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ABSTRACT

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 discusssed 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

THE UNIVERSITY OF THE STATE OF NEW YORK/THE STATE EDUCATION DEPARTMENT/BUREAU OF CONTINUING EDUCATION CURRICULUM DEVELOPMENT/ALBANY, NEW YORK/12224

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

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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*
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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

CONTENTS

Section 1

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	CONTENT DETAILS & TEACHING TECHNIQUES
I. Introduction	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.
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 OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
4. Class schedule	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.
B. Target jobs	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.
1. Job descriptions	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.)
2. Background required	Discuss the personal characteristics and training required for a *unit-record machine operator*. Do the same for related jobs in the data-processing organization.
3. Further training opportunities	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
II. Evolution of Data Processing	
A. Recording techniques	
1. Clay tablets	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.
2. Papyrus	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	CONTENT DETAILS AND TEACHING TECHNIQUES
	several thousand years, these rolls have reappeared as adding-machine tape, and as magnetic and paper tape for computers.
3. Bookkeeping	Both the Greeks and Romans used orderly bookkeeping but it was a rather simple kind. The earliest known double-entry bookeeping was developed in Italy in the 14th and 15th centuries.
4. Paper and quill pen	About this time paper and the quill pen came into wide use in Western Europe.
5. The typewriter	The next development in recording technique came in the latter part of the 19th century when the Remington Company produced the first commercial typewriter. In 1920 the first *electric* typewriter was produced.
6. Bookkeeping machines and other business machines	This led to the design and production of bookkeeping machines, teletypewriters, automatic typewriters, and many other devices important to data processing.
	Suggested teacher reference:* Arnold pp. 15-20.
B. Computing devices	Give a brief history of computing devices
1. Abacus and Arabic numbers	as outlined below.
	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.

*Full reference citations are given in the bibliography.

CONTENT OUTLINE	CONTENT DETAILS AND TEACHING TECHNIQUES
3. Keyboard calculators, first bookkeeping machine	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 "macaroni box"), the cash register, and the first bookkeeping machine.
4. First *accounting* machine	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. (The second limitation was later overcome by the use of punched tape; both were overcome by the punched card.)
5. Conveniences	The window envelope, carbon paper, carbon sets, and continuous forms added to the efficiency and convenience of the machines. Suggested teacher references: Arnold, pp. 20-25. Schmidt, pp. 6-12.
C. Punched card machines	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.
1. Babbage's analytical engine	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.
2. Hollerith's work on the U.S. census	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

CONTENT OUTLINE	CONTENT DETAILS AND TEACHING TECHNIQUES
	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

CONTENT OUTLINE	CONTENT DETAILS AND TEACHING TECHNIQUES
	50 times the speed with punched cards. The magnetic core was added, which cut the access time to millionths of a second. The magnetic drum, added later, increased storage capacity further.
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.

Section 2

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	CONTENT DETAILS & TEACHING TECHNIQUES
I. The Basic Functions	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.
A. Classifying	Point out that *classifying* consists of identifying data to distinguish them from other data, and to ease arranging them into a desired sequence.
1. Steps in classifying	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 artifical codes are alphabetic, numeric, and alphanumeric.
B. Sorting	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
C. Calculating	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.
D. Summarizing	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.
1. Examples	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.
2. Relation to sorting	Explain that summarizing is related to sorting because data arranged into categories are usually part of a summary.
3. Reports as a result of summarizing	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.
E. Recording	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.
1. Done frequently in data processing	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 "rewriting" methods and are important elements in recording.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
F. Communicating	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.
G. Storing	*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.

Section 3

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	CONTENT DETAILS & TEACHING TECHNIQUES
I. The Unit-Record Principle	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.
A. Compared with manual system	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.
B. Examples 1. In a manual system	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.
2. In a mechanical system	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
II. The Punched Card	State that in a punched card system information from a source document or other document is punched into a card, which makes it a unit record.
A. Physical description	Either pass out a 90-column card and an 80-column card to each student or use a transparency or other visual aid to show them. Explain that the 90-column card is used in some places today but is gradually going out of use.
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

