The course contained in this book was written for training data processing machine operators; it is intended to prepare adults to qualify for an entry-level job. It is not aimed at developing high proficiency on any one machine, but rather at introducing the student to a variety of equipment, and developing an understanding of how the data flow through a unit-record system. The topics discussed include: the basic functions of data processing; the unit record principle and the punched card; the card punch and verifier; the interpreter; the sorter; the reproducer; the collator; the accounting machine or tabulator; the calculating punch; documentation; and integrated applications. A bibliography and introductory projects are included. This course is related to two others published by the New York State Education Department: "Keypunch Operation" and "Introduction to Automatic Data Processing." (PT)
UNIT-RECORD MACHINE OPERATION
UNIT-RECORD MACHINE OPERATION

A Suggested Adult Business Education Course

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of Continuing Education Curriculum Development
Albany, New York 12224
1970
THE UNIVERSITY OF THE STATE OF NEW YORK

Regents of the University (with years when terms expire)

1984 Joseph W. McGovern, A.B., LL.B., L.H.D., LL.D., D.C.L. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - New York
1985 Everett J. Penny, B.C.S., D.C.S., Vice Chancellor - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - White Plains
1978 Alexander J. Allan, Jr., LL.D., Litt.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Troy
1973 Charles W. Millard, Jr., A.B., LL.D., L.H.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Buffalo
1972 Carl H. Pforzheimer, Jr., A.B., M.B.A., D.C.S., H.H.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Purchase
1975 Edward M. M. Warburg, B.S., L.H.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - New York
1977 Joseph T. King, LL.B. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Queens
1974 Joseph C. Indelicato, M.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Brooklyn
1976 Mrs. Helen B. Power, A.B., Litt.D., L.H.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Rochester
1979 Francis W. McGinley, B.S., LL.B., LL.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Glens Falls
1980 Max J. Rubin, LL.D., L.H.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - New York
1971 Kenneth B. Clark, A.B., M.S., Ph.D., Litt.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Hastings on Hudson
1982 Stephen K. Bailey, A.B., B.A., M.A., Ph.D., LL.D. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Syracuse
1983 Harold E. Newcomb, B.A. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Owego
1981 Theodore M. Black, A.B. - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - Sands Point

President of the University and Commissioner of Education
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Director, Division of Occupational Education

Chief, Bureau of Business Education
Hobart H. Conover
FOREWORD

Machines for handling data processing cards are used widely and a big backlog of demand exists for machine operators qualified to operate several machines. The course contained in this book has been written for training such operators. This course is related to two others published by the New York State Education Department: Keypunch Operation and Introduction to Automatic Data Processing, both published in 1968.

The scope of this course and its general nature were determined by an advisory committee consisting of the following: Sanford Bernstein, Ulster County BOCES (Board of Cooperative Educational Services), New Paltz; Charles Cartwright, assistant to the district superintendent of Washington County, Fort Edward; George Gearhardt, chairman of the business department, Guilderland Central High School, Guilderland Center; and Carl Kraushar, assistant director of vocational education, BOCES, second supervisory district, Westchester County, Port Chester.

The basic draft of the text was written by Mr. Gearhardt. Mrs. Robbie Lou Ashworth, Data Computing Center, Albany-Schoharie-Schenectady County BOCES, Albany, revised the text. Eugene P. Whitney, Associate, Bureau of Business Education, reviewed the final manuscript before publication. E. Noah Gould, Associate, Bureau of Continuing Education Curriculum Development, guided the development and writing of this booklet and prepared it for publication.

HERBERT BOTHAMLEY, Chief
Bureau of Continuing Education
Curriculum Development

WILLIAM E. YOUNG, Director
Curriculum Development Center
MESSAGE TO THE INSTRUCTOR

This course, Unit-Record Machine Operation, is intended to prepare adults to qualify for an entry-level job. It is not aimed at developing high proficiency on any one machine, but rather at introducing the students to a variety of equipment, and developing an understanding of how data flow through a unit-record system. It is unlikely that any course given will use all the text material presented here.

The instructor will need to select the material he requires for his class, based on which machines are available and the amount of time to be allocated to the course. Including most or all of the material in this guide can provide a complete course which would take about 120 hours of instruction. A good course, however, can also be presented in about 60 hours if the amount of instruction on wiring of control panels is cut considerably.

Most authorities agree that a keypunch, a sorter, and a verifier are essential for the kind of course being described here. Some would even require an accounting machine. In any case, a total of about five pieces of equipment could be used (with proper scheduling) to instruct a class of up to about 15.

Because classroom equipment will vary, no time schedule has been suggested for covering the various machines. A cyclical approach is recommended, in which the instructor provides an overview of each machine in the laboratory, then follows it with a second cycle of coverage, this time with more depth of instruction on each machine. A third cycle could cover complex problems and wiring of control panels for those machines that require it.

The class can be scheduled for either 2- or 3-hour sessions with appropriate intermissions. Part of each session should be devoted to "hands on" experience in operating the equipment.

At least one problem should be used in this course which follows the flow of data through the whole system. With this problem the instructor should stress the details of preplanning, the proper sequence of machines used, the nature of the final report, and the documentation of the whole operation.

HOBART H. CONOVER, Chief
Bureau of Business Education
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ORIENTATION

OBJECTIVES OF THIS SECTION:
1. To present a brief overview of the whole field of data processing and to show the place of unit-record data processing in it
2. To present an overview of the course

CONTENT OUTLINE

I. Introduction

A. Overview of the course
1. Beginning experience on basic machines
   Explain that the course is aimed at giving the students beginning experience with at least the keypunch, the sorter, and the accounting machine. If your school has other unit-record machines for the class to use, mention them and tell the students they will be trained on them, too.

2. Unit-record principle
   State that the unit-record principle is the basis for using the equipment they will learn about. Give a simple definition of unit-record principle such as the following: a principle of data processing in which each piece of information is recorded once (and only once) in a medium which can be processed by machine.

3. Level of skill to be taught
   Explain that the instruction will include discussion, demonstration, and "hands-on" machine experience. Point out that after completing the course the students should be qualified to start on a beginning job as operator on some of the machines.

CONTENT DETAILS & TEACHING TECHNIQUES

Introduce yourself to the students and explain your background in a few words, particularly as it applies to the course.

To help create a friendly atmosphere have each student introduce himself.
CONTENT OUTLINE

4. Class schedule

B. Target jobs

1. Job descriptions

2. Background required

3. Further training opportunities

II. Evolution of Data Processing

A. Recording techniques

1. Clay tablets

2. Papyrus

CONTENT DETAILS & TEACHING TECHNIQUES

Explain the time of each class meeting, the length of classes, and the number of weeks they will last. Also mention any variations (such as holidays) from a regular schedule.

Point out that after completing this course the students might become unit-record machine operators. Show on a diagram where such an operator fits into a data-processing organization.

Present a job description of unit-record machine operators from a good source, such as the Dictionary of Occupational Titles, Vol. I. Also discuss the descriptions of other closely related jobs. (Note: You will find full citations of references in the bibliography.)

Discuss the personal characteristics and training required for a unit-record machine operator. Do the same for related jobs in the data-processing organization.

Point out that those who complete this course, after some experience in a job, could make further progress in data processing by additional training and education. Mention the kinds of training and education applicable and the places (particularly local places) where it is available. This could include:

- Other adult courses
- Courses given by manufacturers of data-processing equipment
- Junior college programs
- Four-year college programs

Point out that the oldest surviving written records were kept by the Sumerians and Assyrians on clay tablets, 5000 or more years ago. They used the cut end of a reed to mark the wet clay.

The Egyptians used sheets of papyrus and a reed pen; they also used rolls of papyrus as long as 50 feet. Now, after
## CONTENT OUTLINE

<table>
<thead>
<tr>
<th>Content Details and Teaching Techniques</th>
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<tbody>
<tr>
<td>3. Bookkeeping</td>
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<tr>
<td>4. Paper and quill pen</td>
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<tr>
<td>5. The typewriter</td>
</tr>
<tr>
<td>6. Bookkeeping machines and other business machines</td>
</tr>
</tbody>
</table>

**Suggested teacher reference:** Arnold pp. 15-20.

## B. Computing devices

1. Abacus and Arabic numbers

One of the earliest computing devices was the abacus invented in China about 2600 B.C. The next significant development in computing was the gradual acceptance of Arabic numbers, starting about 1200 A.D.

2. Napier's logarithms and "bones"

No mechanical computing aid worth very much was produced until the 17th century. In that century Napier developed logarithms and an arrangement of numbered strips of bone (called Napier's bones) to use logs for multiplying. Other significant advances were made in that century: the slide rule, the digital counter, and a calculating machine which multiplied by repeated addition.

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*Full reference citations are given in the bibliography.*
### CONTENT OUTLINE

<table>
<thead>
<tr>
<th>3. Keyboard calculators, first bookkeeping machine</th>
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<tbody>
<tr>
<td>In the 19th century, calculating machines were developed using keyboard operation and applying the principle of direct multiplication. Also produced in that century were the Comptometer (often called a &quot;macaroni box&quot;), the cash register, and the first bookkeeping machine.</td>
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<tr>
<th>4. First accounting machine</th>
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<tbody>
<tr>
<td>In the 20th century, the first accounting machine (hand-operated) was made; electromechanical calculating machines came into general use about 1920. All these machines had the limitations of (1) requiring the operator to press a key, and (2) operating separately so that continuous data processing could not be done.</td>
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<th>5. Conveniences</th>
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<tr>
<td>The window envelope, carbon paper, carbon sets, and continuous forms added to the efficiency and convenience of the machines.</td>
</tr>
</tbody>
</table>

### CONTENT DETAILS AND TEACHING TECHNIQUES

<table>
<thead>
<tr>
<th>1. Babbage's analytical engine</th>
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<tr>
<td>The first attempt to use punched cards for computation was by Babbage in his difference engine, and then in his analytical engine, in the early 1800's. The analytical engine had a memory unit, an arithmetic unit, and a control unit, but he never got it to work.</td>
</tr>
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<tr>
<th>2. Hollerith's work on the U.S. census</th>
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<tr>
<td>Hollerith developed a method of recording data in cards with a hand punch. When the cards were put into his tabulating machine, electrical circuits were completed causing the machine to tabulate</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>C. Punched card machines</th>
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<tr>
<td>Outline developments in punched card machines as given below. The Jacquard loom was one of the earliest machines to use punched cards; they were used to select threads and designs.</td>
</tr>
</tbody>
</table>

Suggested teacher references:
Arnold, pp. 20-25.
Schmidt, pp. 6-12.
the data. With this machine and the cards, the 1890 census tabulation was completed in one-third the time taken for the 1880 census.

