ELECTRONIC DATA PROCESSING--IMPLICATIONS FOR
BUSINESS EDUCATION IN HIGH SCHOOL

by
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Willard M. Thompson, Chair
William R. Blackler

Advisory Committee
Date May 29, 1958
The writer wishes to express his grateful appreciation for the friendly guidance and helpful assistance of Doctors Willard M. Thompson and William R. Blackler.
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CHAPTER I

THE PROBLEM AND ITS IMPORTANCE

There can be little doubt that electronic data processing is assuming increasing importance to the business world. New books and recent articles, both in professional journals and popular magazines, draw attention to new developments in the field. Mitchell says that electronics will usher in "the world's most promising technological revolution."

He thinks that electronics will come to displace atomic energy in future importance.

The electronics industry in the Western United States is continuing to grow. According to one estimate, it now accounts for nearly 25 per cent of the total electronics business in the United States. Los Angeles is allegedly the computer center of the nation, "accounting for more computer manufacturers of significance than any other metropolitan area." Estimated 1957 sales in the Los Angeles electronics industry amount to one billion dollars; in the Bay Area to


2 Ibid.


4 Ibid., p. 55.
to one million dollars per day.  

The nationwide impact of new developments is being felt now:

Years of man-hours [caps. in original], millions of dollars are currently being invested in electronic data-processing systems by pioneer firms. Others are asking: How are we to judge the practicability of available equipment for our specific needs?  

Lately nearly all business groups have discussed the importance of electronics in their meetings. Both manufacturers of electronic equipment and institutions of higher learning are developing courses in electronic data processing.

Figure 1 indicates the rapid growth of the computer industry in recent years. During the years 1930 to 1934, inclusive, only eighteen organizations entered the computer field, but by the years 1950 to 1954, inclusive, some eighty-seven organizations entered the field. The post World War II period saw a rapid increase in numbers of new organizations. During 1940 to 1944, inclusive, only twenty-six organizations entered the field, but during the 1945 to 1949 period, inclusive, seventy-eight entered.

Statement of the Problem

The purpose of this study was to describe electronic data processing, and to discuss its implications for vocational business
NUMBER OF ORGANIZATIONS ENTERING THE COMPUTER FIELD, 1930-1957
(BASED ON DATA FROM COMPUTERS AND AUTOMATION, JUNE, 1955, AND JUNE, 1957)

*Incomplete data; includes period to May 15, 1957.
education in high school.

Justification of the Problem

The growing importance of electronic data processing to the business world naturally brings up the question of implications for business education. Since the development of the typewriter in the later years of the nineteenth century, the mechanization of business offices has continued to increase with attendant, but sometimes lagging, alteration of the secondary school business curriculum. Reason would seem to indicate that electronic data processing will have, if anything, a greater influence on the curriculum than have other forms of mechanization to date. Like accounting, electronic data processing is a management tool. Management needs operating information quickly, and the more rapidly it gets it, the better it can adapt its operations to meet competition and widening markets. Whole batteries of electronic equipment, operating in unison, provide management with data which enables, even forces, the making of rapid and intelligent decisions.

Electronic data processing is a new problem, and one which has just begun to challenge business educators. The need for research in this field is revealed in letters from organizations in the computer industry:

I think you have made a wise choice for a thesis as the problems you will be working with will be of increasing importance in the

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4 Mitchell, op. cit., p. 10.
years to come.  

The field of Electronic Data Processing badly needs to have people in the academic world raising questions like yours.  

We are particularly pleased that you have the pioneering spirit to write about this tremendous subject which we think is of primary importance in the business world today.

Delimitations of the Problem

No attempt is made to deal with other than business uses of electronic data processing; scientific and industrial applications, for example, are not covered. The limitation to business uses of electronic data processing further restricts the discussion of computer units to the electronic digital type. Computing devices are usually classified as either digital or analog, but there is also a hybrid combining features of both types. While "the digital computer works directly with integers which are expressed by . . . electrical pulses in the electronic digital computer," the "analog computers are continuous variable devices which represent numbers by measuring some physical quantity such as shaft rotation,

11 Letter dated February 16, 1956 from G. M. Lock, Secretary-Treasurer, Benson-Lehner Corporation, West Los Angeles, California.

12 Letter dated March 6, 1956 from Paul Armer, Head, Numerical Analysis Department, The Rand Corporation, Santa Monica, California.


voltage, resistance, or position of a hand on a scale." Analog systems are usually used in connection with scientific and industrial applications; digital systems, on the other hand, are quite useful for business applications. Whenever dollars-and-cents accuracy is required a digital computer is needed. Analog computers do not give other than approximate answers, having a typical error of about 1 per cent, but digital computers are accurate to the penny. 16

Only the implications of electronic data processing for vocational business education in high school (grades nine to twelve inclusive) are discussed in this study.

This study specifically includes and is limited to a representative sampling of the electronic data processing equipment available from several manufacturers. This equipment is classified as general purpose (large, medium, and small size) and special purpose. The large general purpose equipment is represented in this study by:

- International Business Machines Corporation (702 and 705)
- Radio Corporation of America (BIZMAC)
- Remington Rand Univac Division of Sperry Rand Corporation (UNIVAC I and II)

Medium general purpose and small general purpose equipment are

---


represented by the equipment of the ElectroData Division of Burroughs Corporation. The Datatron is their example of a medium sized general purpose system, while the M101 is their example of a small sized general purpose system.

The special purpose equipment included in this study, together with the name of the manufacturer, and the type of application, is listed below:

- **Airborne Instrument Laboratories, Modac Division (MODAC 404—especially accounts receivable)**
- **Stanford Research Institute, Stanford University (ERMA—Electronic Recording Machine, Accounting—especially for servicing checking accounts)**
- **Teleregister Corporation (Magnetronic Inventory Control System)**

The nationwide count of electronic computers stands at 153 large size machines in existence and 262 on order; 748 medium size machines in existence now and 1,454 on order, and 4,256 small size machines and 1,727 on order. The grand total is 5,192 machines of all sizes in existence now and 3,443 on order—a combined total 8,635 machines of all sizes in existence now and on order.

There are several installations that either exist in or are projected for Sacramento and vicinity:

<table>
<thead>
<tr>
<th>System</th>
<th>Location</th>
<th>Date Installed or Projected For</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERMA</td>
<td>Bank of America</td>
<td>?</td>
</tr>
<tr>
<td>IBM 650 Magnetic Drum</td>
<td>Department of Public Works</td>
<td>circa April, 1956</td>
</tr>
</tbody>
</table>

15 "A New Count of Electronic Computers" (Albany: Bureau of Business and Distributive Education, The State Education Department, c. 1957. Mimeographed.)
System | Location | Date Installed or Projected For
--- | --- | ---
IBM 650 Tape | Sacramento Signal Depot | November, 1957
IBM 704 | Aerojet-General Corporation (Liquid Rocket Plant) | 1956
IBM 705III | Department of Employment | 1956
UNIVAC 1105 | McClellan Air Force Base | November, 1958
UNIVAC File Computer | McClellan Air Force Base | August, 1958

Definition of Terms

**Electronic data processing.** Electronic data processing should be interpreted throughout this paper as a means of rapidly processing business data with the aid of an electronic computing system. Electronic data processing should be thought of as a process, not as a thing, such as a piece of equipment, though the processing is accomplished with the aid of equipment.

Data processing. This term has been defined by Bradshaw and Newman as the "paperwork required to produce and distribute goods and services." It includes the five basic steps of classifying, sorting, calculating, summarizing, and recording. In broadest form then, it includes all manner of accounting and clerical functions, but for the purposes of this study, this definition seems too broad, since it


21 Ibid.
would include both industrial and business data processing. Tonne says that industry is concerned with the production of goods, while business is concerned with the distribution of such goods. To preclude the possibility of including industrial paperwork, data processing should be thought of as business data processing, in the sense that business is defined by Tonne.

**Electronic processing.** Electronic processing of data refers to that processing which is "accomplished by pulses of electricity . . . never converted to mechanical movements." According to Arnott and Condon, "electronics is that branch of physics or electrical engineering which deals with the phenomena of the flow of electric currents through vacuum, gases, and vapors."

**Computer.** This definition has been made broad enough to include desk calculators:

A computer is an information processing device. It has been defined as a "device which accepts quantitative information, may arrange it and perform mathematical and logical operations on it, and makes available the resulting quantitative information as an output."  

---


**Electronic computer or data processing system.** An electronic computer or data processing system comprises that equipment or machinery which processes data by electronic means. An electronic computer or data processing system is composed of a variable combination of units of equipment or machinery, usually classified as input, output, memory, arithmetic, and control. The five units can be broken down into even simpler terms: input, output, and everything in between (meaning the processing equipment or computer itself). The input component receives "decimal and alphabetic data represented by holes in cards or paper tape, or magnetic spots on plastic or metal tape."²⁶ Thus imagine data being fed into a system from input; under the direction of the control unit the data is processed by means of memory and arithmetic, and finally emerges on output in finished form, such as punched tape. Between input and output something happened to process the data fed in, "like its addition to another number already in the machine; and this intermediate stage was the processing."²⁷ For a system to be classified as electronic, the computing units must operate electronically; in such a system input and output may be mechanical or semi-mechanical, but the actual computing is done at the speed of light.


²⁷Morgan, *op. cit.*, pp. 61-62.

²⁸Roedel, *loc. cit.*
Automation. This word is included not because it is used extensively in this thesis—it is not, since it is too broad a term to have any precise meaning—but because it is one likely to be met with frequently in the literature of data processing. Here are some of the definitions:

(1) A word coined in 1948 by Delmar S. Harder, vice president, Ford Motor Company, describing "the automatic transfer of auto parts from one metalworking machine to the next." 29

(2) A word coined by John Diebold. 30

(3) A term "applied only to completely automatic machines that feed back into themselves reports of how they are doing, and correct themselves if necessary." 31

(4) When machines do a man's work, that's mechanization. When they do his work and control and correct their own operations as well, that's automation. This means machines that can adjust to changing conditions of production, correct their own mistakes, and even replace their worn-out parts . . . " 32

(5) A term used by businessmen meaning "all automatic machines and processes, including the giant tools that follow directions punched on a tape, huge computers . . . , gauges that check fractions of a hairbreadth with a tiny beam of light." 33

The third definition seems to be the definition of "purists" or electronics engineers. Sometimes businessmen prefix the word "office" to "automation" and this narrows the definition to mean something like "all automatic or semi-automatic equipment found in a business office."

32 Kehoe, loc. cit.
33 "Automation," Time, loc. cit.
Business education. Business education is herein taken to mean "education that is of value on the job or that is derived from, or related to, job activities." Vocational training is specifically intended.

Other terms. Electronic data processing has developed a terminology of its own. Useful glossaries of such terms have been published in several places.

Procedural Step One—Preliminary Survey

At the outset of this study a preliminary survey of the organizations in the computer field was made in order to gather general information. Of 302 entries, 268 organizations listed in "The Computer Directory," the June, 1955 issue of Computers and Automation, were included in the survey. Two form letters were sent to the organizations; the second of the two letters was sent out fourteen days after the first. These letters were designed to obtain these responses:

Information concerning types of electronic data processing equipment available now and projected for the future.

34 Tonnes, op. cit., p. 33.


Information concerning the application of electronic data processing equipment to business functions.

Information concerning the training required of personnel who apply electronic data processing to business functions—especially the nature, extent, and sources of such training.

Ninety-six copies of the first letter (see Appendix), sent out on February 10, 1956, brought forty-eight responses, twenty of which were useful in the development of this thesis. The second letter (see Appendix) was sent to 172 organizations. Seventy-seven replies were received, thirty-five of which were useful in the development of this thesis. Replies included printed and duplicated literature, bibliographical references, and directions to individuals and organizations in the computer field. Many of the respondents, at the expense of what must have been considerable time and effort, gave encouraging comment; they helped in such ways as outlining differences between analog and digital computers, and by emphasizing the differences between wholly electronic and other types of computers. A fantastic quantity of specific information was and is available on electronic data processing. It appeared that this thesis would help to fill the need for bringing together material that, standing alone, is confusing and overwhelming.

Procedural Step Two—Gathering the Data

The data needed for this study were:

Examples of electronic data processing applied to business functions.

Information concerning the nature, extent, and sources of the training required of personnel who apply electronic data processing to business functions.
Implications for vocational business education derived from the data and from the opinions of business educators.

Sources of data. The sources of data for this study were:

Organizations in the computer field.

Individuals in organizations having electronic data processing installations.

Business educators.

The methods of obtaining the data. The data required above pertaining to examples of electronic data processing applied to business functions, was obtained through individual correspondence in January of 1958 with the following seven organizations:

Airborne Instruments Laboratories, Modac Division
864 Franklin Avenue, Thornwood, N. Y.

ElectroData Division of Burroughs Corporation
460 Sierra Madre Villa, Pasadena, Calif.

International Business Machines Corporation
590 Madison Avenue, New York 22, N. Y.

Radio Corporation of America, Components Division
19th and Federal Streets, Camden, N. J.

Remington Rand Univac Division of Sperry Rand Corporation
315 - 4th Avenue, New York 10, N. Y.

Stanford Research Institute
Menlo Park, Calif.

Teleregister Corporation
445 Fairfield Avenue, Stamford, Conn.

As the preliminary survey did not yield much information on training personnel for the computer field, it was decided to survey by mail (see Appendix) individuals in the computer field for information relating to the training of computer personnel. Those 295
persons (not counting two Europeans) listed in the June, 1956 issue of "The Computer Directory."\(^{37}\) were selected because their computer interests included applications, business, construction, design, electronics, logic, mathematics, programming, and sales. A broad consideration of the following questions was thus assured:

Kinds of jobs available in an electronic data processing installation.
Education background required for these jobs.
Special training required for these jobs.
Length of special training required for these jobs.
Who gives the special training required for these jobs?

