained are merely history. Take the case where a company's national sales offices close their sales on Fridays each week and summarizes these results by Thursday of the following week. If management has to wait until Thursdays each week for these data,
then data for the rates of sales for the first part of the current week have been excluded and management is one week late in its function of control. These facts must be obtained fast enough for managers of large and complex organizations to act on them. The application of Electronic Data Processing to sales can aid management in the following ways:

1. Economically interpret sales made through various channels, thereby permitting timely and accurate sales policy decisions.

2. Determine the effectiveness of sales performance by salesmen, districts, division, branch offices.

3. Readily obtain gross profit by customer, type of merchandise, and territory.

4. Develop compensation plans based on performance and sale of products at varying commission rates.

5. Develop bonus arrangements which permit quick and accurate payments for results produced.

6. Improve service to customers by keeping abreast of customer preferences as to price, size, color, packaging.

7. Secure better control over advertising expenditures.

8. Direct advertising more accurately by proper emphasis on publications, mediums and types of advertising, localities, trade groups, industries, brands.

9. Determine quality of sales effort.

10. Discover weaknesses and strength of sales organization and thus take proper action in training, supervising, promotion, and releasing personnel.

11. Allocate sales strength to better advantage by analyzing territory coverage.
Management Applications

Management by exception is a concept publicized by manufacturers of Electronic Data Processing machines. This concept entails decisions only when there is a variation from a standard established by management in original planning. Any variation in a predetermined standard constitutes an exception to which management must exercise corrective action. In inventory control, for example, management need concern itself with items either below or above the predetermined range. This concept gives management timely information to the effect that materials are costing too much or that sales personnel are failing to achieve a pre-determined sales quota.

In addition to pointing out these exceptions, Electronic Data Processing machines can compare a series of circumstances within the data to a predetermined sales quota.

In addition to pointing out these exceptions, Electronic Data Processing machines can compare a series of circumstances within the data to a predetermined pattern and whenever a deviation from the predetermined standard is encountered, the machine will follow a course of action chosen by management to fit such variations.

"Probably the most important use of Electronic Data Processing will be providing better management information

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7International Business Machines Corporation, "Sales Application," IBM Accounting, p. 9.
more rapidly", says John Diebold. "It won't be a matter of producing the same kind of reports by computing machinery but producing better and fewer reports with newer and faster machinery." 8

Payrolls

Payrolls are highly susceptible to the application of Electronic Data Processing. A payroll is subject to burdensome actuarial arithmetic, that stems from the many deductions and allowances. Allowances and deductions have to be made for: social security taxes, federal withholding taxes, state and federal contributions to the unemployment insurance programs, union dues, stock purchase plans, hospitalization insurance programs, and many others.

Electronic Data Processors can be programmed for every conceivable fact of a payroll nature and re-programmed for certain deletions and changes in situations.

Practical Applications

A few examples will illustrate the applications of speed, flexibility, accuracy, and economy of Electronic Data Processors in business.

General Electric Corporation has taken giant strides

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8John Diebold, Automation, p. 151.
in processing the flood of paper work that is connected with its order-processing job through electronic data processing.\(^9\)

In several plants it was taking approximately sixteen weeks to process a large order; twelve weeks for the processing of the paper and four weeks for the handling of the goods.\(^10\)

After automation this twelve-week period could be narrowed down to twelve hours.

Another typical example of the rapidity in the processing of sales orders is a Chicago mail order firm that has 8,000 different types of items which are sold by catalogues through about one thousand outlets. The labor force of about sixty clerks, formerly necessary to handle from 3,000 to 15,000 orders daily, has been replaced by an electronic data processor that is capable of performing the identical work with only ten operators.\(^11\) In addition, it automatically lists the position of stocks of all eight thousand items; how much is in stock of each item, what items have reached the reordering points, and the summary of sales made during the previous day.\(^12\)


\(^10\)Idem.


