COMPUTER SCIENCE & TECHNOLOGY:

# SELECTION OF DATA ENTRY EQUIPMENT



NBS Special Publication 500-55
U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

# NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards[1] was established by an act of Congress on March 3, 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the Nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau's technical work is performed by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology.

**THE NATIONAL MEASUREMENT LABORATORY** provides the national system of physical and chemical and materials measurement; coordinates the system with measurement systems of other nations and furnishes essential services leading to accurate and uniform physical and chemical measurement throughout the Nation's scientific community, industry, and commerce; conducts materials research leading to improved methods of measurement, standards, and data on the properties of materials needed by industry, commerce, educational institutions, and Government; provides advisory and research services to other Government agencies; develops, produces, and distributes Standard Reference Materials; and provides calibration services. The Laboratory consists of the following centers:

Absolute Physical Quantities[2] — Radiation Research — Thermodynamics and Molecular Science — Analytical Chemistry — Materials Science.

**THE NATIONAL ENGINEERING LABORATORY** provides technology and technical services to the public and private sectors to address national needs and to solve national problems; conducts research in engineering and applied science in support of these efforts; builds and maintains competence in the necessary disciplines required to carry out this research and technical service; develops engineering data and measurement capabilities; provides engineering measurement traceability services; develops test methods and proposes engineering standards and code changes; develops and proposes new engineering practices; and develops and improves mechanisms to transfer results of its research to the ultimate user. The Laboratory consists of the following centers:

Applied Mathematics — Electronics and Electrical Engineering[2] — Mechanical Engineering and Process Technology[2] — Building Technology — Fire Research — Consumer Product Technology — Field Methods.

**THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY** conducts research and provides scientific and technical services to aid Federal agencies in the selection, acquisition, application, and use of computer technology to improve effectiveness and economy in Government operations in accordance with Public Law 89-306 (40 U.S.C. 759), relevant Executive Orders, and other directives; carries out this mission by managing the Federal Information Processing Standards Program, developing Federal ADP standards guidelines, and managing Federal participation in ADP voluntary standardization activities; provides scientific and technological advisory services and assistance to Federal agencies; and provides the technical foundation for computer-related policies of the Federal Government. The Institute consists of the following centers:

Programming Science and Technology — Computer Systems Engineering.

[1]Headquarters and Laboratories at Gaithersburg, MD, unless otherwise noted; mailing address Washington, DC 20234.
[2]Some divisions within the center are located at Boulder, CO 80303.

# COMPUTER SCIENCE & TECHNOLOGY:

# SELECTION OF DATA ENTRY EQUIPMENT

Steve A. Recicar

Institute for Computer Sciences and Technology
National Bureau of Standards
Washington, D.C. 20234




U.S. DEPARTMENT OF COMMERCE
Luther H. Hodges, Jr., Under Secretary
Jordan J. Baruch, Assistant Secretary for Science and Technology
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

Issued November 1979

National Bureau of Standards Special Publication 500-55
Nat. Bur. Stand. (U.S.), Spec. Publ. 500-55, 77 pages (Nov. 1979)
CODEN: XNBSAV

Library of Congress Catalog Card Number: 79-600173

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1979

For sale by the Superintendent of Documents, U.S. Government Printing Office,
Washington, D.C. 20402
Stock No. 003-003-02133-4 - Price $3.50.
(Add 25 percent additional for other than U.S. mailing).

# SELECTION OF DATA ENTRY EQUIPMENT

Steve A. Recicar

## ABSTRACT

This publication provides information to be used by Federal organizations in the selection of data entry equipment. The objective is to make available information that could lead to the selection of more efficient and economical data entry systems. This report provides information about economic and general operational considerations, steps to be followed in acquisition and training, and other factors pertinent to data entry equipment selection. Equipment profiles for the different data entry methods are also provided.

Key words: Application; character set; computer interface; cost; data entry; edit; operator speed; record size; transaction volume; transfer speed; validate; verify.

Recognition. An Operations Report entitled "Data Entry Guide" was published about 1975 by the Operations Research Division, Research Design Center, at Gunter Air Force Station, Alabama, with Captain Donn Kearns as project officer. That report provided the basis for many of the equipment profiles in this report.

Contents



Tables

SELECTION OF DATA ENTRY EQUIPMENT
Steve A. Recicar

# Introduction

## Purpose of this Report

The purpose of this report is to provide Federal ADP managers an aid for selecting data entry equipment. The cost of data entry represents from 30 to 40 percent of the total EDP budget in typical installations. Since data entry is more labor-intensive than most EDP operations, proper equipment selection can produce substantial savings in operator costs. The process of data acquisition, transcription and entry is continually evolving. Keeping track of this market becomes more challenging every year. The types of products being marketed are extremely varied. The number of vendors who are participating in this market is quite large, as is the size of the market itself. It is estimated that by the end of 1978 there were over 2,000,000 data entry devices installed in the United States. It is also estimated that the overall installed base will grow at 17 percent per year over the next five years.

Because of this enormous growth rate, in numbers and technology, new opportunities are continuously being presented for use of more efficient and economical advanced data entry systems in many Federal agencies. It is expected that this report will make it easier for the Federal ADP manager to take better advantage of these opportunities.

## Organization of this Report

This report is divided into three chapters--Basic Keyboard Input Devices, Reader Type Devices, and Special Input Devices. These three chapters provide equipment profiles for the different data entry methods. Each chapter is subdivided into equipment categories (such as keyboard-to-disk, optical character readers, voice recognition systems, etc.). Within the equipment profiles, the following information is provided:

. A general description of the equipment category including its definition, characteristics, and options normally available.

. Operator requirements normally associated with the equipment.

. A cost range for the equipment.

. Typical applications of the equipment.

. Advantages and disadvantages of the equipment.

(Most equipment referred to in this guideline operates from 60 Hz, 115 volt power sources and requires less than 2 kilowatts.)

The basic information needed by an ADP manager to select equipment categories meeting the requirements of a data entry application is presented. It should be stressed that this report is not intended to provide comprehensive specifications for every data entry device (or system), but rather to introduce the types of data entry equipment that are available. There are several other reference sources (such as Auerbach, Datapro, and Data Entry Today) which cover specific data entry devices in greater detail. Some other sources of information about data entry are:

. Studies such as those done by "Computerworld" and others.
. Manufacturers' brochures and presentations.
. Courses by organizations such as the Data Processing Management Association and the American Management Association.
. Meetings with others interested in the advancement of data entry, such as DEMA (the Data Entry Management Association).
. GSA's National Archives and Records Services' program of paperwork modernization, including the use of source data automation techniques.
. The organizations' own data entry, data processing, or user personnel.

Once an equipment category has been selected, these reference sources should be used to research individual devices or systems in order to determine which are best suited for the application.

## Factors in Data Entry Equipment Selection

The selection process is complex, especially in large agencies with many departments originating transactions in multiple locations. Three levels of selection factors can be identified as primary, secondary, and tertiary factors according to their relative importance.

The three primary factors in the selection of data entry equipment are:

. Transaction volume
. Point of data origin
. Transaction class

Transaction volume is probably the single most significant factor in properly selecting data entry equipment; however, transaction volume and point of data origin should be

considered together because individual remote locations within an agency may generate sufficiently large transaction volumes to justify specialized equipment or even the installation of multiple data entry systems at a single remote location. Volume analysis can help determine whether or not an optical character reader or distributed processing system can be justified. For example, the data entry volume that originates from remote locations can help determine whether data entry can be economically decentralized, or whether data collection equipment is a viable alternative to centralized keying. For large agencies, the volume at each decentralized data entry location will govern which equipment type should be selected for each remote location.

There are three basic classes of data entry transactions:

1. Record Creation: File additions that involve creating a file or adding complete records to an existing file. Examples are new customer accounts, new employees, new part numbers, new suppliers, etc. where the input transaction consists of adding a record or account not already contained in the file.
2. Record Modification: Record changes that involve modifying or correcting complete records in an existing file. Examples of record changes are changes of marital status, beneficiary, address, gross pay, deductions, etc.
3. Data Updating: Data field activities that involve only changing or updating certain data fields within the records of a file. These consist of the day-to-day transactions for established files. These include any other activity on an established file except for items 1 and 2 above.

The significance of classifying data entry transactions into these classes is that different categories of equipment are better suited for handling different types of transactions. As a general rule, transaction classes 1 and 2 must be entered using general purpose alphanumeric data entry equipment. Class 3 transactions can be keyed on the same devices as classes 1 and 2. However, class 3 transactions usually are much simpler in nature, the data frequently consists of numerics only, and relatively few characters are required to accomplish each transaction. Consequently, other less costly, and in some cases, highly specialized devices have evolved for class 3 transactions, to enable fast and accurate operations by relatively unskilled operators.

The secondary factors in equipment selection are accuracy controls and administrative controls for ensuring proper administration. Accuracy controls are equipment features that may be designed into the equipment to enhance the accuracy of data entry. For example, field controls on

keypunch equipment can prevent alphabetic characters from being entered in numeric fields or vice versa. Administrative controls include such items as accounting functions, data security provisions, and various features that may be provided to limit or restrict data entry operations from improper employee actions.

Tertiary factors in data entry equipment selection include media compatibility and communications considerations. For example, if a data transmission link is to be used between the data entry stations and the processing center, there are communication factors that must be considered to ensure compatibility between the remote and central sites. Alternatively, locally-prepared magnetic media such as diskettes, cassettes, or cartridges may be required for accounting purposes to ensure the integrity of each remote data entry station, providing a basis for auditing as well as for archival storage.

General Considerations

When considering equipment for data entry applications, the following questions should be asked.

Performance

. Is the equipment sufficiently reliable for the application?
. Are keys arranged on the keyboard for most efficient operation?
. Is the effective speed and accuracy of the data entry equipment adequate to meet application throughput requirements?
. Will parallel operation of multiple units be required?

Physical Specifications

. Is the currently available source of power adequate for the device?
. Are there any special, hard-to-satisfy environmental requirements?
. Will the necessary number of data entry stations and related equipment fit the available space?
. Is portable equipment required for the intended application?

Input

. Is the type of input medium appropriate for the intended application?
. Are special forms required?
. Must special fonts be used to prepare data for input?
. Is the method of the input mode (real-time or batch) appropriate for the intended application?

. Does the device support an adequate character set for the application?
. Is the character set compatible with that of the installation's computer or will certain special conventions be required, such as keying a "%" to represent a "("?
. Are provisions included for entering characters that are not contained in a standard character set?

Output

. Are the format control facilities adequate to meet the requirements?
. Are the output facilities suitable with respect to type and size of medium, code, character set, and record length?

Error Checks and Safeguards

. How convenient are the error correcting procedures for the operator?
. Does the verification process require a separate machine?
. Do the error detection facilities meet the accuracy requirements of the application?

Training and Maintenance

. Is adequate customer training available for new operators?
. Is maintenance available where the equipment will be located and with the responsiveness required by the application?

Future Growth Potential

. Can the system be upgraded?
. Does the manufacturer of this equipment make more sophisticated equipment? Does its product line include current "state-of-the-art" systems?
. How expensive is upgrading the system?
. How much retraining or program and format changing will it involve?

Table 1 is a summary of the more significant characteristics of the principal categories of data entry equipment. The information in the table was obtained primarily from the following Chapters 1, 2, and 3 and is provided so that the reader may more easily compare the various systems.

## Economic Considerations

Economic justification of a data entry system should be based upon a cost/performance comparison between the proposed systems and the currently-installed system or among

candidate systems if none is presently installed. A valid economic analysis requires that the total life cycle cost of a data entry system be determined and evaluated. This includes the initial procurement, operating and maintenance costs, accounting for potentially increasing data entry volumes, the need for system augmentation and the effects of annual inflation. Accurate cost and performance estimates should be based on detailed knowledge gained from the analysis of the user's data entry applications and from a study of available data entry equipment or techniques.

Data entry system cost/peformance comparisons are normally specified in terms of cost per character of input. In order to calculate accurately the cost per character of input, the volume of data and the total cost of entering this data must be known.

The following generalized formula can be used to compute the cost per character of input.

Cost per Character of Input = (Equipment Costs + Personnel Costs + Cost of Supplies + Facilities Costs + Error Handling Costs)/Data Entry Throughput

Equipment costs generally include:

- Rental or purchase cost of the data entry equipment
- Maintenance costs
- Communications cost (if on line)

Personnel costs generally include:

- Operator salaries
- Personnel overhead (supervision, leave benefits, vacation, etc.)