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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. IBM Publication 320-1443, pp. 1-4. 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	CONTENT DETAILS & TEACHING TECHNIQUES
I. The Card Punch	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.
A. Basic function	Explain that data can be recorded in a standard-size punched card by punching holes with a keypunch.
B. Operating features of the keypunch	Terminology in this section refers primarily to IBM punches. Explain the basic differences among the IBM 24, 26, and 29 card punches.
1. Card hopper	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.
2. Punching station	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.
3. Reading station	Explain how the reading station can sense holes in a punched card. Demonstrate duplication of a card.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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	CONTENT DETAILS & TEACHING TECHNIQUES
D. Additional features	
1. Column indicator	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.
2. Pressure-roll release lever	Demonstrate the removal of a card from under the punch dies or under the reading station.
3. Main-line switch	Point out the main power switch. Explain that the IBM 24 and 26 punches need time to warm up. The IBM 29 keypunch, however, can be used immediately after the switch is turned on.
4. Chip box and fuses	Indicate the location of the chip box, and the fuses which are behind it.
5. Program control unit	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.
E. Some operating procedures	
1. Replacing a damaged card	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.
2. Correcting an error card	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.
3. Sight-checking cards	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	CONTENT DETAILS & TEACHING TECHNIQUES
4. Continuous punching from a source document	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.
5. Punching under program control	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.
6. Print control	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	CONTENT DETAILS & TEACHING TECHNIQUES
F. Practice by students	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.

CONTENT OUTLINE

CONTENT DETAILS & TEACHING TECHNIQUES

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

Section 5

THE INTERPRETER

OBJECTIVE OF THIS SECTION:
To provide an understanding of the basic functions, operating features, applications, and procedures of the interpreter

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
I. The Basic Function: Printing	Explain that in data processing, *interpreting* 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.
A. Need for interpretation	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.
B. Basic concepts illustrated by the interpreter	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.
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	CONTENT DETAILS & TEACHING TECHNIQUES
A. Hopper and stacker	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.
B. Machine controls 1. *Main-line switch*	Note the location of the main-line switch which must be *on* for the machine to operate.
2. Start and stop keys	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.
C. Control for printing position	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.
D. Printing unit	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.
E. Card-reading device	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.
III. Operating Procedures	
A. Printing controlled by wired panel	Explain that printing on a card is controlled (in the interpreter) by a wired control panel, prepared by the machine

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	operator. When this panel is inserted into the interpreter, it directs the operations of the machine.
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.

CONTENT OUTLINE

CONTENT DETAILS & TEACHING TECHNIQUES

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

Section 6

THE SORTER

OBJECTIVES OF THIS SECTION

To provide an understanding of the functions, physical components, operating procedures, and applications of the sorter

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
I. Functions	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.
A. Basic operations	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.
B. Basic concept illustrated	State that the sorter clearly shows another basic use of a hole in a card column: detecting a hole at a specific time causes a card to be directed to a particular pocket. The sorter easily allows an observer to see how cards are read.
II. Physical Features of the Sorter	Terminology in this section refers to IBM sorters. Note the basic differences among IBM 82, 83, and 84 sorters.
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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
1. Reject pocket	Explain that the 13th pocket is for cards unpunched in the column being sorted. It is called the *R* or *reject* pocket.
2. Pocket-stop lever	Point out the pocket-stop levers which stop card-feeding when any pocket is full.
C. Machine controls	
1. Main-line switch	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.
2. Start and stop keys	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.
D. Column indicator and selection handle	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.
E. Sort brush (or photoelectric device)	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.
F. Selection switches	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.
G. Additional features	Mention some additional devices often found on a sorter, such as a card counter. Describe briefly how to use the edit switch and edit-stop switch on the IBM 83 and 84 sorters.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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	CONTENT DETAILS & TEACHING TECHNIQUES
F. Selection	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.
G. Checking cards	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.
IV. Applications	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