For implications of electronic data processing for vocational business education in high school, it was necessary to get the opinions of business educators, especially supervisors and administrators, because they would be better able, by virtue of position and experience, to consider the total impact of electronic data processing upon business education. Accordingly, 208 persons listed in the May, 1957 Administrative Issue of The National Business Education Quarterly were surveyed by means of a form letter questionnaire (see Appendix).\(^{38}\)

Procedural Step Three—Presentation of the Data

The data obtained by means of the four surveys mentioned above


is presented in the main body of this thesis. Chapter II contains a
general discussion of the background of electronic data processing.
Chapter III consists of descriptive data on some recent types and
applications of representative electronic data processing systems.
Chapter IV reports on some of the positions in public and private
electronic data processing installations for which high school
graduates may qualify themselves.

Procedural Step Four—Implications

Chapter V considers the implications of electronic data
processing for vocational business education in high school.

Related Literature

There is no literature directly related to the problem of this
thesis. Tonne, in a letter dated January 11, 1956 said that "there
is nothing tangible" in the field. In another letter dated January
10, 1958, he indicated again that he did not know of any studies
related directly to this problem.
CHAPTER II

THE BACKGROUND OF ELECTRONIC DATA PROCESSING

This chapter contains a general discussion of the background of electronic data processing. It was designed to present necessary descriptive and historical information.

Data Processing As a Problem

Electronic data processing may be looked upon as the most recent attempt to solve a very old management problem—the problem of what to do with a mass of business paperwork. Data processing equipment, from adding machine to UNIVAC, has been devised to lighten the load and solve this problem in a better, more efficient manner. The problem is basically one of classifying, sorting, calculating, summarizing, and recording data, and all data processing equipment is designed to perform one or more of these five basic operations. In the final analysis "we see that electronic computers are no more than a significant advancement in solving a problem that has seen many other significant advancements over a long period of years." Some of these advances have been in the development of better ways to perform individual data processing jobs. Others have been in the improvement of mechanical and

electro-mechanical equipment. The adding machine made it possible for a single machine to replace the dual functions of summarizing and recording. Later, punched card equipment, consisting of key punches, sorters, reproducers, accounting machines, and other devices, were integrated by means of the punched card. This means that while each machine performs a specific function, or combination of functions, the punched card makes all the equipment mutually compatible. This means that the same data can be handled on different machines by moving the cards that contain the data. It is not necessary to obtain duplicate data for use on each machine.

More recently, punched tape makes possible the integration of even more equipment. Any office machine, from a typewriter to a calculator, can be made to produce a punched tape as it operates, and this tape may be used to integrate and make compatible not only conventional office machines, but punched card equipment as well. When this degree of integration is attained, we may refer to the data processing as being integrated, hence the term integrated data processing.

The latest development, at the front of all others, is the rapid processing of data by electronic devices. At this stage the data processing functions are not only integrated, but the processing equipment "talks to itself" as well: it needs no manual transfer of tape or cards from machine to machine:

For the first time, one piece of equipment made by a single manufacturer, capable of storing raw data and processing instructions, will perform all the functions at the speed of light (186,324 miles per second).²

²Ibid., p. 21.
Simplification of individual steps in the data processing problem, mechanization of one or more of the steps, integration of two or more steps by means of punched cards or tape, and intercommunication (automatic integration of steps), are thus seen to be the principle factors in the development of more adequate data processing techniques. The concept is shifting from use of single machines, such as adding machines and desk calculators, for working independently on segments of the data processing problem, to utilization of an entire battery, or system of equipment, for integrated handling of the whole data processing problem. Integrated data processing involves manual operations while electronic data processing is automatic.  

Components of Electronic Data Processing Systems

Electronic systems process data by means of an electronic computer, but there must also be a means of getting the data to be processed into the computer and a means of taking it out; these means for getting data into and out of a computer are commonly known as input and output devices. An electronic system, therefore, basically consists of a computer and input-output devices. The computer itself has arithmetic, control, and memory units. The computer units are sometimes referred to as "electronic brains" and the memory units have been especially regarded as the "hearts" of the electronic systems.  

\[3\]
\[4\]

There are two general types of digital computers. The first is the general purpose computers, which, as the name implies, may be adapted to a variety of purposes. The second is special purpose computers which by nature are restricted to the performance of specific functions. Both general and special purpose computers are in turn of two types, either mechanical or electrical. There are also electro-mechanical hybrids such as the Mark I general purpose computer. The UNIVAC is an example of the purely electronic general purpose digital computer. The Magnetronic Inventory Control System is representative of electronic special purpose devices.

The computer component industry seems to be in a state of high activity. A seemingly infinite number of devices either exist or are in process of being developed. Common input devices are magnetic or paper tape, or punched card readers. All kinds of sensing devices fall into the input class, for example, photoelectric scanners. Output devices are commonly paper tape or punched card punches, magnetic or photographic records, printers of various sorts, or visual displays. One recent development is the Stromberg-Carlson Charactron, which is capable of an output of ten to fifteen thousand characters a second. The Charactron has a tube which is capable of minutely reproducing alphameric (letters or numbers) data. The tube-screen is then

---


photographed at a rate that is fast enough to copy a three hundred
page book in thirty seconds. A similar device is the Hughes Typotron
tube, a component of the SAGE master weapons control system. The
Typotron is capable of read-out at twenty-five thousand characters a
second. Burroughs has also made a coin-sized glow tube called
Nixie.

The memory or storage element is the most important device in
any computer, and there are several types with varying technical
characteristics. A memory device simply stores information inside
(or outside) the computer until it is needed—Babbage, as a matter of
fact, actually called the memory for his engine a store. Magnetic
drums, tape, discs, cores, belts, and wire are some of the media used.
Others are electrostatic storage tube, punched card and tape, plug-
board, etc. Some new developments are the Magnacard of The Magna-
vox Company, a one by three inch magnetic card capable of storing six
hundred alphabetic characters, and the photochromic process, being
developed by the National Cash Register Company; in this process in-
fomation stored in dye cells may be read by light beam—one square

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9 "A Pictorial Introduction to Computers," *Computers and Auto-
foot of the paper used will hold twenty million bits.

Next in order of importance is the arithmetic component, which is incidently, not strictly limited to arithmetic functions. The field of symbolic logic must be included here, and there are several logical operations applicable to the computing field. Thus an arithmetic component might more properly be designated a logical component, since it may reason in both numerical and non-numerical terms. An arithmetic unit may be called upon to solve purely arithmetic problems, and also to do such things as compare, transfer, and combine. There is intercommunication between arithmetic and memory—one component can go to the other for information as often as required. A computer utilizes complex circuits, inexplicable except in technical terms, but a rough idea of how the arithmetic device operates may be fairly simply explained: the system is even simpler than Morse code dot-dash, because there is either something happening, or there is nothing happening; that is, there is either a sub-millisecond pulse or the absence of a pulse. This binary numeric system, which of course may be used to represent letters in the alphabet or other characters as well, has a base of two, a pulse or no pulse, one or zero. The numbers zero to thirty-two are listed as follows in both decimal and binary form:

---

12Newsweek, 50:102, November 25, 1957
The binary system obeys all the usual laws of arithmetic:

\[
\begin{align*}
2^{(3)} &= 6 & \text{or} & \quad 11 \\
\quad & \quad \quad \times 10 & \quad & \quad \quad \quad 00 \\
\quad & \quad \quad \quad \quad \quad 11 & \quad & \quad \quad \quad \quad \quad 110 \\
\end{align*}
\]

and

\[
\begin{align*}
2^{(32)} &= 64 & \text{or} & \quad 1000000 \\
\quad & \quad \quad \times 10 & \quad & \quad \quad \quad 1000000 \\
\end{align*}
\]

and

\[
\begin{align*}
2 & \div 2^{(4)} \\
\quad & \quad \quad \quad \quad \quad 10 \\
\end{align*}
\]

and

\[
\begin{align*}
5 & \div 2^{(5)} \\
\quad & \quad \quad \quad \quad \quad 101 \quad 1110 \\
\end{align*}
\]

and

\[
\begin{align*}
8 & \div 2^{(6)} = 16 & \text{or} & \quad 1000 \\
\quad & \quad \quad \quad \quad \quad +1000 & \quad & \quad \quad \quad \quad \quad 10000 \\
\end{align*}
\]

and

\[
\begin{align*}
12 & \div 2^{(7)} = 25 & \text{or} & \quad 1100 \\
\quad & \quad \quad \quad \quad \quad +1101 & \quad & \quad \quad \quad \quad \quad 11001 \\
\end{align*}
\]

and

\[
\begin{align*}
29 & \div 2^{(8)} = 20 & \text{or} & \quad 11101 \\
\quad & \quad \quad \quad \quad \quad -1001 & \quad & \quad \quad \quad \quad \quad 10100 \\
\end{align*}
\]
30-10 = 20
or
11110
-1010
10100

One or usually more binary digits are the equivalent of each decimal digit, letter of the alphabet, or symbol. A binary digit is designated a bit, and a group of bits constitute a character (decimal number, letter, or symbol). Characters are handled by computers in the form of words of either uniform or variable length. A group of words then constitute a block.

Last, but by no means least in importance, is the control component, which has intercommunication with memory. This unit sees that the computer does, according to scheduled sequence or program, the job it has been "told" to do. In some cases the control device can be made to correct or type out a description of the trouble whenever something goes wrong.

History of Digital Computing Devices

This brief history is non-technical; it is limited to digital

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prototypes, and does not consider any of the early analog developments such as the slide rule.

**History from earliest times to the end of the nineteenth century.**

In an era when electronic computers, like aircraft and missiles, are experimental when planned and obsolete before leaving the drawing board, we should not underestimate the spadework that has made possible an age of electronic computing systems. The quest for faster and more efficient ways to compute has been going on for perhaps as long as man himself has existed. Many historians have traced the development of numbers far into the dim past; we know that accounting is as old as civilization.

The hand may possibly be spoken of as the first rapid digital calculating machine; the Romans by means of a sign language, used their fingers to lighten the load of their computational work, and with practice the Roman clerks could become highly proficient. The Romans, like other peoples, also used as a calculating device the manipulation of pebbles; as the method evolved, the pebbles were placed in racks or strung on wires in a frame. Such an apparatus is known as an abacus, and even today its use is widespread, especially in the Orient. It was used as early as five thousand years ago in the Tigris-Euphrates Valley.

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16 Morgan, *Total to Date*, p. 7.


18 Morgan, *loc. cit.*

19 Roedel, *op. cit.*, p. 28.
The abacus has been called "the model of almost all modern calculating machines." It is an ancient instrument, and though used in countries the Western World has long regarded as primitive, it should not be considered as an object of scorn; it is in fact an extremely useful and efficient instrument. The 1947 contest in Tokyo, in which an expert on an abacus beat an expert on a calculating machine in addition and subtraction, the abacus losing out by a few seconds in multiplication and division, is fairly well known. The abacus was at one time used in American schools to teach addition and subtraction. Being at once cheap, rapid, and efficient, it has much to commend it. Perhaps it will return.

From abacus to adding machine was no great jump. As early as the tenth century A. D. the Moors had thought of a calculating device, and Gerbert of Aurillac (Pope Silvester II, 999-1003), in the years after his visit to Moorish universities in 960 A.D., tried to make practical such a machine. He used his abacus, which lacked a zero, of "27 divisions and a thousand counters of horn" as an aid in the

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23 Roedel, loc. cit.
teaching of arithmetic and perhaps geometry.

Today we have in general two kinds of digital calculators: mechanical (or electro-mechanical), using rack and register, and electronic, using electronic pulses for computing. Sign language for computational purposes may be regarded as the forerunner of electronic computing, which makes use of the binary numeric system, a sign language of its own; this language enables electronic pulses to do their work. On the other hand, the abacus may be compared to the electro-mechanical calculator, since the manipulations one must go through to perform on an abacus are similar to the whirring of gears and movement of rack and register that a mechanical calculator, whether assisted by an electric motor or not, must go through to calculate.

At the age of eighteen, the French philosopher, Blaise Pascal, built at Rouen in 1642 a device to aid his father check accounts; it sped up the abacus and proved to be the first useful adding machine, being simply a set of toothed, numbered wheels that provided for automatic carry-over from one disc to another. Pascal's machine illustrated the desirability of automatic carrying, and also demonstrated that

26 Ibid., p. 7.
subtraction could be accomplished by reverse adding (as on the abacus), and that repeat addition would multiply (as on the abacus).

Sir Samuel Morland presented to Charles II a machine that would add and subtract. In 1666 he replaced "Napier's bones" with wheels, thus inventing a multiplier.

Baron Gottfried Wilhelm Leibniz (1646-1716) in 1671 improved Pascal's machine, and he built a device that could multiply in 1694. Viscount Charles Mahon (3rd Earl Stanhope) improved Morland's machine in 1780, and in 1842 Dr. Roth also improved upon "this type of stylus-driven instrument." Many attempts were made during the eighteenth century to develop satisfactory commercial machines, but the major difficulty was that the state of technology was not yet caught up to invention. By the end of the eighteenth century repeat addition equation solving machines had been made.

By 1820 the Alsatian, Charles Xavier Thomas de Colmar, had devised a way to speed up the multiplication process: once having set a number on his machine, he could turn the crank once and multiply by

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28 Roedel, loc. cit.
29 Morgan, op. cit., p. 15.
31 Roedel, loc. cit.
33 Baxandall and Eckert, loc. cit.
34 Morgan, op. cit., pp. 15-17.
two, turn it twice and multiply by three, "and so on up to nine."  
Thomas' instrument is still made in Paris.  
Leibniz was far ahead of Thomas with this limitation—Thomas' machine worked, while Leibniz' did not, owing to the primitive state of technology in his day, especially in metal working.  
Shortly after Thomas, D. D. Parmalee in 1850 replaced clumsy dial turning with key pressing.