3. Improvements in cards and machines.

In the 1920's and 1930's punched cards were developed using 80 and 90 columns; electromechanical machines that multiply were also produced, permitting full-scale accounting. These machines still were not fast enough and had the further disadvantage of performing each step of operation on a separate machine. To do a complete data-processing job the cards had to be moved from one machine to another.

In 1944, Professor Howard Aiken of Harvard, working with IBM engineers, produced the Mark I. This was the first machine to realize Babbage's dream of doing all data-processing operations on one machine.

This machine was still too slow to handle the enormous demand for data processing brought on by World War II. The increase in speed needed was finally achieved only in the electronic machine.

D. Electronic computers

Tell the students that electronic computers will now be covered briefly for general information, but that the course will not cover their operation. Point out, however, that computer-based systems often use unit-record machine operators.

1. The first computers

Explain that the ENIAC, developed at the University of Pennsylvania from 1942 to 1946, was the first electronic computer. It used vacuum tubes in place of the relays of previous machines and thus increased the processing speed tremendously. It was quite limited, however, in its storage capacity and in its capacity for accepting instructions.

a. Magnetic tape and other improvements

The use of magnetic tape began in 1954; this increased the processing speed to
2. The second generation of computers

In the mid-1950's the second generation of computers came into use. These replaced the vacuum tubes with solid state elements, such as transistors. These computers were smaller and more reliable, and put out less heat.

3. The third generation

In 1964 the third generation was introduced. These computers used microminiature circuits and thin-film memory. They are even smaller than the second generation machines, have greater capacity, and operating speeds in billionths of a second. The elements of a system in these computers are also compatible with the elements of other systems.

III. Demonstration

Demonstrate the basic machines to the class, as explained in Project 1. Note: Prepare for this demonstration before the meeting of the class in which you present it.
THE BASIC FUNCTIONS OF DATA PROCESSING

OBJECTIVES OF THIS SECTION:
To provide an understanding of the basic functions of data processing including: classifying, sorting, calculating, summarizing, recording, communicating, and storing

CONTENT OUTLINE
I. The Basic Functions

A. Classifying

1. Steps in classifying

B. Sorting

CONTENT DETAILS & TEACHING TECHNIQUES

Explain that the basic functions apply to the processing of information regardless of the media with which it is processed. This means the functions apply whether the information is recorded and processed with paper and pencil, with punched card equipment, or with the most sophisticated electronic computer.

Point out that classifying consists of identifying data to distinguish them from other data, and to ease arranging them into a desired sequence.

Usually data are grouped within classes which have been previously determined. Examples of these are customer's name, geographical area, and kind of product. A code symbol is then usually applied to each item in a class, if unit-record processing is to be used. The basic artificial codes are alphabetic, numeric, and alphanumeric.

Explain that sorting is the arranging of data according to a prescribed arrangement. This could mean merely separating customers in the Northeast from those in the Southeast. Or it could mean putting a set of cards into alphabetical order by customer's name, or into numerical sequence by value of purchases in a given month.
<table>
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<tr>
<th>CONTENT OUTLINE</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
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<tbody>
<tr>
<td>C. Calculating</td>
<td>Mention that calculating includes adding, subtracting, multiplying, and dividing, whether it is done by hand, by electronic computer, or by any other method. Give a few simple examples of these four operations applied to data.</td>
</tr>
<tr>
<td>D. Summarizing</td>
<td>Point out to the class that summarizing is the condensing of data so that main points are emphasized. It usually means listing or tabulating data and totaling each list.</td>
</tr>
<tr>
<td>1. Examples</td>
<td>Mention that running a list of figures on an adding machine is a simple example of summarizing. A sheet of figures comparing monthly sales of the departments of a store is an example of a summary. The box score of a baseball game is also an example.</td>
</tr>
<tr>
<td>2. Relation to sorting</td>
<td>Explain that summarizing is related to sorting because data arranged into categories are usually part of a summary.</td>
</tr>
<tr>
<td>3. Reports as a result of summarizing</td>
<td>Point out that the objective of summarizing is usually to make a report, even if it's a simple one. For instance, the summary of monthly sales mentioned above is a report.</td>
</tr>
<tr>
<td>E. Recording</td>
<td>Explain that recording includes writing (and rewriting) data, typing data on a typewriter, punching cards, recording data on a magnetic tape, etc. In a manual system all recording is done by hand; in a punched card system a piece of data is usually recorded only once, by keypunching, and is then reproduced by machine when needed again.</td>
</tr>
<tr>
<td>1. Done frequently in data processing</td>
<td>Mention that recording is done at just about every step of data processing. Also explain that methods of reproduction like carbon paper, stencil duplicating, fluid duplicating, and photocopying are &quot;rewriting&quot; methods and are important elements in recording.</td>
</tr>
</tbody>
</table>
State that communicating in data processing is essentially the transfer of information. This means that communicating includes distributing carbon copies or duplicated copies of data, and the movement of data within the machines of a data-processing system (for example on punched cards). It also includes the movement of data between the plants of a corporation by data-phone, by teletypewriter and by facsimile.

Explain that the purpose of communicating is to bring data to a place where they are needed for further processing or for making decisions.

Storing means the filing of data for future use; they might be stored for seconds or for years. Storing of data includes keeping them on paper in file cabinets, in punched cards awaiting processing in a machine, and in magnetic tape available for use in an electronic computer.

Data are stored before processing; an example is the data on paid bills stored in a file cabinet before being entered manually in a journal. Another example is the data in cards just punched and held by the keypunch operator before processing. Data are also stored between steps of processing and after being processed.

Suggested teacher references:
Awad & DPMA, Chap. 5.
Arnold, Chap. 1.
Robichaud, Chap. 1.
THE UNIT-RECORD PRINCIPLE AND THE PUNCHED CARD

OBJECTIVES OF THIS SECTION:
1. To provide an understanding of the unit-record principle
2. To present a punched card as an example of a unit record
3. To explain the parts of a punched card and show how information is recorded on it

CONTENT OUTLINE

I. The Unit-Record Principle

A. Compared with manual system

B. Examples

1. In a manual system

2. In a mechanical system

CONTENT DETAILS & TEACHING TECHNIQUES

Give the definition of unit-record principle, which is that each piece of information and each transaction is recorded once, and only once, in machine-processable form. Give several examples of the information in a unit record. Discuss the disadvantages of manual systems which the unit-record principle overcomes.

Mention that in a manual record system a given piece of information must be copied and recopied several times as it moves through the system. Each time it is copied there is a chance of an error.

Explain that a manual system does not generally use the unit-record principle, but one simple manual application of this principle can be found: A library catalog with the information for each publication on a separate 3x5 card.

Point out that the use of punched cards is a much better example. Once the information about a transaction has been punched into a card, any of the information can be used as many times as needed without manual repunching or recording.
II. The Punched Card

A. Physical description

1. Dimensions

Give the length, width, and thickness of the 80-column card and describe the kind of paper from which it is made.

2. Columns and rows

Point out the 80 columns and 12 rows and show how they are identified. Explain zone-punching positions and digit-punching positions.

a. Punching of data

Explain and illustrate with a visual aid how numerical data and alphabetical information are punched, as well as special characters.

3. Card edges and color

Explain and illustrate 9-edge, 12-edge, corner cut, and color stripe on cards, and colored cards. Discuss the significance of each feature.

B. Types of cards

Illustrate and explain the following types of cards: transcript card, dual card, mark-sensed card, summary card, and stub card.

C. Design of the card

Explain that design of a punched card consists mainly of planning the arrangement of data on it. Point out that the following are the important factors in card design:

1. Factors in design

- the requirements of finished reports using the data
- the nature of source information and source documents
- the way the machine reads data from the card
- the desirability of having uniform cards to be processed together
- the method of punching to be used
2. Fields

Explain the meaning of *field*; illustrate and explain the arrangement of several fields on an actual card.

Suggested teacher references:
Arnold, Chap. 6.
IBM Publication F20-0074-0, pp. 2-5.
Robichaud, pp. 64-70.
Van Ness, pp. 24-33.
THE CARD PUNCH AND VERIFIER

OBJECTIVES OF THIS SECTION:
To provide an understanding of the functions, physical components, and operating procedures of both the card punch and the verifier

CONTENT OUTLINE

I. The Card Punch

A. Basic function

B. Operating features of the keypunch

1. Card hopper

2. Punching station

3. Reading station

CONTENT DETAILS & TEACHING TECHNIQUES

Point out that none of the basic functions of data processing discussed in Section 2 can be carried out automatically with unit-record equipment until the written records have been transcribed to punched cards.

Explain that data can be recorded in a standard-size punched card by punching holes with a keypunch.

Terminology in this section refers primarily to IBM punches. Explain the basic differences among the IBM 24, 26, and 29 card punches.

Locate the card hopper and demonstrate the proper way to place cards in it. Show how cards are fed from the hopper to the card bed when the feed key is depressed.

Point out the punching station where the 12 punch dies are located. Demonstrate how to register a card under the punch dies and punch a number of card columns in a card to illustrate column-by-column movement.

Explain how the reading station can sense holes in a punched card. Demonstrate duplication of a card.
4. Card stacker

Locate the card stacker and show how cards move from the reading station to the stacker. Note that cards in the stacker are in the same sequence as they were punched.

5. Reading board

State that the reading board serves as a desk for the source documents from which data is read.