Cost of supplies generally include the cost of:

- The recording media (punch cards, paper tape, magnetic tape, magnetic disk, etc.)
- The storage and handling of each item

Facilities costs generally include the costs of:

- Floor space
- Environmental controls (air conditioning, heating, etc.)
- Electrical power

Error handling costs generally include:

- Personnel costs for the time it takes to track down and correct an error
- System throughput reduction caused by the error

| | ter Sets Available | Edit/Validate Capabilities | Operator Requirements |
|---|---|---|---|
| Keypunch | lerith, EBCDIC, or | limited | skills higher than those for typists |
| Keyboard-to-Tap | lerith, EBCDIC, r vendor unique sets | moderate to extensive | somewhat more skill/training than for keypunch |
| Keyboard-to-Dis | lerith, EBCDIC, r vendor unique sets | moderate to extensive | somewhat more skill/training than for keypunch |
| Alphanumeric Di | CD, or EBCDIC | extensive | limited skills may be adequate - depends on the application |
| Teleprinters | CD, EBCDIC, or | limited to moderate (buffered devices only) | limited skills may be adequate depends on the application |
| Optical Charact | CR-B, Farrington 7B, 1428 | moderate to extensive | limited skills may be adequate depends on the device and the application |
| Optical Mark Re | | most are limited | limited skills are adequate |
| Optical Bar Cod | ABAR, Distribution Telexon codes & others | limited | limited skills are adequate |
| Magnetic Ink Cha | 0 thru 9 plus 4 or l characters | moderate | limited skills are adequate |
| Pushbutton Tele | d numeric characters enerated | limited | limited skills are adequate |
| Voice Recognitic | a vocabulary of eric and command | moderate to extensive | limited skills are adequate |
| Digitizing Table | | None | drafting skills preferable only in inputting mechanical or graphic drawings |
| Point-of-Sale | and control rs | limited to moderate | cash register experience is helpful |

| | Transfer Speed | Volume Per Unit Time | Operator Speed Possible | Environment | Approximate Area Required | Record Sizes | Character Sets Available | Edit/Validate Capabilities | Operator Requirements |
|---|---|---|---|---|---|---|---|---|---|
| Keypunch | 18-65 characters per second | 125 eighty character cards per hour | 10,000 keystrokes per hour | normal office | 20 sq. ft. | 80 or 96 characters | BCD, Hollerith, EBCDIC, or ASCII | limited | skills higher than those for typists |
| Keyboard-to-Tape | usually not greater than 2400 bps | 20% increase over keypunch | 10,000-18,000 keystrokes per hour | normal office | 20-25 sq. ft. | less than 200 characters | BCD, Hollerith, EBCDIC, ASCII, or vendor unique sets | moderate to extensive | somewhat more skill/training than for keypunch |
| Keyboard-to-Disk | up to 2400 bps | 25-50% increase over keypunch | 12,000-20,000 keystrokes per hour | normal office | 20-25 sq. ft. | generally up to 128 characters | BCD, Hollerith, EBCDIC, ASCII, or vendor unique sets | moderate to extensive | somewhat more skill/training than for keypunch |
| Alphanumeric Displays | depends on quality & type of line or cable - up to 1,000,000 characters per second | limited by speed of operator | 8,000 keystrokes per hour | normal office | 5 sq. ft. | 80-1920 characters | ASCII, BCD, or EBCDIC | extensive | limited skills may be adequate - depends on the application |
| Teleprinters | up to 9600 bps | limited by speed of operator | less than other keyboard devices | normal office | slightly more than typewriter | depends on computer software | ASCII, BCD, EBCDIC, or APT | limited to moderate (buffered devices only) | limited skills may be adequate depends on the application |
| Optical Character Readers | depends on the capabilities of the device and the interface | up to 3600 characters per second | N/A | larger units require supplemental air conditioning | 40 sq. ft. | up to 7000 characters | OCR-A, OCR-B, Farrington 7B, and IBM 1428 | moderate to extensive | limited skills may be adequate depends on the device and the application |
| Optical Mark Readers | depends on the capabilities of the device & communication line | 80-1500 forms per minute | N/A | normal office | 10-15 sq. ft. | typically, up to 1,000 marks per side per page | N/A | most are limited | limited skills are adequate |
| Optical Bar Code Readers | depends on the device reading speed | 0-480 forms per minute | N/A | normal office (some harsh) | up to 15 sq. ft. | usually 12 numeric characters | UPC, CODABAR, Distribution Symbol, Telexon codes & others | limited | limited skills are adequate |
| Magnetic Ink Character Recognition | up to 1600 characters per second | up to 1600 six-inch documents per minute | N/A | usually computer room | 25 sq. ft. | up to 60 characters | numerics 0 thru 9 plus 4 or 5 control characters | moderate | limited skills are adequate |
| Pushbutton Telephone | up to 2400 bps | limited to speed of operator | about 1.5 characters per second | almost any environment | less than 1 sq. ft. | depends on the number of characters grouped together at the computer | alpha and numeric characters may be generated | limited | limited skills are adequate |
| Voice Recognition | up to 19,200 bps | limited to the speed that an operator can clearly pronounce words | about 2 words per second | almost any environment | less than 1 sq. ft. | N/A | usually a vocabulary of alphanumeric and command words | moderate to extensive | limited skills are adequate |
| Digitizing Tablets | up to 4,480 bps | limited to the speed of operator | up to 6600 coordinate points per second | normal office | 5 sq. ft. | N/A | N/A | None | drafting skills preferable only in inputting mechanical or graphic drawings |
| Point-of-Sale | up to 9600 bps | depends on configuration | 500-3500 keystrokes per hour | retail store environment | depends on configuration | Typically, 18-26 characters | numeric and control characters | limited to moderate | cash register experience is helpful |

**TABLE 1. GENERAL SUMMARY OF CHARACTERISTICS**

Data entry throughput is defined as the average number of correct characters entered during a specified period of time. This period of time must be the same as that used for the costs (e.g., monthly).

Total justification for a data entry system includes not only cost/performance considerations, but also system flexibility, user acceptance, and the feasibility of possible future enhancements to the installation's data entry operation.

It is appropriate at this point to discuss error handling costs, because they can be a significant percentage of the total cost of a data entry system. Furthermore, the cost of error detection and correction can be quite sensitive to the time and place of discovery. For example, it has been estimated that errors detected and corrected at the time of data entry are relatively inexpensive--about 10 cents per character in error, but those that go undetected until they reach the destination file media or the processing environment are much more expensive--$2 or more per character depending on the installation. Error handling costs can exceed 30 percent of the total cost of a data entry system. This fact provides considerable motivation to incorporate one or more data validation checks as early as feasible in the sequence of the data acquisition, transcription, and entry processes.

The basic function of all data entry equipment is to prepare information for entry into a computer. Some computer applications can tolerate inaccurate data more than others. In general, the recorded data must constitute an accurate representation of the source data, within the accuracy limits dictated by the application requirements and the necessary economic tradeoffs. Prospective users should realistically evaluate the overall cost of undetected errors (including the intangible factors such as customer irritation), and weigh it against the cost of more powerful error-control facilities to decide just how much protection against errors is really necessary.

## Steps to be followed in Selecting Data Entry Equipment

The following basic steps should be taken in the process of selecting data entry equipment. Some applications or circumstances may dictate omitting some steps, taking the steps in a sequence different than the order in which they are listed, or taking additional steps. Also, in most cases, several steps in the selection procedure will be conducted concurrently.

1. State-of-the-Art Familiarization
   - Review available alternatives
   - Talk to others having similar applications
   - Talk to others using the various types of

equipment being considered
. Select equipment category
. Research individual devices

2. Requirements Analysis
. Perform workload analysis
. Conduct technical feasibility study
. Conduct cost/benefit analysis

3. Specification Development
. Prepare procurement justification documents
. Prepare technical specifications, statements, etc. for inclusion in RFP

4. Solicitation
. Request for proposal

5. Evaluation
. Review vendors' proposals
. Arrange demonstrations by vendors
. Run benchmarks
. Perform formal evaluation

6. Contract Award
. Install system

7. Acceptance
. Run acceptance tests

8. Operation
. Initiate parallel operation and cutover
. Conduct post-installation evaluation (continuing basis)

Considering the magnitude of the costs and the potential benefits involved, careful study and sound selection procedures are essential.

With the passage of time, some of the equipment profiles in this report will become out of date due to advances in technology. Also, as a result of competition and advances in technology, the prices in this report will become increasingly inaccurate. They are entered here merely for comparison purposes. Accordingly, the user of this report should take these factors into account.

Chapter 1

# BASIC KEYBOARD INPUT DEVICES

Several factors influence the prospective performance of any keyboard encoder and can have a significant effect on throughput. These factors include:

.The operator's keying speed.

.The time required to feed, duplicate, skip, backspace, check, punch, or record.

.The time required to correct errors and machine faults.

Physical limitations of the human operator of keyboard input data entry equipment permit steady keying speeds on the order of 3 to 4 keystrokes per second. This would correspond to a sustained keying speed of about 11,000 to 15,000 keystrokes per hour. Machine speeds are much faster than those of even highly skilled operators. Machine function time, in most cases, is negligible in comparison to the time required to key data or to correct errors. Some types of equipment can automatically duplicate repetitive portions of the data and this, of course, increases the operator's effective speed.

1.1 Equipment Category: Keypunch - A keypunch is an electromechanical device which converts operator keystrokes into machine-readable holes on cards. Typical components of the device include an input card hopper, a card punch mechanism, a print mechanism, a card interpret mechanism, a card stacker, a keyboard, and control electronics.

1.1.1 Equipment Characteristics

1.1.1.1 Data Capacity/Speed

1.1.1.1.1 Transfer Speed - For most commercially available keypunch equipment, the hardware capabilities generally provide for a transfer rate from keyboard to a single card ranging from 18 to 65 characters per second (this speed does not reflect delay caused by mechanical feeding of cards).

1.1.1.1.2 Volume Per Unit of Time - Based on an average 7500 keystrokes per hour and an average of 60 characters punched per card, a keypunch has a data entry volume of approximately 125 cards per hour (this speed is limited by two factors: mechanical feeding of cards and the speed of keypunch operators).

1.1.1.1.3 Operator Speed - Operator speed ranges from 8000 to 15,000* keystrokes per hour which is equivalent to 100 to

---

*Speeds include both buffered and unbuffered keypunches. In most instances the lower speeds are for unbuffered units and the higher speeds are for the buffered units. The speed advantage of the buffered units is due to their ability to overlap the keying and mechanical punching operations.

200 eighty-character cards per hour. Most sources rate the average keypunch operator at 10,000 keystrokes per hour (or slightly less than 3 characters per second) on unbuffered devices and slightly higher on buffered devices. However, this speed does not take into consideration factors such as card and document handling, coffee breaks, error correction time, etc. These factors restrict the average sustained speed in a typical commercial application to approximately 7500 key strokes per hour.

1.1.1.2 Operational and Environmental Requirements

1.1.1.2.1 Temperature/Humidity Requirements - Keypunches can be operated in an office environment. Punched cards, however, generally require a controlled environment, particularly when stored for long periods; otherwise the dimensions of the cards will change with changes in humidity and result in equipment malfunctions. Cards must also be kept free of contaminants such as dirt and oil.

1.1.1.2.2 Area/Physical Location - Equipment is desk sized self-contained units requiring approximately 20 square feet per unit.

1.1.1.2.3 Computer Interface - Keypunches create 80 or 96 column EDP cards. Some units offer online capabilities but are generally limited to slow speed card reading and punching.

1.1.1.3 Input Characteristics

1.1.1.3.1 Record Sizes - Depending on card type, maximum record sizes per card are limited to 80 or 96 characters. Longer records may be accommodated by employing a sequence number field in each card designating the card's position within the record.

1.1.1.3.2 Character Sets Available - Keypunch and card tabulating units with up to 64 alphanumeric and special characters using BCD, Hollerith, EBCDIC, or USASCII code sets are available.

1.1.1.4 Output Capabilities - Output from keypunches is recorded as rectangular holes punched in standard EDP cards (whose dimensions are defined by ANSI X3.11-1969). Most keypunches also print the punched data along the top margin of the card.

1.1.1.5 Edit/Validate Capabilities - Keypunches have a limited range of capabilities including printing, field definition, zero insertion, skipping, check-digit generation, and character inhibition.

1.1.2 Options - Available options include the following: punch/verify capabilities, from 1 to 31 program levels

(stored data entry formats), from 80 to 800 character buffer storage, batch production totals, and others depending on manufacturers.

1.1.3 Operator Requirements - Keypunches are operated by one operator per station. Skill levels and salary levels are usually higher than those for typists.

1.1.4 Cost Ranges

| | Purchase | Lease |
|---|---|---|
| Unbuffered | $1,800 - $10,000 | $35 - $200/month |
| Buffered | $4,600 -$11,500 | $60 - $260/month |

1.1.5 Typical Data Entry Applications - Punched cards had been the most widely used data entry media. The keypunches which create these cards are used as input devices for many data entry applications. Almost every type of data entry application has been or is still being performed by keypunches.

1.1.6 Advantages and Strong Points

.Many data processing systems today are card-oriented and do not require modification when additional keypunch equipment is added.

.Keypunches have been used many years and both data processing personnel and users are familiar with their operation.

.Equipment cost is low.

.Individual card records are easy to manipulate, inspect, and change manually.

1.1.7 Disadvantages and Limitations

.Re-transcription of data (i.e., keypunching from data sheet to punched cards followed by "reading" the punched cards to convert the data to electrical signals) results in additional cost and time for computer data preparation.

.Keypunching usually requires a separate unit for verification or the use of more expensive punch/verify equipment.

.Keypunching is susceptible to undiscovered data errors because of the manual keying process and because the keypunches are generally not near the source data location.

.Punched cards are fixed in record or record segment size and do not allow for flexible record formats.

.Errors in cards require that entire new cards be

created.

.The noise generated by keypunches adds to the fatigue of the operators and requires that the devices be acoustically isolated from other offices.

.Keypunches are slow due to the mechanical card movement, duplicating, and skipping operations.

.Card storage can be expensive.

1.2 Equipment Category: Keyboard-to-tape. A keyboard-to-tape unit is an electronic data entry device which converts operator keystrokes into machine-readable codes recorded on magnetic tape.

This category includes both the keyboard-to-computer-compatible tape* and the keyboard-to-magnetic cartridge/cassette devices. The keyboard-to-computer-compatible tape type devices are now considered to be obsolete. These machines perform both encoding and verifying functions. Output is either used directly by the computer or may be merged with other tapes and pooled onto a master tape at higher recording density for computer input.

A typical keyboard-to-tape data recorder includes a keyboard conforming to either a keypunch or typewriter keyboard, a tape transport, and control electronics.

1.2.1 Equipment Characteristics

1.2.1.1 Data Capacity/Speed - Online transmission speeds (from the keyboard-to-tape unit to the central computer) normally do not exceed 2400 bps. The data transfer speed from the keyboard to the tape is not the determining factor when analyzing the speed of this equipment. Operator speed and automated entry features, such as automatic field duplication, determine the throughput of the device.