At this point developments speeded up very rapidly. The German, Arthur Burkhardt, in 1873 made his Burkhardt Arithmometer. Many machines of this type were produced in Europe and America; the American representative was the Allen (1927). Frank Stephen White Baldwin replaced the Leibniz stepped wheel in 1875 with a device later known as the "Odhner wheel," and during the same period W. T. Odhner, a Russian, made a machine that used the same device. This type machine was made under the name Brunsviga beginning in 1892. It has been produced in Europe and America. The representative American machines are the Marchant (1911), Lehigh (1919), Arrow (1921), and Rapid (1923). William Seward Burroughs (1857-1898), a bank clerk, got the idea for a printing adding machine about 1882. The pilot model was exhibited in 1884, and the machine was in production

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35 Maloney, op. cit., p. 242.
36 Roedel, op. cit., p. 30.
37 Maloney, loc. cit.
38 Morgan, op. cit., p. 17.
39 Baxandall and Eckert, op. cit., pp. 549, f.
by 1890. In 1887 Dorr Eugene Felt patented his **Comptometer**, called the first successful "key-driven multiple-order calculating machine." The **Comptograph**, a printing **Comptometer**, came out in 1889. Many workers have contributed to the development of adding and listing machines, but Felt and Buroughs made the first practical machines. Leon Bollee made the first successful direct multiplication device in 1887. Automatic division was accomplished on the 1908 **Madas**, introduced by Hans W. Egli. An almost infinite variety of machines have been produced, and refinement upon refinement added since the turn of the century, but it would be inappropriate to discuss them here. Instead, turn back to the early years of the nineteenth century.

**Babbage’s dreams.** A genius was hard at work on his great "folly."

The great engines conceived of by the Englishman, Charles Babbage (1792–1871), posed many of the computer problems that have only recently been solved. The IBM–Harvard Mark I "was hailed as 'Babbage’s dream come true'!"

Babbage was a friend of John Herschel, son of the famous astronomer William, and it is possible that the younger Herschel lit

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42 Roedel, *loc. cit.*
44 Morgan, *op. cit.*, p. 17.
the spark that started Babbage off on his magnificent lifetime of failure:

Herschell "had brought in some calculations made for the Astronomical Society. In their tedious checking of the figures Herschel and Babbage found a number of errors, and at one point Babbage said, "I wish to god these calculations had been executed by steam." 'It is quite possible,' remarked Herschel," and Babbage began to think.46

Babbage is said to have conceived of his digital difference equation solver in 1812. He proposed that the British government take over the project in 1822, and it did so, but the only component of the Difference Engine ever actually constructed was "an accumulator mechanism." 47 This Difference Engine was intended to handle twenty decimal digit numbers and "differences up to the sixth order." 48 This machine was to have a printed output, thus eliminating errors introduced in the transcription of computed data. In 1833, after the expenditure of £17,000 government funds and £6,000 of his own funds, and an argument with his engineer, work on the Difference Engine stopped, and in 1842 the project was given up. 49

Now Babbage had a great new plan, on a scale more grand than his previous ideas. Gaining his inspiration from a silken portrait

47 Roedel, loc. cit.
49 Philip and Emily Morrison, loc. cit.
woven by a card programmed Jacquard loom, he decided that he would build an Analytical Engine that would "consist of (a) a 'store' to record information in a set of registers, (b) a 'mill' where arithmetic operations were ground out, and (c) an unnamed portion consisting of transfer mechanisms." This engine was to have both card controlled "store" and "mill." A friend of Babbage said "the Analytical Engine weaves algebraical patterns just as the Jacquard loom weaves flowers and leaves." The reader will easily see the similarity between components of Babbage's Engine and modern computing systems: the "store" was to be a one thousand, fifty-digit capacity memory device; the "mill" was an arithmetic and logic component. A punched card input and output was planned. The Analytical Engine was to be faster in operation, more versatile, and easier to build than the Difference Engine. Babbage estimated that his Analytical Engine would be capable of multiplying two fifty-decimal-digit numbers in about three minutes. Babbage's engine was probably the first data processing system.

After years of work Babbage dropped this engine and began work on a second Difference Engine. The output device was to stamp numbers,


51 Pattu, loc. cit.

52 MacWilliams, loc. cit.

53 Philip and Emily Morrison, op. cit., pp. 67-68.
with "steel punches . . . on a copper engraver's plate."

Babbage's engines were never completed and put into operation, but the magnitude of his vision is truly astonishing. This frustrated genius, who never saw the finish of his projected two-ton engine, once remarked that "machinery which will perform . . . common arithmetic . . . will never be of that utility which must arise from an engine which calculates tables." He was the first to look upon data processing from the systems approach.

It should be noted that the Jacquard cards, which Babbage intended to use, were even then by no means new. The Jacquard loom was an unparalleled improvement over the hand loom, and it represented the culmination of a series of improvements begun by Basile Bouchon in 1725, who made use of an endless belt of punched paper. M. Falcon in 1728 controlled his Jacquard machine with perforated cards, and in 1745 Jacques de Vaucanson integrated the features of Bouchon's and Falcon's machines. Jacquard (1752-1834) saw Vaucanson's loom and finally perfected it. Dr. Herman Hollerith in 1887 reintroduced the Jacquard punched card. Hollerith's machines were to automatically sort, analyze, and tabulate the mass of data gathered in the United

54MacWilliams, loc. cit.
55Philip and Emily Morrison, op. cit., p. 68.
States census of 1890. Hollerith formed his own company, now IBM, which has developed the Jacquard-Hollerith cards. The basic principle is that metal brushes make electric circuit contact through the punched holes. John Powers, an associate of Hollerith, entered the organization now known as Sperry-Rand Corporation. The eighty-column IBM cards are easily spotted by their characteristic rectangular punchings. The Powers or Remington Rand ninety-column cards have round punchings which are used for mechanical rather than electrical sensing.

Babbage was not the only inventor to dream of difference engines; as early as 1786 J. H. Muller thought of one but it was never built. However, the Swede, George Scheutz, more practical than his contemporary, Babbage, actually built and used a difference engine of simpler design. By 1833 Torres conceived of an essentially electro-mechanical counterpart of Babbage's Analytical Engine.

The twentieth century. It has been said of computing devices that "a summary of the progress in this century is very nearly a summary of the entire past history of the art." Around the turn of the present century mechanical computing devices began to be modified

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58 ANG Course Outline (Course Outline for National Bureau of Standards in Automatic Data Processing Systems For Key Management Personnel). This document consists of "Notes For Course on 'Introduction to Automatic Data Processing Systems'" which were developed for the Air Material Command by the National Bureau of Standards, 1955, 1.3-6. (Duplicated.)

59 Ibid., 1.3-15.

60 MacWilliams, loc. cit.
to perform special business functions. A typewriter accounting 
machine was produced in 1924, and in general computing devices 
were transformed into increasingly more complicated billing machines. 
In the 1920's mechanical computers began to be replaced by faster, 
larger, and more complex electrical devices.

Three of the first computer efforts were the Mark I and its 
successors, the BTL or Bell Telephone Laboratory series, and the 
ENIAC.

Mark I. The twenty-three decimal digit electro-mechanical 
IBM-Harvard Mark I (or IBM Automatic Sequence Controlled Calculator) 
is located at the Harvard Computation Laboratory. It was donated to 
Harvard in 1944. It was the first large scale general purpose relay 
digital computer ever built. It used punched cards for input and 
memory; relays were used in arithmetic. In all it weighed five tons, 
two and one-half times the weight of Babbage's proposed creation. 
The inventors were Howard H. Aiken, B. M. Dirfee, F. E. Hamilton, 
and C. D. Lake. This machine was used by the Navy.

Mark II. The Harvard Mark II, a large scale general purpose 
relay digital computer, is located at the Naval Proving Ground, 
Dahlgren, Virginia. This machine cost $400,000 and is twelve times 
faster than the Mark I.

61 Ibid. 
62 Morgan, op. cit., p. 39. 
63 MacWilliams, op. cit., pp. 2 f.
Mark III. The Harvard Mark III, a large scale general purpose electronic digital computer, is also located at the Naval Proving Ground, Dahlgren, Virginia.

Mark IV. The Harvard Mark IV is located at the Harvard Computation Laboratory. It too is a large scale general purpose electronic digital computer. Both the Mark III and the Mark IV incorporated electronic vacuum tube switching, storage, and arithmetic.

BTL Models. As early as 1938 George Stibitz at Bell Telephone Laboratories had developed a fairly simple relay computer that could be remotely controlled. The Bell Telephone Laboratories built a special purpose relay computer in 1940, the BTL Model I.

BTL Model V. In 1944, the year of the Mark I, the electromechanical large scale general purpose relay digital computer, the BTL Model V, was started. Its nine thousand relays and fifty pieces of teletype equipment covered one thousand square feet of floor space and weighed ten tons, five times the weight of Babbage's projected machine. Two BTL Model V's are located at the Ballistic Research Laboratories, Aberdeen Proving Ground.

BTL Model VI. The BTL Model VI is located at the Bell Telephone Labs, Murray Hill, New Jersey. It is a medium sized general purpose relay digital computer.

ENIAC. Around 1944 the Moore School of Engineering of the University of Pennsylvania built the first large scale general purpose
all electronic (excepting possibly input and output) digital computer, the Electronic Numerical Integrator and Calculator. This machine, which had eighteen thousand vacuum tubes, was used by Army Ordnance until 1946 when it was sent to Aberdeen Proving Ground to make room for ENIAC (a forty-four binary digit large scale general purpose electronic digital computer, the Electronic Discrete Variable Automatic Computer, which was both smaller and faster than ENIAC—it was also built by the University of Pennsylvania and used by Army Ordnance). ENIAC was built for solving trajectory problems involving bombs and 64 projectiles. It was designed by Dr. John W. Mauchly and J. Presper Eckert, Jr. The memory was built by Burroughs. ENIAC "in about 70 hours, computed \( \pi \) to 2035 decimals. Such a computation by hand might take all of a normal lifetime of hard labor." 65 ENIAC weighs thirty tons, and thus is fifteen times larger than the machine conceived by Babbage. ENIAC can handle twenty ten-digit decimal numbers, which is to say two hundred decimal digits or seven hundred binary digits.


CHAPTER III

REPRESENTATIVE RECENT ELECTRONIC DATA PROCESSING SYSTEMS

This chapter describes some recent types of electronic data processing systems; it brings the history of digital devices up to date, and tells how the new electronic data processing equipment is applied to the performance of business functions.

The following seven organizations proved helpful by supplying, through correspondence, much useful information concerning the types, historical background, and application of the various systems:

Airborne Instruments Laboratories, Modac Division
ElectroData Division of Burroughs Corporation
International Business Machines Corporation
Radiocorporation of America
Remington Rand Univac Division of Sperry Rand Corporation
Stanford Research Institute
Teleregister Corporation

The researcher, early in 1958, personally observed the RAMAC 305 being demonstrated in IBM's San Francisco headquarters, and inspected carefully the UNIVAC installation at McLelllan Air Force Base.

Bookkeeping in the 1950's

This decade has been one of rapidly increasing utilization of electronic calculating and tabulating devices; in 1956 it was estimated that eight hundred thousand calculators, four hundred thousand accounting and billing machines, and fifty thousand key punch machines
wires being used in American offices. New devices have been used for accounting for payrolls, for accounts receivable, for accounts payable, for income analysis, and the like. Original documents of transactions are prepared, journalized, and posted all at once. Double entry principles of bookkeeping are not changed in the least, but bookkeepers and accountants have been and will continue to be forced into a consideration of both mechanical and electronic methods.

Consider but one example, and that not an electronic data processing system, the Burroughs Sensimatic. It is said of this machine that it:

... carried further than ever before the ability to perform a series of operations automatically in set sequence. Thus, it could enter a sum, date it, add it to another number, carry the total, subtract this from another total, enter the answer in the appropriate credit or debit column, repeat all this in abbreviated form for a duplicate copy, and finally open the carriage—by the pressure of a single bar. Further, four different such sequences could be chosen at the turn of a knob, and the potential variety of them was almost infinite. The "Sensimatic" did not merely compute, but performed many different "programmes" of operations.

Computer technology is advancing so rapidly today that new developments are difficult to keep up with. In speed alone digital computers are a million times faster than Babbage dreamed—"from

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one operation per minute to some 20,000 operations per second."

Today, just as in the past, for the imagination to outstrip technology is not unusual. For example, data processing equipment is now instructed in machine language, but what if one could use human speech instead? and what if the equipment could answer back? The "Audrey" speech recognition system . . . can recognize the speech sounds for the ten digits," and:

"Voder, a demonstrated in 1939 at Philadelphia, Pa., was a device with "vocal cords" of vacuum tubes that reproduced vowels, consonants and monosyllables. The operator, who used a keyboard and footpedal, produced whole sentences of human speech from the mechanism."

An amazing variety of automatic computing machinery exists today. A fairly complete list has been published in Computers and Automation. All known electronic digital computers in the United States to May 3, 1956 are among the devices listed.

**Large General Purpose Equipment**

This equipment is characterized by high cost and by the large amount of power and space required. Generally speaking, the price of

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this fast and versatile large scale equipment is in the million dollar
range.

**IBM 702.** In July of 1954 the IBM 702 was being advertised as
"A 'Giant Brain' that's Strictly Business." The IBM 702 is similar
to the IBM 701, but the basic difference is one of emphasis on input-
output devices. Speed is not as important in most business applica-
tions as it is in scientific use, so input-output can be somewhat
slower. In scientific applications difficult problems must be solved,
but in business the capacity for handling vast quantities of simple
problems is more important. The IBM 702 can use up to one hundred
magnetic tape units, each unit being capable of reading or writing
fifteen thousand alphabetic (letters or numbers) characters a
second. Each reel of tape holds in excess of five million characters,

enough capacity to hold every number in a large metropolitan tele-
phone directory. Punched card punchers and readers, and line
printers, or other input-output devices may be used. On both the
IBM 702 and IBM 705, the card reader or card-to-tape input devices
have a speed of two hundred fifty cards a minute. Card puncher or
tape-to-card output is handled at one hundred cards a minute. Print-
ing and tape-to-printer devices handle an output of one hundred fifty
lines per minute, each line having one hundred twenty characters.
The IBM 701, 704, 702, and 705 can intercommunicate through a

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8John M. Carroll, "Electronic Computers for the Businessman,"

standard 727 Magnetic Tape Unit.

All of the common memory devices—magnetic core, tape, and drum, and electrostatic storage, are used by the IBM 702. Using a magnetic drum memory, the word capacity is sixty thousand characters. Capacity with electrostatic tubes is ten thousand characters. Using twenty-four hundred feet reels of magnetic tape, the speed of access time is seventy-five feet per second. The arithmetic unit has a capacity in excess of ten million operations per hour.