C. Keyboard and controls

1. Keyboard

Discuss the card-punch keyboard as compared with a typewriter keyboard. Locate the alphabetic and numeric keys on both, and note the special characters available on a keypunch.

Explain that shifting is no longer between lowercase and uppercase letters, but between alphabetic and numeric characters. Note the special control punches which activate other unit-record equipment.

2. Control keys

Demonstrate the following keys:

1. Feed key (FEED)
2. Register key (REG)
3. Release key (REL)
4. Duplicate key (DUP)
5. Skip key (SKIP)
6. Multiple punch (MULT PCH)
7. Alternate program (ALT PROG)
8. Auxiliary duplication (AUX DUP)
9. Numeric shift key (NUM)
10. Alphabetic shift key (ALPH)

3. Control switches

Point out the switches on the keyboard panel for controlling automatic feeding, automatic duplicating and skipping, program selecting, printing, and clearing.

4. Backspace key

Note that this key is not on the keyboard but is located below the card bed between the reading station and the punching station. Demonstrate its use and note which three objects move backward in synchronism.

Explain how the backspace on the IBM 24 and 26 punches releases the keyboard when it is locked. On the IBM 29 the error reset key releases the keyboard.
CONTENT OUTLINE

D. Additional features
   1. Column indicator
   2. Pressure-roll release lever
   3. Main-line switch
   4. Chip box and fuses
   5. Program control unit

E. Some operating procedures
   1. Replacing a damaged card
   2. Correcting an error card
   3. Sight-checking cards

CONTENT DETAILS & TEACHING TECHNIQUES

Locate the column indicator and stress the fact that this indicator points to the next column to be punched. Note that the use of the indicator is a basic necessity when spacing forward or back to a particular column of a card.

Demonstrate the removal of a card from under the punch dies or under the reading station.

Point out the main power switch. Explain that the IBM 24 and 26 punches need time to warm up. The IBM 29 key-punch, however, can be used immediately after the switch is turned on.

Indicate the location of the chip box, and the fuses which are behind it.

Explain that this feature is on IBM punches only. Point out the four basic parts of the program control unit: the program drum, the program card, the starwheels, and the program control lever. Discuss the use of program control for automatic operations and compare it with manual control by the operator.

Demonstrate how to reproduce the punches from a damaged card into a blank card with the program control off, the automatic feed switch off, and manual insertion of cards in the card bed.

Using a card containing incorrect punching, show how to duplicate those columns that are correct and manually repunch the correct information in the mispunched columns. Point out use of the column indicator; also the numeric shift key, if it is needed.

In both of the demonstrations just covered, stress the need for comparing the old and new cards by sight-checking, while holding the cards up to the light.
CONTENT OUTLINE

4. Continuous punching from a source document

5. Punching under program control

6. Print control

CONTENT DETAILS & TEACHING TECHNIQUES

Demonstrate the punching of four or five cards without program control. Point out that depressing a key automatically punches the proper combination of holes in a card column. Include use of the space bar, shift keys, and duplicate key for part of the data.

Mention that for punching under program control the keypunch operator prepares a program card, using five basic program codes. Explain each code and its function. Show how to attach the program card to the drum and insert the drum in the keypunch.

Demonstrate how to turn on the program control lever to put the keypunch under control of the program unit. Point out the starwheels which touch the program card and sense the control punches in the card.

Punch several cards under program control. Include automatic duplicating and automatic skipping, as well as both alphabetic and numeric punching.

Explain that a blank unpunched program card on the drum with the program control lever on puts the keyboard in numeric shift; with program control off, the keyboard is in alphabetic shift. Warn against turning the program control lever on if no card is on the drum in the punch, since this can damage the keypunch.

Locate the printing mechanism and state that some punches are nonprinting. Mention that an interpreter can print on cards produced on a nonprinting keypunch.

Demonstrate punching with print control on, noting that printing occurs directly above the punched holes for each character. Discuss the printing of nonsignificant numbers at the beginning of a field, and the control of left-zero printing by a program code or a switch. Explain the use of print suppression.
CONTENT OUTLINE

F. Practice by students

CONTENT DETAILS & TEACHING TECHNIQUES

Have students practice both alphabetic and numeric punching on a keypunch. Suggest punching such data as name and address to become familiar with the keyboard and other parts of the punch.

After some brief informal practice have the students do practice exercises from an exercise book. Stress the fact that accuracy is more important than speed in keypunching.

Suggested reference:
IBM Publication 540-053, pp. 62, 63, 67, 85, and 86.

Also include exercises using program control, and have the class as a whole prepare the program cards.

Selected reference:
IBM Publication 540-0503, pp. 91-135.

After the students are familiar with the keypunch, start Project 2.

II. The Verifier

Stress the importance of verification at all times, to check keypunching accuracy. Note that visual verification is possible if punching is done on a printing keypunch.

A. Basic function

Explain that data recorded in punched cards can be checked mechanically by means of a verifier.

B. Operating features

Point out the basic parts of a verifier and note that a verifier and a keypunch work similarly. Show that the backspace key is missing, and there is now an error light.

C. Procedures

Explain that the operator works with punched cards and original records, repeating the key strokes of the card punch operator. Point out that the 12 punch dies have been replaced by a sensing mechanism which checks hole patterns as the keys are depressed. When there is disagreement, the error light comes on.
Discuss the error notch over a card column on the third attempt at agreement, and the final OK notch on a card which is correct for all 80 columns.

Suggested teacher references:
Arnold, pp. 106-7, 138-44, 166-68
Awad & DPMA, pp. 76-84
Cashman & Keys, Basic Projects, pp. 11-18
Cashman & Keys, Practical Projects, pp. 13-20.
Cashman & Keys, Text and Project Manual, pp. 17-31
Hartkemeier, Chap. 1
IBM Publication 540-0503
Robichaud, pp. 70-74
Salmon, Chap. 3
Van Ness, pp. 34-42
## The Interpreter

**Objective of this section:**
To provide an understanding of the basic functions, operating features, applications, and procedures of the interpreter.

<table>
<thead>
<tr>
<th>Content Outline</th>
<th>Content Details &amp; Teaching Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. The Basic Function: Printing</strong></td>
<td>Explain that in data processing, <em>interpreting</em> means translating punched holes into printed information on the same card. Reading of punched data by a person is simplified when it is displayed in print.</td>
</tr>
<tr>
<td><strong>A. Need for interpretation</strong></td>
<td>Point out that cards punched on the IBM 24 keypunch and the IBM 514 reproducing punch are not interpreted by those machines. Often these cards need to be read by people as well as by machines. Often only part of the data punched in a card needs to be printed on it, and usually in specific places marked off on the face of the card.</td>
</tr>
<tr>
<td><strong>B. Basic concepts illustrated by the interpreter</strong></td>
<td>Note that the interpreter demonstrates one basic use of a hole in a card: a punched hole (cause) produces a printed character (effect). The interpreter also shows clearly the method used by unit-record machines to sense and translate holes in a card.</td>
</tr>
</tbody>
</table>
| **II. Operating Features** | Point out that several parts of this machine are common to all unit-record equipment discussed in this and later sections: *card feeding device*  
*card reading device*  
*card stacking device*  
*wired control panel* |
CONTENT OUTLINE

A. Hopper and stacker

B. Machine controls
   1. Main-line switch
   2. Start and stop keys

C. Control for printing position

D. Printing unit

E. Card-reading device

III. Operating Procedures

A. Printing controlled by wired panel

CONTENT DETAILS & TEACHING TECHNIQUES

Demonstrate how to put cards in the hopper according to the instructions on each model. Point out the location of the stacker. Explain that cards drop out automatically after being interpreted. Point out the stacker-stop switch, which stops card feeding when the stacker is full.

Note the location of the main-line switch which must be on for the machine to operate.

Point out the start key (which must be held down for three card-feed cycles to start the machine operating automatically) and the stop key, which will stop card-feeding and interpreting when it is pressed. Explain that the interpreter will stop by itself when all cards have dropped into the stacker.

Locate the knob or dial which must be set by the operator to select the line on which printing occurs. Note that the IBM 548 can print on either one of two lines, while the IBM 557 can print on any of 25 lines. However, the machine can interpret only one line at a time.

Explain that only 60 columns of punched data can be printed in one line on the face of a card. Point out that the printing mechanism consists of either 60 typebars or 60 typewheels. Each contains all alphabetic and numeric characters, and three special characters.

State that the cards feeding into the machine are read by 80 brushes, one for each column. Explain that reading consists of a metal brush falling through a hole in a card column and touching a metal roller, thus creating an electrical impulse at a specific time.
B. Demonstration of a wired control panel

On a control panel (or a diagram of such a panel) show the location of the 80 hubs for the reading brushes and the 60 hubs for print entry. Demonstrate the method of inserting a wire in a panel to connect any brush through its corresponding control panel hub to the print-entry hub for the desired printing position. Mention that each wire serves as a path for an electrical impulse, initiated by a reading brush and directed to activate the printing mechanism.

1. Flexibility in printing

Explain that the wired control panel provides flexibility in the printing done by the interpreter. It permits printing information across a card in any desired order, printing only selected information, printing in selected areas of the card.

State that the flexibility in printing is provided by the rearranging of the wires in the control panel.

2. Other basic features

Also point out other features available on interpreter control panels, such as column splits (or X-eliminators), zero-print control, selectors, and print suppression, and describe their uses.

C. Additional devices available

Mention some of the special devices available on some models of the interpreter, such as proofreading, comparing, selective line printing, and selective stacking, all under the control of panel wiring.

IV. Application

Have the students prepare wiring diagrams for interpreting the name and address cards they keypunched in Section 4. If panels are available, have the students wire them and then use the panels to interpret their cards.
Use preprinted cards with data already punched in and have the students wire a control panel to interpret that data. For example, use cards punched in Section 4 using the sales analysis card on page 96 of the Student Text on Card Punch Training.

Later have students interpret the cards made on the reproducer in Project 5.