\(^12\)Idem.
Other business applications are sited below:

"Among the pioneers in clerical and accounting use of electronic data processing is Monsanto chemical. Besides running a heavy schedule of technical calculations on its equipment, Monsanto now regularly computes general accounting records, financial reports, department expense reports, production cost reports and plant service accounts. The company's financial statements are handled in two hours, compared with 300 hours by the manual method. For marketing strategy, the machine prepares statements of sales, cost of goods sold, gross profit by production and overall sales analysis. The company also processes property accounting records, computes dividends, employee bonuses and pension reserves."

"The possibilities of computer systems when they are thus tied together is illustrated by the nationwide system set up by the Sylvania Electric Company.

Brain center of the system is a new office building at Camillus, New York, built expressly to serve as a data processing center.

Twelve thousand miles of leased wire circuits bring together data from seventy-one points in sixty cities."

"All of the Chesapeake and Ohio Railroad's 90,000 quarterly dividend checks are prepared in less than an hour, and the company also uses the machines to produce basic reports for management action, exceptions for investigation and detailed listings for reference."

"A computer shows how Rexall Drug Stores are doing in each of 3,000 counties and how they can be better.

Rexall has more than 11,500 franchised and 270 company-owned stores. For proper management of salesmen and advertising and for decisions on where to open new stores, the management needs specific up-to-date answers on such questions as: 'In what counties are our sales in line with the business potential? In which above? In which below?'

14 Idem.
15 Ibid. p. 6.
Rexall now gets this information in just one week - while it still has the maximum dollars and cents significance."16

16Idem.
CHAPTER IV

ELECTRONIC DATA PROCESSING AND AUDITING

In recent years auditors of medium and large accounting firms have encountered the use of recording accounting data by the use of Electronic Data Processing machines. Many problems are presented by this new method of keeping accounting records where visible records are non-existent. The method of retracing calculations, as originally made, without going through an entire clerical operation for a second time is almost impossible.

These statements lead persons to believe that there are some important and fundamental differences between auditing records made on Electronic Data Processing machines and those produced conventionally. Auditing is the same regardless of the kind of records involved. "Auditing is an examination intended to serve as a basis for the expression of opinion regarding the fairness, consistency, and conformity with accepted auditing principles of statements prepared by a corporation or other entity for publication."\(^1\)

Evaluation of Internal Control

One of the first things an auditor must do in starting

\(^1\)Roy T. Culey, Auditing, p. 1.
an audit is to examine the system of accounting employed with particular emphasis on internal control. Stated simply, internal control must provide means to safeguard assets and to see that the organization adheres to management policies.2

In providing internal control the duties and functions of the employees must be divided in such a manner that no one person has complete control over an important part of a business transaction and that one individual's work is checked by another individual in respect to related transactions. The primary responsibility for safeguarding assets, preventing and detecting errors, and minimizing opportunities for fraud rests on the function of auditing. The quality and extent of the internal control governs the scope of the audit by the public accountant.

Basically, the main difference between Electronic Data Processing accounting and traditional methods of accounting is the speed and flexibility in which the financial results are obtained.3 This does not alleviate the need of checks necessary in obtaining adequate internal control. An adequately designed internal control procedure is more essential today than before in that more and more business functions

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are integrated. Functions that were originally segregated to provide adequate internal control are now delegated to one person. It is a necessity to provide the fundamental safe-guards, both physical and mechanical, to insure the adequacy of a system of internal control in Electronic Data Processing.

Revision of the Auditing Program for Electronic Data Processing

Auditors who are accustomed to using standard programs or questionnaires will find it necessary to revise them because of the rearrangement of duties and functions in an electronic processing operation. The following questionnaire was designed by Price Waterhouse and Company for an installation computing the journal entries for posting to the inventory control records and to accounts receivable:

1. Are the serial numbers of all invoices accounted for at the computer center?

2. Are copies of all invoices forwarded directly to the accounts receivable department by the computer center independently of the accounts receivable department?