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
I. Functions	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.
A. Basic operation: reproducing	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.
1. Verifying	Stress the fact that the comparing feature of the reproducer can check the accuracy of the automatic punching from the original cards.
B. Gang punching	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
C. Summary punching	When connected by cable to an accounting machine, the reproducer can punch summary or total cards with amounts accumulated in the other machine.
D. Mark sensing	Point out that the reproducing punch can, when equipped with the mark-sense feature, automatically translate information recorded on cards by pencil marks into punched holes in the cards.
II. Operating Features	Explain that in reproducers such as the IBM 514 reproducing punch, there are two feed units—the reading unit and the punching unit. Note that the read unit and punch unit can be used either together or as two separate units, depending on the machine operation involved.
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	CONTENT DETAILS & TEACHING TECHNIQUES
E. Summary-punch cable	Indicate location of the summary-punch cable which must connect the reproducer and an accounting machine for automatic summary punching.
F. Control panel and switches	Stress the fact that all operations of the reproducing punch are dependent on control-panel wiring and the proper setting of the functional switches on the machine. Locate the switches and show how to insert a control panel in the reproducer.
III. Procedures	
A. Reproducing and verifying	Explain that reproducing always involves two sets of cards: original punched cards in the *read* unit and blank (or partially blank) cards in the *punch* unit. Note that the *reproduce* switch must be *on* for this basic operation.
1. Path of the cards	Point out that cards in the read unit are read by two sets of wire brushes, each containing 80 brushes. Cards in the punch unit first pass under 80 punch dies and then they too are read by 80 brushes. Stress that cards in both units move in synchronism from hopper to stacker through the two stations in each unit.
2. Control-panel wiring for reproducing	On a control panel (or a diagram of a panel) show the location of the 80 hubs for the reproducing brushes and those for the punch magnets. Note that data read from the source cards can be punched in the new set of cards in any desired columns. Remind students that a wire connecting hubs on a panel serves as a path for electrical current; an impulse from sensing of a hole in the read unit at a specific time causes a punch die to punch a similar hole in the punch unit.
3. Wiring for verifying	Indicate the proper wiring from the comparing brushes and punch brushes to matching compare magnets. Urge students to add necessary control-panel wiring to automatically verify all reproducing operations.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
B. Gang punching	Note that for gang punching, only one set of cards is used in the machine—in the punch unit. The *reproduce* switch must be *off* to allow the units to operate independently.
1. Control-panel wiring	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.
2. Interspersed gang punching	Briefly discuss gang punching with interspersed master cards. Also discuss verifying the punching by use of the *read unit* 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 *read* X-brushes and 6 *punch* X-brushes.
3. Combined reproducing and gang punching	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 *on*.
C. Mark-sense punching	Point out that for mark-sense punching only the punch unit is used and only the *mark-sensing* switch should be *on*. 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.
1. Control-panel wiring	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
2. Wiring for verifying	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.
D. Summary punching	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.
1. Control-panel wiring	Indicate the necessary wiring from the counter-total exit hubs to the punch magnets.
E. Additional features	On a control panel note some of the special devices available such as the gang-punch emitter, column splits, and selectors.
1. Selectors	Mention that selectors are necessary for such operations as field-selected reproducing and offset-interspersed gang punching.
2. End printing	Point out that the IBM 519 reproducing punch has, in addition, a print unit for end printing on cards passing through the punch unit.
IV. Applications	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.

CONTENT OUTLINE

CONTENT DETAILS & TEACHING TECHNIQUES

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	CONTENT DETAILS & TEACHING TECHNIQUES
I. Functions	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.
A. Filing	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.
B. Basic function	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.
C. Main operations	
1. Merging	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.
2. Matching	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	CONTENT DETAILS & TEACHING TECHNIQUES
3. Selecting	State that individual cards can be selected from a group in many more ways by the collator then 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.
4. Sequence checking	The collator can check a file of punched cards for numerical order; it can be made to stop for an out-of-sequence condition.
5. Combination of these	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.
II. Physical Features of the Collator	Terminology in this section refers to IBM collators, such as the numerical group (77, 85, 88) and the alphabetic machines (87, 89).
A. Card hoppers	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.
B. Stackers or pockets	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.
C. Machine controls 1. Main-line switch	Note the location of the main power switch on the collator.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
2. Start and stop keys	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.
3. Runout key	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.
D. Error light and reset key	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.)
E. Additional features	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.
III. Operating Procedures	Stress the fact that a properly wired control panel must be inserted in the collator to direct machine functions.
A. Basic operating principle	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.
B. Path of 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.
C. Comparing units	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	CONTENT DETAILS & TEACHING TECHNIQUES
D. Sequence checking	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.
1. Combined operations	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.
E. Selecting	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.
F. Merging	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.
1. Combined operations	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.
G. Matching	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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.
IV. Applications	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 Cashman & Keys, *Text and Project Manual*, pp. 95-106, 160-71 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	CONTENT DETAILS & TEACHING TECHNIQUES
I. Functions	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.
A. Basic purposes	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.
B. Importance of printing	Point out that printed reports prepared automatically by the tabulator are the finished products of a data processing system.
C. Additional operation	Note that in addition to printing data, the tabulator can control the punching of summarized numerical data into cards when connected to a machine capable of summary punching. See Section 7.
II. Operating Features	Terminology in this section refers to IBM accounting machines. Note the basic differences among IBM 402, 403, and 407 tabulators.
A. Feed hopper and stacker	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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	State that the function of the print unit is to record data on continuous paper forms.
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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	many different reports can be produced by one machine and a number of different control panels.
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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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 alphamerical 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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	On a panel locate the hubs for *setup change*. Show how to use a *setup change* switch and a selector to control this alternating between reports.
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*. Point out the hubs for *transfer plus* and *transfer minus* on a control panel. Totals accumulated can all be printed from the same typebars or from different typebars depending on panel wiring.
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	Explain that summary punching is the automatic punching of one total card to replace a group of detail cards. Such summary cards are usually produced in conjunction with the printing of a report.
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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
I. Basic Function	Stress that *calculating* is one of the basic functions of all data processing. (See Section 2.)
	Point out that calculators are machines able to perform addition, subtraction, multiplication, and division.
II. Physical Features	Terminology in this section refers to the IBM 602 calculating punch.
A. Hopper and stacker	Locate the hopper and stacker; demonstrate how to put cards in the feed hopper.
B. Machine controls	Point out the main-line switch, *start* key, *stop* key, *reset* key, and *compare* light.
	Also note the location of the adjustable *skip* bar which allows control of the location of punching.
C. Control panel	State that proper wiring of a control panel is of the utmost importance. Accurate computations cannot be obtained without proper wiring.
III. Operating Procedures	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
I. Need for Documentation	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. 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.
A. Objectives	
1. Clarification	Explain that documentation in sufficient detail enables operators to process applications with little or no supervision.
2. Continuity	Point out that documentation enables one operator to assume the duties of another in case of illness or vacation.
3. Controls	Discuss the need for the control of checkpoints. Indicate how documentation assures adequate controls.
4. Changes	Changes are frequently made in input, output, and processing. Documentation provides the means for making such changes in an orderly way. 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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	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"