1.2.1.1.2 Volume Per Unit of Time - Reference sources have estimated a 20% increase in throughput for the key-to-tape devices over keypunch units (covered in section 1.1). This increase in throughput is due to the absence of mechanical card movement (particularly with regard to the unbuffered keypunch) and improved entry and validation features for the key-to-tape equipment.

1.2.1.1.3 Operator Speed - Some sources estimate that 10,000

---

*Keyboard-to-computer-compatible tape produces an industry standard 1/2 inch wide, 7 or 9-track (556/800 or 800/1600 bpi) magnetic tape (usually on a reel 10.5 inches in diameter) which can be read by computer peripheral magnetic tape drives.

to 18,000 keystrokes per hour are possible on keyboard-to-tape systems. However, in an actual production environment it is difficult to sustain this speed. One study found that 7150 keystrokes per hour is a more realistic average.

1.2.1.2 Operational and Environmental Requirements

1.2.1.2.1 Temperature/Humidity Requirements - Normal office environment is acceptable.

1.2.1.2.2 Area/Physical Location - Size of the units vary depending on the design of the system. Some are completely self-contained units with the keyboard, logic and recording device in a desk sized package that occupies 20-25 square feet per unit.

1.2.1.2.3 Computer Interface - Keyboard-to-tape devices are primarily intended to interface to computers via 1/2 inch magnetic tape. Tapes from individual units are often pooled by a tape pooler into a more efficient master tape. Some keyboard-to-tape units produce 0.15 inch tape on Phillips type cassettes or .25 inch 3M type tape cartridges. These media are prescribed by FIPS PUB 51 "Magnetic Tape Cassettes for Information Interchange" and FIPS PUB 52 "Recorded Magnetic Tape Cartridge for Information Interchange."

Most models offer online operation in a "store-and-forward" mode, where a batch of data is keyed, recorded on magnetic tape, and later transmitted to the central computer or to a pooling device.

1.2.1.3 Input Characteristics

1.2.1.3.1 Record Sizes - Maximum record sizes are generally less than 200 characters.

1.2.1.3.2 Character Sets Available - Keyboard-to-tape units are available with up to 96 (upper and lower case) alphanumeric and special characters using BCD, Hollerith, EBDCID, USASCII, and vendor unique code sets. Except for the tape control functions, the keyboard layout can either be a keypunch keyboard style or a typewriter keyboard style. The latter is normally found on many of the text-oriented cassette recording devices.

1.2.1.3.3 Special Form Requirements - Tape requirements range from 10.5 inch computer-compatible tape reels for 1/2 inch wide computer magnetic tape to the self-contained cassettes or tape cartridges.

1.2.1.4 Output Capabilities - All keyboard-to-tape devices incorporate some means of displaying recorded data. Some units produce a printed copy of the recorded data; other units, lacking hardcopy capability, display only the current

character. In this category, there are two principal types. One is a binary configuration designating the character. The other is the display of the actual character entered. However, the use of alphanumeric displays (CRT's) for display of the entire format is becoming more prominent. Other types of output include punched card, punched paper tape, and online operation with central computer, or other keyboard-to-tape units.

1.2.1.5 Edit/Validate Capabilities - The following features are common with the stand-alone keyboard-to-tape systems:

. Check digit verification - A check digit is appended to a numeric field as an additional character whose value is determined by a simple formula. Its value can be checked at any later time to enhance confidence in the validity of the data field.

. Data verification/format checks - This guards against skipping designated fields during keying (must-enter fields), placing alpha characters in a numeric field or numeric characters in alpha fields, and overruning records.

. Record search - This allows searching tape for a record identified by a unique key.

In addition to the above, keyboard-to-tape systems which incorporate a shared processor have many of the features described for the keyboard-to-disk (shared processor) equipment category presented in section 1.3.

1.2.2 Options - Options available for the keyboard-to-tape systems include the following:

. Line printers
. Card punches
. Communication interfaces
. Tape poolers
. Data converters
. Unattended operation mode (data transmission)
. Search and edit tape functions
. CRT displays
. Paper tape punches

1.2.3 Operator Requirements - One operator per station. Keyboard operation is similar to that of a keypunch (or typewriter), but tape threading, etc., may require somewhat more skill/training than keypunch operation. Reference sources indicate that operator acceptance is normally higher for the key-to-tape units than for keypunch equipment.

1.2.4 Cost Ranges - The cost of keyboard-to-tape units is as follows:

Purchase - $3,000 - $10,000

Lease/month - $100 - $250

1.2.5 Break-Even-Point(s) - The monthly lease cost of the keyboard-to-tape units is generally more than twice that of the widely used IBM 029 keypunches. Several factors should be considered when analyzing the cost effectiveness of the keyboard-to-tape units versus the keypunch.

First, a replacement ratio of three to five can normally be applied. That is, three keyboard-to-tape units can replace a combination of five keypunch and verification units. This is due to a throughput increase of 20 to 40% and the fact that the keyboard-to-tape units function as both data transcribers and data verifiers.

Second, magnetic tapes are reusable and punch cards are not.

Third, the cost of storing and handling cards is normally much higher than that of magnetic tape since cards occupy much more space and usually require environmental controls to ensure that dimensional stability is maintained.

Fourth, if a data converter (for cassette devices) is required or if pooling equipment is used, the cost of replacing the keypunches will increase. If, however, 10 or more keyboard-to-tape units share this additional equipment, the cost per unit would not significantly increase.

1.2.6 Typical Data Entry Applications - Key-to-tape units are normally used for direct keypunch replacement. With online capabilities, the keyboard-to-tape units can be used for remote data entry in a store-and-forward mode. In this mode, data is batched on tape and transmitted at a later time.

1.2.7 Advantages and Strong Points

. Keystrokes per hour can be from 20-40% higher with key-to-tape devices than with keypunches.
. Magnetic tape, as an input medium, is much faster than punch cards.
. Operators can concentrate on keying data with no interruptions for card handling.
. Data search and error correction capabilities are available.
. The edit/validate features of key-to-tape devices are more extensive than those of keypunch equipment.
. Key-to-tape units can be located at the functional users site and be used as a source data entry device.
. Keying operation is quiet and generally acceptable in office environments.

1.2.8 Disadvantages and Limitations

. Keyboard-to-tape units are from two to three times

more expensive than keypunch units.

. Data conversion or tape pooling is usually necessary prior to input into the computer.

1.3 Equipment Category: Keyboard-to-disk - A keyboard-to-disk is an electronic data entry device which converts operator keystrokes into digital codes recorded on magnetic disk. This category includes both the shared-processor keyboard-to-disk and the stand-alone keyboard-to-diskette units. A keyboard-to-disk system typically includes a small processor with 8K or 16K word memory, a magnetic disk drive, a tape drive, a supervisory station and from 4 to 64 key entry stations. Data keyed simultaneously from any number of stations first goes through the processor for formatting, verification, and editing and then is stored on disk. At selected time intervals, a command sent from the supervisory station will "dump" the stored data onto magnetic tape. Some systems also allow data to be transferred from disk directly to the host computer. The disk storage of these systems can also be used to store up to 1,000 pre-programmed file, record, or page formats.

1.3.1 Equipment Characteristics

1.3.1.1 Data Capacity/Speed

1.3.1.1.1 Transfer/Transmission Speed - Some systems offer online operation with up to 2400 bps transmission speeds. The data transfer speed from the keyboard to the disk is not the determining factor when analyzing the speed of the equipment. Operator keying speed and entry features/software determine the throughput of the device.

1.3.1.1.2 Volume Per Unit of Time - It is estimated that a 25-50% increase in throughput can be realized for the key-to-disk devices over keypunch units. This is due to the absence of mechanical card movement, to the systems' ability to insert constants, justify, skip, duplicate, and to the many software features which may be implemented in the shared-processor systems.

1.3.1.1.3 Operator Speed - Speeds of from 12,000 to 20,000 keystrokes per hour are possible, but an average of approximately 7150 keystrokes per hour can be expected for a typical application.

1.3.1.2 Operational and Environmental Requirements

1.3.1.2.1 Temperature/Humidity Requirements - A normal office environment is acceptable.

1.3.1.2.2 Area/Physical Location - Space required for each unit varies depending on the arrangement of the clustered units (shared-processor) but each individual unit requires

approximately 20-25 square feet. The self-contained units occupy about the same space.

1.3.1.3 Input Characteristics

1.3.1.3.1 Record Sizes - Keyboard-to-disk systems are capable of creating records larger than 80 characters. Maximum record sizes vary depending on the hardware, generally up to 128 characters for data entry and 1024 characters for tape output operations.

1.3.1.3.2 Character Sets Available - Keyboard-to-disk systems are available with up to 96 (upper and lower case) alphanumeric and special characters using BCD, Hollerith, EBCDIC, ASCII, and vendor unique code sets. Keyboard layout can be either keypunch or typewriter.

1.3.1.3.3 Special Forms Requirements - The medium for output is normally computer-compatible 10.5 inch reels or industry standard flexible diskettes.

1.3.1.4 Output Capabilities

(1) Visual Output
- CRTs
- Typewriter Printers
- Line Printers
- Character Displays

(2) Computer Media Output
- Punched Cards
- Punched Paper Tape
- Online communications with computer
- 1/2 inch magnetic tape
- Diskettes

1.3.1.5 Edit/Validate Capabilities - Numeric Checks - Insure the numeric correctness of keyed-in data. Some of these are:

- Check digit. A check digit is appended to a numeric field as an additional character whose value is determined by a simple formula. Its value can be checked at any later time to enhance confidence in the validity of the data field.
- Zero Balancing. This provides summation or subtraction of specific data fields before and after data entry. The results are then compared.
- Range values. This checks that the data lies within prescribed numeric limitations.
- Logical checks. This checks that keyed data from one field is in specific relation to other data fields, e.g., greater than, less than, etc.
- Format Checks. These checks guard against skipping specified data fields during keying (must-enter fields),

placing alpha characters in numeric fields or numeric characters in alpha fields, and overruning records.

. Table Lookup. This is a comparison of keyed data with data stored on disk.

Most editing/validation of data can be done "on the fly" which permits error detection and display during keying. The system will stop and display the error to permit immediate data correction.

In addition to the listed features, the shared-processor systems are flexible and perform many user-defined edit/validate functions.

1.3.2 Options - Optional equipment available for keyboard-to-disk systems include the following:

. Line printers
. Card punches
. Card readers
. Communication interfaces
. Data converters
. Paper tape punches
. Paper tape readers
. OCR, OMR readers
. Additional memory and/or disk capacity

1.3.3 Operator Requirements - One operator per station. Operators with keypunch or typewriter skills can be easily retrained to operate key-to-disk systems.

1.3.4 Cost Ranges -

| | Lease/mo./station | Purchase/station |
|---|---|---|
| Stand-alone diskette | $160-$250 | $6,000-$10,000 |
| Shared processor systems | | |
| 4 station system | $170-up | $8,000-up |
| 8 station system | $150-$275 | $6,100-$12,000 |
| 16 station and up | $100-$215 | $4,400-$8,500 |

1.3.5 Break-even-points - The keyboard-to-disk devices suffer from the same cost disadvantages (when compared to keypunch) as the keyboard-to-tape devices described in Section 1.2. The same factors mentioned in the keyboard-to-tape profile should also be considered for the keyboard-to-disk systems. Most of the keyboard-to-disk systems share a processor and other common components. This sharing makes the economics-of-scale more apparent. To be cost effective, the keyboard-to-disk units will have to be deployed in centralized configuration containing 16 or more units, and a keypunch/verifier to keyboard-to-disk replacement ratio of either 5 to 3 or 8 to 5 is required.

1.3.6 Typical Data Entry Applications - Most keyboard-to-disk systems are intended to replace large

centralized keypunch operations. Individual keyboards can be as much as 2000 feet from the shared processor (up to 4000 feet with the use of in-line amplifiers). This tends to decentralize source data entry to a limited degree. The stand-alone diskette systems can be located at remote sites and be used as source data entry devices. The output from these units must be converted to a computer compatible format.

1.3.7 Strong points and advantages

. Shared-processor systems possess both a price and speed advantage over most stand-alone encoders if a user has a large enough installation to require a number of keyboards. Since multiple keyboards share a processor, intermediate storage devices and tape drives, the cost of having a tape drive and controller unit for each keyboard is eliminated. The cost of a larger, more versatile processor and of intermediate storage devices is substituted.

. Shared-processor systems with disk storage eliminate the need for pooling tapes.

. Verification can be initiated before record entry is complete.

. Numerous edit/validate programs can be stored in a program library and called by a single key.

. Operator can enter data fields in most efficient sequence and the system can reformat the data for input to the computer.

. Many key-to-disk systems make validation checks possible at the data entry level, thus eliminating the high cost of error correction at the mainframe.

. In comparison to keypunches, it is estimated that operator productivity increases 25%-50% due to the system's ability to insert constants and to justify, skip, and duplicate fields.

. The use of key-to-disk systems eliminates the cost of card handling and card storage.

. Key-to-disk operation is reasonably quiet, making it suitable for use in an office environment and essentially eliminating operator noise-fatigue.

1.3.8 Disadvantages and Limitations

. Failure of a shared component in a shared-processor system will render the entire system inoperative.

. Most keyboard-to-disk units are not easily adapted to decentralized source data entry because of the limited distance (up to 2000 or 4000 feet) they can be from the processor.

. Keyboard-to-disk units are more expensive than keypunches.

1.4 Equipment Category: Portable Keyed Devices - Portable data recorders are small, lighweight, low cost, manually-operated data recording devices. They record data

on punch cards, paper tape, magnetic tape, or storage media or they may be designed to transmit data directly to a computer through a communications interface. These devices are simple to operate since their principal application is for on-site data entry, usually performed by other than data processing personnel.