3. Are invoices summarized and totals thereof furnished to the accounting department by the computer center independently of the accounts receivable department?

4. Is an investigation of open orders made from time to time by an outside group to ascertain that all shipments are being billed?

5. Are the entries for the inventory control record prepared at the computer center?

6. Is there a direct correlation between the credits
to customers' accounts for returned merchandise and the related adjustment to the inventory control records?

7. Before they are made, are all changes in product master tape information checked for approval of: Sales department and Management?

8. (a) Is a complete visible record of all changes in product master information automatically produced by the computer?

(b) Is it checked in detail by someone outside the data processing department? Credit Department?

9. Before they are made, are all changes in customer master information checked for approval of: Sales Department? Credit Department?

10. (a) Is a complete visible record of all changes in customer master information automatically produced by the computer?

(b) Is it checked in detail by someone outside the department?

11. Is the detail of the product master file, particularly unit price information, checked from time to time by someone outside the data processing department?

12. Are all exceptions to product master file prices reported to an outside group for follow-up as to propriety?

13. Are the prices used in valuing transactions at inventory values for entry in the inventory control records subjected to the same checks as the prices used for billing?

14. Is the number of transactions in a batch as reported by the branches checked to see that all shipments and orders have been recorded by the computer?

15. Are shipments to customers not appearing in the customer master file referred to an outside
The flexibility of Electronic Data Processing, as opposed to traditional methods of accounting, is obvious when considering means of recording transactions. Where a book-keeper used a pen and ledger, to record transactions, the entries remain permanently fixed. They cannot be used for the purpose of recording that particular transaction subsequently. Instead, the records must be re-written. On the other hand, when an Electronic Data Processor is used for this purpose, the entry is made once. Thereafter the entry may be used repeatedly in other records; whereas, if the entry were made under traditional methods, it must be made all over again with possibility of errors. The whole valid concept of Electronic Data Processing is negated if some station records data manually.

Control Over Source Information

As a result of the growing importance of Electronic Data Processing machines it is essential that the auditor is assured of the accuracy and reliability of the original entries made; that is, checking the machine data against such original records as invoices, remittance memorandums, etc.

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Herein lies a shortening to auditing accounting records. Prior to the use of Electronic Data Processing it was necessary to check the original source materials for each applicable record. Under Electronic Data Processing once the original data are ascertained to be proper, it is no longer necessary to check data which has been further processed from original records.

In auditing data which are processed electronically, the auditor must be aware of the various methods of checks and controls available through manufacturer's built-in devices and through different types of controls that can be programmed into the processor. Utilization of such checks and controls permits the auditors to better evaluate internal control. The best assurance to the auditor that all transactions have been recorded and processed properly lies in the system of control records for machine balancing purposes. Following are some checks and controls that are presently instituted in business firms using electronic data processors.

Hash Totals

Hash totals are totals of data that are not ordinarily added into one sum; such as, stock numbers, unit prices and description numbers. The use of this control prevents omission of entire accounting records. The results of the

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addition are compared with pre-determined totals to provide for the check.

Proof Figures

Proof figures are used to verify various multiplications.

"An example of this is the multiplication of quantity by cost required in grocery billings. The check is based on the relationship between cost and a so-called proof cost. An arbitrary figure Z, larger than any normal cost is set up. Then the proof cost is expressed by the formula. Cost plus proof cost equals Z.

When quantity is multiplied by cost, it is also multiplied by proof cost. Normally two of the totals needed for the check, quantity and quantity times cost, are accumulated during the program. The other factor needed for the check, quantity times proof cost, is also accumulated in the program." 6

Reverse Multiplication

This device is used to check the accuracy of multiplication. The calculation, A times B equals C, is verified by multiplying B times A and subtracting C. If the result is zero the accuracy has been proven.