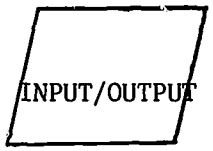
CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	statements. Point out that decision tables in these cases would avoid long, drawn-out narrative procedures to discuss each condition.
2. Disadvantages	Point out that decision tables are not easily read. Cite or use railroad or airline timetables 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:

1 in col. 80	Y	Y	Y	Y	Y	Y						N
2 in col. 80							Y	Y	Y	Y	Y	N
1 in col. 79	Y	N		Y	N		Y	N		Y	N	
2 in col. 79		N	Y		N	Y		N	Y		N	Y
month-end run	Y	Y	Y				Y	Y	Y			
weekly run				Y	Y	Y				Y	Y	Y
sort cols. 6-1	X			X		X				X		
sort cols. 2-1			X				X		X			
file in pending	X			X		X				X		X
forward to collator			X				X		X			
error; notify control		X			X			X			X	

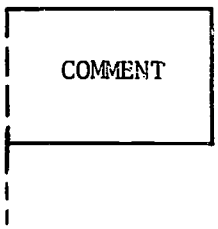
CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
C. System flowcharts	
1. Advantages	Explain that flowcharts are graphic illustrations equivalent to narrative procedures. Explain also that the symbols and lines of direction, combined with a minimum or words, can often convey the same meaning as 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

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

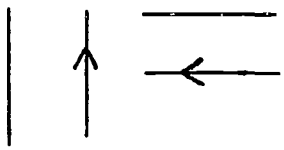


General input/output function; information available for processing (input), or recording of processed information (output).



Additional description, clarification, or comment. Dotted line can be extended to symbol being described.

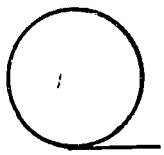
Connector. Exit to or entry from another part of the flowchart.



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.

Input/output function in card medium.

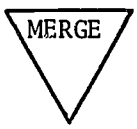


Magnetic tape.

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

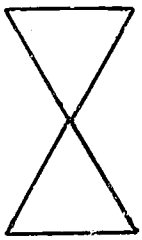
Input/output for punched paper tape.

Any operation using a key-driven device as in punching, verifying, typing.

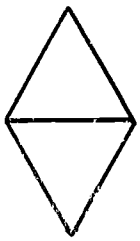


Combining two or more sets of items into one set.

Remove one or more subsets of items from a set.

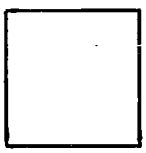


Collate. Merging with extracting; forming two or more sets of items from two or more other sets.

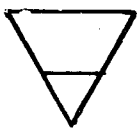


Sort. Arrange a set of items into sequence.

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.