**Typical applications of the IBM 702.** Monsanto Chemical received the first IBM 702 in early 1955. This company plans a completely automatic system of accounting. They started with cost reports (they make twelve hundred per month) and monthly financial statements. One cost report, possibly taking an accountant two hours to prepare, can now be completed in thirty seconds. IBM, using its own machines, turns out a payroll for eight thousand persons in forty-six minutes (auxiliary operations take another three hours). General Electric in June, 1955, received an IBM 702 which it uses for inventory, payroll, and other purposes. Commonwealth Edison handles a complete one million eight hundred thousand customer billing job on its IBM 702. Prudential Life can use its IBM 702 to service daily eighty thousand policies.

**IBM 705.** The IBM 705 was scheduled for first delivery in December, 1955—ten months after first delivery of the IBM 702. The IBM 705 can handle an almost unlimited quantity of magnetic tape units (reader-recorders). Each twenty-four hundred feet reel of tape
holds over five million characters, the equivalent of over sixty thousand punched cards, "a stack about 35 feet high." Magnetic tape reading and writing can be done simultaneously at a speed of fifteen thousand alphanumeric characters a second; if Gone With the Wind were taped, it could be sent through the machine and be retaped in three and one-half minutes. The input-output time of the tape can be cut even more by addition of a magnetic core record storage device which cuts down the quantity of instructions needed and hence eliminates the time necessary to otherwise carry them out.

On both the IBM 705 and the IBM 705, card reader or card-to-tape input devices have a speed of two hundred fifty cards a minute. It is possible for the magnetic core memory to read punched cards directly (no card-to-tape conversion necessary) at the rate of twenty thousand characters a minute. Card punch or tape-to-card output is handled at one hundred cards a minute. Printer and tape-to-printer devices handle an output of one hundred fifty lines per minute, each line having one hundred twenty characters. The flexibility of the input-output devices makes the IBM 705 unique. Punched card or line printed output is possible. Tape units may be taken off the IBM 705 and connected to card readers, punches, and line printers, thus creating interchangeable card-to-tape, tape-to-card, and tape-to-printer auxiliary equipment.

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11 Ibid.
While the IBM 705, like the IBM 702, uses all the common memory devices, the magnetic core memory, composed of ferrite core matrices, each about the size of a postage stamp, may be regarded as the "heart" of the whole system. Magnetic core memories are the fastest yet developed, and that of the IBM 705 has a capacity of twenty thousand alphameric characters. Several magnetic drums can be used to supplement the magnetic core memory, and each drum has an additional capacity of sixty thousand characters. Magnetic tape reels have access time of seventy-five feet per second. The IBM 701, 704, 702, and 705 are all compatible through the 727 Magnetic Tape Unit. Operating speed of 700 Series machines is, of course, measured in milliseconds.

The IBM 705 II is said to have a magnetic core memory of forty thousand positions. The new IBM 705 III's magnetic core memory is capable of storing eighty thousand characters; its magnetic tape units read or write sixty thousand characters a second, and the tape stores as many as 534 characters per inch (in contrast to two hundred on the IBM 705). The IBM 705 III is faster than the IBM 705: additions and subtractions are done at eleven thousand four hundred per second, multiplications at one thousand seven hundred per second, divisions at seven hundred per second, and logical decisions at forty-five thousand four hundred per second. One printing device, the IBM 730A Printer, is now capable of producing one thousand lines per minute.

Typical applications of the IBM 705. This machine can be

12 Computers and Automation, 6:72, June, 1957.
applied to a wide variety of business problems including control and analysis of inventories, cost and general accounting, file maintenance, forecasting requirements, payroll, production control, purchasing, recordkeeping, sales, and shipping. The largest order for electronic data processing machinery ever placed to 1956 was Prudential Life's request for rental of seven IBM 705's. An IBM 702 had already been ordered, bringing the annual rental for all eight computers to over three million eight hundred thousand dollars. Prudential planned to use the machines for such tasks as customer billing and premium accounting.

BIZMAC. A Time article referred to the BIZMAC, meaning Business and Management Automatic Computer, as the "world's largest computer system (197 units, covering 20,000 sq. ft.)," and said that it "will keep automatic inventory of 12 U.S. and overseas depots for Army Ordnance Tank-Automotive Command in Detroit . . . ." The BIZMAC, like most other systems, uses the building block approach. This means that a system of equipment may be selected from basic and peripheral units for adaption to the individual requirements of any

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A variety of input equipment may be used with BIZMAC. The Tapewriter and Tapewriter-Verifier has a keyboard which may be used to produce either pages or punched paper tape in binary code. A Paper Tape Transcriber may be used to transfer paper tape to magnetic tape at the rate of two hundred characters per second. The Card Transcriber can convert IBM cards to magnetic tape at the rate of four hundred cards per minute. Other input devices may be used for special purposes.

The output equipment is even more varied than the input equipment. An Electro-Mechanical Printer can print out six hundred lines of one hundred twenty characters each per minute. An Electronic Printer consists of an Ultratype Camera, a Film Processor, and an Electrofax Printer. The Ultratype Camera reads magnetic tape on 35 mm. film at the rate of two thousand characters per second. The Film Processor develops the film at the rate of one hundred feet every thirty minutes. The Electrofax Printer exposes the printing paper, and develops and fixes the paper at the rate of six inches of paper per second.

Another output device is the Magnetic Tape Transcriber, which converts magnetic tape to paper tape at the rate of twenty characters per second. The Transcribing Card Punch produces one hundred fifty cards per minute from magnetic tape. Another device, the Paper Tape Coder, changes, at ten characters per second, seven-channel paper tape to five-channel paper tape for teletype sending. An Interrogation Printer receives cable signals from the Interrogation Unit and prints
the results on an electric typewriter at the rate of eight characters per second. A Document Printer reads paper tape and prints pages at the rate of five to eight characters per second.

The magnetic tape used on the BIZMAC is the standard twenty-four hundred feet length, and each reel stores an average of two million characters. Tape speed is eighty inches per second. Magnetic tape reels must be manually moved from unit to unit unless a central Switching Unit, operated from a Master Console, is used. The Interrogation Unit searches tape files for particular messages and prints them either locally or remotely on the Interrogation Printer. Searching is done in three minutes on the average, and the printing is done in an average of thirty seconds.

The BIZMAC uses both magnetic core and magnetic drum memories, with total character capacity of eighteen to thirty-six thousand. Capacity of the high speed magnetic core memory is 2,048 characters, and capacity of the magnetic drum memory is 16,368 characters.

A Sorter, actually a special purpose computer used for file maintenance, may be used in conjunction with the computer. Since the active accounts normally comprise under 5 per cent of the file, the Sorter in effect saves the computer the trouble of passing over the great bulk of the 95 per cent accounts that are inactive.

A typical BIZMAC installation consists of one magnetic core memory and one magnetic drum memory, four input trunks, eight output trunks, ten Teapriters and Teapriter-Verifiers, one Paper Tape Transcriber, one Interrogation Unit, one Electro-Mechanical Printer, and fifteen Tape Stations and Control Units.
Typical applications of BIZMAC. BIZMAC is capable of handling all routine bookkeeping functions, and in addition can handle a variety of other tasks. Some of its uses are: accounting for accounts receivable and accounts payable, cost accounting, cost analysis, inventory control, management reports, market forecasting, payrolls, product control, and sales analysis. 15

UNIVAC I and II. UNIVAC (Universal Automatic Computer) is a large scale general purpose electronic digital computer which was introduced in 1951. The magnetic tape storage has a length of fifteen hundred feet, and a ninety-six thousand word capacity. The rapid access mercury delay line memory of UNIVAC stores, in seven mercury tanks, 16,130 words. Magnetic tape input and output is handled at the rate of 255 words per second. Typewriter output is handled at 660 characters a minute. Computing time is measured in milliseconds.

Many input and output devices and other peripheral equipment is available for this building block type machine system. Unitypers and Card-to-Tape Converters are used for input. That is, they produce the magnetic tape which is placed on the Uniservos for entry into the Central Computer. Tape-to-Card Converters or High-Speed Printers may


16 Carroll, loc. cit.
be used for output. The Univac High-Speed Printer operates at the rate of six hundred lines of one hundred thirty characters each per minute. Dr. John W. Mauchly, speaking of the UNIVAC system he co-invented, said:

Every part of that system incorporates built-in checking devices which constantly and automatically monitor every operation, from the time that information is first recorded on tape to the time that printed results are obtained.

UNIVAC II is essentially "A compatible modification of UNIVAC, to use magnetic core memory instead of mercury delay line memory, applicable to existing or new Univacs." The speed of UNIVAC was doubled by adding the twenty-four thousand numeric character instant access magnetic core memory (capable of increase to one hundred twenty thousand characters). Magnetic tape input-output was increased to twenty thousand characters per second.

Typical applications of UNIVAC I and II. The Bureau of the Census received the first UNIVAC in March of 1951. Four others were ordered by government, and the first three civilian organizations on the priority list were Prudential, Home Life, and A. C. Nielsen.


20Office Management, 26:back cover, August, 1955.
General Electric at their Appliance Park plant near Louisville, Kentucky, made the first successful application of computers to large scale accounting problems. This pioneering effort has been written-up in the Harvard Business Review. Sylvania Electric claims to have constructed the first electronic data processing center; this company planned to use UNIVAC for invoicing, sales accounting, statistical control, inventory control and scheduling, market research, sales forecasting, and production control, in that order. Sacramento Air Materiel Area, McClellan Air Force Base, was scheduled to receive a UNIVAC in July of 1956. According to a recent announcement, this UNIVAC has just completed one year of successful operation. Expected annual savings in computing parts requirements are five million dollars. The present UNIVAC will be replaced with a larger machine and a second "slave" machine to be installed in 1958. Pacific Mutual Life Insurance Company, Los Angeles, with one million eight hundred thousand persons insured, apparently has a UNIVAC; it claims to be "first in the world to have all individual life insurance records controlled by electronics."

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23 Robert M. Smith, "Is This a Blueprint For Tomorrow's Offices?" Office Management, 26:12, August, 1955.


Medium General Purpose Equipment

Equipment in this category is somewhat slower and less versatile than that in the million dollar class. It requires less space and less power than larger machines. The price range of this medium equipment is roughly fifty thousand dollars to one million dollars.

Datatron 205. The components of the typical Datatron 205 system include the Datatron computer, the magnetic tape system (Magnetic Tape Control Unit, which controls ten Datareader input-output units, which add forty-four million characters to the internal computer memory; Single Tape Units of four million digits; and Datafile Multiple-Tape Units of twenty million digits), console with photoreader (operates at 540 decimal digits per second), high speed tape punch (sixty decimal digits per second), typewriter control, card readers, card punches, printers, Cardatron Input-Output System (output, control, input), Magnetic Electronic Power Supply, and floating point. Input may be typewriter, punched paper tape, manual keyboard, or punched card. Output may be typewriter, punched paper tape, visual display, punched card, or line printed report. Punched card (Cardatron) and Magnetic Tape (Datafile) combined make a good business data processing system. The Cardatron can handle up to seven units of input-output punched card machines in any combination.

The capacity of the magnetic drum is 4,080 words. Word capacity of the twenty-four hundred feet reels of magnetic tape is

26 Carroll, op. cit., p. 129.
two hundred thousand. Three typical input-output mechanisms are paper-tape handlers, automatic typewriters, and decimal keyboards. Paper tape input is at 32,400 characters a minute; punched card input at one hundred cards a minute; paper tape output is eight hundred characters a minute. Flexowriter output is six hundred characters a minute; and punched card output is one hundred to one hundred fifty cards a minute.

Typical applications of the Datatron 205. Allstate Insurance Company was the first company to make general business use of a medium-sized computer. The first specific application was preparation of quarterly reports to the Underwriting Department. Each report manually compiled took eighteen hundred man-hours; the IBM 407 Accounting Machine and the IBM 607 reduced the time to one hundred man-hours; the Datatron has reduced the time to twelve hours. This company is not only interested in dollar savings, but also wants its management to have up-to-date reports as quickly as possible. IBM input-output equipment is used in conjunction with the Datatron computer in Allstate's data processing installation.

Late in 1955 another insurance company, General of America,

27"Datatron Electronic Data Processing Systems" (Bulletin 3205D, Pasadena: ElectroData Division of Burroughs Corporation, c. 1957); Russell E. Carr and others, The Digital-Computer Facility of the Jet Propulsion Laboratory (Memorandum No. 20-99, Pasadena: Jet Propulsion Laboratory, California Institute of Technology, October 1, 1954), passim.

became the first in the Pacific Northwest (Seattle) to introduce fast electronic data processing. Applications planned were billing, rating, accounting (especially checking of agents' accounts), and report making—financial, production, and underwriting.

Sears, Roebuck & Company has used the Datatron for budgeting of sales and inventory. In late 1956 the Datatron 205 was computing the budgets of four hundred thirty of Sears seven hundred retail stores; each of seventeen thousand departments averaged four-tenths of one minute, a total of some one hundred hours. Time previously used had been ten man-hours per department. Sears has three other Datatrons (including Cardatron and Datafile) on order. Tasks from mail order to ten thousand employee payrolls will be processed. Allstate Insurance, a Sears subsidiary, has two Datatrons and six ordered. A ten thousand employee payroll processed in less than twelve hours is a typical Datatron application.

Small General Purpose Equipment

This is the cheapest equipment of all—fifty thousand dollars and under. This equipment requires the minimum of space and power.

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30 "Inventory Takes Its Turn . . . With Datatron," Data From ElectroData (Pasadena: ElectroData Division of Burroughs Corporation, September, 1957), pp. 4-5.

**Burroughs E101.** The E101 is a small desk size general purpose electronic digital computer. First delivery of the E101 was scheduled for June of 1955. The magnetic drum memory has a 220 word capacity. Input is either by eleven column manual keyboard or by paper tape at a rate of twelve hundred characters per minute. Output is by a twelve digit semi-ganged page printer at the rate of 1,440 characters per minute. Both the Punched Tape Input unit, and the Output unit, are optional. The paper tape itself is prepared for input in a variety of ways—Flexowriter, Teletype, Sensimatic with punched tape output, and card-to-tape converters. The unit will read instructions and data from five- to eight-channel tape. The taped instructions, rate tables for example, may be introduced directly into the machine from stored tape. Taped instructions can be used to supplement the pinboard program and the magnetic drum memory. To program the E101, the programmer marks pin positions on a paper pattern or template. Then, placing the pattern over the pinboard, the programmer drops the pins into place. The pinboard is then put into the E101. The paper templates, or any or all of the eight pinboards themselves, may be filed or stored for future use.