Sequence Check

Another program control is the sequence check, where the correct sequence, either numerical, alphabetical, or

6Ibid., p. 10.
alpha numerical is programmed to recognize an ascending sequence. If the file is not in correct sequence, signals to the operator indicate that external actions needs to be taken.

Auditors should have sufficient knowledge of an installation to be able to apply these above mentioned controls in evaluating the internal control of a business.

Electronic data processing methods are the future standard methods of accounting. A review of the applications, are presented in Chapter II, indicates future uses in Electronic Data Processing in every company; in the larger ones through purchased installations and the smaller ones through service bureaus. The author of this thesis is convinced of the speed, accuracy and flexibility of the volume of information processed; hence it is not logical for the business world not to accept these advantages. It is important that auditors become experts at auditing, as well as intimately familiar with methods of processing accounting information automatically.

7Ibid., p. 11.
CHAPTER V

CONCLUSION

Similar to the Industrial Revolution with its impact on factory management during the early nineteen hundreds is the electronical means of processing data to the office. This new era in office and accounting procedure has opened the door to many new systems in the processing of paper. For the first time in the history of man we are able to do these things:

1. **Present timely reports to management of large-scale operations.** Although an Electronic Data Processor cannot perform any function that cannot be formed by a human being, it can perform these functions several thousands of times faster. It can literally perform the work of a regiment of actuaries and statisticians. The Model 702 of the International Business Machine Corporation can keep up with about 8,500 people operating desk calculators.\(^1\) Gathering information for management will be more than merely gathering historical data. Instead it becomes the collection and use of live, up-to-date information so that a timely basis is provided for making necessary decisions about immediate future plans. In addition, management is enabled to review

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the operations over a wider field.

2. **Eliminate present manual and machine methods with their undesirable elements of inaccuracy.** Nearly synonymous with the advantages of timeliness is the element of accuracy or reliability. A paper flood is created by a single sales order. By the time the customer's order is filled, the order has passed through literally scores of operations. It is practically impossible to assure complete accuracy on the part of all the participants in a given operation.

3. **Eliminate the necessity of writing down an element of information more than once.** The whole essence of electronic data processing is negated if at some station after the original recording, data are reprocessed manually.

4. **Introduce an up-grading of labor.** When a thorough job of programming is done, machines can be made to exercise a degree of human intelligence. Such relief is welcomed by many who have routine tasks that can be exchanged for skilled ones. As a result of automation fewer persons will be accomplishing things that are more in keeping with development of talents.

The installation of Electronic Data Processing Equipment must be primarily based on economic considerations, some of which are described above. The importance of a systems study cannot be stressed too strongly. Such a study, in
addition to appraising the economics can be of great aid in determining weaknesses of the present system. It would be short-sighted for management to deny itself the uses of Electronic Data Processing Equipment, provided the company's functions can be utilized effectively and economically.

The auditing function becomes even more essential where electronics is concerned than in auditing manually prepared records. Accounting functions, that were once separated to provide adequate control are now integrated into one person. As a result it behooves the "internal" and "external" auditors to revise their procedures to allow for an electronic data processing operation. A computer cannot be guilty of fraud; it can perform only those instruction programmed into the machine.

Electronic Data Processing Equipment is not a cure-all for all business problems. Computers are merely tools, appropriate for some jobs and inappropriate for others. Electronic Data Processing is justified only by a large volume of work.

Human beings are not entirely eliminated even in a highly automatic operation. It is through human intelligence that procedures are organized or "programmed" for machine application. The machine intelligence, through programming, supplies accuracy, speed, and flexibility at an unprecedented rate in carrying out the objectives of human intelligence.
The machine is still a robot that will operate under man's instructions but it permits man to perform operations in a manner considered impossible ten years ago.

Electronic methods have met the problem of providing an accounting device for the unprecedented pyramiding of business in the past twenty years. Increased automation in the future is inevitable. In considering the economics and efficiencies of automation it is apparent to the author of this thesis that new and better electronic developments will take place in the next decade. Fantasies of yesterday have already become realities of the present day. What form will these developments take? To handle accounting and the job of recording for business, electronic devices must do even more matching, selecting, arranging, filing, etc. in order to process the flood of paper work.