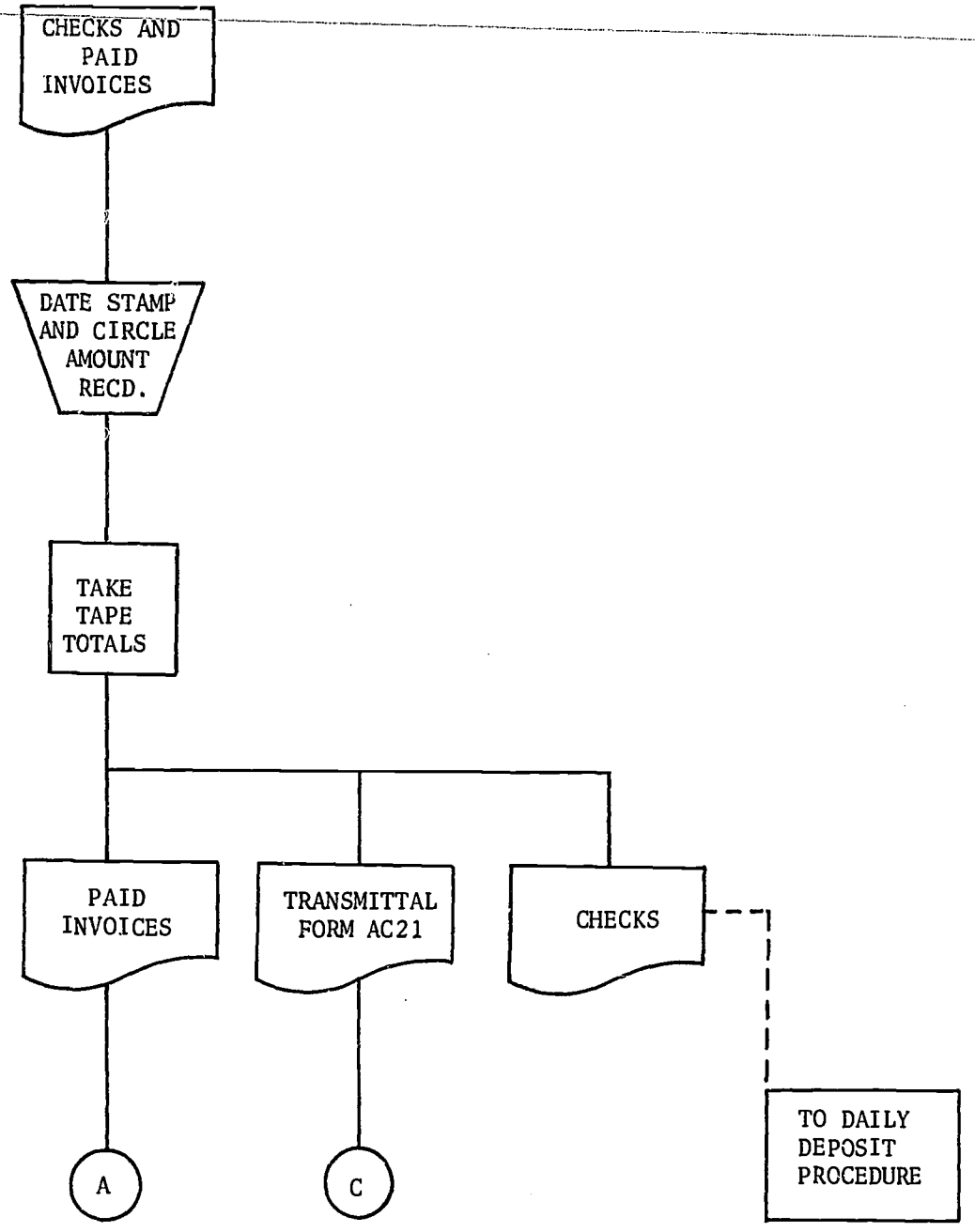
CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
D. Other documentation	Explain that *narrative procedures*, *decision tables*, and *system flowcharts* describe ways to document. Explain that preprinted forms are often used in a particular operation for outlining procedures. Point out such examples