**Typical applications of the Burroughs E101.** In addition to engineering, statistical, and mathematical problem applications, the E101 is suited to a variety of business tasks:

- Actuarial computations
- Bond amortization

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*Carroll, op. cit., pp. 125-131.*
Branch office sales quota calculations
Budget analysis
Building assessment valuation
Commercial loan accrual
Cost distribution
General interest tables
Insurance premium calculations
Loan reduction payment schedules
Material inventory and control
Mortgage loan accounting
Parimutuel payoff
Pension plan rate tables
Production cost analysis
Retrospective time and budget reports
Securities analysis
Spreading overhead costs
Train operating statistics
Utility billing

The E101 is especially useful for problems too involved for desk calculators and yet not complex enough for economical solution on larger machines. The Loan Division of Guaranty Trust Company (New York) used an E101 for only one application: loan bookkeeping. The machine caused no disruption of existing routine, and was used as a "proving ground" experiment to explore other applications and for the training of programmers. The E101 can make one hundred bookkeeping entries per hour, including interest computations. The Loan Division had only three to four hundred transactions per day. The reduction in man-hours, from fifty-one to fifteen, alone justified its rental.

33 "E101" (Form E-103F. Pasadena: ElectroData Division of Burroughs Corporation, c. 1957); "Burroughs E101 Low-Cost Electronic Computation" (Form EDP 103. Paoli: Burroughs Corporation Research Center, 1955).

Special Purpose Equipment

**MODAC 404.** This machine is defined as a small sized general purpose electronic digital computer. The MODAC 404 (Mountain Digital Automatic Computer) appears to be a four cabinet installation with one desk, one filing cabinet, one electric typewriter with table, and a paper tape unit. Remington Rand cards are punched by machine or by hand; punched paper tape input is prepared by Tapecorder, Flexowriter, or Friden tape adding machine. The punched paper tape is the same type used by Western Union or TWX office and may be transmitted over ordinary teletype circuits; cards and tape are punched simultaneously. The tape is read into the machine by a photoelectric tape reader at about the rate of ninety decimal digits per second. The magnetic drum memory has twenty thousand registers, each with a capacity of up to six decimal digits. Addition or subtraction is carried out at the rate of fifteen operations per second. Paper tape output is perforated at twenty characters per second and printed on the Flexowriter at ten characters per second.

**Typical applications of the MODAC 404.** The Reader’s Digest Condensed Book Club is making use of the MODAC 404 for accounts receivable, statistical, and monthly trial balance applications. The Book Club managers are also interested in receiving better reports more quickly than before.

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35 MODAC 404 As Used In The Reader’s Digest Condensed Book Club (Thornwood: Mountain Systems, Inc., c. 1955).
ERMA. Only the prototype of this large scale system has been built by Stanford Research Institute, but thirty-eight are on order by Bank of America and are being built by General Electric. ERMA (Electronic Recording Machine, Accounting) is said to be "the greatest advance in bookkeeping in the history of banking." Every working day the system can process all bookkeeping for fifty thousand checking accounts. Although ERMA will replace fifty bookkeepers with nine clerks and operators, normal growth is expected to absorb the displaced persons. The first machines are to be installed in California, and Sacramento is scheduled to receive one.

Twelve Magnetic Tape Storage Units will hold the account number and balance of every depositor. Two magnetic drum memories will carry bank balances and hold or stop-payment orders. As input data is read by the electronic reader, accounts are posted at the rate of ten per second. The magnetic drums and Magnetic Tape Storage Units were furnished by ElectroData.

Bank of America will furnish to its customers free personalized checks and deposit slips which have magnetically inked account number

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37 News item in the San Francisco Examiner, September 22, 1955, p. 34.

38 Ibid.

and bank branch. This information will be read by the input device after the amount of each check has been key pressed into the machine by the operators using the five input keyboards. Input data is also typed on paper tape.

The drums have a capacity of six hundred thousand digits, and the tapes used are standard twenty-four hundred feet length. Daily transactions will be stored temporarily on the drums and permanent storage will be on tape. After daily checking of tape against drum stored data, the tape, at the end of the fiscal period, can be used for preparation of bank statements and records. The cylinder printer prints ten to fifteen lines per second—one twentieth of a second per line. Checks to be returned to customers are sorted after processing at the rate of ten per second.

The production model of ERMA, the Mark II (General Electric Model 2B-100 Data Processor), will embody many improvements based on both new developments and experimental operation. Transistors and magnetic core memory will be used. Manual keyboards will be replaced by automatic input using magnetic character sensing.

Typical Application of ERMA. Assume a hypothetical case:

Mr. Campbell writes a check for $19 worth of groceries. The storekeeper deposits the check to his own account. In due course the


\[41\] "Accounting for ERMA," SRI Journal, Fourth Quarter, 1957, pp. 119-123.
check arrives at ERMA. The operator enters "$19" into the keyboard and places the check into the check reader. The check reader "sees" the branch and account numbers and automatically pulls down the appropriate keys on the keyboard. The operator then depresses an entry bar which signals ERMA to begin bookkeeping. ERMA simultaneously calls for Mr. Campbell’s balance, and any possible stop payment or hold orders, from the magnetic drum. Assuming that the check is not stopped, the arithmetic unit proceeds to subtract "$19" from the account balance (overdrafts are communicated by signal light for special handling). The subtraction is checked and the new balance is placed on the drum.

The account number and "$19" debit are also stored temporarily in another place on the drum. As soon as it is convenient for the machine to transfer this temporarily memorized data to magnetic tape for permanent storage, the details are printed on paper tape. Each day the machine calculates Mr. Campbell’s magnetic tape balance and checks it against his magnetic drum balance. Then the new balance is entered on magnetic tape.

At the end of the month Mr. Campbell will receive his bank statement which has been printed from the magnetic tape records. His processed checks, machine sorted, will accompany the statement.

Magnetronic Inventory Control System. This special purpose system, the first in the rubber industry, was developed for Hood

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Rubber Company (Watertown, Massachusetts), a division of B. F. Goodrich, by the Teleregister Corporation, which is a subsidiary of Ogden Corporation. Teleregister states that its industrial inventory control systems are flexible enough to accommodate either small or large problems of inventory control, and they may be modified to control inventories of "mail order houses, distributors' warehouses, large retail establishments and in many military materials-handling situations." Another adaptation could be made for use by insurance companies.

Orders are processed by means of keyset operated paper tape punches. The warehouse also uses a keyset operated paper tape punch. The Shipment Tape from the Order Processing Stations, and the Production Tape from the Warehouse, are manually moved to the paper tape reader. From here data is entered into Electronic Control, which has access to Magnetic Drum Storage. The Control Panel or a keyset can send information to Electronic Control. A Flexowriter may either receive or send information to Electronic Control. Output is to Visual Display (which may also receive keyset data), and to paper tape which may then be manually transferred to Flexowriters. Electronic Control supervises the punched paper tape output and Flexowriters; Electronic Control is itself controlled by Control Panel or keyset.

The magnetic drum memory was described as being:

part of a system of reporting inventory quantity (on hand and on order) of boots and shoes—for 3000 styles and colors, with an

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43 Special Purpose Electronic Engineering . . . That Sets The Pace (Stamford: The Teleregister Corporation, c. 1956).

44 Ibid.
average of 10 sizes per style, and up to 4 decimal digits of inventory information for each combination of style and size.
CHAPTER IV

ELECTRONIC DATA PROCESSING PERSONNEL

This chapter reports on the positions open to high school graduates in both public and private electronic data processing installations. When electronic data processing equipment is used for business purposes, the operators of such equipment are business machines operators; their training therefore falls naturally within the scope of vocational business education.

Individuals in the computer field were surveyed by mail for information relating to employment opportunities in computer installations. During January and February of 1958, 295 persons listed in the June, 1956 issue of "The Computer Directory" were contacted. Their interests encompass business, construction, design, electronics, logic, mathematics, programming, and sales. The purpose was to find out:

- Kinds of jobs available in an electronic data processing installation
- Education background required for these jobs
- Special training required for these jobs
- Length of special training required for these jobs
- Who gives the special training required for these jobs?

The response consisted of 103 replies, or 35 per cent of all the questionnaires mailed out.

Two lists of positions found in computing centers precede the report of the survey in order to show the scope of positions available

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in typical electronic data processing installations.

Positions Available in a UNIVAC Installation

Operations manager. Supervises Chief Operator, Administrative Control Chief and Chief Tape Librarian in order to administer the established procedures of the Center.

Operations coordinator. Supplies assistance to facilitate the operational efficiency of the UNIVAC Center. Analyzes reports, and makes recommendations for the improvement of procedures and production operations with standardization and cost reduction as the objective.

Chief operator. Supervises three Shift Chiefs and the Outside Installations Chief. Supplies operational and technical assistance as required to attain optimum use of the Central Computer and Peripheral Equipment.

Administrative Control chief. Supervises the Chief Unitypist, Scheduler-Dispatcher, Material Control Clerk, Statistical Clerk and Clerical Staff. Administers appropriate controls to attain optimum use of UNIVAC Center facilities.

Chief tape librarian. Supervises supporting staff in order to obtain, review and distribute Library routines.

Shift chief. Supervises the performance of assigned Operator Personnel in order to facilitate production. Supplies operational advice and assistance from a detailed knowledge of problem and production requirements, supplements operator instructions.

Outside installations chief. Supervises the performance of assigned Operator Personnel in order to facilitate production. Supplies operational advice and assistance from a detailed knowledge of problem and production requirements, supplements operator instructions.

Computer operator. Operates the Central Computer, High Speed Printer, Card to Tape Converter, Tape to Card Converter, and other equipment as may be developed.

Electronic machines operator. Operates the High Speed Printer, Uniprinter, Card to Tape Converter, Tape to Card Converter, and other equipment as may be developed.

Chief unitypist. Supervises the personnel of the Unityping Section, and supplies administrative direction for all work performed by the Section.
Unitypist "A". Operates Unityper machines, transcribing all
types of data forms from coded copy to magnetic tape for use on
the Central Computer and High Speed Printer.

Unitypist "B". Operates Unityper machines, transcribing data
from coded copy to magnetic tape for use on the Central Computer
or High Speed Printer.

Scheduler-Dispatcher. Schedules and allocates time for all
projects on the Central Computer and Peripheral Equipment. Maint-
tains maximum utilization of all production time on all equipment.

Material control clerk. Receives, checks, counts, records,
ships, and provides for storage of UNIVAC Center and customer
property and material.

Statistical clerk. Summarizes, audits, adjusts, and processes
equipment log data for billing, evaluation, and operational
purposes.

Programming manager. Supervises Administrative Programmers
and Scientific and Procedures Specialists in order to administer
the established procedures of the Center in attaining optimum
programming efficiency.

Administrative programmer (systems analyst). Supervises and
directs more than one Senior Programmer. Supplies professional,
technical, and administrative assistance to attain optimum pro-
gramming efficiency.

Senior programmer. Supervises and directs one or more pro-
gramming teams. Supplies professional, technical, and adminis-
trative assistance to attain optimum programming efficiency.

Programmer. Acts as Project Leader, unless project is ex-
ceptionally large and complex, then will share responsibility
with Senior Programmer. Assists project team in analyzing, chart-
ing, coding and processing assigned problems.

Coder. Assists in the preparation of detailed flow charts by
which the problem will be processed. Translates the details into
a series of coded instructions for use on the Central Computer.
Carries the coding through computer testing and production phases.

Trainee. Following successful completion of the Programming
Course, assists in the coding of new projects under the immediate
supervision of his project leader. 2

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2 UNIVAC Center Operations Manual (New York: Remington Rand,
1957).
Qualifications of Typical Electronic Data Processing Personnel.

Systems analyst. Uses much logical reasoning and some mathematics through high school algebra. A college education or equivalent is desirable but not essential. Studies most helpful are those in business and the logical sciences such as mathematics. Training in punch card equipment is desirable but not essential.

Programmer. Equivalent of four years of high school. Uses much logical reasoning and some mathematics through elementary algebra. Training in punch card equipment is desirable but not essential.

Standards planner. Same as for programmer.

Console operator. The ability to read and write, add, subtract, multiply and divide whole numbers, decimals and fractions; understand and follow written and verbal instructions. Knowledge of elementary algebra. Equivalent to four years high school. Knowledge of basic wiring principles of punch card equipment.

Auxiliary operator. The ability to read and write, add, subtract, multiply and divide whole numbers, decimals and fractions, understand and follow written and verbal instructions.

Librarian. Same as for auxiliary operator.

Programmers may be divided into three grades. The starting position is "Coder" or "Trainee programmer." The second level is simply called "Programmer"; and the third or top level position is called "Senior programmer" or "Blocker." It should be noted that formal education requirements do not bar anyone who has the aptitude, initiative, and ingenuity needed on the job.

Report of the Survey

BIZMAC and RCA Recorder Central (Medium Size Computer for

The two positions that require high school education are keypunch operator and librarian; keypunch operators "must be good typists with a small error factor per volume of data keypunched;" with previous typing experience, training of one to two months is required, usually under the direction of the senior keypuncher at the installation site. Librarians also require training of one to two months under the machine room supervisor; "previous evidence of careful meticulous work" is required "because loss of magnetic tapes is dangerous."

**Datatron 205.** Three jobs are open to high school graduates on this equipment: computer (for check work), IBM operator, and programmer (elementary). Several weeks training is required for computers, and this training is usually acquired in high school; a "short course in desk calculation" plus "excellent grades in mathematics" are needed. Operators generally receive training of from one day to several months, given usually in IBM or high school business courses. Programmers (elementary) need several months training from the manufacturer, on-the-job, or in special schools; special training required includes a coding course.