1.4.1 Equipment Characteristics

1.4.1.1 Data Capacity/Speed

1.4.1.1.1 Transfer/Transmission Speed - The transmission speeds of the online devices vary from 100 bps to 2400 bps.

1.4.1.1.2 Volume Per Unit of Time - The volume of data transmitted or recorded is dependent upon the speed of the operator. However, some of the devices producing punched cards may be limited in speed by their mechanical operation.

1.4.1.1.3 Operator Speed - The speed of the operator is the limiting factor for most of the portable recording devices.

1.4.1.2 Operational and Environmental Requirements

1.4.1.2.1 Temperature/Humidity Requirements - Portable data recorders that will be exposed to extreme weather conditions are designed to withstand these conditions. The devices which produce punched cards are not suited for areas with high humidity. The devices which record on magnetic tape and the units with communication capabilities usually have a temperature range of -18C to 50C and a humidity range of 0% to 100% (as long as condensation does not occur).

1.4.1.2.2 Area/Physical Location - Some of the units such as the portable teleprinters, CRT's, card punches, etc., require a table top. Others are small hand held devices which may be carried in the hand or placed on a working surface for ease of use.

1.4.1.2.3 Computer Interface - Some of the devices offer online operation through standard interfaces such as the EIA standard 232C designed for use with modems or acoustic couplers used with telephones. The devices that record on magnetic cassettes or cartridges require a data converter to produce computer-compatible magnetic tape.

1.4.1.3 Input Characteristics

1.4.1.3.1 Record Sizes - The devices producing punched cards are limited to 80 character records. The record size limitations of the other units vary depending on the equipment.

1.4.1.3.2 Character Sets Available - The larger, less portable, units (teletypewriters, etc.) are available with

up to 96 alphanumeric and special characters producing ASCII, EBCDIC, BCD, Baudot, or Hollerith codes. The small hand held units (and some desk top models) typically have from 12 to 18 keys, including 0-9, a few alpha characters and several function keys.

1.4.1.3.3 Special Form Requirements (recording media) - The following recording media may be required depending on the type of portable recording device:

- Thermal paper
- Magnetic tape cassettes
- Paper tape
- Paper strip roll (for strip printer)
- Plastic cards (similar to credit cards)
- 80 column punch cards

1.4.1.4 Output Capabilities - Typical display of input data is on paper, plasma display, LED (light emitting diodes) display, or CRT's. Some of these portable data entry devices may also be equipped to function as a computer output device. In this case, output from a computer is limited to those devices which have online capabilities. The output media may include hardcopy, visual (LED or CRT) display, or voice response.

1.4.1.5 Edit/Validate Capabilities - The edit/validate features of portable keyed devices are either non-existent or were not covered by the sources reviewed.

1.4.2 Options

- Hard copy printers
- Communication interfaces
- Magnetic tape cassette recorders
- Optional character sets
- Paper tape punches/readers
- Memory size

1.4.3 Operator Requirements - Most of these devices are designed to be operated by the user at the site where the data is generated. In many cases, these devices have special-purpose features and keyboard arrangements specifically designed to the application. Typing or adding machine skills are usually advantageous.

1.4.4 Cost Ranges -

| Type | Purchase Price |
|---|---|
| Teleprinter | $1,500-$3,800 |
| CRT | Approx. $4,000 |
| Punched card | $ 55-$1,500 |
| Hand held cassette recorders | $ 950-$2,500 |

1.4.5 Typical Data Entry Applications - These devices are

well suited for capture of data at its source. The use of portable keyed devices should be considered for the following applications:

- Inventory control
- Maintenance reporting
- Any data entry task accomplished in the field or at remote locations.

1.4.6 Advantages and Strong Points

- The devices can be used for source data entry by the functional users in offices, in shops, or wherever data originates.
- Many of the units can be used in extreme environments, i.e., in areas not normally suited for other data entry equipment.
- The units are simple to operate.
- Many of the smaller units do not require an AC power source since they operate on batteries.
- The portable keyed devices are less expensive than most other data entry equipment.

1.4.7 Disadvantages and Limitations

- The portable keyed devices lack the edit/validate features available on other types of data entry equipment.
- The data recorded on magnetic tape cassettes by some of the devices require data conversion prior to input to the computer.

1.5 Equipment Category: Alphanumeric Display Terminals - An alphanumeric display terminal is a compact unit that resembles a small television set equipped with a keyboard. Although there are a variety of screens on which alphanumeric data may be displayed (including light-emitting diodes, liquid crystal, and plasma screens), the most common type, and the one discussed in this report, is the cathode ray tube (CRT) display.

CRT display terminals are available in one of two basic terminal configurations, stand-alone or cluster. Stand-alone units are typically those that contain all components that support the operation of the terminal, including the CRT screen, keyboard, communication interface, buffer memory, and in some cases varying degrees of local processing or editing capability provided by a small processor with program memory, all in a single cabinet. A cluster configuration typically includes a terminal control unit and a number of individual, cable-connected keyboard/display units. The component- sharing technique used in cluster systems usually results in a lower cost per display unit.

Display units can be connected directly to a computer for

online operations or to some form of independent storage unit for off-line operations.

### 1.5.1 Equipment Characteristics

#### 1.5.1.1 Data Capacity/Speed

1.5.1.1.1 Transfer/Transmission Speed - Most units have selectable transmission speeds ranging from 110 to 9,600 bps. Their speed is limited by the quality of the communication line. The following are speeds obtainable with various types of line quality:

- Voice-grade switched network - up to 4800 bps
- Leased or private lines - 9600 bps
- Direct cable connection to a computer - Some vendors publish rates of up to 1,000,000 characters/second. This speed may be restricted by the ability of the application program to accept data or by the speed of the I/O channel used for connecting the unit. Also, cable characteristics and length affect speed.

1.5.1.1.2 Volume per Unit of Time - The throughput of the display unit is generally higher than for other less sophisticated data entry devices as a result of various human-engineered features that may be provided to enhance operator accuracy and speed. In any case, the throughput will be limited by the skill of the operator and by the features actually available on the device. These human-engineered features include:

- Keyboard design
- Split screen display
- Operator prompting (fill-in-the-blank)
- Simple data editing or error correction

1.5.1.1.3 Operator Speed - Because of the higher degree of equipment and software sophistication providing various automated functions, the operator of a display terminal probably needs less than average keypunch or typing skills in a source data entry application. Features such as operator prompting and split-screen display serve to compensate for lack of skill and may significantly increase throughput in many applications.

#### 1.5.1.2 Operational and Environmental Requirements

1.5.1.2.1 Temperature/Humidity Requirements - Most units require a normal office environment although some units can operate in less controlled environments, such as warehouses or shops.

1.5.1.2.2 Area/Physical Location - A typical alphanumeric display unit requires approximately 5 square feet and can be placed on a desk or table top. Some displays have

detachable keyboards, providing increased configuration flexibility and operator convenience.

1.5.1.2.3 Computer Interface - Alphanumeric display terminals are interfaced to a computer by:

. Direct connection to computer via cable, or
. Communication lines (leased or dialed)

1.5.1.3 Input Characteristics

1.5.1.3.1 Record Sizes - Record sizes are limited to the size of the internal buffer which is at least equal to the maximum number of character positions which can be displayed on the screen. Typical record sizes may range from the number of characters in a line (80) to the number of characters displayed on a full screen (1920).

1.5.1.3.2 Character Sets Available - Most units offer 64 to 95 graphic character keyboards, representing ASCII, BCD, or EBCDIC code sets.

1.5.1.3.3 Special Form Requirements - None.

1.5.1.4 Output Capabilities

. Hard copy printers - thermal, inkjet, or impact
. Photographic devices that use polaroid or microfilm techniques for permanent record of CRT display
. Visual display on CRT screen, typically from 480 to 1920 characters
. Paper tape punches
. Magnetic tapes - computer compatible or cassette
. Card punches

1.5.1.5 Edit/Validate Capabilities - Alphanumeric display units are usually considered to be one of the most flexible source data entry devices currently available. The features which aid in the edit and validation of data include the following:

. Protected fields - This feature allows the use of forms for a "fill-in-the-blank" technique of data entry. The transition from a manual method is eased when a familiar form can be displayed on the screen and the user can insert the required information in the appropriate fields. All data entry applications can have the formats of required forms stored for retrieval when needed.
. Split screen - This feature is similar to protected fields. One part of the screen can contain fixed (protected) data and the other part of the screen is used for the variable data to be entered by the operator.
. Cursor movement - On most units, the cursor can be moved up, down, right, left, and home. This allows the operator to easily progress to any field for data entry or for correction of an error.

. Error correction - Characters or lines can be inserted or deleted.

. Tabulation - The cursor can move to a predetermined position. This feature is similar to the tab function on a typewriter.

. Character or field emphasis - Characters or fields can be emphasized by varying their intensity and/or causing them to blink on the screen.

. Scrolling - This technique eliminates the top (or bottom) line of displayed data, moves all lines of data up (or down) the screen one line, and inserts a new line at the bottom (or top). This feature is normally used for reviewing textual data.

. Paging - This feature stores two or more frames or pages of data and displays any selected page.

1.5.2 Options - Alphanumeric display devices offer a wide range of options, including both peripherals and operating features. The most common peripherals include: magnetic tape (computer compatible and cassette), hard-copy printers (thermal, inkjet and impact), remote TV monitors, magnetic disk, card readers, card punches, paper tape readers, paper tape punches, photographic recorders, badge readers and light pens. Optional operating features include: choice of keyboard style (keypunch or typewriter), numeric cluster and special function keys, various numbers of characters per displayed line or lines per page, variable transmission speeds, communication interfaces, protective housings, a choice of character sizes, character sets, and memory sizes, special purpose software and firmware, and bells or buzzers (for operator attention).

1.5.3 Operator Requirements - Alphanumeric display devices can be used effectively by the personnel responsible for the capture of source data. These devices are being used in many applications by professional as well as clerical personnel. Many levels of skill can be accommodated by the alphanumeric display units because of their flexibility. Obviously, the more skilled operator can achieve more throughput. The operational procedures can be designed so that the operator can be led through each input step, not worrying about which field comes next, or how many leading zeros are needed, for example.

1.5.4 Cost Ranges - The cost of alphanumeric display units has been steadily declining during the past few years, primarily as a result of decreases in the cost of electronics hardware and logic components. This trend to lower prices for the same functional capabilities is expected to continue as user acceptance (and sales volume) increases. The price of a display unit is influenced by the number of characters displayed on the screen, the editing and formatting features offered, and the quality and legibility of the image. The cost of a display terminal is also affected significantly by whether the terminal operates

in a complete stand-alone mode or whether it is one terminal in a multiterminal system in which much of the storage and logic required for each terminal is centralized in a control unit. The purchase price of units range from less than $1,000 to $15,000 and lease prices from $50 to $400 per month.

1.5.5 Typical Data Entry Applications - Alphanumeric displays are considered to be the most flexible data entry devices available today. Almost any application can be accommodated with alphanumeric displays. Professional and clerical personnel find the units easy to use because of the unit's ability to display formats, operator instructions, error conditions and other helpful information. Typical data entry applications include: inventory control, production control, accounting and finance, personnel, maintenance, flight scheduling and online software development.

1.5.6 Advantages and Strong Points

. Speed - An alphanumeric display is an electronic device that is inherently faster than its electromechanical competitors. Teleprinters typically operate at 10 characters per second. During input, a CRT can display as fast as the operator types; during output it can operate up to 40,000 characters per second. When memory is used in the display, data exchange with the computer can be at the same speed regardless of the direction of transmission. However, speed limitations (typically from 300 to 600 characters per second) are usually imposed on display operations when they are connected by telephone lines to the computer.

. Human Factors - An alphanumeric display is reasonably noiseless and therefore preferred in environments that are sensitive to disruptive sounds. Operator noise fatigue does not present the problem that is found in the electromechanical devices.

. Flexibility and Convenience - A user typically has a number of unique data input and output requirements. An alphanumeric display can be used to fulfill many of these specific needs by combining input and output capabilities within one unit. In addition, unique data presentation features reduce operating complexity and facilitate operator/computer information interchange. The ability to partition display memory, for example, allows the user to display instructions or special forms to aid the operator in performing his task without having to retype permanent or semipermanent information. The data formats displayed on the screen can be quickly changed by the computer or by the operator. The display, therefore, is uniquely suited for a variety of data input/output applications.

. Error Control - Immediate data display, special

editing features, and the interaction between the computer and the terminal operator greatly simplify and improve error detection and correction. Since the data is not permanently recorded on the CRT screen, it can be changed easily. Typical operating experience indicates that 90 percent of the keyed errors are sensed by the operator and can be corrected immediately after they are made. Computer control, in many cases, can detect data input errors as they are being recorded. Consequently, the complexity of error detection and correction is greatly reduced, and the resulting "correction time" is minimized.

1.5.7 Disadvantages and Limitations

. Cost - Alphanumeric displays themselves are normally less expensive than the keypunch; but, in addition to the cost of the display, communication interface costs and line costs must be considered. Generally this additional cost results in the comparative cost being slightly higher.

. Lack of hard copy capability - A printing device (sometimes a built-in feature) is required to produce a hard copy of the image displayed on the screen.

1.6 Equipment Category: Teleprinters - A teleprinter is an electromechanical typewriter-like keyboard entry device designed to transmit data over communication lines. It also provides hard-copy paper output capability. The teleprinter can perform as an online remote data entry terminal. Although data is usually not buffered and is transmitted asynchronously (character by character) as the keyboard is actuated, a paper or magnetic tape attachment permits off-line data preparation and storage for batched continuous transmissions. Recently, bubble memories, diskettes and RAM memories have become increasingly popular as storage devices for batched continuous transmission instead of punched paper tape equipment.