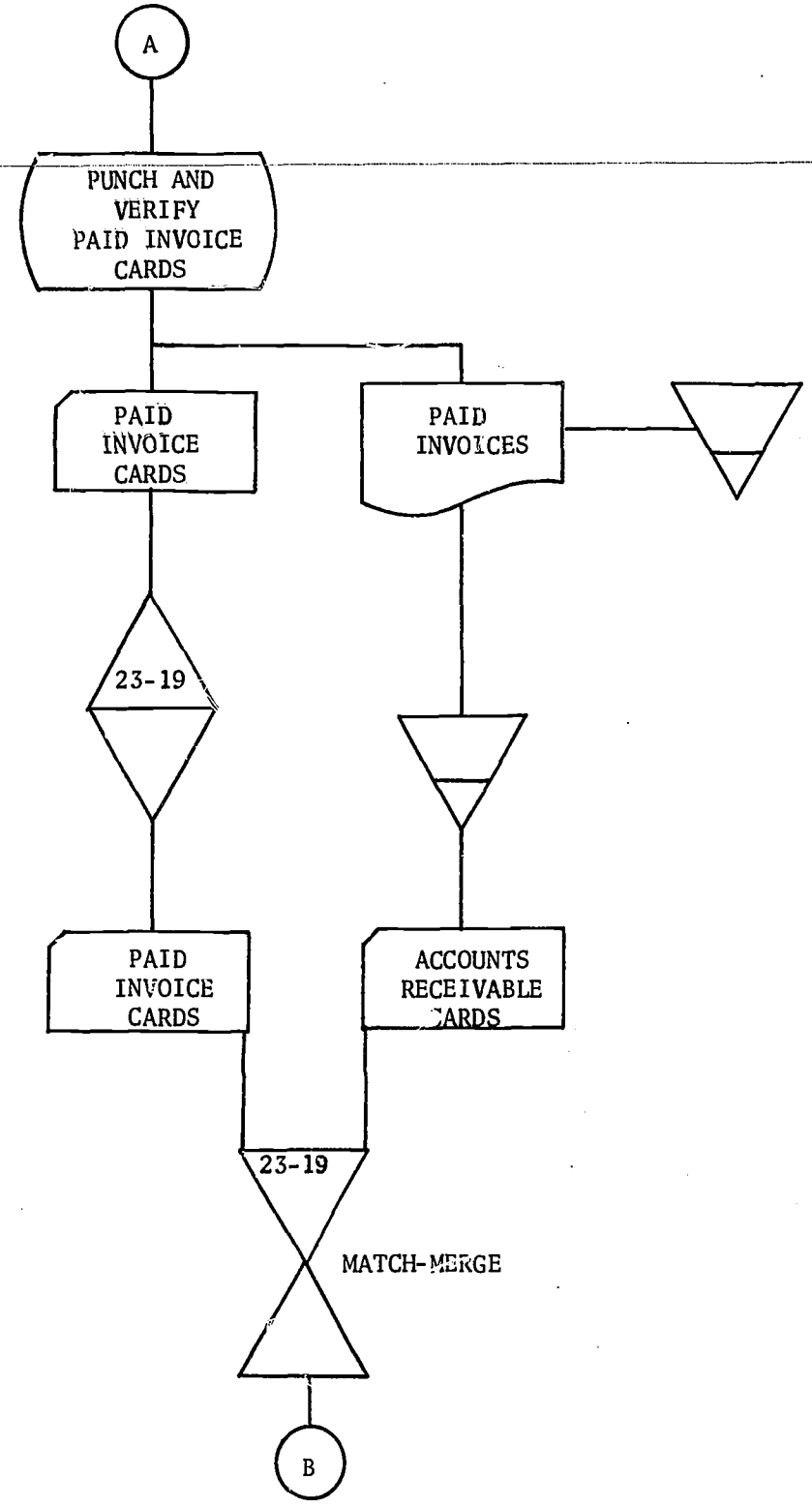
CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	as: keypunch instructions, sorter instructions, and computer run instructions. Also point out that layouts describing records used in data processing often supplement procedures. Examples are: card record layouts, disk record layouts, and tape record layouts.
III. Documentation Project	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.
A. Narrative procedure Input control	1. Receive in the mail payments to accounts receivable. 2. Date stamp and circle the amount received on *invoice*. 3. Take the tape total from *invoices* and *checks* received and determine the balance. 4. Process *checks* as in the daily deposit procedure. 5. Forward *paid invoices* to Key Punch. Forward *transmittal form AC21* to Computer, showing current date and tape total of *paid invoices*.
Key punch	6. Punch and verify *paid invoice cards* as per keypunch instructions. 7. Forward *cards* to Unit Record. 8. File *paid invoices* in invoice file.
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.