**IBM.** None of the projected IBM installations is in operation yet, but according to officials of the Bank of America, there will be at least four jobs open to high school graduates. Equipment operators will receive "general orientation and special training in operation of component equipment" in the "bank's own programming course and on the job training." Duration of this special training will be six months.
The training for utility clerks will be the same as for equipment operators excepting that the duration of training will be only four months. Flexowriter operators will require six months "typing and special training in Flexowriter operation" in high school, business college or on-the-job. Mail clerks will require training of one month, on-the-job, in "operations of special equipment" and in "form and document distribution."

IBM 650. Programmers should have three to five years on-the-job experience on IBM machines; training at the IBM 650 Advanced Programming school for two weeks is necessary; in addition from one to three months training in programming for the IBM 650 is needed, and this training is given usually by the manufacturer or on-the-job. "Punched card machine wiring training is helpful but not necessary."

A supervisor needs special training in "machine operation" and "administrative techniques" of two weeks duration given on the job. Previous on-the-job training of two to four years is needed, including attendance at various IBM schools, and "experience and adaptability along with academic background must be considered here." An IBM specialist needs two to four years on-the-job training plus several IBM schools (Basic Wiring, 402, 403, Collator, and 407). An IBM machine operator needs six months to two years experience on IBM machines. Also, "punched card machine operation training is helpful" but "not necessary." Other special training mentioned for operators was "IBM sponsored Basic Wiring, 402, 403, and Collator Schools" which require "1/4 weeks in school—3 to 6 months on-the-job;" another reply stated that
machine operation could be learned in two weeks under the direction of
the supervisor. **IBM 650 operators** require "experience and adaptability
... with academic background ..." They should have some basic
IBM courses behind them, and also should take the IBM Primary 650
Programming School which is of one or two weeks duration. Also needed
on this installation are **IBM keypunch operators**, and they should have
from six months to two years experience on IBM machines. Actual train-
ing in machine operation takes two weeks under the direction of the
supervisor.

**IBM 702.** There are several jobs open to high school graduates
on this installation. First are **component operators** who need six
months of "general orientation to EDPM" and "operation of computer
and components" in the company's "own programming course and on-the-
job training." **Tabulating supervisors** need three to five years ex-
perience in operation of all types of tabulating equipment and "ex-
perience in personnel supervision;" this special training could be
obtained from equipment manufacturers and on-the-job experience.
The **tape librarians** require four months of "general orientation to
EDPM component operation" in the company's "own program and on-the-
job training." **Tabulating machine operators** need one to two years
experience in the operation of all types of tabulating equipment
obtained from equipment manufacturers and on-the-job experience.
**Keypunch operators** need one year of experience in the operation of
the keypunch machine, obtained from the equipment manufacturers and
on-the-job experience. Also needed on this kind of installation are
Mail clerks and secretaries. Mail clerks should have one month of on-the-job training in the "operation of special equipment and form distribution." Secretaries require the usual general secretarial training which may be obtained in six months in a "secretarial college or equivalent."

**IBM 705.** It seems reasonable to assume that the jobs open to high school graduates on the IBM 705 should be about the same as those open on the IBM 702. One reply stated that the position of programmer was open to high school graduates with IBM and on-the-job special training—consisting of a "5-week programming course" and "2 months case studies." The same reply stated that special training from IBM in a "5-week programming course" was sufficient to qualify a high school graduate for EDP analyst. Also, a console operator required IBM and on-the-job training of a "5-week programming course" and "2 months apprenticeship."

**National Cash Register 304.** There are several kinds of jobs open to high school graduates on this installation. Magnetic tape handlers require only one or two days of on-the-job experience. Magnetic tape librarians require only one or two weeks of on-the-job experience, but the "person must be careful, neat, and efficient." Printer and paper handlers require only one or two days of on-the-job experience. Operators need experience and three months "operator's training" from the manufacturers. Auxiliary operators need the same special training as operators. Keypunch operators need about two
months of business keypunch training. Coders need clerical training of three to six months.

**RAMAC 305-A.** High school or technical school will qualify machine operators who also need one year of special training from the manufacturer of equipment and on-the-job. The special training needed is in punched card and computer operation.

**UNIVAC.** Several positions are open to high school graduates on this large scale installation. College men are preferred for programmer, but under some circumstances high school graduates can qualify. Mathematics, logic, and accounting seem to provide a useful background. The special training required for the programmer consists of a Remington Rand programming course of six weeks to three months duration. Additional on-the-job training of three months is probably desirable. A high school education "plus industrial experience" might qualify a systems analyst. "Punch card machine operation experience" and some manufacturer courses would qualify the punched card methods analyst. The console operator should have a background similar to that of the programmer—mathematics, logic, and accounting, and should have special training of two to twelve weeks in an operator class. The senior IBM equipment operator needs "some IBM school," but "mostly on-the-job" training on "various IBM machines and wiring principles, plus background as IBM operator." The IBM equipment operator needs two weeks training from the manufacturer in "basic machine operation and basic wiring principles." The auxiliary
equipment operator requires about two weeks to one month of on-the-job training in auxiliary equipment operation. Unitypers need about one week of special typing instruction. For chief clerk (operations), ten weeks of company or manufacturer training is needed. "Operational knowledge of all equipment" is also required. To qualify control and distribution clerks, about one week of on-the-job training in "operation of bursters, decollators, check signers, etc." is needed. It is conceivable that a high school graduate with a background of electronics, "such as navy radar school," could qualify for the position of maintenance technician, after about eighteen weeks manufacturer training in a maintenance class.

Summary of the Results of the Survey

It is easily seen that most of the jobs available to high school graduates in electronic data processing installations are, for the most part, of the clerical and operator variety, often involving operation of peripheral or auxiliary equipment rather than the computer itself. Positions found to be available to qualified high school graduates were:

General
Electronic data processing analyst
Punched card methods analyst
Systems analyst

Programmer

Supervisor
IBM specialist

Maintenance technician
Operator

Auxiliary equipment operator
Equipment operator
IBM operator
Component operator
Console operator
IBM 650 operator
IBM keypunch operator
Magnetic tape handler
Printer and paper handler

Clerical

Chief clerk
Computer
Control and distribution clerk
Flexowriter operator
Librarian
Mail clerk
Secretary
Tape librarian
Utility clerk
Unityper

Because most of the above jobs listed were in the operator and clerical fields does not mean that higher level jobs (such as programmer, coder, systems analyst, coordinator, and the like) are closed to high school graduates. In fact, one reply to the survey stated:

Educational requirements vary widely and really exist only when a man is being hired from the outside at a pretty high level or as a "college trainee." Most companies will train qualified methods people with punched card experience who have proven themselves on the job regardless of previous education. IBM has an NDMF aptitude test which indicates aptitude for programming and which is relied upon widely in industry. I have known programmers at all levels who have had varied educational levels—high school to MBA. I would recommend math in high school and math and accounting in college.

A letter from The National Cash Register Company makes similar observations:

Your questionnaire is enclosed. The brevity of our comments arises not from unwillingness to cooperate, but rather from a
reluctance to suggest any boundaries on education of people who are interested in a field as new and dynamic as is electronic data processing. It is our experience that opportunity exists in this field for people of various educations ranging from high school degrees through graduate study at universities. We have also found people with limited education, but wide practical experience have been employed successfully in electronic installations.

We believe it will be helpful . . . to consider that certain other factors are equally as important as specific education. Attitude, aptitude, persistence, willingness to work, curiosity, logicalness and interest all effect importantly the suitability of a person for this type of work. This is true whether he be involved at a junior level of programming of a small-scale computer or aspires to the highest level of systems analysis and administration of a large-scale data processing installation.

It is reasonable to conclude that operating, maintenance, and clerical jobs will be open to many high school graduates, and that certain of the better qualified and more experienced high school graduates may qualify for higher level jobs such as programmer and systems analyst. Ability, experience, and personal characteristics seem to be more important than educational background in the selection of electronic data processing personnel.  

Civil Service Positions

In addition to many kinds of tabulating equipment operator and related peripheral equipment jobs, there are some civil service positions in the area of electronic data processing which are open to high

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school graduates. Early in 1958 the Bureau of the Census announced
an examination for "Electronic Computer operator (Trainee)." Applica-
tants were required to have three years of experience and the written
test covered "(1) abstract reasoning, (2) coding, and (3) ability to
act upon somewhat complicated oral instructions." Annual compensation
for this position ranges from $3,670 to $4,480.6

The California State Personnel Board, on September 20, 1957,
set up specifications for the position of "Programmer, Electronic Data
Processing." Applicants are required to have four years experience in
tabulating machines and a high school education. Five years of tabu-
lating machine work and high school graduation is qualifying for the
position of "Supervisor, Electronic Data Processing," set up also on
September 20, 1957. In the Department of Employment, with sufficient
experience, the high school graduate might advance to "Assistant Chief,
Data Processing Section," and to "Chief, Data Processing Section."
Both of these last two positions were established also on September
20, 1957. The monthly compensation for these positions is:

Programmer, Electronic Data Processing------$530-$644
Supervisor, Electronic Data Processing------$644-$782
Assistant Chief, Data Processing Section,
Department of Employment---------------$710-$862
Chief, Data Processing Section,
Department of Employment---------------$950-$1,0507

6"U. S. Civil Service Commission Announcement No. 144 B"
(Washington: Board of U. S. Civil Service Examiners, Bureau of the

7California State Personnel Board specifications for the
classes: Code #1370, Code #1373, Code #1375, and Code #1376, all
established or revised September 20, 1957.
Undoubtedly, many new positions in the electronic data processing field will be created in future years.
CHAPTER V

IMPLICATIONS OF ELECTRONIC DATA PROCESSING
FOR BUSINESS EDUCATION IN HIGH SCHOOL

This chapter consists of the report of a survey of business educators, and of a review of some recent professional business education literature. The implications derived from the survey are compared with data derived from the literature.

The implications are drawn from the opinions of teachers, supervisors, and administrators of business education. When 208 business educators, listed in the May, 1957 Administrative Issue of The National Business Education Quarterly, were contacted by questionnaire (see Appendix), 146 business educators, or 70 per cent, replied.

The report of the survey of business educators is presented item by item; each of the items is followed by a discussion of the implications derived from the report and from a consideration of recent literature.

Report of the Survey of Business Educators

Item #1. The first question asked was: "Electronic data

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processing will have (no-some-tremendous) effect on high school vocational business education.\cite{2} As shown in Table I, an overwhelming majority of business educators, 81 per cent, believe that electronic data processing will have some effect on high school vocational business education. Recent literature verifies the responses obtained in this survey. One article states that we will have to "revise our textbooks, course programs, and counseling\cite{2} if automation causes a reduction in the number of clerical workers. Another article says that "it is certain that the eventual widespread use of these machines will affect the curriculum offerings of our schools.\cite{3}"

**Item #2.** The second question asked the business educators was:

"Electronic data processing will make necessary (no-some-entire) revision of the high school vocational business curriculum." The majority of business educators who replied, 86 per cent, as shown in Table II, page 79, believe that electronic data processing will make necessary some revision of the high school vocational business curriculum. The effect that electronic data processing might have on the business education curriculum has been given attention in several recent articles. First of all, we should note that it has been predicted that electronic data processing is expected to bring about a cut of 25 to 90 per cent in the number of clerical workers. If this cut materializes

\begin{itemize}
  \item \cite{2} Leslie J. Whale, "What's Automation Been Up To In Detroit?," *Business Education World*, 38:30, October, 1957.
  \item \cite{4} News item in the *Sacramento Valley Union Labor Bulletin*, May 31, 1957, p. 3.
\end{itemize}
**TABLE I**

RESPONSE OF 146 BUSINESS EDUCATORS TO THE QUESTION: "ELECTRONIC DATA PROCESSING WILL HAVE (NO—SOME—TREMENDOUS) EFFECT ON HIGH SCHOOL VOCATIONAL BUSINESS EDUCATION"

<table>
<thead>
<tr>
<th>Choice</th>
<th>Number of Educators Choosing</th>
<th>Percentage of Educators Choosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No effect</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Some effect</td>
<td>118</td>
<td>81</td>
</tr>
<tr>
<td>Tremendous effect</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Multiple choices*</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Unspecified</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>146</td>
<td>100</td>
</tr>
</tbody>
</table>

*Two or more of the three choices listed above.
TABLE II

RESPONSE OF 146 BUSINESS EDUCATORS TO THE QUESTION: "ELECTRONIC DATA PROCESSING WILL MAKE NECESSARY (NO-SOME-ENTIRE) REVISION OF THE HIGH SCHOOL VOCATIONAL BUSINESS CURRICULUM"

<table>
<thead>
<tr>
<th>Choice</th>
<th>Number of Educators Choosing</th>
<th>Percentage of Educators Choosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No revision</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Some revision</td>
<td>125</td>
<td>86</td>
</tr>
<tr>
<td>Entire revision</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Multiple choices*</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Unspecified</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>146</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*"Two or more of the three choices listed above, as: "none now, some later."
it will certainly affect the business education curriculum. When an
insurance company converted from tabulating equipment to an elec-
tronic computer in July of 1954, it found that it could retire its
one hundred tabulating machines with their 135 operators. In
Detroit most replaced personnel were absorbed into the company, so
it should be realized that a cut in the number of clerical personnel
does not necessarily mean that these persons are thrown out of work.

The business education curriculum is dominated in enrollments
by four subjects: bookkeeping, typing, shorthand, and general
business. What effect will electronic data processing have on these
subjects? It will be profitable to pause here to consider each of
these subjects.

Bookkeeping duties have been comprehensively enumerated by
Herring; he finds that:

Some of the most common bookkeeping duties in order of their
frequency of performance, were: preparing a trial balance, com-
puting a payroll, computing withholding taxes on wages, posting
to an accounts receivable ledger, computing social security
taxes, posting to the general ledger, writing checks, and balancing
cash. Bookkeeping work in large offices so so specialized
and routinized that employees who have had little or no bookkeep-
ing training can perform most of the duties satisfactorily.