Suggested teacher references:
Arnold, pp. 112-13, 147-50, 170-71
Awad & DPMA, pp. 91-92
Cashman & Keys, Basic Projects, pp. 47-50
Cashman & Keys, Practical Projects, pp. 59-62, 77-82
Cashman & Keys, Text and Project Manual, pp. 111-18, 147-53
Hartkemeier, pp. 340-46
Robichaud, pp. 86-87
Salmon, Chap. 10 and 14
Van Ness, pp. 50-51
THE SORTER

OBJECTIVES OF THIS SECTION
To provide an understanding of the functions, physical components, operating procedures, and applications of the sorter

CONTENT OUTLINE

I. Functions

A. Basic operations
Stress the fact that sorting is one of the basic functions of all data processing. (See Section 2.) Point out that cards punched with data usually need to be arranged in some logical sequence before that data can be useful.

B. Basic concept illustrated
Explain that the sorter can group punched card records according to some definite sequence at a very high speed. A sorter can arrange cards in both numerical and alphabetic sequence, and it can also select certain cards from a deck of punched cards.

II. Physical Features of the Sorter

A. Hopper
Point out the card-feed hopper and demonstrate the correct way to place cards in it.

B. Pockets
Show the students the 13 card pockets which receive the sorted cards. Mention that there is one pocket for each of the 12 rows (or punching positions) in a card column.
<table>
<thead>
<tr>
<th>CONTENT OUTLINE</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reject pocket</td>
<td>Explain that the 13th pocket is for cards unpunched in the column being sorted. It is called the R or reject pocket.</td>
</tr>
<tr>
<td>2. Pocket-stop lever</td>
<td>Point out the pocket-stop levers which stop card-feeding when any pocket is full.</td>
</tr>
<tr>
<td>C. Machine controls</td>
<td>Show the location of the main-line switch. Explain that the IBM 82 and 83 sorters need time to warm up, while the IBM 84 sorter is ready for immediate use.</td>
</tr>
<tr>
<td>1. Main-line switch</td>
<td>Indicate that once the start key has been pressed, cards feed automatically until the hopper is empty. Note the stop key which can stop card feeding at any time; explain that the sorter will stop by itself when all cards have dropped into pockets.</td>
</tr>
<tr>
<td>2. Start and stop keys</td>
<td>Stress the fact that cards can be sorted on only one column at a time. Point out the column indicator, and demonstrate how to set it on any one of the 80 columns by turning the selection handle or knob.</td>
</tr>
<tr>
<td>D. Column indicator and selection handle</td>
<td>Explain that actual sorting is controlled by a sort brush which must be set on the column to be read (with the help of the column indicator). Note that in the IBM 84 sorter, holes in a card column are sensed by a photoelectric device rather than a wire brush.</td>
</tr>
<tr>
<td>E. Sort brush (or photoelectric device)</td>
<td>Discuss the selection switches which control rejecting of cards containing a punch in a certain row (or rows) of the column being sorted. Note that these switches are called digit suppression keys on the IBM 83 and 84 sorters.</td>
</tr>
<tr>
<td>F. Selection switches</td>
<td>Mention some additional devices often found on a sorter, such as a card counter.</td>
</tr>
<tr>
<td>G. Additional features</td>
<td>Describe briefly how to use the edit switch and edit-stop switch on the IBM 83 and 84 sorters.</td>
</tr>
</tbody>
</table>
III. Operating Procedures

A. Card handling

Point out that most of the difficulty in sorting is due to improper handling of cards by the operator.

Demonstrate correct procedures for preparing cards and placing them in the hopper; show how to fan, joggle, flex, and align the cards.

1. Card jams

Indicate the proper procedures to follow in case cards jam in a sorter.

B. Basic principle

Note the basic principle of sorting cards in order: sort first the low-order position or unit position of a field (the column furthest to the right of the field); then sort each column of the field from right to left across it.

Show how to remove cards from the sorter pockets, also from right to left down the sorter, to maintain the sequence.

C. Numerical sorting

Explain that sorting cards in numerical order means one pass through the sorter for each column in the field being sorted. Briefly discuss numerical sorting on more than one field—a major and a minor sort.

D. Alphabetic sorting

Point out that alphabetic sorting requires two sorts on each column since there are two holes to be read in each column punched with alphabetic data. Demonstrate the use of the alphabetic sorting switch in the second pass on each column, and note the differences among IBM 82, 83, and 84 sorters when sorting alphabetic data.

E. Block sorting

Discuss the technique of block sorting a large number of cards on the high-order position of a field first, to break the file into smaller groups. Point out the advantages of this procedure, and note that it can be used on both numeric and alphabetic sorts.
CONTENT OUTLINE

F. Selection

G. Checking cards

IV. Applications

CONTENT DETAILS & TEACHING TECHNIQUES

Explain the use of the sort selection switches when selecting cards punched with a certain digit in a specific column, while leaving the rest of the card file undisturbed.

Note that cards should be sight-checked when they are removed from each pocket. Demonstrate use of the sorting needle to check large groups of cards.

Have the students practice sorting using some of the cards prepared when they were learning to keypunch in Section 4.

Then have them do Project 3 and Project 4 using the cards made in Project 2.

Suggested teacher references:
Arnold, pp. 113-17, 150-51, 171-72
Awad & DPMA, pp. 94-102
Cashman & Keys, Basic Projects, pp. 19-26
Cashman & Keys, Practical Projects, pp. 21-32
Cashman & Keys, Text and Project Manual, pp. 33-56
Hartkemeier, Chap. 2
Robichaud, pp. 75-77
Salmon, Chap. 5
Van Ness, pp. 55-59
## Section 7

### THE REPRODUCER

**OBJECTIVES OF THIS SECTION:**
To provide an understanding of the functions, operating features, procedures, and applications of the reproducing punch

<table>
<thead>
<tr>
<th>CONTENT OUTLINE</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Functions</td>
<td>Point out that once information has been recorded in cards as holes, and the punched cards have been verified, the reproducer can be used to copy automatically part or all of this information into other cards. Remind the students of the basic unit-record principle as explained in Section 3.</td>
</tr>
<tr>
<td>A. Basic operation: reproducing</td>
<td>Explain that the reproducer can duplicate exactly a set of cards, or it can punch any part of the original information into another set. It can also copy data into different card columns in a second set. Note that the keypunch could be used to automatically reproduce all or part of a small number of cards, but moving data to new card columns would require manual keypunching of the data.</td>
</tr>
<tr>
<td>1. Verifying</td>
<td>Stress the fact that the comparing feature of the reproducer can check the accuracy of the automatic punching from the original cards.</td>
</tr>
<tr>
<td>B. Gang punching</td>
<td>Mention that in data processing, gang punching means punching information from a master card into detail cards that follow it. This is similar to automatic duplicating of a field on the keypunch.</td>
</tr>
</tbody>
</table>
II. Operating Features

A. Hoppers and stackers

Locate the two hoppers, one for each unit, and demonstrate how to place cards in them. Point out the two stackers where the processed cards fall automatically.

Mention that if either hopper becomes empty or either stacker becomes full, the machine will stop automatically.

B. Machine controls

1. Main-line switch

Note the location of the main power switch which must be on for the reproducer to operate.

2. Start and stop keys

Point out the start key which must be held down for three card-feed cycles to make the reproducer operate automatically. The stop key can be used to stop card feeding whenever desired.

C. Comparing indicator unit

Demonstrate use of the comparing indicator to show the number of the comparing magnet which has detected a punching error. Show how to turn off the compare light and clear the indicator by using the restoring lever.

D. Reset key and DP&BC light

Explain how a special feature can detect double-punched or blank columns in card columns being compared.
CONTENT OUTLINE

E. Summary-punch cable

F. Control panel and switches

III. Procedures

A. Reproducing and verifying

1. Path of the cards

2. Control-panel wiring for reproducing

3. Wiring for verifying
**CONTENT OUTLINE**

<table>
<thead>
<tr>
<th>B. Gang punching</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control-panel wiring</td>
<td>Note that for gang punching, only one set of cards is used in the machine—in the punch unit. The <strong>reproduce</strong> switch must be <strong>off</strong> to allow the units to operate independently. Demonstrate wiring from punch brushes to punch magnets when only one master card is used in front of the detail cards. Show how to verify the gang punching by visually comparing the last card with the master card.</td>
</tr>
<tr>
<td>2. Interspersed gang punching</td>
<td>Briefly discuss gang punching with interspersed master cards. Also discuss verifying the punching by use of the <strong>read unit</strong> operating as an independent unit. Also, comment on the use of the X-punch in a card column to distinguish master cards from detail cards. Locate on a control panel the hubs for the 5 <strong>read</strong> X-brushes and 6 <strong>punch</strong> X-brushes.</td>
</tr>
<tr>
<td>3. Combined reproducing and gang punching</td>
<td>State that these two basic operations can be performed in one pass through the reproducer if only one master card is involved. In this case the reproduce switch should be <strong>on</strong>.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Mark-sense punching</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control-panel wiring</td>
<td>Point out that for mark-sense punching only the punch unit is used and only the <strong>mark-sensing</strong> switch should be <strong>on</strong>. Explain that there are only 27 mark-sense columns on each face of a card. Marks must be recorded on the card with a special electrographic pencil, and normally only one mark should be made in any one column. On a control panel (or a diagram of a panel) locate the hubs for the 27 mark-sensing brushes. Point out that these are not to be wired directly to the punch magnets, but through an amplifying unit between the mark-sensing in and out hubs.</td>
</tr>
</tbody>
</table>
Note that mark-sense punching can be verified by wiring the punch brushes for the columns that have been punched to hubs for double-punch and blank column detection, and turning on the necessary switches.

Discuss briefly the summary-punching operation in which the reproducer is connected to an accounting machine by cable. Blank cards should be placed in the punch unit and no switches should be turned on.

Indicate the necessary wiring from the counter-total exit hubs to the punch magnets.

On a control panel note some of the special devices available such as the gang-punch emitter, column splits, and selectors.