1.6.1 Equipment Characteristics

1.6.1.1 Data Capacity/Speed

1.6.1.1.1 Transfer/Transmission Speed - Older teleprinter equipment is electromechanical and is generally classified as a slow data communications device. While some of the more recently developed electronic units contain input/output data buffers and can operate up to 9600 bps, most units receive and transmit asynchronously in a range from 110 to 300 bps. This range equates to approximately 10 to 30 characters per second.

1.6.1.1.2 Volume Per Unit of Time - While teleprinters are generally slow, low-volume devices, throughput is limited by operator keying speed (most units are unbuffered) and low-speed electromechanical keyboard and printing mechanisms. These constraints have been overcome in more

modern units that have electronic keyboards and ink jet, electrostatic or thermal printers.

1.6.1.1.3 Operator Speed - As noted above, operator keying speed is sometimes a limiting factor when assessing the speed of teleprinter devices. The keying speeds achieved on these devices are generally lower than those of other keyboard devices that have such human-engineered features as better keyboard design, skipping, automatic field justification and field definition.

1.6.1.2 Operation and Environmental Requirements

1.6.1.2.1 Temperature/Humidity Requirements - Most teleprinters are designed to operate in the normal office environment. Some units are more ruggedly designed for use by the military or to operate in a less controlled environment such as a warehouse or shop.

1.6.1.2.2 Area/Physical Location - The typical unit requires slightly more space than an office typewriter. Many units are available with small table or pedestal fixtures.

1.6.1.2.3 Computer Interface - Most teleprinter units are designed to interface with a computer by cable or by telephone lines through either a modem or an acoustic coupler. Off-line operation can be accomplished using paper tape, magnetic tape cassette, or a diskette.

1.6.1.3 Input Characteristics

1.6.1.3.1 Record Sizes - Other than the number of characters that can be typed per line, the grouping of characters to form records is determined by the computer to which the teleprinter is attached; thus record sizes are dependent on the software controlling the teleprinter. If the teleprinter uses a paper tape or magnetic tape unit for buffering, logical records could be captured by one of these media.

1.6.1.3.2 Character Sets Available - Newer teleprinter models are available with up to 128 (upper and lower case) alphanumeric and special characters representing ASCII, EBCDIC, BCD, and APT character sets.

1.6.1.3.3 Special Forms Requirements - Depending upon the printer mechanism, paper requirements for teleprinters range from specially treated paper for thermal printers, to standard paper used with the impact printers. Many of the teleprinters have attachments for handling paper tape, magnetic tape or diskettes for performing off-line batch-oriented data entry operations.

1.6.1.4 Output Capabilities - Teleprinter output capabilities include printed hard copy, punched paper tape,

magnetic tape, diskettes, and online communications with a computer.

1.6.1.5 Edit/Validate Capabilities - Edit/validate features of teleprinter devices are available only on those devices that provide some form of buffering.

1.6.2 Options - Teleprinter options include:

. Various communication interfaces and transmission speeds.
. Intermediate storage devices such as paper tape units and magnetic tape units.
. A choice of character sets and keyboard layout.
. Several printing techniques (inkjet, impact, or thermal) and printing speeds.

1.6.3 Operator Requirements - In a production environment, the operator should possess teleprinter or typewriter skills. If the device is used in a functional area (source data automation environment), these skills will prove beneficial.

1.6.4 Cost Ranges - The purchase prices of teleprinter devices range from $600 to $12,000. Lease prices range from $40 to $550 per month.

1.6.5 Typical Data Entry Applications - Teleprinter terminals find use in many teleprocessing and data communication applications, with computer time sharing being perhaps the most significant. Other applications include file updating, data retrieval, data dissemination and message interchange. Traditionally, the primary application of teleprinter terminals has been for low-volume, time-dependent communications where the data is not temporary in nature and a local hard copy is needed.

1.6.6 Advantages and Strong Points

. Teleprinters are low cost data entry terminals.
. They can be used as a source data entry device.
. Many units are designed to be rugged and portable and can be used anywhere a telephone is located.
. They produce printed hard copy.
. Their operation is no more complicated than an electric typewriter.
. Units with temporary storage devices (paper tape, diskette, magnetic tape) can be operated in store-and-forward mode.

1.6.7 Disadvantages and Limitations

. Teleprinters are one of the slowest terminal devices available.
. They generally have no edit/validate capabilities.

. Operator acceptance is normally not as high as compared with the electronic devices such as alphanumeric display units.

. Some of them are very noisy.

Chapter 2

# READER TYPE DEVICES

2.1 Equipment Category: Optical Character Readers (OCR)* - An optical character reader is a device which recognizes the shape of characters by the contrast of light and dark areas created when light is reflected from the surface of a document (or transmitted through a film).

OCR's are generally classified by three characteristics:

- the style of characters or fonts which can be recognized
- the character sets and repertoire which can be recognized
- the size or type of forms which can be accommodated

Based on the number of character styles (fonts) an OCR can recognize, it is classified as a single-font, multi-font, multiple-font, omni-font, or handprint reader. Within these classes, OCR's may be further divided by the character set(s) recognized: numeric, alphanumeric, symbols, and special function notation. In addition, OCR's are distinguished by the size or type of forms that the device will accept. Page readers typically accept forms up to 11 by 14 inches while document readers typically accept forms up to 4 by 9 inches. An example of a form used on a document reader is the "turnaround" credit card document. Document readers generally read one or two lines per document, while page readers are capable of reading a whole page.

Other forms frequently used as input to OCR devices include journal tapes (e.g., paper cash register rolls) and microfilm.

There are two basic modes of operation used with OCR systems. When the generation of source documents can be controlled (i.e., the correct font is used, the quality of the paper and of the printing is consistent, and acceptable document sizes are used) a Direct Read mode is used. This means the source documents are read directly by the OCR. However, if the generation of source documents cannot be controlled, a Retype mode is used. In this mode, part or all of the source data is retyped on acceptable forms using an appropriate font.

Before the advent of key/disk systems, typing on electric typewriters and subsequent scanning (the retype mode of

---

*OCR is also used as an abbreviation for Optical Character Recognition.

operation) proved to be more economical and accurate than keypunching and verifying, if the installation was utilizing a large typing pool comprising thirty or more employees. At the present time, using the retype mode of operation would, in most cases, be difficult to justify.

2.1.1 Equipment Characteristics

2.1.1.1 Data Capacity/Speed

2.1.1.1.1 Transfer/Transmission Speed - OCR speeds are limited by three factors: the rated speed of the communications interface used, the capabilities of the mechanism that handles the documents or pages to be read and the electronic character reading speed of the device.

2.1.1.1.2 Volume Per Unit of Time - Typical speeds for page and document readers are as follows:

| | Pages/Min. | Characters/Sec. |
|---|---|---|
| Page Readers | Up to 400 | Up to 3600 |
| Document Readers | Up to 1600 | Up to 3600 |

2.1.1.1.3 Operator Speed - Not applicable.

2.1.1.2 Operational and Environmental Requirements

2.1.1.2.1 Temperature/Humidity Requirements - Most OCR units can operate in ordinary office environments; however, some of the larger units require supplemental air conditioning.

2.1.1.2.2 Area/Physical Location - Most of the OCR units can be connected directly to a computer through an I/O channel similar to that used by a card reader. Other OCR units are designed for remote operations and are connected to a computer through a modem and communication lines. Some OCR's are designed to be used in an off-line mode and provide an intermediate magnetic tape, magnetic disk, punched cards, or punched paper tape.

2.1.1.3 Input Characteristics

2.1.1.3.1 Record Sizes - Minimum and maximum record sizes for OCR devices range from several characters per document for the simple, single line special purpose devices up to approximately 7,000 characters per page for the more sophisticated page readers.

2.1.1.3.2 Character Sets Available - The most significant difference among OCR's is their ability to recognize different shapes (styles) of machine-generated characters (fonts) and their ability to recognize handprinted characters. The more common machine-generated fonts include ANSI OCR-A and OCR-B, Farrington 7B, and IBM 1428. Most OCR's with the ability to recognize handprinted characters

are limited to a small repertoire of characters including numerics only or numerics and few alpha and special characters such as C, T, X, N, Z, +, and -. However, several OCR manufacturers provide machines that can recognize the full set of alpha and numeric handprinted characters. Although handprinting at the source seems to be a very good technique of collecting data in certain application areas where data collection personnel can be adequately trained, error rates ranging from 3 percent to 20 percent are common depending on the operating environment and data preparation controls. FIPS PUB 32 "Optical Character Recognition Character Sets" and FIPS PUB 33 "Character Set for Handprinting" provide information in this area of interest.

2.1.1.3.3 Special Form Requirements - Forms are probably the most critical requirement of an OCR operation. The design of the form must meet the requirements of the reading device and also have an efficient layout for the user. The OCR depends on the contrast of the characters to the background of the form for character recognition. The paper must be of high quality, free of dirt and other foreign substances, and its thickness must be in a specified range. Data usually must be in predefined locations and the characters must be properly registered,* crisp, and well defined with very little skew. FIPS PUB 40 "Guideline for Optical Character Recognition Forms" provides guidance in this area.

2.1.1.4 Output Capabilities - The input to optical character readers is in human-readable form and the output is in machine-readable form. Optical character readers can operate in either an online or an off-line mode. When operating online, the OCR transmits to a host computer via communication interfaces or a direct channel connection. Off-line, the OCR uses a temporary storage medium for output. This may take the form of punched cards, paper tape or magnetic tape. Some OCR's use a CRT for communications with the operator, displaying operational status and error conditions. The CRT also facilitates error correction if employed with a keyboard.

2.1.1.5 Edit/Validate Capabilities - The control component of any OCR system is a minicomputer. As with medium and large scale computers, the capability to manipulate and edit or validate data in local storage is thus an inherent feature of all OCR equipment.

The following are examples of editing functions that can be performed by the OCR:

. Character deletion

---

*The physical positioning of a character, vertically and horizontally, with relation to the form.

- Line deletion
- Header data insertion
- Keyboard insertion
- Numeric field check
- Rearranging of fields

Reject correction can be accomplished "on the fly" using a CRT device.

2.1.2 Options - Options available on Optical Character Readers are as follows:

- CRT terminals
- Line printers
- Communication interfaces
- Expandable computer memory
- Disk drives
- Tape drives
- Teleprinters (consoles)
- Optional fonts, including handprinting, mark-sense, etc.
- Paper tape punches, paper tape readers
- Card readers
- Journal tape readers
- OMR, MICR
- Additional sort pockets
- Journal tape listers (printers)
- Microfilm/microfiche image recognition

2.1.3 Operator Requirements - If the OCR system uses a keyboard device (CRT or teleprinter) for error correction, keying skills are beneficial. However, the personnel who place the data on the forms read by the OCR are the critical link in the success of an OCR system. This is especially important where the reading of handprinted characters is involved. If the OCR input is prepared on a typewriter, the typist should be specifically trained in the preparation of the OCR forms. If the input will be handprinted, the personnel preparing the OCR input should be thoroughly familiar with the rigid requirements of OCR handprinting.

2.1.4 Cost Ranges - The price of OCR has decreased considerably during the last several years due to the decreasing cost of electronic logic components. Document readers can be rented for under $1,000 per month, single font page readers for $2,000 to $4,000 per month, and multi-font readers for over $10,000 per month. Purchase price for single-font readers range from $20,000 to $30,000 while purchase prices for multi-font readers range from $100,000 to $1,000,000. Although low-cost OCR devices offer an economical means of data capture, they require tighter controls on preparation of forms than do higher-priced, more sophisticated units.

2.1.5 Typical Data Entry Applications - In many instances,

OCR's are used as direct replacement for keypunches with typing and visual verification being substituted for the keypunching and verification processes. An application which requires the generation of a hard copy as a by-product of data collection could lend itself very easily to an OCR system. OCR's have had a tremendous impact on applications using "turn-around" documents as in the insurance, retail and oil industries. The ability of Optical Character Readers to read handprinted characters should make the OCR a prime candidate for applications where small amounts of data need to be collected from many locations. This ability makes the pencil and paper a powerful source data entry tool.

2.1.6 Advantages and Strong Points

. OCR's convert human-readable and human-prepared data directly into computer-readable codes. The key to efficient and more economical data entry lies in the elimination of data transcription and the associated labor costs by direct data capture at the source. Optical Character Readers offer a means to accomplish this feat by direct reading of printed, typed, or handprinted data without special manual intervention.

. When the OCR is used as a keypunch replacement, the keypunch can be replaced by a typewriter. Reference sources state that the operation of the typewriter is faster and generally more accurate than keypunching. Users consistently support the idea that accuracy via typing and proofreading is comparable with that obtained by keypunching and verification; i.e., 1 to 3 percent error rate.

. Extensive edit/validation procedures can be applied to the data as it is being read by the OCR. Software executed on the OCR's minicomputer can assume some of the data manipulation normally accomplished on the larger host computer.

2.1.7 Disadvantages and Limitations

. OCR operations are unique in that document control plays a significantly more important role in reading reliability than does any other single consideration. When there is strict control over source documents, OCR works well. Controlled conditions exist when operating personnel are experienced, well trained, and can be directly supervised. While low-cost OCR devices offer an economical means of data capture, they require tighter controls over the form than do higher priced, more sophisticated units. To date, only very large applications can justify the expense of the more sophisticated character readers capable of functioning satisfactorily with completely uncontrolled field documents.

. In addition to the high cost of the hardware, the introduction of OCR units into an EDP system can entail indirect or hidden costs. These include comprehensive design of forms to meet OCR requirements, adjustments of input preparation procedures, and modification of the data processing system itself.

. The most serious shortcoming of OCR readers today lies in the reliability with which they interpret handprinting. Handprinting is presently being read, but with an appreciable rejection and substitution rate. Rejections require human intervention, thus a high reject rate can essentially neutralize the automation benefits of the reader. Errors may not be discovered until late in the data processing cycle, and correction then is usually more costly. In brief, new technology is needed to lower the rejection rates and thus reduce the need for correction procedures.