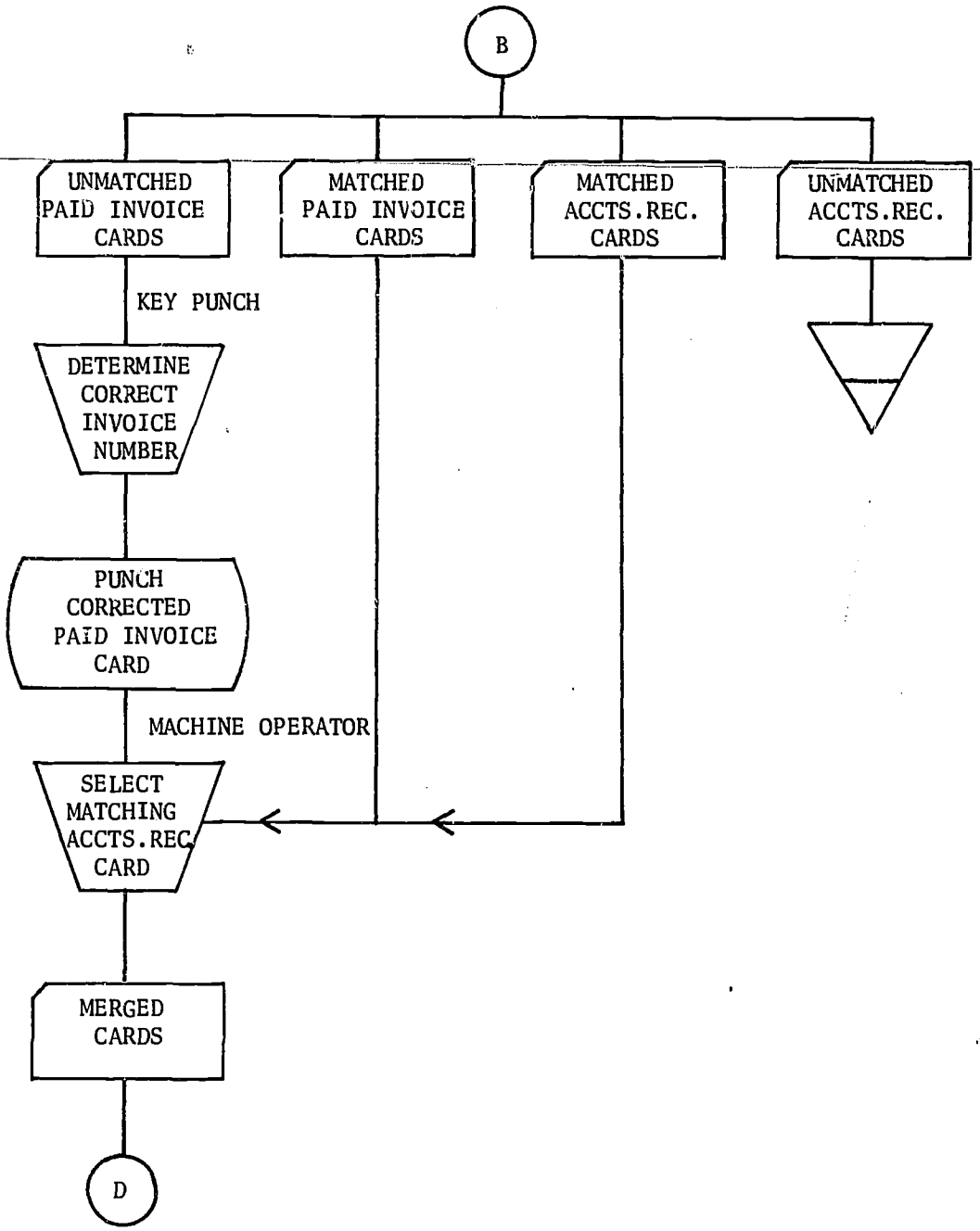
CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
	12. Match-merge the *paid invoice cards* and *accounts receivable file* on invoice number, columns 23-19.
	13. Forward unmatched *paid invoice cards* to Key Punch for correction of invoice numbers.
Key punch	14. Obtain *paid invoices* and correct the *paid invoice cards*. Then return them to Unit Record.
Unit record	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.
	16. Forward matched *cards* to Computer.
	17. Process *cards* against program AC002 and produce *paid invoice listing* in triplicate.
	18. Balance the total against *transmittal form AC21* received from Key Punch. Clear any discrepancy with Input Control.
	19. Forward *paid invoice listing* as follows: original and first copy to Accounting, second copy to Sales.
	20. Return *cards* to Unit Record.
Unit record	21. File them in *paid invoice file*.