Mention that selectors are necessary for such operations as field-selected reproducing and offset-interspersed gang punching.

Point out that the IBM 519 reproducing punch has, in addition, a print unit for end printing on cards passing through the punch unit.

Have students prepare wiring diagrams for reproducing the cards made when learning to keypunch in Section 4. Move some of the data to different card columns and add a master card for gang punching a date into the new deck. If panels are available, have students wire them and reproduce their cards.

Then have them do Project 5 using the cards made in Project 2.

If mark sensing is available, students can mark some mark-sense fields with electrographic pencils, wire a control panel, and mark-sense punch their cards.
Suggested teacher references:
Arnold, pp. 107-12, 144-47, 168-70
Awad & DPMA, pp. 84-90
Cashman & Keys, Basic Projects, pp. 33-38
Cashman & Keys, Practical Projects, pp. 39-44, 83-88
Cashman & Keys, Text and Project Manual, pp. 81-94, 154-60
Hartkemeier, pp. 331-40
Robichaud, pp. 77-79
Salmon, Chap. 6 and 15
Van Ness, pp. 42-50
Section 8

THE COLLATOR

OBJECTIVES OF THIS SECTION:
To provide an understanding of the functions, physical components, operating procedures, and applications of the collator

CONTENT OUTLINE

I. Functions

A. Filing

B. Basic function

C. Main operations
   1. Merging

CONTENT DETAILS & TEACHING TECHNIQUES

Remind students that one of the main objectives of data processing is the preparation of printed reports from punched cards which have been arranged in a meaningful way.

Note that the collator is a filing machine which can arrange cards at high speeds, for further processing through other machines or storing for future use.

Point out that the principal function of the collator is to feed and compare two groups of cards simultaneously, either to match them or to merge them into a single file.

The collator can combine two presorted files of cards into one file which is in numerical order. This is usually a faster method than combining the cards on the sorter.

Note that this is the only way to combine the files mechanically if the control field is in different card columns in the two groups of cards.

Explain that the collator can check two card files for matching cards or groups of cards; in this process, unmatched cards in either or both groups would be taken out of the files.
CONTENT OUTLINE

3. Selecting

4. Sequence checking

5. Combination of these

II. Physical Features of the Collator

A. Card hoppers

B. Stackers or pockets

C. Machine controls
   1. Main-line switch

CONTENT DETAILS & TEACHING TECHNIQUES

State that individual cards can be selected from a group in many more ways by the collator than are possible on the sorter; for example, last card of a group, first card of a group, cards out of sequence, cards with a specific number.

The collator can check a file of punched cards for numerical order; it can be made to stop for an out-of-sequence condition.

Point out that some or all of these basic operations can be performed simultaneously on the collator, and often are. Match-merging two groups of cards while sequence checking both is a common operation.

Terminology in this section refers to IBM collators, such as the numerical group (77, 85, 88) and the alphabetic machines (87, 89).

Locate the two card-feed units: primary and secondary. Point out that on some collators both hoppers are on the same side of the machine, but on the IBM 88 they are on opposite sides.

Show how cards should be placed in the two hoppers and note which one is the primary feed hopper. Describe briefly the file feed on the primary hopper of the IBM 88 collator.

Explain that there are four stackers on most collators, but the IBM 88 has a fifth stacker to receive processed cards.

Mention that the collator will stop automatically if any stacker becomes full or either hopper becomes empty.

Note the location of the main power switch on the collator.
CONTENT OUTLINE

2. Start and stop keys

3. Runout key

D. Error light and reset key

E. Additional features

III. Operating Procedures

A. Basic operating principle

B. Path of the cards

C. Comparing units

CONTENT DETAILS & TEACHING TECHNIQUES

Also point out the start and stop keys. Remind students that the start key must be held down for three cycles before automatic operation begins, except on the IBM 88 collator.

Explain that this key must be held down to run all remaining cards out of the collator after the last card has fed from either hopper and the machine has stopped automatically.

Demonstrate use of the error reset key to turn off the error light. (This light goes on when an error condition is detected in cards being run through the collator.)

Discuss briefly the additional features found on the IBM 88 collator, such as the ready light, fuse light, transport light, DP&BC light, check lights, and stop lights.

Stress the fact that a properly wired control panel must be inserted in the collator to direct machine functions.

Explain that for all of the basic operations of the collator, two number fields must be compared. After cards are read and the data compared, the result controls card-feeding and selects the proper pockets for the cards.

Point out that cards in the primary feed are read by two sets of 80-wire brushes, while those in the secondary feed pass only one reading station.

State that control-panel wiring to the sequence unit allows comparison of the two readings in the primary feed, to determine whether the value in first card is more than, equal to, or less than in the following card.

Wiring to the selector unit from both primary and secondary read hubs allows comparison of the cards in the two feeds, to determine whether they are equal, or if unequal, which of the two is lower in value.
CONTENT OUTLINE

D. Sequence checking

1. Combined operations

E. Selecting

F. Merging

G. Matching

CONTENT DETAILS & TEACHING TECHNIQUES

Note that this operation calls for a comparison of two consecutive cards in one file in the primary feed hopper.

Point out that cards which are in correct numerical order would all fall in one pocket. An out-of-sequence card would cause the machine to stop.

Mention that sequence checking can be done alone or along with another operation. On the IBM 88 collator, sequence checking can be done also in the secondary feed unit since the machine has two reading stations.

Comment briefly on the various kinds of selection possible. Cards which are selected from a file are usually directed to a different pocket from the rest of the file, based on control-panel wiring.

Point out that this operation implies two files of cards already in correct numerical order. A comparison is made between two cards, one from each file, to determine which will move first into the pocket containing the combined files.

Stress that for equal numbers, the card in the primary feed will be merged in front of the equal card in the secondary feed.

State that merging can be performed along with sequence checking and selection. The combined file will be directed to one pocket while the selected cards will go to two separate pockets, one for each feed.

Explain that matching is similar to merging with selection except that there will be four groups of cards in the four pockets. The matching cards will not be combined into one file but will be directed to two separate pockets, while the unmatched cards will be in their two separate pockets.
H. Control-panel wiring

On a control panel (or a diagram of a panel) point out the 80 hubs for the primary read brushes, for the secondary read brushes, and the sequence read brushes.

Locate also the hubs which control the feeding of cards and the selection of pockets, as well as those which provide the results of comparisons on the data read.

Have students prepare wiring diagrams to do one or more of the basic operations discussed in this section.

If panels are available, have students wire them and run their cards through the collator.

Suggested reading references:
Arnold, pp. 117-21, 151-54, 172-73
Awad & DPMA, pp. 103-8
Cashman & Keys, Basic Projects, pp. 39-46
Cashman & Keys, Practical Projects, pp. 45-58, 95-96
Hartkemeier, pp. 346-54
Robichaud, pp. 79-81
Salmon, Chap. 9 and 17
Van Ness, pp. 59-65
Section 9

THE ACCOUNTING MACHINE OR TABULATOR

OBJECTIVES OF THIS SECTION:
To provide an understanding of the functions, operating features, procedures, and applications of the accounting machine

CONTENT OUTLINE
I. Functions
   A. Basic purposes
      Mention the fact that summarizing is one of the basic functions of all data processing. (See Section 2.) This usually means listing or tabulating data, and totaling the lists.
   B. Importance of printing
      The two basic functions of the accounting machine are to print alphabetical and numerical data from punched cards, and to accumulate totals according to desired classifications.
   C. Additional operation
      Point out that printed reports prepared automatically by the tabulator are the finished products of a data processing system.

II. Operating Features
   A. Feed hopper and stacker
      Terminology in this section refers to IBM accounting machines. Note the basic differences among IBM 402, 403, and 407 tabulators.
      Point out the card hopper and stacker. Demonstrate how to put cards in the feed hopper. Note that the tabulator will stop automatically when the stacker is full, and when the last card is fed from the hopper.
B. Machine controls
1. Main-line switch
   - Point out the main power switch, under the right end of the reading table on the IBM 402 and 403 machines.

2. Start and stop keys
   - Also locate the start and stop keys which start and stop the feeding of cards through the machine.

3. Final total key
   - Explain that this key allows manual control of total printing when wired correctly on the control panel.

4. Operating lights
   - Discuss briefly the various signals which include the ready light, stop light, fuse light, form light, and card-feed stop light.

C. Print unit
1. Typebars or printwheels
   - Note that on the IBM 402 and 403 tabulators the print unit consists of a maximum of 88 typebars. The 43 typebars on the left side can print both alphabetic and numeric characters, while the 45 on the right can print only numeric characters.

   - On the IBM 407 machine there are 120 printwheels, all containing the same 47 characters.

2. Method of printing
   - Explain that parallel printing is the method used by IBM accounting machines. Each typebar or printwheel is positioned for printing a specific character according to the holes punched in the card being read by the machine. Then all characters are pressed against the paper simultaneously so that an entire line is printed at one time.

3. Hammerlock levers and hammersplit levers
   - Describe briefly the hammerlocks which when raised can prevent printing from corresponding typebars under certain conditions. Differentiate between the short and long hammerlocks.

   - Also discuss the hammersplit levers which can suppress the printing of nonsignificant zeros.
D. Functional controls

Mention the setup change switches, gangpunch switch, last card auto total switch, feed interlock start button, and nonprint runout button on the left side of the IBM 402 and 403 machines. Similarly describe the functional switches on the right side of the IBM 407 tabulator.

E. Tape-controlled carriage

Point out the carriage which automatically controls the feeding and spacing of continuous forms during printing.

1. Controls and tape

Discuss briefly the carriage controls on the accounting machine, and the control tape, which is prepared and inserted in the machine by the operator for each form to be printed.

2. Carriage features and forms

Note the various controls for guiding the continuous forms through the accounting machine. Demonstrate inserting and positioning a form ready for printing.

F. Control panel

Stress the fact that the control center of any accounting machine is the control panel prepared by the operator. If this panel is properly prepared the machine will read the desired information from the cards and print this data in the proper places on a report form.