. Key-to-disk systems are currently more cost-effective in many data entry environments than are optical readers. The combination of key-to-disk and OCR systems is being offered by some vendors. This combination offers the best of both systems and will be covered in section 3.4 of this report.

2.2 Equipment Category: Optical Mark Readers (OMR) - Optical Mark Readers are electronic devices which sense the physical position or location of marks on a document and correlate each mark position to a previously defined equivalent character. There are three categories of optical readers: Optical Character Readers (OCR), Optical Mark Readers (OMR), and Optical Bar-Code Readers (OBR). OMR readers are the simplest of the three different types of optical readers. Some of the mark readers handle conventional 80-column cards while others handle full-size sheets of paper. Mark readers typically read data in one of two ways. The first is by interpreting rows of marks in exactly the same way as punches in a card are interpreted. Thus, one column of marks can be used to represent one character. This technique is usually limited to the coding of numeric information, since manual encoding of alphabetics requires at least two marks in a column and requires memorization of the Hollerith code. The second technique used by mark readers transmits to the computer a binary image of the marks which is then interpreted by software.

2.2.1 Equipment Characteristics

2.2.1.1 Data Capacity/Speed

2.2.1.1.1 Transfer/Transmission Speed - The online transmission speeds of the OMR readers vary depending on the model and manufacturer. They are, however, usually limited by the paper-handling mechanism, the speed of the

communication line or by the electronic reading speed of the device.

2.2.1.1.2 Volume Per Unit of Time - The reading speed of an OMR reader is application dependent. Reading speeds generally range from 1,000 to 250,000 marks per second and from 80 to 1,500 forms per minute. The faster speeds in the range are possible when both sides of a form are read concurrently.

2.2.1.1.3 Operator Speed - Not applicable.

2.2.1.2 Operational and Environmental Requirements

2.2.1.2.1 Temperature/Humidity Requirements - OMR units will operate in a normal office environment.

2.2.1.2.2 Area/Physical Location - OMR's are commonly found in computer rooms and in offices. Some units are contained in stand-alone cabinets about the size of an office desk while others, such as the remote OMR's covered in section 2.5, can be placed on a desk or table top.

2.2.1.2.3 Computer Interface - Most of the OMR readers can be connected directly to the computer through an I/O channel similar to that of a card reader. They can also be connected by communication lines. OMR's used off-line may create punched cards, magnetic tape, or punched paper tape.

2.2.1.3 Input Characteristics

2.2.1.3.1 Record Sizes - Record sizes are dependent upon the maximum number of mark (or response) positions which can be accommodated on the largest form size or page acceptable to an individual OMR unit. Typically a single 8-1/2" by 11" form can accommodate about 1,000 marks on each side, each representing a "yes" or "no" binary choice.

2.2.1.3.2 Character Sets Available - Optical mark readers sense the presence or absence of marks on the form being scanned. The location of these marks is interpreted by the software in accordance with previously defined meanings.

2.2.1.3.3 Special Form Requirements - Generally, each application has unique requirements for the design of a form. It should be noted, however, that in many cases forms manufacturers may already have developed a form which will satisfy any particular application.

Forms used on OMR equipment must be of high quality and free from dirt, stains, and other foreign substances, and their thickness must be within a specified range. The design of the form must also be acceptable to both the user and the OMR reading device. Since an OMR detects only the absence or presence of a mark, and since it may be used in an

application where erasures can occur, OMR forms can be "rougher" than OCR forms. This roughness implies less light reflectivity; however, this is acceptable for OMR's since they only need to detect marks (as opposed to reading characters).

2.2.1.4 Output Capabilities - OMR readers can operate in either an online or an off-line mode. Online, the OMR transmits directly to a host computer via communication interfaces or directly to an I/O channel. Off-line, the OMR uses a temporary storage medium for output such as punched cards, paper tape, or magnetic tape. Some OMR's use a CRT or teletypewriter to communicate with the operator.

2.2.1.5 Edit/Validate Capabilities - A few of the Optical Mark Readers are minicomputer-controlled and have the same edit/validate capabilities as the OCR readers discussed in Section 2.1. However, most OMR readers have very limited edit/validate capabilities.

2.2.2 Options - Options available on Optical Mark Readers include the following:

- Punched card read feature
- Magnetic tapes
- Paper tape punches
- Communication interfaces
- Error stackers
- CRT or teletypewriter operator consoles
- Edit and reformatting features

2.2.3 Operator Requirements - Operator skills play a small part in the OMR operation. Individuals who enter data on the OMR forms should have instructions and basic training on how to fill out the form. In general, however, the training requirements for OMR are much less than those for OCR since the OMR equipment is more tolerant, accepting greater tolerances of marking. Information has been successfully captured for many years on OMR forms in such applications as test scoring and taking surveys. These applications typically involve people who are given only a few instructions and who then are able to complete the forms easily.

2.2.4 Cost Ranges - The purchase price of optical mark readers are much lower than OCR readers and are generally in the $2,000 to $50,000 range. Lease prices range from $50 to over $1,000 per month.

2.2.5 Typical Data Entry Applications - One of the most common OMR applications is in the field of testing and test scoring. Multiple choice questions are used and the person taking the test simply "marks" the appropriate box. Other applications include meter reading, surveys, inventory accounting, exception reportings, and sales ordering.

Applications which need to capture a limited amount of data from semi-controlled sources could be a candidate for an OMR system.

2.2.6 Advantages and Strong Points

. OMR equipment is much simpler and less costly than OCR devices.
. Preparation of OMR data does not have to be as closely controlled as data for OCR equipment.
. Data can be collected wherever there is an acceptable form and a pencil or pen.

2.2.7 Disadvantages and Limitations

. OMR systems are inflexible due to preprinted forms, packed format, and difficulty in human reading of the data.
. It is questionable whether the optical mark reader is a "state-of-the-art" data entry technique. Most sources agree that as soon as OCR's handprinting readability improves (and its cost becomes more competitive) the OCR will replace the OMR.

2.3 Equipment Category: Optical Bar Code Readers (OBR) - Optical bar code readers are electronic reading devices which optically sense special combinations or arrangements of marks (bars) and correlate these marks to previously defined characters. Various types of marks are used, but in most cases they cannot be formed by hand and are not easily readable by humans. Usually, special devices are required to produce the bar code imprinting. The most significant area of OBR application is in point-of-sale (POS) equipment. This equipment category is described in section 3.6.

2.3.1 Equipment Characteristics

2.3.1.1 Data Capacity/Speed

2.3.1.1.1 Transfer/Transmission Speed - OBR's are typically connected on-line to a local microprocessor incorporated in a cash register. The transmission speeds are at the device reading speed between the OBR and the microprocessor.

2.3.1.1.2 Volume Per Unit of Time - OBR's reading speeds range from 50 to 400 characters per second and from 8 to 480 forms per minute. These speeds are limited by the operator's ability to handle the products being scanned.

2.3.1.1.3 Operator Speed - Not applicable

2.3.1.2 Operational and Environmental Requirements

2.3.1.2.1 Temperature/Humidity Requirements - Most units can operate in a normal office or store environment. Some of the scanners used for package routing (label reading) are

placed in facilities with harsher environments, such as warehouses.

2.3.1.2.2 Area/Physical Location - The size and location of OBR units vary from the small hand-held wand readers used in POS systems to the larger units which require a table top pedestal, or dedicated floor space.

2.3.1.2.3 Computer Interface - OBR readers can be connected directly to the host computer through a channel similar to that of a card reader. Some offer on-line capability via communication interfaces. In an off-line mode, OBR's may use peripheral devices to produce punched cards, magnetic tape, or punched paper tape.

2.3.1.3 Input Characteristics

2.3.1.3.1 Record Sizes - Record sizes are dependent on the number of characters that can be represented on a form (label, document, etc.). Twelve numerics are most commonly used.

2.3.1.3.2 Character Sets - Characters are represented by combinations of marks (bars). Most bar code sets are limited to numerics. A typical bar code is the Universal Product Code (UPC) which is now found on the labels of many grocery items. Some other bar codes are: CODABAR, for library book inventory and circulation control; Distribution Symbol, for use on distributor shipments as shipping container outer markings; and, Telexon Code, used for shelf marking of in-store inventory.

2.3.1.3.3 Special Form Requirements - Some applications use ordinary typing paper, some use specially designed turn-around forms. Imprinting on self-adhesive labels is becoming common in shipping/receiving and inventory applications.

2.3.1.4 Output Capabilities - Optical bar code readers can operate in either an on-line or off-line mode. In an on-line mode, the OBR transmits directly to a host computer via communication interfaces or an I/O channel connection. In an off-line mode, the OBR uses a temporary storage medium for output, e.g., punched cards, paper tape, or magnetic tape.

2.3.1.5 Edit/Validate Capabilities - A check digit is included with each bar coded label. Also, a parity bit is associated with each character.

2.3.2 Options - Options available for OBR readers include line printers, card punches, paper tape punches, magnetic tape drives, and communication interfaces.

2.3.3 Operator Requirements - This is not a critical

requirement. An advantage of the OBR is that it is not particularly sensitive to direction of scanning and does not require more than minimal operator training or attention.

2.3.4 Cost Ranges - Purchase prices of optical bar code readers range from approximately $6,000 to $40,000.

2.3.5 Typical Data Entry Applications - Some credit card applications use bar code imprinting for sales receipts. Point-of-sale (POS) applications use bar codes such as the UPC code. Supermarket, inventory and warehouse applications use bar codes imprinted on labels for routing and inventory control functions.

2.3.6 Advantages and Strong Points

. Optical bar code readers are simpler and less expensive than optical character readers.

. Skew and character registration is not as critical for OBR readers as it is for OCR's. Thus, bar coding can be read on containers of different shapes (other than flat surfaces).

2.3.7 Disadvantages and Limitations

. Bar code readers are limited in their usefulness in human-oriented systems since the bar codes cannot be easily read and are impossible to write by humans.

. Bar codes are not space-efficient, i.e., a considerable amount of space is required to represent a few characters.

2.4 Equipment Category: Magnetic Ink Character Recognition (MICR) - MICR readers are electronic reading devices that recognize characters by analyzing the magnetic waveform of the individual characters and identifying them. The ink used in imprinting these characters is a special ink with iron oxide particles. This ink is magnetized prior to reading. The entire MICR technology was developed for and is presently used almost exclusively by the banking industry. MICR characters are encoded on checks and deposit slips (through a manually operated keyboard device that encodes amounts and serves to validate amount totals of these documents). MICR readers are usually dual purpose devices. In addition to reading, they also sort the documents into as many as 32 sort pockets.

2.4.1 Equipment Characteristics

2.4.1.1 Data Capacity/Speed

2.4.1.1.1 Transfer/Transmission Speed - MICR readers can operate in an online or an off-line mode. In the online

mode, the reader is connected directly to the computer via an I/O channel and can read and sort documents and send the information directly to the computer. In this mode, transmission speed is limited to approximately 1600 characters per second (based on 1600 documents per minute with 60 characters per document). In the off-line mode, the MICR reader is only capable of reading the documents for the purpose of sorting them.

2.4.1.1.2 Volume Per Unit of Time - The maximum volume currently available is 1,600 six-inch documents per minute and is limited by the reader's paper handling mechanism.

2.4.1.1.3 Operator Speed - The operator speed is normally not a factor in MICR reader operation.

2.4.1.2 Operational and Environmental Requirements

2.4.1.2.1 Temperature/Humidity Requirements - MICR readers are designed to connect directly to the computer and are usually in the controlled environment of a computer facility.

2.4.1.2.2 Area/Physical Location - The MICR reader can be as large as (or larger than) a standard card reader (depending on the number of sorter pockets). The unit is normally located in a computer room.

2.3.1.2.3 Computer Interface - MICR readers are normally connected directly to a host computer via an I/O channel.

2.4.1.3 Input Characteristics

2.4.1.3.1 Record Sizes - Most MICR readers are capable of reading up to 60 characters per document.

2.4.1.3.2 Character Sets Available - Character sets used with MICR readers are generally limited to the numerics 0 through 9 and four or five special characters. These are uniquely shaped characters printed with magnetic ink. The special characters are symbols used in the banking industry. Some MICR units provide OCR capabilities with character sets typical of OCR readers.

2.4.1.3.3 Special Form Requirements - Most MICR readers are capable of reading documents ranging in length from 5-3/4 inches to 9-1/2 inches and ranging in width from 2-1/2 inches to 4-1/2 inches. Paper quality is not as critical in MICR applications as it is in OCR. Characters read by MICR readers must be printed with a special ink containing iron oxide particles.

2.4.1.4 Output Capabilities - MICR readers transmit directly to the computer. Some units offer lister attachments which list transactions as they are being processed. Operator

communications and reentry correction operations are sometimes accomplished through the use of CRT units.

2.4.1.5 Edit/Validate Capabilities - In MICR applications, edit/validate operations are normally performed by the use of check digits and software executed on the host computer.

2.4.2 Options - Some of the more common options available on MICR readers include combination MICR and OCR reading capability, automatic endorser, and additional sorting pockets. Some vendors offer such options as microfilming systems, a wide variety of reject-reentry systems (key-to-disk, punch card, OCR), and sophisticated document repair equipment (mechanical devices that physically repair items so they can be processed automatically).

2.4.3 Operator Requirements - Except for the document handling functions that involve loading the reader, clearing jams, and removing unreadable documents for reentry, this is not a critical factor in a MICR operation.

2.4.4 Cost Ranges - Purchase prices of MICR readers range from below $30,000 to over $200,000 and lease prices range from around $700 to over $3,000 per month.