In business machine applications electronics offers one new basic technique which might be called "inter-company communication." Present machine methods utilize individual units for different functions and require communication from a company to its branch or affiliate company. Substantial dollar savings can result from inter-company and inter-industry exchange of business data in the form of machine language.

Business language which can be read into and simultaneously coded in machine language represents a challenge
to manufacturers of Electronic Data Processors. An example of data inter-change can be cited from the American banking system. The American Banker's Association has pretty well finished plans for a standard bank check which is printed in both machine and human language.

Once full automation of check handling is accomplished, many writers on the subject of office automation conclude that the next intermediate step will be in the electronic processing of inter-company and inter-industry sales and purchase orders. In other words, the purchase order of one company becomes the sales invoice of another. Such documents with machine sensible information are susceptible to posting to voucher and sale's journals.

An interchange of business information between companies and industries will result in the advantages of:

1. Standardization of form of business information, such as purchase orders and sales invoices.
2. Standardization of material specifications within each industry.
3. Standardization of standard terminology for each given industry.

Punched paper tapes have made important contributions in business fields. This type of record is faster, more

compact, and has the advantage of being used over and over without harmful effects. To date Consolidated Edison and General Electric submit their quarterly wage forms that report wages subject to the Federal Insurance Contribution Act (F.I.C.A.). Such reporting methods will undoubtedly become more widespread throughout the business world.

The ultimate in future machine development lies in the new principle whereby a machine is capable of recognizing signs or to be able to perceive writing. The purpose of this, of course, is to eliminate the need for costly methods of translating human language into machine language. Such a machine that could recognize signs or handwriting would replace key punch operators and expensive input methods of putting data into a machine.
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APPENDIX I
APPENDIX I

IBM ACCOUNTING MACHINE FUNCTIONS

CARD PUNCHING is the basic method of converting source data into IBM punched cards. The operator reads the source document and, by depressing keys, converts the information into punched holes. The machine feeds, positions, and ejects the card automatically. The operator's primary concern is to depress the proper keys in the correct sequence.

This is basically the same kind of function as typing or other key-driven operations. Card punches equipped with printing mechanisms automatically interpret the punched information at the top of the card directly above the hole being punched.

DUPICATING is automatic punching of repetitive information from a master card into a group of succeeding detail cards. This is normally performed as part of the card-punching function. Instead of depressing keys repetitively for common information (such as Entry Date, which is to be punched in every card), the operator punches the common information only once in the first card of each group, and it is automatically punched into all remaining cards for the group. This reduces the work per card, insures consistency of common data, and increases productivity of the operator.

CARD VERIFYING is simply a means of checking the accuracy of the original key punching. A second operator verifies the original punching by depressing the keys of a verifier while reading from the same source data. The machine compares the key depressed with the hole already punched in the card. A difference causes the machine to stop, indicating a discrepancy between the two operations.

A notch in the upper right edge of the card indicates that it has been key punched and verified correctly. A notch directly above a column signifies that the punching of that column is in error.

This is basically the same type of function as typing or other key-driven operations.
GANG PUNCHING is the automatic copying of punched information from a master card into one or more detail cards that follow it.

In single master-card gang punching, one master card precedes all detail cards to be punched with the same information.

Where information changes from one group of cards to the next, interspersed gang-punching methods may be used. A master card precedes each group of detail cards. Information in the master card is automatically selected for punching into all following detail cards until a new master is read. The punching pattern then changes to conform with the new master.

Gang punching can be performed separately or in combination with reproducing and summary punching for both alphabetical and numerical information.

REPRODUCING from one card to another is like copying from one record to another. Information from one set of punched source cards is automatically punched into another set of cards. The two sets of cards are fed through the machine synchronously.