Show how to insert a control panel in the rack provided for it. This rack is on the left side of the IBM 402 or 403 machine, and on the right side of the IBM 407 machine.

III. Procedures

A. Basic principle of operation

Point out that accounting machines operate from electrical impulses which result when contacts are made between a brush and a metal roll. These impulses result from the sensing of holes punched in card columns.

1. Directed by wiring

Through proper control-panel wiring, each electrical impulse can be directed to perform a required operation. Thus
2. Difference in models

Explain that the same basic control panel serves both the IBM 402 and 403 tabulators, but the IBM 407 panel is quite different.

Also mention that the IBM 402 machine normally prints only one line from a card, while the IBM 403 tabulator can print three lines from a single card.

B. Path of the cards

State that the IBM 403 machine has three sets of brushes called first, second, and third reading, while the IBM 402 tabulator has only two sets labelled second and third reading.

Cards passing through the IBM 402 accounting machine are read first by the 80 brushes of the second reading station, and then by those at the third reading station.

1. Second reading brushes

Note that these brushes can read zone punches to prepare the machine to print alphabetic characters. They can also detect a special punch (such as an X-punch) for use as a control over an operation like adding or subtracting.

2. Third reading brushes

Point out that these brushes can read digit punches to raise typebars to a desired printing position, or to provide counters with numerical data to be accumulated.

3. Comparison of readings

Explain that it is possible to determine whether or not a certain field of information in the cards at second reading is equal to the same field at third reading. When the values are different, the machine can be wired to perform a specific operation such as printing a subtotal or skipping the form to a predetermined printing line.
## C. Control panel for IBM 402 and 403 tabulators

On a control panel (or a diagram of a panel) show the location of the 80 hubs for the *second reading* brushes and those for the *third reading* brushes. Mention that there are two sets of third-reading hubs which can be used interchangeably.

State that hubs enclosed in heavy lines are for use on the IBM 403 machine only. The rest are used on both the IBM 402 and 403 accounting machines.

## D. Detail printing or listing

Indicate that *detail printing* means the printing of information from each card as it passes through the machine. With proper control-panel wiring, only the data required will be listed, and it can be printed anywhere on the report form.

1. **Wiring for listing**

   Locate on a control panel (or a diagram) the 43 hubs labelled *normal alphanumerical print entry* and the 45 hubs for *numerical print entry*. These accept impulses from the third reading brushes to print numerical data punched in the card columns involved.

2. **Printing alphabetic information**

   Also locate the 43 hubs labelled *normal zone entry* which accept zone impulses from second reading brushes to print alphabetical characters when combined with digit punches.

Tell the students that detail printing requires wiring the *all cycles* hub to the *list* hub, so that every card will print.

3. **Spacing chart for planning**

   Describe the use of a *spacing chart* to determine which typebars should be used to print a report on a preprinted form.

## E. Accumulating totals

Stress that one of the basic functions of tabulators is *accumulation*. This is performed by counters which can add or subtract data on the basis of punches in individual cards. Counters vary in size from 2 positions to 8 positions, and they can be coupled together for a maximum of 16 positions.
1. Wiring for addition

On a control panel (or a diagram) point out the hubs for counter entry, counter exit, counter control plus and minus, counter total, card cycles (to control counters to add or subtract), and final total.

Explain how to print a final total from a listing of amounts by using the final total key on the tabulator.

2. Wiring for subtraction

Note that cards containing amounts to be subtracted (credits) are usually identified by an X-punch in a specific column of the card, to distinguish them from cards whose amounts are to be added.

Describe the wiring needed to selectively add or subtract amounts by using a pilot selector to control the impulse from the card cycles hub to counter control plus and minus.

F. Group printing or tabulating

Explain group printing as follows:
Data from cards is summarized by classification, and only the total for each classification is printed on a report, along with the identification for each.

Information read from punched cards is entered into counters by addition or subtraction; totals are then read out and printed at the end of each group of cards.

G. Program control

Explain that an accounting machine can distinguish a card of one classification from a card of another. The machine does this by comparing a value in a card at the third reading position to a value in the same field in a card at the second reading position. If the two values are the same, the machine recognizes two cards of the same program group. If the two values are different, the machine recognizes the card at the second reading position as the first card of a new classification.
1. Three levels of program control

The IBM 402 and 403 tabulators can take up to three program steps, known as minor program, intermediate program, and major program. Point out that one, two, or three program steps can be started when the machine detects the first card of a new group.

Note that during a program step, group totals are read out of counters for printing on a report or punching in a card, and the paper form is spaced to a specific printing line.

2. Wiring for program start

On a control panel locate the hubs for comparing entry, comparing exit, program start, and total program. Discuss the wiring necessary

- to start a minor program by comparing the identifying numbers in one field among all cards of the deck,
- to accumulate amounts punched in another field, and
- to print minor totals for each group.

Also discuss briefly how to wire a control panel to compare three different fields and produce three levels of totals.

IV. Additional Procedures

A. Selection

Explain that accounting machines have the ability to react in different ways to a given set of data punched in cards. Which way a machine reacts depends on the wiring of the control panel.

1. X-selection and digit selection

Suppose you have a deck of cards with electric meter readings punched into some of them and gas meter readings punched into the rest. The cards containing one kind of meter readings (say the gas meter readings) will have an X-punch in one column of the card. The rest of the deck will be NX, that is, will not have an X-punch in that same column. Proper wiring of the control panel can cause the two sets
of readings to be entered into separate counters, and be printed from different typebars, on different lines of the same bill form. In the same way, two different kinds of data can be printed under two different headings on a report.

Mention that digit punching may also be used to cause the same kind of selection. Locate the digit selector on the control panel, since this may be needed to properly wire a panel for digit selection.

2. Selective printing

Discuss briefly the possibility of certain cards of a group being detail-printed while other cards are being group-printed.

3. Field selection

State that when two kinds of cards contain similar data in two different fields on the two cards, the data can be entered into one counter or printed from one set of typebars on a report by means of proper control panel wiring.

On a control panel locate the co-selector I PU (immediate pickup) hubs and the co-selectors which operate in conjunction with pilot selectors through the pickup hubs.

4. Class selection

Point out that class selection is necessary when different typebars are to be used for data punched in the same field in different cards. Here again the wiring involves use of co-selectors.

B. Space control

Note briefly the space control hubs on the control panel which allow variations from automatic spacing by the tabulator.

C. Setup change

Explain that one control panel can often be used for several reports which are closely related. Without changes in wiring, it is possible to have one control panel which will produce either a detail printing or a group printing of a certain report.
D. Total transfer

Describe briefly how data to be accumulated with three levels of totals can be processed accurately by reading from the card only into the minor total counter, and then transferring the contents to the counter for the next higher level. This method is called rolling totals.

E. Crossfooting

State that accounting machines have the ability to add together several fields of the same card and to produce a crossfoot total. As many as three fields may be crossfooted, using three counters and three program levels.

F. Summary punching

1. Connection to IBM 514 reproducing punch

Note that the punching is done by a machine such as the IBM 514 reproducing punch. (See Section 7.) The two machines are connected by a cable over which totals and identifying data from counters are transferred to the punch from the tabulator.

2. Wiring for summary punching

Stress that control panels in both machines, when properly wired, control the summary-punching operation. On a control panel for the IBM 402 tabulator locate the hubs for summary punch switch and summary punch control. On a panel for the IBM 514 machine point out the hubs which accept data from counters in the accounting machine.
V. Applications

Have students prepare wiring diagrams to list the name and address cards which they keypunched in Section 4. If panels are available, have students wire them and list their cards.

Also have students prepare wiring diagrams to do one or more of the other basic operations discussed in this section. If panels are available, have students wire them and run some cards through the tabulator.

Later have them do Project 6, including keypunching, sorting, and two listings on the accounting machine.

Suggested teacher references:
Arnold, pp. 123-25, 158-61, 173-75
Awad & DPMA, pp. 115-22
Cashman & Keys. Basic Projects, pp. 27-32
Cashman & Keys, Practical Projects, pp. 33-38, 89-94
Cashman & Keys, Text and Project Manual, pp. 57-80, 172-99
Hartkemeier, Chap. 3 and 4
Robichaud, pp. 84-85
Salmon, Chap. 7 and 18
Van Ness, pp. 72-78
Section 10

THE CALCULATING PUNCH

OBJECTIVES OF THIS SECTION
To provide an understanding of the basic function, physical components, and operating procedures of the calculator

<table>
<thead>
<tr>
<th>CONTENT OUTLINE</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Basic Function</td>
<td>Stress that calculating is one of the basic functions of all data processing. (See Section 2.)</td>
</tr>
<tr>
<td>II. Physical Features</td>
<td>Terminology in this section refers to the IBM 602 calculating punch.</td>
</tr>
<tr>
<td>A. Hopper and stacker</td>
<td>Point out the main-line switch, start key, stop key, reset key, and compare light.</td>
</tr>
<tr>
<td>B. Machine controls</td>
<td>Also note the location of the adjustable skip bar which allows control of the location of punching.</td>
</tr>
<tr>
<td>C. Control panel</td>
<td>State that proper wiring of a control panel is of the utmost importance. Accurate computations cannot be obtained without proper wiring.</td>
</tr>
<tr>
<td>III. Operating Procedures</td>
<td>Explain that in a calculating punch, a series of mathematical steps can be performed in one processing. The results can then be punched into the same card from which the data was read, or into designated cards that follow.</td>
</tr>
</tbody>
</table>
A. Path of the cards

Describe briefly the movement of cards from the feed hopper past the 20 control brushes, which read control punches, then past 80 reading brushes, which read the factors for making the calculations, then on to the punch bed where results are punched, and finally on to the stacker.

B. Storage and counters

Mention that the IBM 602 calculating punch has storage units which accept factors read from a card, store results during calculation, and provide results to the punching mechanism. In addition six counters do all of the addition, subtraction, multiplication, and division.

C. Control panel wiring

Note that control panel wiring is done only after considerable planning. The necessary calculating is broken down into program steps, with each step representing a sample arithmetic operation. A planning chart and control-panel diagram are then used to assist the programmer in analyzing and wiring the problem.