2.4.5 Typical Data Entry Applications - Since its inception, MICR equipment has primarily been used for a single application, the processing of banking documents (especially checks). Almost all of the MICR readers features have been dictated by its prime user, the banking industry.

2.4.6 Advantages and Strong Points

. They allow the direct reading of magnetic ink encoded characters which are insensitive to pencil or ink overmarkings.
. They have been used successfully for many years in the banking industry.
. MICR specifications are standardized (ANSI X3.2-1970 "Print Specifications for Magnetic Ink Character Recognition" and ANSI X3.3-1970 "Bank Check Specifications for Magnetic Ink Character Recognition").

2.4.7 Disadvantages and Limitations

. MICR readers require special forms preparation and read a limited character set.
. Ultimately, the development of inexpensive, flexible, fast, and reliable optical character readers will probably replace most MICR readers.
. MICR's have not gained popularity in any industry except banking. For this reason, capabilities and features which would be beneficial to other types of applications are not readily available.

2.5 Equipment Category: Remote Scanners - Remote scanners are optical readers (either OCR, OMR, or OBR) which are configured to operate as remote data terminals. They are designed to provide both remote data capture and timely transmission of processed data to the computer. Previous sections of this report were devoted to large, fast, and generally expensive optical readers that are usually configured to operate as centralized data input devices. In contrast, the remote scanner is capable of economically scanning data at decentralized locations and allows the functional users to retain complete control of their source documents. Present remote scanners vary in their capability to read marks, bars, and characters. Each, however, permits operator intervention via a keyboard at the source for operator communication and reentry/error correction. Because previous sections have covered the basic characteristics of OCR, OMR, and OBR equipment, the equipment profiles for the remote scanners will not be included in this report.

2.6 Equipment Category: Prepunched Tag Readers - Prepunched Tag Readers are reading devices that read small merchandise tags encoded with prepunched holes. Prepunched tag systems have been in use for nearly 20 years in the retail merchandising industry. Currently the systems are being replaced by magnetic encoded tags and other more sophisticated POS systems. Reference sources do not consider prepunched tag readers to be "state-of-the-art" data entry devices. For this reason, an equipment profile for this device will not be included in this report.

Chapter 3

# SPECIAL INPUT DEVICES

3.1 Equipment Category: Pushbutton Telephone - Pushbutton telephones use pushbuttons rather than rotary dials for entering the dialing information. Rotary-dial telephones have a disk with 10 "fingerholes," with each hole representing one of the 10 numerics, 0 through 9. Dialing information (telephone numbers) is entered by placing a finger in the hole representing the appropriate number and then rotating the disk clockwise.

Pushbutton telephones have a pushbutton keyboard (similar to the numeric keyboard of an adding machine, although the order of the keys is inverted) instead of a rotary-dial disk. The depression of the pushbuttons (keys) enters the dialing information. Each key generates a unique combination of frequencies which is interpreted by the telephone switching system.

In addition to the pushbutton telephone's primary purpose (voice communication), it can easily be adapted to function as a data entry terminal. In this mode, the user simply "dials" the host computer's telephone number, awaits the connection, and then enters data through the pushbuttons. The host computer can communicate to the user by transmitting audible tones or by voice response (machine generated or recorded speech).

## 3.1.1 Equipment Characteristics

### 3.1.1.1 Data Capacity/Speed

3.1.1.1.1 Transfer/Transmission Speed - Transmission speed is the user's keying speed.

3.1.1.1.2 Volume Per Unit of Time - The throughput of a pushbutton telephone would be limited to the keying speed of the operator.

3.1.1.1.3 Operator Speed - It has been estimated that the average operator keying speed using a pushbutton telephone is 1.5 characters a second.

### 3.1.1.2 Operational and Environmental Requirements

3.1.1.2.1 Temperature/Humidity Requirements - Telephones can be placed in almost any environment, including offices, shops, warehouses, outside, moving vehicles, etc.

3.1.1.2.2 Area/Physical Location - Telephones require less than one square foot of space.

3.1.1.2.3 Computer Interface - Normal telephone lines are used for transmission.

3.1.1.3 Input Characteristics

3.1.1.3.1 Record Sizes - Data is transmitted one character at a time and record sizes are dependent on the number of characters grouped together at the computer.

3.1.1.3.2 Character Sets Available - The keyboard of the pushbutton telephone has 12 keys (16 keys are also available) - numeric 0 through 9 and two (or six) keys which can be used as function or special purpose keys. Alphanumeric characters can be generated by the pushbutton telephone. Numeric characters require only one key depression while alpha characters require two or three key depressions. Another way of entering data is by prepunched plastic cards which can contain up to 14 characters and are read by a Card Dialer. The card can be divided into fixed fields and can stop after each field transmission, thus permitting variable data to be entered at the keyboard.

3.1.1.3.3 Special Form Requirements - Not applicable.

3.1.1.4 Output Capabilities - Hard copy output capability exists by means of a quarter-inch strip printer attached to the telephone. Audio response capability, either by tone or voice response, is used to communicate with the user.

3.1.1.5 Edit/Validate Capabilities - While there are no error- detection features associated with the touch tone pad, the computer program may perform this function and interact with the user. On the other hand, when the user recognizes one or more keys have been depressed in error, data correction can be accomplished by depressing the appropriate button (or special combination of pushbuttons) that indicate the last character(s) were in error. The character(s) in error will be deleted and the user may then enter the correct data. The user is notified of rejection or acceptance of input by either an audible tone or by the verbal repetition of the input received.

3.1.2 Options - Normal options include a hardcopy strip printer (one quarter inch paper), an automatic card dialer, and audio response (at the host computer). A pushbutton key pad and adapter are available for use in conjunction with rotary-dial telephone sets.

3.1.3 Operator Requirements - Not applicable.

3.1.4 Cost Ranges - Pushbutton telephones range from $7 to $30 per month. The higher rates include the hardcopy strip printer.

3.1.5 Typical Data Entry Applications

. Sales ordering

. Remote inquiry such as credit authorization, bank balance, etc.

. Production control

. Inventory control

3.1.6 Advantages and Strong Points

. Equipment cost is low.

. Telephones are commonly found in almost any location.

. Audio acknowledgement of data transmission is possible with a voice response system.

. Fixed or constant type information can be transmitted with the optional automatic card dialer. The card may contain information such as a telephone number, a salesman's number, a product code, etc.

3.1.7 Disadvantages and Limitations

. Data entry is slow.

. Generation of alpha characters requires two or three keystrokes, thereby increasing entry time and the probability of keying errors.

. Limited hardcopy output.

. All editing/validation of data must be done by the computer.

. Error correction is complex.

3.2 Equipment Category: Industrial Data Collection Equipment - This equipment category covers specialized data entry systems designed to capture data in an industrial (factory) operating environment. The devices in this section are classified on the basis of the applications for which they are used. These applications include employee time reporting, plant security, materials accounting, production scheduling, quality control, maintenance, shipping/receiving, sales/marketing, and purchasing.

Industrial Data Collection systems incorporate many automated analog and digital, sensing and data entry devices. Some of the most common devices include:

Badge Readers - These devices read identification cards or badges which contain prepunched or magnetically encoded information such as employee number or social security number. Badge readers are commonly found in employee time

reporting systems, production control, and plant security systems.

Time Clocks - These devices are usually configured with a badge reader (or other identification devices such as a keyboard or card reader) and are used to capture data concerning an employee's work time.

Card Readers - These are normally slow-speed, low-volume punched card readers used to capture information such as employee number, product code, routing information, operation code, etc.

Remote Scanners - Optical Bar Code Readers (OBR) are often used to read product information from bar coded labels. Applications include inventory control, production control, materials routing, quality control, etc.

Keyboards, Levers, Thumb-wheels, Toggle Switches, Rotary Dials - These devices are used to input information such as employee number, work station, operation code, product number, inspection data, security codes, and location identifiers.

Hand Geometry Recognition Equipment - This equipment recognizes the unique features or shape of an individual's hands (the fingers and palm). It is primarily used in limited-access security systems.

Voice Recognition Systems - These systems are most often used in industrial data collection or control applications which require that the operator enter data while his hands are used for other purposes. Voice recognition systems are described in section 3.3 of this report.

Hand-held Portable Keyed Devices - These devices are used in data entry applications where operator mobility is required. This equipment category is described in section 1.4 of this report.

Alphanumeric Display Units - These devices with keyboard input are used in many industrial data collection applications. Because of their flexibility, they can be used in conjunction with the capture of almost any type of data. Alphanumeric displays are described in section 1.5 of this report.

Teleprinters - Industrial data collection applications which require an immediate hardcopy of the input data frequently use teleprinters. This equipment category is described in section 1.6 of this report.

These individual data entry devices (above) can be combined to form a configuration referred to as an integrated data

entry system. The heart of the integrated data entry system is a controller or minicomputer which is capable of coordinating data entry from all the entry stations, editing and validating the data, manipulating local files, informing managers or supervisors of exceptions, and communicating with other computers. Because industrial data collection encompasses such a broad spectrum of specialized equipment, the profiles for industrial data collection will not be included in this report.

3.3 Equipment Category: Voice Recognition Systems (Speech Recognition Systems*) - Voice recognition systems are electronic systems which are capable of interpreting spoken words according to predefined meanings. Voice recognition represents a new dimension in source data entry techniques. While the technique is still in its infancy, with considerable research currently being conducted by a number of companies, there are many applications of voice recognition that employ spoken vocabularies ranging from 10 to 100 or more words.

The National Aeronautics and Space Administration (NASA) has been using a 100 word vocabulary speech recognition system since November 1973. The United Parcel Service and several commercial air carriers have been using speech recognition systems with somewhat limited vocabularies of 20 to 50 words for package and baggage sorting operations. Several companies have been identified as having commercially available voice or speech recognition systems that can be used for source data entry. In all of these systems, it is necessary for the system to be adapted to recognize each speaker in a training session before actual operation.

3.3.1 Equipment Characteristics

3.3.1.1 Data Capacity/Speed

3.3.1.1.1 Transfer/Transmission Speed - Vendors were found to provide interfaces for data communications with rates up to 19,200 baud.

3.3.1.1.2 Volume Per Unit of Time - Throughput is limited to the speed with which an operator can clearly pronounce words.

3.3.1.1.3 Operator Speed - One reference source indicates that acceptable rates of speech are 4 words per second for reading out loud, 2.5 words per second for spontaneous

---

*Speech recognition is a process or interpreting spoken words according to predefined meanings whereas speaker recognition is a process of identifying a speaker by analyzing his speech pattern.

speech, and approximately 2 words per second for machine distinguishable voice input (isolated word recognition). This data rate is substantially faster than writing or keying. Keying speed (typewriter), for example, is approximately one word per second. Handwriting and handprinting speeds are approximately 0.4 words per second. Keying speed using a pushbutton telephone is rated at 0.3 words per second. Marking on a mark sense card is rated at 0.1 word per second.

3.3.1.2 Operational and Environmental Requirements

3.3.1.2.1 Temperature/Humidity Requirements - Voice recognition equipment will operate in most environments.

3.3.1.2.2 Area/Physical Location - The only device required at the source data entry location is a wired or wireless microphone, or in some cases, a telephone. The recognition hardware (preprocessor, minicomputer, etc.) can be located elsewhere.

3.3.1.2.3 Computer Interface - The speech recognition process requires considerable computational capability and as a consequence all voice recognition systems operate online to a computer which may also be shared for other processing functions. Additionally, some vendors provide an intelligent terminal option, permitting the system to act as an off-line, remote interactive terminal. Between the speaker and the computer, there is usually a microphone, cable, and a preprocessor/feature extractor. The preprocessor and computer (usually a minicomputer) are used to convert the voice input into predefined digital format. Once this conversion is accomplished, the resulting code can be directed to a storage medium, used to update or manipulate local files, or transmitted to another computer.

3.3.1.3 Input Characteristics

3.3.1.3.1 Record Sizes - Not applicable.

3.3.1.3.2 Character Sets Available (Vocabulary) - The vocabulary of a voice recognition system is the set of predefined words which can be converted into machine understandable code. The NASA system, referred to earlier, has a vocabulary of 100 words. Most systems have a basic vocabulary of 32 words and are expandable in 64 word units. Memory size and processing speed are the two primary factors which limit vocabulary. In a source data entry application, the vocabulary could include spoken alphanumeric and command words. Examples of these would be "one" (1), "two" (2), "zero" (0), "alpha" (A), "delete" (delete last entry), etc. New speakers or new vocabularies are accommodated by a "training" session with the system. This is accomplished by keying the word, on a CRT or teletypewriter, and then entering the word vocally. Periodic "training" sessions may

be needed to reduce errors to within an acceptable range.

3.3.1.3.3 Special Form Requirement - This requirement depends on the peripherals used with the system. For instance, if a paper tape reader is used, paper tape would be required. If a thermal printer is used, treated paper is needed.

3.3.1.4 Output Capabilities - Output from a voice recognition system can be in several forms. Output from the system can be transmitted to another computer. Voice response can be used as an acknowledgement of the voice input or to request data entry in a tutorial mode. Alphanumeric displays are used (CRT or light emitting diode display) for input verification, operator instruction, error correction, and for the system "training" sessions referred to earlier. Teletypewriters can also be used to produce hardcopy output. There are many output devices available for use with minicomputers. Although they are not usually included in standard configurations, magnetic tape units, magnetic disk units, line printers, paper tape punches, and other devices can be used for output from a voice recognition system.

3.3.1.5 Edit/Validate Capabilities - A high degree of data editing and validation can be accomplished by the voice recognition system. Since a minicomputer is normally used as a controller, software separate from that employed for the recognition function also can perform the necessary data edit/validation requirements. The amount of memory available and the processing speed of the minicomputer will determine how extensive the data editing software can be. Data correction can be accomplished with operator feedback using voice response or an alphanumeric display followed either by respeaking or use of a keyboard.