The comparing feature proves agreement between originals and reproductions. Differences are automatically indicated.

MARK-SENSED PUNCHING is the automatic punching of a card by means of electrically-conductive marks made on the card with a special pencil.

Thus, original facts may be recorded anywhere—in the office, plant or field, by workmen, timekeepers or field workers—and these facts are translated directly into punched-hole form.

INTERPRETING is the translation of punched holes into printed information on an IBM card.

Alphabetic or numerical information can be printed in many different positions on the same card from which it is read. Common data can be repetitively printed on a group of detail cards from punched information on a master card.
Interpreting is advantageous when punched cards are used as documents on which additional information is written or marked, or wherever reference to filing operations is involved.

END PRINTING converts punched information into bold printing across the end of the card simultaneously with gang punching, summary punching, reproducing, and mark-sensed punching. This is similar to interpreting, and makes possible quick reference to the card.

Cards are printed in this manner for use in prepunched files where cards are stored on end, or in attendance-card racks for convenient reference and selection.

TICKET CONVERTING is the process of changing prepunched ticket stubs (2.7" wide by 1" deep) into IBM cards. The ticket is made up of a basic section and one or more stubs that are numerically prepunched and printed with identical information.

When a transaction occurs, a stub is detached from the ticket and put into a receiver; the receiver is then placed directly in the ticket converter. The ticket stubs are fed from the receiver, and IBM cards are punched with the corresponding information. A typical application of the ticket converter is in merchandising where price tickets often represent the greatest volume of transactions.

SORTING is the process of grouping cards in numerical or alphabetical sequence according to any classification punched in them. To group cards by account, for instance, they are sorted into account sequence. This makes possible summarizing the cards by account.

A fast, automatic machine process thus is provided for arranging cards for the preparation of various reports—all originating from the same cards, but each requiring a different sequence or grouping of information.

SELECTING is the function of pulling from a mass of data, certain items that require special attention. Selection of individual cards is accomplished automatically by either the sorter or collator, according to the type of selection. Typical selections are:
Cards punched with specific digits
Certain type of cards for a specific date
All cards containing a specific number
All cards higher than a specific number
All cards lower than a specific number
Cards between two specific numbers
First card of each group
Last card of each group
Unmatched cards
Cards out of sequence

MERGING is the combining of two sets of punched cards into one set of given sequence. Both files of cards must be in the same sequence before they are merged.

This function makes possible automatic filing of new cards into an existing file of cards. It is a faster method than sorting to use in placing related cards together.

MATCHING is a checking function used to check the agreement between two sets of cards. Groups of cards in one file are compared with similar groups in a second file. Unmatched cards or groups of cards in either file may be selected or separated from the files.

This function is frequently performed in conjunction with merging.

DETAIL PRINTING is the printing of information from each card as the card passes through the machine. The function is used to prepare reports that show complete detail about each transaction.

During this listing operation the machine adds, subtracts, cross-adds or cross-subtracts and prints many combinations of totals.

GROUP PRINTING is the accounting-machine function that summarizes groups of cards and prints the totals on a report. Totals may involve adding, subtracting or crossfooting.

Information read from punched cards is entered into counter units; at the end of each group of cards, the totals are read out of the counters and printed on the report.

This function is used in preparing all types of reports requiring summarized totals. Complete descriptive information identifies all totals.
FORM FEEDING is the rapid, accurate positioning of reports and documents on which accounting-machine results are printed. The type-controlled automatic carriage feeds continuous paper forms—single or multiple copies—such as registers, reports, and paper checks. The bill feed positions single forms, such as ledger sheets, envelopes, or IBM cards. The dual-feed carriage feeds two different forms simultaneously, for printing some or all of the same accounting-machine results from the same type bars but with different spacing. All of the devices control feeding within each form, as well as form-to-form ejection.