IV. Application

It is unlikely that calculators will be available in the typical unit-record installation. Hence, students will not see a machine, a control panel, or even a control-panel diagram.

Suggested teacher references:
Arnold, pp. 121-23, 154-58
Awad & DPMA, pp. 112-14
Cashman & Keys, Practical Projects, pp. 63-64
Cashman & Keys, Text and Project Manual, pp. 107-9
Robichaud, p. 77
Salmon, Chap. 11
Van Ness, pp. 65-72
### Section 11

**DOCUMENTATION**

**OBJECTIVES OF THIS SECTION:**
1. To provide an understanding of the needs for and the techniques of documenting data processing applications

<table>
<thead>
<tr>
<th>CONTENT OUTLINE</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Need for Documentation</td>
<td>Discuss the three basic steps in a data processing job: input, manipulation of data, and output. Point out that operation of any unit-record machine involves all three steps.</td>
</tr>
<tr>
<td></td>
<td>Explain that a data-processing application, such as payroll, consists of many steps and that it would be difficult to process all these steps accurately without documentation.</td>
</tr>
<tr>
<td>A. Objectives</td>
<td>Explain that documentation in sufficient detail enables operators to process applications with little or no supervision.</td>
</tr>
<tr>
<td>1. Clarification</td>
<td></td>
</tr>
<tr>
<td>2. Continuity</td>
<td>Point out that documentation enables one operator to assume the duties of another in case of illness or vacation.</td>
</tr>
<tr>
<td>3. Controls</td>
<td>Discuss the need for the control of checkpoints. Indicate how documentation assures adequate controls.</td>
</tr>
<tr>
<td>4. Changes</td>
<td>Changes are frequently made in input, output, and processing. Documentation provides the means for making such changes in an orderly way.</td>
</tr>
<tr>
<td></td>
<td>Point out that in most data-processing installations there is usually a person whose duties include development of documentation for applications. However, this might be done by a unit-record equipment operator.</td>
</tr>
</tbody>
</table>
Indicate that operators are frequently responsible for modifying the documentation when there is a change in requirements. Discuss the need for making such a change at the right time.

II. Types of Documentation

State that documentation may be accomplished in many ways, depending on the particular needs of the organization. Point out that documentation may be oriented to a single machine or to several machines, depending on job coverage.

Indicate the three basic ways to document: using narrative procedures, decision tables, or flowcharts.

A. Narrative procedures

1. Advantages

Explain that narrative procedures spell out jobs with great detail, clarity, and conciseness. They are more readable than decision tables or flowcharts. Therefore, narrative procedures are more easily understood by new or inexperienced people.

2. Disadvantages

Indicate the difficulty in showing the flow of work when a job breaks down into several operations that need simultaneous processing.

Discuss also the difficulty of describing in narrative the many conditions arising out of an operation. For example, if a card has a 1 in column 80, you must follow these steps; if a card shows a 2 in column 80, you must follow these steps; etc.

3. Techniques

Stress that procedures should be written with as little excess wordage as possible. Avoid adjectives whenever possible and avoid passive verb sentences such as "The cards can then be sorted on columns 10-6." Instead, start sentences with imperative verbs, like "Sort cards on columns 10-6."

B. Decision tables

1. Advantages

Discuss procedures that contain many "if," "or if," "then if," or "and if not"
2. Disadvantages

Point out that decision tables are not easily read. Cite or use railroad or airline timetables as examples of decision tables that are difficult to decipher.

Note that straightforward procedures, without many "if" conditions, cannot be shown as easily by decision tables as by narrative.

3. Techniques

Explain that decision tables are in the form of a grid. The grid is usually divided horizontally, with the top half describing various conditions and the bottom half describing various actions to be taken. Following each condition is a Y or N (yes or no) to indicate whether or not the condition exists. Following each action is an X to indicate action to be taken.

Discuss the following example:

<table>
<thead>
<tr>
<th>Description</th>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in col. 80</td>
<td>Y Y Y Y Y Y</td>
<td></td>
</tr>
<tr>
<td>2 in col. 80</td>
<td>Y N Y N Y N</td>
<td></td>
</tr>
<tr>
<td>1 in col. 79</td>
<td>Y Y N Y N Y</td>
<td></td>
</tr>
<tr>
<td>2 in col. 79</td>
<td>Y Y N Y N Y</td>
<td></td>
</tr>
<tr>
<td>month-end run</td>
<td>Y Y Y Y Y Y</td>
<td></td>
</tr>
<tr>
<td>weekly run</td>
<td>Y Y Y Y Y Y</td>
<td></td>
</tr>
<tr>
<td>sort cols. 6-1</td>
<td>X X X X X</td>
<td></td>
</tr>
<tr>
<td>sort cols. 2-1</td>
<td>X X X X X</td>
<td></td>
</tr>
<tr>
<td>file in pending</td>
<td>X X X X X</td>
<td></td>
</tr>
<tr>
<td>forward to collator</td>
<td>X X X X X</td>
<td></td>
</tr>
<tr>
<td>error; notify control</td>
<td>X X X X X</td>
<td></td>
</tr>
</tbody>
</table>
C. System flowcharts

1. Advantages

Explain that flowcharts are graphic illustrations equivalent to narrative procedures. Explain also that the symbols and lines of direction, combined with a minimum of words, can often convey the same meaning as several paragraphs of narrative procedure.

Discuss how flowcharts may overcome the disadvantage of narrative procedures for showing operations to be carried out simultaneously.

2. Disadvantages

Point out that flowchart symbols sometimes vary in meaning from one place to another. Also, that a flowchart may not show as much information as a narrative procedure. For these reasons a new or inexperienced operator may have trouble reading a flowchart.

3. Techniques

Indicate that USASI (United States of America Standards Institute) has adopted a standard set of symbols. Point out that flowcharts are generally drawn down the page and to the right, with connecting lines and arrows showing the flow or work.

Following are examples of USASI symbols and their meanings:

**BASIC SYMBOLS**

- **PROCESS**
  - Any processing function causing change in value, form, or location of information.

- **INPUT/OUTPUT**
  - General input/output function; information available for processing (input), or recording of processed information (output).
Additional description, clarification, or comment. Dotted line can be extended to symbol being described.

Connector. Exit to or entry from another part of the flowchart.

Arrowheads and flowlines link symbols to show operation sequence. Arrowheads are required if the flow is right to left or bottom to top.

Note that the above symbols could be used without any others. Those shown below add more detailed information.

- **Punched Card**
  - Input/output function in card medium.

- **Magnetic Tape**
  - Magnetic tape.

- **Online Storage**
  - Input/output using any kind of online storage such as magnetic tape, drum, or disk.

- **Punched Tape**
  - Input/output for punched paper tape.

- **Keying**
  - Any operation using a key-driven device as in punching, verifying, typing.
Combining two or more sets of items into one set.

Remove one or more subsets of items from a set.

Collate. Merging with extracting; forming two or more sets of items from two or more other sets.

Sort. Arrange a set of items into sequence.

An offline process without mechanical aid.

Auxiliary operation. Offline performance on equipment not under direct control of computer.

Offline storage. Storing offline, regardless of recording medium.

**CONTENT OUTLINE**

D. Other documentation

**CONTENT DETAILS & TEACHING TECHNIQUES**

Explain that narrative procedures, decision tables, and system flowcharts describe ways to document. Explain that preprinted forms are often used in a particular operation for outlining procedures. Point out such examples
CONTENT OUTLINE

III. Documentation Project

A. Narrative procedure

Input control

1. Receive in the mail payments to accounts receivable.

2. Date stamp and circle the amount received on invoices.

3. Take the tape total from invoices and checks received and determine the balance.

4. Process checks as in the daily deposit procedure.

Key punch

5. Forward paid invoices to Key Punch. Forward transmittal form AC21 to Computer, showing current date and tape total of paid invoices.

6. Punch and verify paid invoice cards as per keypunch instructions.

7. Forward cards to Unit Record.


Unit record

9. Receive paid invoice cards.

10. Sort paid invoice cards on invoice number, columns 23-19.

11. Draw accounts receivable cards from file.

CONTENT DETAILS & TEACHING TECHNIQUES

as: keypunch instructions, sorter instructions, and computer run instructions.

Also point out that layouts describing records used in data processing often supplement procedures. Examples are: card record layouts, disk record layouts, and tape record layouts.

Give out the following narrative procedure and ask students to develop a flowchart. Also, have them develop a decision table for steps 12 through 16 of the procedure.