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6 Whale, op. cit., p. 31.
The things that Herring mentions are precisely the things that can easily be done on electronic computers. The trend towards specialization alone seems enough to justify a conversion of some bookkeeping course content to recordkeeping—or to combine or supplement bookkeeping with clerical or recordkeeping courses. But if electronic data processing is going to result in the elimination of large numbers of clerical jobs, then it does not seem that bookkeeping jobs will be spared, for they are in fact clerical in nature. The need for knowledge of bookkeeping principles will probably always exist, but there will be no need to spend much time on practices like carefully ruling double lines, improving penmanship, balancing accounts, memorizing rules for debiting and crediting, and the like. These practices may be important in individual situations, but it is the principles of bookkeeping which will require the major teaching emphasis.\(^8\) The introductory words of a 1934 bookkeeping text still hold true today, even when applied to electronic data processing equipment:

... Machines cannot do your thinking for you. They can relieve you of some of the drudgery of writing, and computing. You must determine what records you will keep, why you will keep them, how you will keep them, when, and where. You must also decide what statement you will compile to show the results of your record keeping.\(^9\)

The understanding of double-entry principles, the understanding of the

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relationships between business papers, journals, ledgers, and other records may continue to be important; interpretation of the results of record keeping, including the analysis of statements, will probably assume increasing importance.

But the bookkeeper will face another kind of challenge. He will have to learn about new kinds of business papers and records—like original documents in the form of punched or magnetic tapes, produced by office machines at the same time as the original transactions occur. Such original documents can be used to automatically maintain the debits and credits in a customer's account, and to automatically maintain perpetual inventories. The same tapes may be used for billing customers at periodic intervals. When bills are paid, punched cards, the same bills the customers receive, are put into a computing system where they automatically credit the customers' accounts. Bookkeepers and accountants will have to learn to deal with magnetic tape, punched tape, punched cards, memory devices, and whatever other innovations that may be developed. Original documents may become the books of original entry as well, the journals, and magnetic drums and discs will very likely take the place of ledgers, but financial statements will probably continue to be supplied in printed form. It seems safe to say that bookkeeping will not survive not survive in its present form.

Typing will probably be upgraded, for it is the typist who

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will be producing original documents for machine input. The electric typewriter will probably become common in most offices, and some machines may be equipped to produce tapes for machine use while a typed document is being simultaneously produced. Typists will have to be fast, and electric typewriters alone will speed them up some, but additional effort will also be required to at least keep input up with the computers, for idle computers waste dollars. Typists will have to be extremely accurate since the original document prepared in the form of tape will be used by the computer over and over again. One mistake could be multiplied several times over. Some mistakes will be made and they will have to be tolerated; if the mistake is made while the tape is still in the typewriter there will be no difficulty in correcting it—the only loss will be in speed, but if the mistake is not discovered before the tape is run, it could become very costly and time-consuming. There is only one way that the typist will be eliminated because of electronic data processing, and that will be when and if voice-controlled typewriters are perfected. 11

The secretary will come into more and more contact with electronic data processing machines and machine terminology. She will have less and less use for vocational shorthand. There will probably always be a need for those secretaries with a good knowledge of shorthand, but it appears that the typist will be taking over the duties of the stenographer; the typist will type from information dictated

11 Ibid., p. 102.
into a transcription machine. Typist–transcription machine contact will replace the former relationship of boss and stenographer.  

General Business is a course with a more variable content than other business subjects. It is certain that the advent of electronic data processing will at least add one more chapter to General Business texts; information concerning automation will be of general information value in survey courses and in courses used mainly for vocational guidance. Sociological aspects of electronic data processing may be considered also; for example, if automation brings shorter working hours with more productivity, workers are going to have more leisure time, more money to spend, and better living standards. In General Business courses where the emphasis is on consumer economics, students will have to be taught more about how to get the most for their money when they buy goods and services. In contrast, merchandisers will have to redouble their efforts; distributive education courses, especially in salesmanship and advertising, will be needed more than ever before. Salesmen will be putting orders and recording other sales information on transcription equipment, which in turn will be converted to machine tape by typists; later the conversion process may be eliminated and the machine tape produced directly.  

The Office Practice course is where senior students have

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12 Ibid.
14 Gibson, loc. cit.
commonly been given practice in the operation of various business machines—adding machines, calculating machines, transcription machines, duplicating machines, and similar equipment. This course may always be needed. Perhaps punched card equipment should be given some consideration in this course. Changes in office procedures due to electronic data processing should be taken into consideration. It should be recognized however that these clerical tasks, even keypunch training, will be among the first to go when electronic data processing comes in. Perhaps the keypunch and other tabulating machine operators needed for auxiliary and peripheral equipment can be trained in the typing classroom, rather than in Office Practice; there is already some indication that this will be practical, and it is reported that keypunch fingering can be taught on electric typewriters, "the keyboards of which are identical with those of the new key-punch machines." But punch-card training may not be necessary, as ordinary typewriter and ten-key adding machine training may be sufficient for this type of work.

Filing will certainly undergo some changes. Magnetic tape libraries will replace conventional filing cabinets, and entirely new procedures will have to be learned. Many file clerks will probably be replaced by tape librarians.

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15 Olson, op. cit., pp. 254, 256.
17 Whale, loc. cit.
18 Gibson, op. cit., pp. 102-103.
In general, all business courses will be affected by electronic data processing to some degree. Probably all business students should familiarize themselves with the basic principles and concepts of electronic data processing. It is even possible that a whole new Electronic Data Processing curriculum may be set up.

There is reason to believe that the use of electronic computers will require a series of courses specifically designed for the operation of these computers as they are developed in more simple operating forms with the responsibility for these courses falling upon the business education departments.  

Item 62. The third question put to the business educators was: "Personnel who operate and use electronic data processing equipment could best be trained (by the manufacturer—on the job—in high school—in junior college—other)." As shown in Table III, ninety-nine business educators believe that electronic data processing personnel could best be trained on-the-job, frequently in combination with other sources, usually high school or the manufacturer. Twenty-seven of the 146 business educators, or 18 per cent, think that on-the-job training alone will provide the best training for personnel who operate and use electronic data processing equipment, but another seventy-two business educators think that on-the-job training alone is not enough, and that it must be supplemented by other training given either in high school or junior college, or by the manufacturer.

The personnel who operate and use electronic data processing

\[19\text{Ibid.}, \ p. \ 104.\]
\[20\text{Smith, op. cit.}, \ pp. \ 253-254.\]
### TABLE III

RESPONSE OF 146 BUSINESS EDUCATORS TO THE QUESTION: "PERSONNEL WHO OPERATE AND USE ELECTRONIC DATA PROCESSING EQUIPMENT COULD BEST BE TRAINED (BY THE MANUFACTURER-ON THE JOB-IN HIGH SCHOOL-IN JUNIOR COLLEGE-OTHER)"

<table>
<thead>
<tr>
<th>Source of Training</th>
<th>Source Mentioned</th>
<th>Percentage of Educators Choosing Source Alone</th>
<th>Source Mentioned in Combination With Other Sources</th>
<th>Total Number of Times Source Mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>9</td>
<td>6</td>
<td>40</td>
<td>49</td>
</tr>
<tr>
<td>On-the-job</td>
<td>27</td>
<td>18</td>
<td>72</td>
<td>99</td>
</tr>
<tr>
<td>High school</td>
<td>4</td>
<td>3</td>
<td>48</td>
<td>52</td>
</tr>
<tr>
<td>Junior college</td>
<td>7</td>
<td>5</td>
<td>33</td>
<td>40</td>
</tr>
<tr>
<td>Other</td>
<td>83</td>
<td>57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>16</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>146</strong></td>
<td><strong>100</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
equipment have been and probably will continue to be selected from within individual business organizations whenever possible, because it is easier to teach electronic data processing procedures to employees who know the business operations of a given enterprise than to teach the business to people who know electronic data processing. Most employees can be trained with little or no difficulty. There is likely to be a continuing need for increasing numbers of electronic data processing personnel as the equipment becomes more widely used.

The manufacturers of the equipment have been largely responsible for the training of computer personnel, and this type of training has been combined with on-the-job education and experience. It is probable that our schools will be called upon increasingly to provide training for electronic data processing personnel. Also, it is probable that "cooperative work experience programs will become more essential as it becomes more difficult to approximate the office situation in the classroom."

Item #4. The fourth question put to the business educators was: "Electronic data processing will make it desirable for high school vocational business students to have (high intelligence and

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22 Whale, loc. cit.
23 Gibson, loc. cit.
24 Smith, op. cit., p. 255.
25 Olson, op. cit., p. 286.
ability—more background in fundamentals—better trained teachers)."

As seen in Table IV, fourteen of the business educators, or 10 per cent of the 146 educators surveyed, think that electronic data processing will make it desirable for business students to have high intelligence and ability; forty-two of the educators, or 29 per cent of those surveyed, think that students will need more background in fundamentals; and nineteen of the educators, or 13 per cent of the business educators surveyed, think that business students will need better trained teachers. In addition, forty-three educators gave multiple responses; of these, fifteen educators, or 10 per cent, chose all three choices.

The total number of times that each of the three choices was mentioned in the response to the survey is given below:

<table>
<thead>
<tr>
<th>Choice</th>
<th>Number of Times Mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>More background in fundamentals</td>
<td>80</td>
</tr>
<tr>
<td>Better trained teachers</td>
<td>57</td>
</tr>
<tr>
<td>High intelligence and ability</td>
<td>41</td>
</tr>
</tbody>
</table>

Electronic data processing is certain to focus more attention on the kind of business students that are being turned-out. As one article sums up the situation, there probably will be a wide enough range of positions in computer installations to accommodate wide ranges of intelligence and ability. But it is also evident that some positions will require above average intelligence, ability and

\[26\] Smith, loc. cit.
TABLE IV

RESPONSE OF 146 BUSINESS EDUCATORS TO THE QUESTION: "ELECTRONIC DATA PROCESSING WILL MAKE IT DESIRABLE FOR HIGH SCHOOL VOCATIONAL BUSINESS STUDENTS TO HAVE (HIGH INTELLIGENCE AND ABILITY—MORE BACKGROUND IN FUNDAMENTALS—BETTER TRAINED TEACHERS)"

<table>
<thead>
<tr>
<th>Choice</th>
<th>Number of Educators Choosing</th>
<th>Percentage of Educators Choosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>High intelligence and ability</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>More background in fundamentals</td>
<td>42</td>
<td>29</td>
</tr>
<tr>
<td>Better trained teachers</td>
<td>19</td>
<td>13</td>
</tr>
</tbody>
</table>
| High intelligence and ability
  More background in fundamentals
  Better trained teachers                     | 15                           | 10                              |
| High intelligence and ability
  More background in fundamentals
  Better trained teachers                     | 5                            | 3                               |
| More background in fundamentals
  Better trained teachers                      | 18                           | 13                              |
| High intelligence and ability
  Better trained teachers                      | 5                            | 3                               |
| Unspecified                                  | 25                           | 17                              |
| All others                                   | 3                            | 2                               |
| **Total**                                    | **146**                      | **100**                         |
personality:

When routine clerical jobs disappear into the mouth of a computer, business classes as dumping grounds for misfits, for low ability students, and for tired or lazy students can no longer be tolerated. Right now business teachers should start demanding, and getting, the highest quality student into their classes--no other will be wanted in a few years.27

Some of the characteristics that will be required of electronic data processing personnel are already defined: students will have to be alive and interested in their work; they will have to be able to reason and use their minds in making logical decisions; and they will have to have more mathematical ability.

There is no doubt that the best training of all for electronic data processing personnel will be that given in the basic reading, writing, and mathematical subjects. Typing probably will be the second most important kind of training.29 It is held that basic training in fundamental subjects will make business graduates better able to adapt themselves to any job--with fundamentals behind them, they only will have to familiarize themselves "with nomenclature and mechanics."30 One anonymous mathematics professor very clearly stated his opinion: "The main objective of a high school education should be to provide fundamental training in language and mathematics."

This feeling seems to be quite general in the literature of electronic

27Gibson, op. cit., p. 105.
28Ibid.; Whale, loc. cit.
29Whale, loc. cit.
Adequately trained and skillful teachers are always desirable, but as the demand for higher quality business graduates increases, so may it be reasonable to expect that teachers will also have to be better trained. Electronic data processing probably presents the greatest of all twentieth century challenges to the business teacher. As business operations and procedures are affected by electronic data processing, so will the business curriculum be affected, and changes in the curriculum will make necessary some revision of teaching methods. Students will have to be given demonstrations and shown, which will mean that the teacher will have to himself know what he is to demonstrate and show. Audio-visual education will become more important, and the lecture method will receive less attention. It is evident that "the business teacher must wake up to the fact that job changes are ahead." 

Item #5. The fifth and last item on the questionnaire survey of business educators provided space for "Other comments and suggestions." Several business educators took the opportunity to add anonymous comments, and some of the more significant are given below:

Most business teachers are not well enough informed on this topic to discuss it adequately. The high cost of the equipment will tend to place training responsibilities on the manufacturer and larger school districts.

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32 Gibson, op. cit., p. 104.
Training in Electronic Data Processing should include the following equipment:—(1) Key Punch, (2) Sorter, (3) Collator, (4) Tabulator, (5) Reproducing Summary, & (6) Proof Machine.

The influence of Electronic Data Processing on office procedure will be considerable, but I do not feel that it will change need for knowledge of fundamental processes.

I feel that the importance of electronic data processing is not a thing in the future but is rapidly becoming a part of our everyday working life. I feel that it is essential that we begin to train our people in this area.

There is no doubt but that electronic data processing equipment will have a terrific impact on high school commercial programs—will take more intelligence, demand more accuracy and greater understanding of mechanical and electronic fundamentals.

It has been my good fortune to have some first hand experience with such equipment. We also conduct classes in instructing, and have made the acquaintance of many people working with it, and have had opportunities to talk things over with them. In my opinion, a high degree of intelligence and ability in terms of mathematical abstractions would be wasted. That is for the design engineers. What appears to be needed are technicians. The machines are very simple from that standpoint. The binary system is the simplest numbering system ever used by man. The machines operate on a basis of speed. There is nothing about them as complex as machines in common use today. What we are going to need are people with a high degree of mechanical aptitude, and understanding of electricity, with a knowledge of accounting in order to understand what objective is sought. But we have no way of knowing what effect these machines will have on our business methods. Maybe we will revise our accounting procedures, perhaps even our merchandising methods. We can already see many changes in our manufacturing and personnel processes as a result of our experience with electronic data processing equipment. It's anybody's guess, what will happen. With all the experimenting we can do little except leave it to the manufacturer to train people. But standardisation is coming in. It won't be long until the schools will be called on to do as they have been doing with typing. In my opinion the problem of training electronic data processing technicians will in time become no more difficult, if as difficult, as training typists, certainly far less than developing skilled competent secretaries.