SUMMARY PUNCHING is the automatic conversion into punched-hole form of information developed by the accounting machine. Summary punching is used for two purposes:

1. To carry balance figures forward. To do this, it is only necessary to include the previous total-to-date card with the current card or cards, and, while a current report is being run, summary punch new balance-to-date cards. These are saved for the next balance-to-date operation when the process is repeated.

2. To reduce card volume and carry summary data. Summary cards reduce peak-load periods due to accumulated card volume, and can be used as entries to general ledger accounting.

ACCUMULATED TOTAL PUNCHING is the summarizing of detail card information and the punching of a card for the accumulated totals. This is accomplished on the accumulating reproducer through the use of net-balance counters. Classified cards are read and accumulated at the rate of 200 cards per minute, and a summary card is punched for the accumulated totals at the rate of 100 cards per minute. Availability of counters enables the accumulating reproducer to be used as an independent summary punch, without the accounting machine, whenever printed reports are not required. The accumulating reproducer can also be used in conjunction with the accounting machine as a summary punch, thereby increasing total accumulating capacity.

CALCULATING is the computing of a result by multiplication, division, addition, or subtraction. Any combination of these calculations can be performed—often in one run. Factors to be calculated may be read from each card, or series of cards, emitted by a device within the machine, or be
developed by the accumulation of a series of calculations. One or several results are punched in each card or in a trailer card which follows a group of cards carrying the factors.

Many routines allow automatic checking to prove accuracy of calculations. For example, to check the punched result, an A X B calculation can be cross-proofed against a B X A calculation during the same run.

**FACSIMILE POSTING** is the process of transferring by a duplicating process a printed line on a report to a ledger or other record sheet. These may be posted from a transaction listing previously prepared on the accounting machine.

Typical uses of this function are the posting of customer ledgers, employees' earning records, and stock ledger cards.

**CARD-TO-CARD TRANSCEIVING** makes possible instantaneous and accurate duplication of punched cards over telephone and telegraph networks between locations separated by either just a few miles or thousands of miles. A switch on the machine halts card transmission at any time to permit direct voice communication over the same telephone circuits connecting the sending and receiving units.

The machines at either end of a circuit are identical and can be used interchangeably for transmitting or receiving.

**TYPEWRITER TAPE PUNCHING** is a means of recording information in code onto a tape by use of a special IBM typewriter. As a document is being created on the typewriter, any or all of the typed information can be recorded on the 8-channel tape. The tape can be easily transported to other locations and processed through a tape-to-card punch to transfer the information into punched holes in IBM cards.

In general, the typewriter tape punch can be used to prepare any document now created on a typewriter and later used as a source document for key punching and key verifying cards; this eliminates the need for the latter two functions.

Typical applications of this machine are for billing, order writing, personnel changes, address changes, insurance policies, railroad accounting, journal vouchers, purchase orders, receiving reports, directories, inventory control, check reconciliation, and many more.
TAPE READING is a process of feeding coded tapes through a tape-to-card punch to convert the coded information into IBM punched cards. Tapes can be prepared on the typewriter tape punch or on the card-controlled tape punch; the latter is capable of punching tape that can be transmitted by telegraph.

STATISTICAL WORK is essentially a problem of counting units in many different classifications. At the same time, it is frequently desirable to accumulate certain quantities or amounts, check or edit for consistency or reasonableness, and balance counts to the control totals, check the accuracy of the summaries.

All of these functions are performed by the Electronic Statistical Machine to produce printed summaries. This machine also performs sorting and card-arranging operations.

CARD-PROGRAMMED CALCULATING makes use of several connected machine units. The Accounting Machine reads from the punched cards the factors for calculation, and the codes that instruct the machines about calculations to be made. The factors are introduced into counters of the several machines, and calculations are made according to the coded instructions. The storage unit makes possible the holding of figures until they are needed in calculations. Upon completion of the calculations, results may be printed on a report by the Accounting Machine, as well as punched into a card by the punch unit of the calculating punch.