Examples of a flowchart and a decision table follow the procedure.
<table>
<thead>
<tr>
<th>CONTENT OUTLINE</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key punch</td>
<td>12. Match-merge the paid invoice cards and accounts receivable file on invoice number, columns 23-19.</td>
</tr>
<tr>
<td></td>
<td>13. Forward unmatched paid invoice cards to Key Punch for correction of invoice numbers.</td>
</tr>
<tr>
<td>Unit record</td>
<td>14. Obtain paid invoices and correct the paid invoice cards. Then return them to Unit Record.</td>
</tr>
<tr>
<td></td>
<td>15. Hand-select the matching accounts receivable cards and place them in matched file in invoice number order. Return the unmatched accounts receivable cards to file.</td>
</tr>
<tr>
<td></td>
<td>16. Forward matched cards to Computer.</td>
</tr>
<tr>
<td></td>
<td>17. Process cards against program AC002 and produce paid invoice listing in triplicate.</td>
</tr>
<tr>
<td></td>
<td>18. Balance the total against transmittal form AC21 received from Key Punch. Clear any discrepancy with Input Control.</td>
</tr>
<tr>
<td></td>
<td>19. Forward paid invoice listing as follows: original and first copy to Accounting, second copy to Sales.</td>
</tr>
<tr>
<td></td>
<td>20. Return cards to Unit Record.</td>
</tr>
<tr>
<td>Unit record</td>
<td>21. File them in paid invoice file.</td>
</tr>
</tbody>
</table>

The following pages contain the systems flowcharts and one decision table for the narrative procedure above.
B. Systems flowchart

1. CHECKS AND PAID INVOICES
2. DATE STAMP AND CIRCLE AMOUNT RECD.
3. TAKE TAPE TOTALS
4. PAID INVOICES
5. TRANSMITTAL FORM AC21
6. CHECKS
7. TO DAILY DEPOSIT PROCEDURE

A
C
PUNCH AND VERIFY PAID INVOICE CARDS

PAID INVOICE CARDS

23-19

PAID INVOICE CARDS

ACCOUNTS RECEIVABLE CARDS

MATCH-MERGE

B
UNMATCHED PAID INVOICE CARDS

MATCHED PAID INVOICE CARDS

MATCHED ACCTS.REC. CARDS

UNMATCHED ACCTS.REC. CARDS

KEY PUNCH

DETERMINE CORRECT INVOICE NUMBER

PUNCH CORRECTED PAID INVOICE CARD

MACHINE OPERATOR

SELECT MATCHING ACCTS.REC. CARD

MERGED CARDS

B

D
C. Decision table

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>paid invoice cards</td>
<td></td>
</tr>
<tr>
<td>accounts receivable cards</td>
<td></td>
</tr>
<tr>
<td>matched</td>
<td></td>
</tr>
<tr>
<td>unmatched</td>
<td></td>
</tr>
<tr>
<td>return to key punch</td>
<td></td>
</tr>
<tr>
<td>punched corrected cards</td>
<td></td>
</tr>
<tr>
<td>select matching accts. rec. cards</td>
<td></td>
</tr>
<tr>
<td>forward to computer</td>
<td></td>
</tr>
<tr>
<td>refile</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Y</td>
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<td>X</td>
<td></td>
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<tr>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
## INTEGRATED APPLICATIONS

**Objective of this section:**
To provide an understanding of the evolution and techniques of integrated applications.

<table>
<thead>
<tr>
<th>CONTENT OUTLINE</th>
<th>CONTENT DETAILS &amp; TEACHING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Evolution of Integrated Applications</td>
<td>Point out that in a small business there is seldom need for extensive records. Because of its size such items as inventory control, accounts payable, and accounts receivable do not require involved recordkeeping. Discuss a one-man operation where the owner may keep a mental note of his accounts instead of keeping written records.</td>
</tr>
<tr>
<td>A. The small organization</td>
<td></td>
</tr>
<tr>
<td>B. The medium organization</td>
<td>Demonstrate that, as the business grows, the owner finds it necessary to delegate some of his duties to others. He may hire a sales staff, a bookkeeper, a payroll clerk, an accounts receivable clerk, etc. As each of these areas grows in size and complexity, data processing enters the scene. Through accounting functions, such things as accounts payable, payroll, and other accounting functions become mechanized.</td>
</tr>
<tr>
<td>C. The large organization</td>
<td>In the large organization, the various administrative functions develop into departments. Each department requires its own manager, its own staff, and its own requirements from a large data processing installation. Point out that each manager will require different information from the data processing installation.</td>
</tr>
</tbody>
</table>
D. The integrated organization

Discuss the need for the supervisor of an organization to obtain information from other departments. He needs the information to make proper evaluations and decisions. Explain the difference between a one-man operation and a large organization. The single owner, because his business is small, can be familiar with all facets of his business. The large organization, however, may have several departments and even subdivisions of these, each with its own goals and problems. The head of such a large organization finds it extremely difficult to obtain a comprehensive overview of all its activities. Point out that in such a case an integrated application, through data processing, will give the head all the information he needs.

II. Techniques of Integrating Applications

A. The data base

Have students consider the case of the accounts receivable application described in the Section 11 on documentation. Ask the students what other applications might use the paid invoice card. Answers the students might give you include the following:

- sales commission payments
- analysis of sales by territory
- analysis of sales by salesman
- sales forecasting
- inventory control
- cost accounting analysis
- cash flow analysis
- overdue account analysis
- production control analysis

Point out that before applications like those above could be obtained from accounts receivable information, still more data would be needed. For example, to obtain figures on sales commission payments, information would be needed on commission rates and sales by each salesman. In general, to determine what data base is needed for a certain output, analyze the output.
Point out that effective use of such a data base hinges on various departments providing information that is not necessarily part of the function of that department. Use accounts receivable as an example. Show how, by addition of a territory code and salesman's code number on an invoice, it becomes feasible to handle commissions as an outgrowth of accounts receivable.

Elicit other examples from students of providing additional data to satisfy needs of other applications, for example:

- part numbers for inventory control
- dates of payment for cash flow analysis
- "moving average" sales information for sales forecasting.

Show how the use of information from one source becomes available for manipulation against information from other sources, allowing each phase of the organization to deal more effectively with its own problems.

Suggested teacher reference:
Robichaud, pp. 169 and 196
INTRODUCTORY PROJECTS

The following suggested projects for unit-record machines are elementary; use them with the text of the lessons. Also use more advanced problems for each machine. You will find references to such problems throughout the text of this course.

PROJECT 1: TEACHER DEMONSTRATION OF BASIC MACHINES

In one of the early meetings of the class you may wish to demonstrate how unit-record machines operate. You should probably limit this demonstration to the keypunch, the sorter, and the accounting machine. The demonstration should build student interest and give him an overview of these machines.

As an outcome of the demonstration you can hand each student a class roster, giving course title, meeting times, location of the classroom, course objectives, and names of those in the class.

Preparation

Before the first class begins, keypunch the information for the roster into blank cards. Space this information with the number of alphamerical typebars on the accounting machine as a guide. For example, if the machine has 43 alphamerical typebars, use a 40-space line.

Punch each card with a code number for sorting. For example, you might code the first card 001, the second 002, the third 003, the card with your name 021, the time and place card 031. Begin the objectives cards with 041, and the class-member cards with 051. Also prewire the control panel of the accounting machine for a printout, and make a carriage control tape.

Thus, you will punch cards 001 to 051 before the demonstration. You can also punch the cards with the names of class members before the class, or as part of the demonstration you can let each student punch his own name and code number into a card.

The Demonstration

When you have all the cards ready, including those punched by students, put them into the sorter to arrange in numerical sequence. Finally, make a printout of the class list on the accounting machine, for each member of the class.

PROJECT 2: KEYPUNCH

This project will give students beginning experience in the use of a keypunch machine.

NOTE: Before you can carry out this project you will need a program card. You must either punch this card before class or else wait until the class has covered the developing of a program card, and have the students make it.
Preparation
Assign each student 20 or more successive pages from the local telephone directory with no page assigned to more than one student. Have each pick 20 business organizations at random from his pages, with no more than one on a page. Also have each student include at least one business organization with an out-of-town telephone number.

Keypunching
Have each student keypunch the name of the business firm, its telephone number, and the directory page number into 20 cards for the 20 firms. Code each business organization having an out-of-town telephone number with an "X" punch.

PROJECT 3: THE SORTER
This project will give students beginning experience in the use of the sorter. Use the cards from Project 2 for this project.

Sorting
Have each member of the class sort his 20 cards according to directory page number. As a second exercise, have each student sort his cards to select the business organizations with out-of-town telephone numbers.

Now combine the cards for the whole class and have each student sort the whole deck by directory page number. (Be certain that the cards are not already in order of directory pages, even within each group of 20.)

PROJECT 4: THE SORTER: ALPHABETIC SORTING
This project will give students experience in using a sorter for alphabetic sorting.

PROJECT 5: THE REPRODUCER
Use the same card deck as in Project 4.

Reproducing
Let each student make a control panel diagram, wire the control panel, and reproduce the deck of cards that has been used for the preceding projects. The students will now have two decks of cards, but the deck punched by the reproducer will not have the printed information on the top edge of each card.

You can now have the students take this new deck to either an interpreter or a keypunch with an interpreter switch, where information can be printed on each card.

PROJECT 6: THE ACCOUNTING MACHINE OR TABULATOR
This project requires a keypunch, sorter, and accounting machine.

Keypunching
Have the students keypunch into the cards the information from the table below.

Tabulating Machine
Explain to them that the cards they have just punched will be used to make a printout listing all the information given; also minor totals.
of hours and gross pay will be shown for each worker.

Have them do the following:
1. Draw a control panel diagram for doing the problem on the tabulator.
2. Wire the control panel.
3. Make a carriage control tape.
4. Run the cards through the tabulator and make the printout.

As a second exercise, have the students do the following:
1. Rearrange the cards by job number, using the sorter.
2. Rewire the control panel to produce a printout with the information in order of job number, and with a minor total of wages for each job.
3. Run the cards through the tabulator and make the printout.

<table>
<thead>
<tr>
<th>Card Columns</th>
<th>1-6</th>
<th>7-10</th>
<th>11-13</th>
<th>14-18</th>
<th>19-21</th>
<th>22-25</th>
<th>26-28</th>
<th>29-33</th>
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<tbody>
<tr>
<td>Print Position</td>
<td>1-8</td>
<td>10-13</td>
<td>20-24</td>
<td>26-32</td>
<td>34-36</td>
<td>38-42</td>
<td>44-47</td>
<td>49-57</td>
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<tr>
<td>Date</td>
<td>Clock No.</td>
<td>Dep't No.</td>
<td>Acc't No.</td>
<td>Job No.</td>
<td>Hours</td>
<td>Rate</td>
<td>Gross Pay</td>
<td></td>
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<td>410</td>
<td>12147</td>
<td>168</td>
<td>24.00</td>
<td>2.50</td>
<td>60.00</td>
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<td>4167</td>
<td>410</td>
<td>12168</td>
<td>180</td>
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<td>2.50</td>
<td>40.00</td>
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<td>410</td>
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<td>410</td>
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<td>2.00</td>
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Operator training course for IBM 024 and 026 card punch. Marsh-Pierce Co., Inc., 301 E. 48th St., New York, N.Y. 10017. 1961. (Consists of 7 reels of tape, 5 sets of punched cards for practice on a card punch, 5 student manuals, 1 instructor guide.)