It can be assumed that electronic data processing will eventually have some effect upon the high school business training program, but when and how much is not clear at this time. This will probably not become clearly determined for several years since the number of companies using equipment of this type is still quite
small in proportion to the total number of industries in the

I feel that the schools may offer training of an exploratory
country.

nature—as many of our office practice courses do, but on-the-

job training is essential in that each office seems to adapt
teaches these machines to its own needs. I feel that content of es-

established courses will be revised and some courses shortened in

length.

Most of your electronic data processing divides into two

characteristics—those who plan and interpret and those who do. Those "who do" are clerical workers that are involved in card

punching or tape recording. The basic skills for this work are

the typewriter keyboard and the 10-key machines. We train on

these now.

Basic fundamentals are more essential for this type of em-

ployees. Accuracy in use of 10-key adding-listing machine and

fundamentals of typing will be most necessary.

It seems to me that the function of the 4-year high school is

still basically that of giving "general education" plus some

fundamental business skills. However, these fundamentals will

have to be better taught and the student better trained if they

are to cope with the equipment that is now coming into use in the

offices.

Other than the card punch I believe that the best training we

can give is improved basic training—spelling, vocabulary,

business arithmetic and business understanding, perhaps through

a course in business management.

Even the use of electric typewriters has been slow, for the

greater part of high school graduates go into small offices—

professional or small business. Dictating machines, comptometers,
calculators, and the coming "electronic data processing" will

gradually force the high school to give more and more training

in these fields—but the cost of the machines, the limited field

of endeavor will make public high school slow in accepting the

responsibility.

Data processing training may become another curriculum like,

and will incorporate new areas in addition to typewriting, as

additions to the present curriculum. The cooperative plan,

school and business, may prove to be the easiest procedure—
economical too.

It will take considerable time for needed revisions to be

reflected in the high school program.
Cost of such equipment prohibitive for most schools. Teachers could be given background training at college centers.

Equipment must be furnished by Industry plus training for teachers be paid by Industry otherwise teachers can't get or pay for this training.

It is possible that our major concern on the high school level at the present time should be in encouraging the schools to purchase more of the types of machines found in the typical business office.


We take a class to observe and watch electronic equipment in operation followed by a talk with question & answer period.

Coop work programs will serve as best means of providing instruction and practical experience.

I believe that EDP will result in an upgrading of typists among other things because it would appear that in many cases the typist will be making the original entries.

Workers on this equipment will not come from vocational business education alone. They will be glad to get any high caliber student, male or female.

A good briefhand system of shorthand may be sufficient for many business pupils since shorthand may decrease in importance. Their typing skill should be improved especially for accuracy; typing errors now made will be multiplied a thousandfold.

Possibly a decrease in the amount of time given to instruction in stenography.

Teachers who have this training at college will be in a better position to teach related material. Practical instruction best done on the job where equipment and actual job problems are at hand.

Teachers trained and knowledgeable in this field, plus more background in mathematics and statistical materials.

Business education teacher training institutions and teachers should study this problem.

From the preceding comments of business educators, one can
detect certain conditions. First, it appears that some business educators are unfamiliar with electronic data processing; secondly, other business educators are aware of electronic data processing, but seem to have electronic data processing equipment confused with, or identified with, tabulating or punched card equipment; this is understandable since tabulating equipment is often found in electronic data processing installations where it is used for input-output and other auxiliary purposes.

Few business educators deny the coming importance of electronic data processing, and some concede that business methods and procedures may be revised. The general impression seems to be that the high schools will be called upon to prepare students only for the lower level jobs such as keypunch operator and machine operator. Even then it appears that the business educators think that the high school training will be basic and fundamental, and that manufacturers and individual business enterprises will have to continue their responsibility for the higher and more specific vocational training. Some of the business educators think that eventually the high schools will be called upon to train electronic data processing personnel, but that for the present the manufacturer and business must do this.

The high cost of the equipment is given as one reason why schools will be slow in accepting responsibility for electronic data processing training, but some educators have pointed out that perhaps schools should exert more effort in trying to obtain typical business office machines, and also that attempts should be made to find new
ways for getting equipment, or at least the use of it. One distinct possibility is cooperative training between schools and business. Another is for the manufacturer to loan or rent machines for school use. At any rate, it appears to some business educators that most high schools will be slow in revising their curricula to meet the challenge of electronic data processing, and that in this respect cost is a very important factor to consider.

It appeared to some business educators that electronic data processing would cause a general upgrading of business education, especially in the area of typing and business machines, like the ten-key adding machine, because, for example, typists would be making more original documents, and typists and other operating personnel would have to be more accurate, able to think and make decisions for themselves, and be able to assume more responsibility in general. Short-hand, according to some business educators, appears to be heading for de-emphasis as a vocational skill because of the development of recording devices. Some business educators also indicated that teachers would need training in and familiarisation with the field of electronic data processing.
CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

There can be little doubt that electronic data processing is becoming more important to the business world. As electronic data processing causes changes in business methods and procedures it should also cause changes in the high school vocational business education curriculum. The business use of data processing equipment is continuing to expand, and equipment suited to and within the economic means of even small business enterprises will increasingly come into prominence.

Electronic data processing is only the latest advance in the attempt to solve a very old business problem—the problem of what to do with a mass of business paperwork. The history of digital computing devices, in which electronic devices are only the most recent development, is ancient. Even the largest and most complicated equipment is by no means as new as is commonly supposed—punched cards and tapes and "difference engines" are as old or older than the eighteenth century.

The trend in the twentieth century has definitely been towards mechanizing the business office, and the development of electric and electronic devices has played no small part in this movement. Business is looking for ways to avoid doing the same work
twice, and so in the field of bookkeeping, for example, it wants to prepare documents and journalize and post them all at once. Electronic machines of great speed and versatility have been developed to speed up and simplify the handling of business paperwork, and their increasing acceptance by the business world proves their utility. The first machines were large scale and very expensive, but medium scale and small scale systems have been developed for use by smaller businesses with more limited financial resources, and this trend may be expected to continue, so that electronic systems will come to be used more widely by the business world.

The increasing use of electronic data processing equipment will cause some displacement of personnel, but the overall effect should be beneficial. Business, with new up-to-date operating information at its fingertips, will find itself better prepared to expand with growing markets and increasing competition. New jobs have been created—for people to build the electronic equipment, for people to operate and use the equipment, and for people to repair and maintain the equipment and to develop improved models.

Many of the high level positions such as programmer, systems analyst, and coder will go to college trained and highly experienced personnel, but there will be many lower level or starting positions open to qualified high school graduates. These positions will be mostly in the clerical and operating areas. Experience and aptitude seem to be far more important than the school grade level completed, and exceptional personnel will be able to qualify for some of the
higher level positions.

Business educators think that electronic data processing is going to have some effect on high school vocational business education. They also believe that some revision of the curriculum is going to be necessary. For one thing, the number of clerical workers may possibly decline sharply in the coming years. Bookkeeping duties have been reduced to clerical tasks in many large offices, and bookkeeping probably will not survive in its present form; principles will largely take precedence over practice in bookkeeping classrooms. Typists will be upgraded, and they will assume the duties of stenographers; shorthand will decline as a vocational use subject. Typists will be producing original documents for machine use, and they will type from information that has been dictated to a transcription machine. Key-punch fingering may be taught in the typing classroom on electric typewriters. All business courses will be affected by electronic data processing to some extent, and both teachers and students should probably familiarize themselves with the principles that are basic to electronic data processing.

Electronic data processing personnel are usually chosen from within the organization whenever possible. The manufacturer and individual business enterprise are going to continue their responsibility for training computer personnel. Schools will increasingly assume the responsibility for this training as the use of electronic machines becomes more widespread in business. Cooperative work experience programs are going to become important if realistic education is to be provided.
Training in fundamentals, business educators think, is going to be the best kind of training for the workers in the mechanized office. Students are going to have to be more responsible, able to think for themselves, and have a more solid foundation in logic and mathematics. There may always be a wide enough range of jobs in computer installations to fit a corresponding range of intelligence and ability, but it is certain that the higher positions will require higher quality students just as they always have. Certainly business educators, teachers, and students, are all going to have to learn more about electronic data processing.

Conclusions

The conclusions of this study are:

1. Bookkeeping in large offices is becoming largely a clerical task requiring little or no bookkeeping training.

2. Bookkeeping is not going to be as important in the business education curriculum as it has been.

3. Bookkeepers and accountants are going to have to learn to deal with new media such as punched cards and tapes that will take the place of more conventional methods of recording business transactions.

4. Typing will become the most important business subject.

5. Some auxiliary equipment operators, such as key-punchers, may be trained in the typing classroom on electric typewriters.

6. Typists will largely replace stenographers; they will type from information dictated to transcription machines.

7. Shorthand will decrease in importance as a vocational subject.

8. A new data processing curriculum may have to be set up under the charge of the business education department.
9. While the manufacturers of the equipment have been largely responsible for the training of computer personnel, and this type of training has been combined with on-the-job education and experience, it is probable that our schools will be called upon to provide training for data processing personnel as the use of electronic devices becomes more widespread.

10. As the present electronic data processing equipment is very costly, cooperative work experience is going to become essential if the classroom is going to keep pace with office practice.

11. Business students are going to need more background in fundamentals.

12. Business students are going to need higher intelligence and ability for the more responsible tasks they will face in the mechanized office.

13. Business teachers and educators should strive to become more familiar with electronic data processing.

Recommendations for Further Research

1. There is a need for the development of some comprehensive and annotated bibliographies in the field of business data processing.

2. A comprehensive catalog of audio-visual aids in the field of electronic data processing needs to be compiled.

3. Each subject in the high school vocational business education curriculum should be studied individually in relation to the impact of electronic data processing.

4. Some tentative courses of study for revised business subjects should be drawn up—perhaps even an entire tentative data processing curriculum should be formulated.

5. Some attempts should be made to clearly define the responsibility of the high schools in the training of electronic data processing personnel.

6. Opportunities for cooperative work experience programs in the Sacramento area should be thoroughly explored.
7. The problem of how the high school is going to get the use of electronic data processing equipment should be investigated (cooperative work experience programs, rental, use of cheap models and mock-ups in place of the actual equipment, should all be considered).
BIBLIOGRAPHY
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B. COMPANY PUBLICATIONS


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California State Personnel Board specifications for the classes; Code #1370, Code #1373, Code #1375, and Code #1376, all established or revised September 20, 1957.


E. PERIODICALS


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Smith, Robert M. "Is This a Blueprint For Tomorrow's Offices?," Office Management, 26:12, August, 1955.


F. ENCYCLOPEDIA ARTICLES


G. UNPUBLISHED MATERIALS

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H. NEWSPAPERS

The Sacramento Bee, February 8, 1958.
Gentlemen:

This semester I am engaged in thesis research for the Master of Arts degree at Sacramento State College. My topic is: "The Implications for the Secondary Bookkeeping Curriculum of Electronic Data Processing Equipment."

I will attempt to define the bookkeeping and accounting functions now being performed by electronic data processing equipment, and to discuss the implications for the secondary bookkeeping curriculum. I propose to cover the relationships between bookkeeping course content and the character of the training needed to perform bookkeeping functions by electronic data processing equipment.

Since your organization is engaged in the computer field, I will greatly appreciate any information at all that you may be able to send me.

Yours very sincerely,

Enoch J. Haga

8304 Bella Vista Avenue
Fair Oaks, California
February 10, 1956
Gentlemen:

Since your organization is engaged in the computer field I am wondering if you could help me?

This semester I am writing a thesis at Sacramento State College concerning "Some Implications for the Secondary School Vocational Business Curriculum of Electronic Data Processing."

Anything at all about business applications of EDP, or the nature of the training required for its efficient business use would be of help.

Yours very sincerely

Enoch J. Haga
Will you please help me with an important problem?

"Electronic Data Processing--Implications for Business Education in High School" is the subject of a thesis I am writing at Sacramento State College.

Part of this study is directed towards discovering the nature, extent, and sources of the training required of personnel who apply electronic data processing to bookkeeping functions.

INSTRUCTIONS: Please answer the two questions listed below--then turn to the NEXT PAGE and fill in as completely as possible:

1. Are you affiliated with an organization that has an electronic data processing installation?
   
   _____ YES
   _____ NO

2. What kind of installation? Please describe by name.
   
   ____________________________________________
   ____________________________________________
<table>
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<th>KINDS OF JOBS AVAILABLE IN AN ELECTRONIC DATA PROCESSING INSTALLATION</th>
<th>EDUCATION BACKGROUND REQUIRED FOR THIS JOB</th>
<th>SPECIAL TRAINING REQUIRED FOR THIS JOB</th>
<th>LENGTH OF SPECIAL TRAINING REQUIRED FOR THIS JOB</th>
<th>WHO GIVES THE SPECIAL TRAINING REQUIRED FOR THIS JOB</th>
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You, in your capacity as a business educator, by virtue of your position and experience, can help me with an important problem in a new field.

"Electronic Data Processing--Implications for Business Education in High School" is the subject of a thesis I am writing at Sacramento State College.

Your opinions concerning the impact of electronic data processing upon business education are needed:

INSTRUCTIONS: Use a check mark to indicate those statements which best reflect your feelings. Leave all other statements blank:

1. Electronic data processing will have
   ___ no
   ___ some
   ___ tremendous effect on high school vocational business education.

2. Electronic data processing will make necessary
   ___ no
   ___ some
   ___ entire revision of the high school vocational business curriculum.

3. Personnel who operate and use electronic data processing equipment could best be trained
   ___ by the manufacturer.
   ___ on-the-job.
   ___ in high school.
   ___ in junior college.
   ___ OTHER: Please describe on next two lines: __________________

Example: By a combination of high school and on-the-job training.

4. Electronic data processing will make it desirable for high school vocational business students to have
   ___ high intelligence and ability.
   ___ more background in fundamentals.
   ___ better trained teachers.

5. OTHER COMMENTS AND SUGGESTIONS: Use other side if necessary: __________________________________________________________
   __________________________________________________________