Typical uses of card-programmed calculating are preparation of payrolls, general ledger accounting, actuarial studies and statistics, and other business calculations. The CPC is also used in many engineering and scientific calculations.

DATA PROCESSING, from a machine standpoint, entails entering a complete set of instructions as well as initial source data into the machine to enable it to arrive at the completed final results or reports in one operation.

This type of data processing requires the programming of each step in the procedure—including the solution to all exceptions—before source data are to be processed. Through the use of cards, magnetic tapes, magnetic drums, electrostatic storage, and printing units, the machines are capable of high-speed input-output and internal logical ability.
Such features permit accurate processing of large procedures and complex problems at high speed.

STORED PROGRAMMING is the function of entering or "loading" of all instructions into the machine in the proper sequence to perform the steps necessary to complete a given application or problem from data "loaded" in a similar manner.

The number of instructions whether relatively few, or many, required for the complete solution of a problem, can be stored in the internal memory or storage unit of the calculator. One number will tell the machine what operation to perform, another will tell it where the information is stored, and still another will tell it what to do with the answer. All of the arithmetic functions can be performed—as well as rapid and automatic table look-up that facilitates classification and distribution of data.

Problems range from payroll processing, through elaborate studies in manufacturing control, to differential equations of engineering and physics.
APPENDIX II
APPENDIX II

SIMPLIFIED DESCRIPTION OF A COMPUTER

I. OUTLINE
There are six main aspects of a computer, viz:—
   - Program
   - Input Method
   - Storage Unit
   - Arithmetic Unit
   - Control Unit
   - Output Method

II. PROGRAM
Each complicated problem to be handled by the computer has to be broken down into a Program, i.e., a series of simple single steps, which are then stored (in coded form) in the slow-speed storage of the machine. They act as instructions or orders to the Control Unit. The program can be stored on punched cards, perforated tape, or magnetic tape, from which the computer can read the instructions.

III. INPUT METHOD
The Input Method is the form in which words and numbers are fed into the machine. The data has to be coded and is usually presented on punched cards or perforated tape, prepared as a separate operation.

IV. CONTROL UNIT
The Control Unit carries out the programmed instructions. It is not a self-contained unit within the computer but is a combination of circuits and switches.

V. STORAGE UNIT
The Storage Unit is the heart of the computer. It holds the instructions, the data figures relating to the problem, and the interim results.

There are generally two types of information stored, namely external and internal. External storage is used to hold a large number of items which are only required occasionally and can be of relatively slow access. Punched cards, perforated tape and magnetic tape are the most common types of external storage.
Internal storage is used for the small number of items which are required quickly and frequently. The most common types of internal storage are:

Magnetic Drum—Information is deposited in form of magnetic spots. Data is put on or drawn out in about 1/50th of a second.

Cathode Ray Tube—Similar technique to Magnetic Drum but faster.

Mercury Delay Tube—Faster than Magnetic Drum but not as fast as Cathode Ray Tube.

VI. ARITHMETIC UNIT
The Arithmetic Unit carries out all the calculations required, putting into and withdrawing from storage as required and as instructed by the Control Unit.

VII. OUTPUT METHOD
The Output Method is the form of reproducing the answers. The most usual method is by direct printing, but sometimes punched cards or perforated tape are produced which can then be used for other operations.

VIII. COMPARISON WITH HAND METHOD
In simple conception, the layout of the machine follows the same approach to a job, say of multiplication, as would be used by a clerk doing it by wholly manual methods, as the following example shows:

1. Input
   write down the problem on paper.

2. Storage
   refer to multiplication table retained in brain since school days.

3. Arithmetic
   carry out multiplication as taught at school (i.e. follow circuit) using memory or paper to store partial results.

4. Control
   govern process by multiplying in sequence first by units digit, then tens digit, then hundreds digit. Direct hand to record results on paper.
with pencil. On completion of multiplication, do addition and obtain answer. Check answer by repeating the process, by approximation, or some other suitable method.

5. Output

write answer on paper.