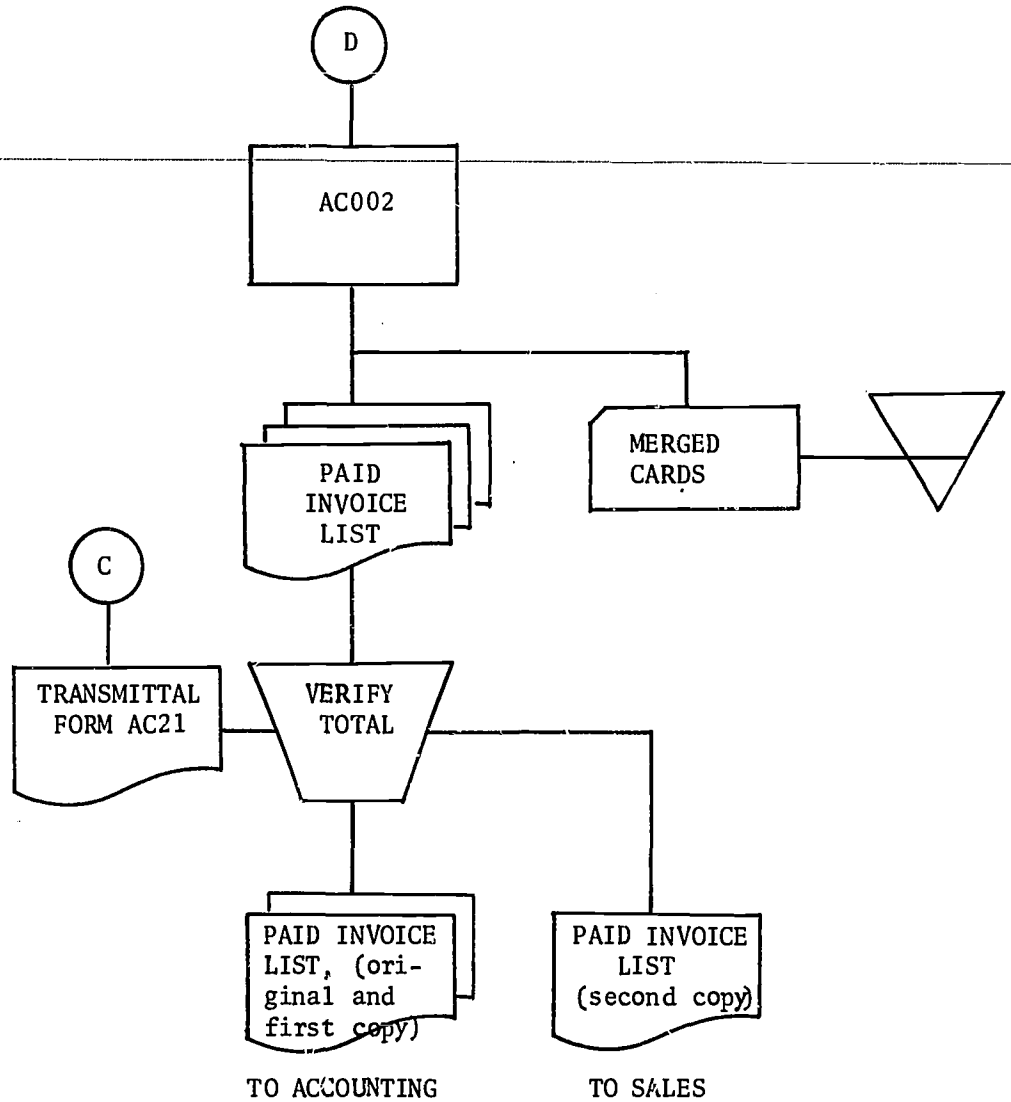
The following pages contain the systems flowcharts and one decision table for the narrative procedure above.

B. Systems flowchart




A
PUNCH AND VERIFY PAID INVOICE CARDS
PAID INVOICE CARDS
PAID INVOICES
23-19
PAID INVOICE CARDS
ACCOUNTS RECEIVABLE CARDS
23-19
MATCH-MERGE
B


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
D



C. Decision table

paid invoice cards	Y	Y		
accounts receivable cards			Y	Y
matched		Y	Y	
unmatched	Y			Y
return to key punch	X			
punched corrected cards	X			
select matching accts. rec. cards	X			
forward to computer	X	X	X	
refile				X

Section 12

INTEGRATED APPLICATIONS

OBJECTIVE OF THIS SECTION:

To provide an understanding of the evolution and techniques of integrated applications

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
I. Evolution of Integrated Applications	
A. The small organization	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.
B. The medium organization	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.
C. The large organization	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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
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.

CONTENT OUTLINE	CONTENT DETAILS & TEACHING TECHNIQUES
B. The integration	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 alphameric 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.

Sorting

Use the cards from Project 2, and have each student sort his 20 cards alphabetically according to name of business concern.

As a second phase, combine the cards of the whole class and let each student repeat the sort by company name for the whole deck.

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 FOR PROJECT 6

Card Columns	1-6	7-10	11-13	14-18	19-21	22-25	26-28	29-33
Print Position	1-8	10-13	20-24	26-32	34-36	38-42	44-47	49-57
	Date	Clock No.	Dep't No.	Acc't No.	Job No.	Hours	Rate	Gross Pay
1	07-01-69	4167	410	12147	168	24.00	2.50	60.00
2	07-01-69	4167	410	12168	180	16.00	2.50	40.00
3	07-01-69	4169	410	12147	168	08.00	2.00	16.00
4	07-01-69	4169	410	12170	170	16.00	2.00	32.00
5	07-01-69	4169	410	12168	180	16.00	2.00	32.00
6	07-01-69	4170	411	12147	168	40.00	2.00	80.00
7	07-01-69	4171	411	12170	170	12.00	2.50	30.00
8	07-01-69	4171	411	12190	176	16.00	2.50	40.00
9	07-01-69	4173	413	12170	170	20.00	2.50	50.00
10	07-01-69	4174	413	12190	176	20.00	2.00	40.00
11	07-01-69	4174	413	12147	168	20.00	2.00	40.00
12	07-01-69	4175	415	12190	176	40.00	2.00	80.00

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