3.3.2 Options - Typical options avaiable for voice recognition systems include the following:

. Additional input stations.
. Additional minicomputer memory. This is required when the vocabulary size is increased over the standard size.
. Expanded vocabulary size.
. Optional microphones. Basic voice recognition systems include a headset type microphone. Optional noise cancelling microphones may be needed if there is a noise background at the data entry location.
. Voice response. Data entry verification can be accomplished through the use of a voice response system. The voice response can be digitally synthesized (machine generated) or "played back" from a recorder.
. Many of the peripheral components (such as magnetic tape cassettes, magnetic disk, paper tape units, punch card units, and keyboard devices) commonly available for

minicomputers can optionally be configured with the voice recognition system.

3.3.3 Operator Requirements - One operator is required for each active input station. The operator can be performing other functions as long as it does not affect his speech input. Reference sources indicate that only minimal training is required for the operator. However, it would probably be advantageous to use an operator that is well-disciplined in clear and consistent pronunciation of words.

3.3.4 Cost Ranges - Basic system cost is $10,000 to $20,000. This includes a minicomputer, two microphones, a 64-word vocabulary, a 16-character display and a local operator console.

3.3.5 Typical Data Entry Applications - Systems are used by airlines for baggage-handling. These systems permit an airline employee to direct baggage via a computerized conveyer system by simply indicating the flight number or destination into a headset microphone. Systems are also being used by a producer of glass products for quality control. In this application, an inspector can input television tube measurements while his hands are free to manipulate gauges.

IBM field engineers are using a voice recognition/response system via telephone, as an aid in equipment diagnostics. The user inputs equipment model number, responds to query type of questions with "yes/no" answers, and is directed to the cause of the problem by audio response.

Voice recognition systems have successfully been used in security applications for speaker verification and identification.

Voice recognition systems can be used in many applications in Government systems such as:

- Equipment and process control
- Tactical data entry
- Automated checkout, diagnosis and instruction
- Air traffic control
- Target search, acquisition, and weapon control
- Computer programming and interactive problem solving
- Access control to secure area
- Aids for handicapped

3.3.6 Advantages and Strong Points

. Voice recognition systems allow the user to input data and at the same time perform manual tasks. For instance, an operator can be inspecting equipment, counting parts inventories, operating machinery, etc., while

inputting data vocally.

. Vocabularies are flexible to a certain extent. Words can be added, changed, or deleted from the vocabulary. However, additions to the standard vocabulary size may require a faster processor and additional memory.

. Speaking is substantially faster than writing or keying.

. Telephones are currently unacceptable as an input device for some of the commercially available voice recognition systems. Reference sources indicate that the quality of telephone transmission is not adequate. However, some systems use telephones as their I/O media. Telephones can be used successfully as an input device to a voice recognition system. In addition, it may be possible to enter data through a portable microphone and radio transmitter, thus eliminating such constraints as cables or other wire connections.

3.3.7 Disadvantages and Limitations

. Voice recognition systems are still relatively expensive. A typical configuration for one or two entry stations would probably cost in the range of $10,000 per station.

. Error rates may be a problem. Vendors claim that overall error rates of as low as 1 percent can be achieved. There are not, however, many voice recognition systems in commercial use, thus error rates based on extensive practical use are not currently available.

. At present, voice recognition systems are not capable of doing a good job of automatically recognizing speech in a general sense, i.e., with a vocabulary approaching that of the average person and as normally spoken in a connected/continuous manner. Presently each word must be spoken as an acoustically separate unit (isolated word recognition).

3.4 Equipment Category - Mixed-Media (Keyboard/Reader) Systems - A mixed-media system is an electronic data entry system which incorporates both keyboard-to-disk and optical scanning equipment. A market for mixed-media systems has developed because many organizations have data entry applications that are well suited for optical scanning yet also require a certain amount of keyboard data entry. Investing in two separate systems could be a waste of money. If keyboard-to-disk and optical scanning is combined into one system, then duplication of the minicomputer controller, memory, edit/validate software, and other features can be eliminated. Source documents unsuitable for scanning are assigned to the key entry section of the installation and

processed in the conventional manner. In addition, data found in error by the optical scanner can be corrected at the key-entry stations. Input from all entry devices is stored on disk and then transferred to computer compatible tape for further processing.

3.4.1 Equipment Characteristics

3.4.1.1 Data Capacity/Speed

3.4.1.1.1 Transfer/Transmission Speed - Operator keying speed, optical reader speed, and entry features/software determine the throughput of mixed-media systems.

3.4.1.1.2 Volume Per Unit of Time - The throughput rates of mixed-media systems are in the general range of 800-3600 characters/second, 180-650 forms/minute.

3.4.1.1.3 Operator Speed - Operator keying speed will affect the system's throughput. Keying speeds from 12,000 to 20,000 keystrokes per hour are possible, but an average of approximately 7150 keystrokes per hour can be expected based on estimates for typical keyboard-to-disk systems in a production environment.

3.4.1.2 Operational and Environmental Requirements

3.4.1.2.1 Temperature/Humidity Requirements - Most of the equipment of this type (optical scanners and keyboard-to-disk) can operate in a normal office environment.

3.4.1.2.2 Area/Physical Location - This varies depending on configuration and location of the keyboard terminals.

3.4.1.2.3 Computer Interface - Mixed-media systems usually operate off-line and produce computer compatible magnetic tape. Communication interfaces are available for online operation or online transmission of data recorded on magnetic tape.

3.4.1.3 Input Characteristics

3.4.1.3.1 Record Sizes - Maximum record sizes range up to 4096 characters but practical maxima are normally under 500 characters.

3.4.1.3.2 Character Sets Available - Some of the mixed-media systems incorporate multifont OCR readers capable of reading most scannable fonts including handprinted characters. The character sets available on the keyboard-to-disk subsystem are typical of the sets available for keyboard-to-disk systems covered in section 1.3.

3.4.1.3.3 Special Form Requirements - Paper for optional

line printers, paper tape punches, or teletypewriters may be required. Forms are probably the most critical requirement of an OCR operation. The design of the form must meet the requirements of the reading device and also have an efficient layout for the user. Since OCR depends on the contrast of the characters to the background of the form for character recognition, the paper must be of high quality and free from dirt and other foreign substances. Its thickness must be within a specified range. Data usually must be in predefined locations and the characters must be properly registered, crisp, and well defined with very little skew.

3.4.1.4 Output Capabilities - Mixed-media systems are capable of generating hard copy output, recording on magnetic tape and magnetic disk, and transmitting to a computer.

3.4.1.5 Edit/Validate Capabilities - The mixed-media systems have most of the same edit/validate features typically found on OCR's and keyboard-to-disk systems. The controlling part of the system is usually a minicomputer, and the capability to manipulate data in memory is an inherent feature of the minicomputer. Software can perform the editing as the data is being entered. The use of alphanumeric displays for operator feedback in combination with OCR increases the edit/validate capabilities. OCR error/rejects can be handled by video image display and keyboard correction techniques. The video image is a duplicate of the field in error exactly as it was "seen" by the optical scanner. In addition, features such as character delete/insert, split-screen, "fill-in-the-blanks," and conversational modes of data entry ease the task of data editing and validating.

3.4.2 Options - Options available for mixed-media systems include journal tape and line printers, punch tag readers, teletypewriters, additional memory, magnetic tape drives, magnetic disk drives, an expandable number of key-stations, application software, user programming languages, and various communication interfaces.

3.4.3 Operator Requirements - Since mixed-media systems incorporate both an OCR system and keyboard-to-disk system, operator requirements should be the combination of the requirements for both systems. The requirements can be found in sections 1.3 (Keyboard-to-disk) and section 2.1 (Optical Character Readers).

3.4.4 Cost Ranges - The least expensive mixed-media system sells for approximately $100,000 for a 20-station configuration and $150,000 for a 32 station configuration. More sophisticated systems cost from approximately $200,000 to $600,000 depending on the options and the number of keystations used.

3.4.5 Typical Data Entry Applications - Because of high

equipment costs and potentially high throughput, mixed-media systems are primarily suited to high-volume, centralized data entry. Mixed-media systems should be considered for applications which can justify an OCR but must also process non-scannable documents.

3.4.6 Advantages and Strong Points - By sharing of components, mixed-media systems offer a cost advantage where both optical scanning and keyboard-to-disk capabilities are required.

Extensive edit/validate features can be applied to both keyed and scanned data, easing the burden on the mainframe computer.

Most of the strong points and advantages that apply to the categories of optical character readers and keyboard-to-disk systems (covered in sections 2.1 and 1.3, respectively) also apply to the mixed-media systems.

3.4.7 Disadvantages and Limitations - Most of the disadvantages and limitations that apply to the categories of optical character readers and keyboard-to-disk systems (covered in sections 2.1 and 1.3, respectively) also apply to the mixed-media systems. In addition, it should be emphasized that the failure of a shared component will disable the entire mixed-media system and may create a severe data entry bottleneck.

3.5 Equipment Category: Digitizing Tablets - Image digitizers (of which digitizing tablets are a specific type) are the broad category of electronic devices which sense the movement or position of a cursor (a stylus or other drawing mechanism) relative to a flat working surface. These devices are generally used for digitally recording the continuous representation of some analog function or measurement or other applications requiring graphic input. Typically, a digitizer is a two-axis device with a cursor that is free to move over a flat working surface. Cursor position is detected and recorded digitally for output to cards, magnetic tape or a computer interface. The most common digitizer appears to be the digitizing tablet.

One tablet that is being marketed is a sonic digitizer incorporating a sound emitting hand-held stylus, a 14 x 14 inch square (optionally up to 72 inches) writing or drawing surface with a perpendicular L-shaped microphone sensor bordering two sides of the tablet. With the standard 14 inch by 14 inch tablet, 4,000,000 points on a 2,000 by 2,000 matrix can be detected and digitized (converted) into (X,Y) coordinate pairs.

Another manufacturer provides a digitizing tablet which incorporates a 14 inch square tablet surface and a hand-held stylus. It has its sensing electronics embedded in the

tablet surface.

3.5.1 Equipment Characteristics

3.5.1.1 Data Capacity/Speed

3.5.1.1.1 Transfer/Transmission Speed - Online transmission speeds of digitizing tablets were not found in the reference sources used in preparing this report. However, the maximum digitizing rate ranges from approximately 200 to 6600 coordinate points per second.

3.5.1.1.2 Volume Per Unit of Time - It is inconceivable that an operator can accurately move the stylus faster than the device can sense the movement. Therefore, the volume of digitized points per unit of time is limited to the speed at which the operator can trace, draw, write or touch the tablet surface.

3.5.1.1.3 Operator Speed - Operator speed is a limiting factor in predicting the input speed of the digitizing tablet.

3.5.1.2 Operational and Environmental Requirements

3.5.1.2.1 Temperature/Humidity Requirements - Temperature and humidity ranges are not critical for this equipment.

3.5.1.2.2 Area/Physical Location - This equipment requires approximately 4 to 5 square feet of space on a table or desk top.

3.5.1.2.3 Computer Interface - The digitized coordinates generated by digitizing tablets can be recorded on external peripheral devices or they can be transmitted to a computer. The communication interfaces and line speeds available for digitizing tablets were not included in the reference sources used in preparing this report.

3.5.1.3 Input Characteristics

3.5.1.3.1 Record Sizes - Not applicable

3.5.1.3.2 Character Sets Available - Not applicable

3.5.1.3.3 Special Form Requirements - Pre-printed forms can be placed on the tablet surface. Various form designs can be used. By assigning specific meanings - alphanumeric characters, programming commands, graphic symbols, even whole sentences - to specific coordinate pairs, the assigned meaning can be determined from the coordinates generated each time the stylus touches the prescribed area. This type form is commonly associated with a menu, where the operator selects his choice by simply touching the item with the stylus.

3.5.1.4 Output Capabilities - Output from the digitizing tablet can be directed to paper tape, magnetic tape, punched card, plotter, programmable calculator, computer (usually a minicomputer), or small display device which displays the (X,Y) coordinates. These (X,Y) coordinates can be in the form of a four digit number or an eleven bit binary number, depending on the application's requirement. Output can also be directed to a graphic display which reproduces all or part of an image, or to a microfilm, or to a slide image generator.

3.5.1.5 Edit/Validate Capabilities - The digitizing tablet does not possess edit/validate capabilities.

3.5.2 Options - Options available for digitizing tablets include:

- Tablet sizes up to 72 inches by 72 inches
- (X,Y) coordinate display screen
- Magnetic tape units
- Paper tape punch units
- Punch card units
- Ball point pen stylus
- Microfilm/slides
- Flat bed plotters

3.5.3 Operator Requirements - If the digitizing tablet is used for the inputting of mechanical or graphic drawings, the operator should preferably have drafting skills. Otherwise, source data entry applications would not require operators with special skills.

3.5.4 Cost - The purchase price of a digitizing tablet begins at approximately $3,000. This price includes only the basic components of the system-tablet surface, microphone sensor base, stylus, and control unit.

3.5.5 Economic Considerations - It would be difficult to justify the use of digitizing tablets for alphanumeric data entry since each tablet costs $3,000. This is not to say that digitizing tablets should not be considered, but instead that there are many keyboard devices in the same price range which have more general flexibility. Most of these keyboard devices are capable of receiving output from the host computer and the actual characters entered are visually displayed rather than just the coordinates which represent them.

3.5.6 Typical Data Entry Applications - Image digitizers are used for many diverse applications, with little in common except that they all convert graphical data to digital form for computer processing. Digitizers are used in fully automated drafting systems for such applications as: the conversion of parts drawings to digital form which are recorded on magnetic tape to be used by numerically

controlled machine tools, the generation of input from rough sketches to produce accurate drawings, and the digitization of the shapes of design models used in the ship building, automotive, and aircraft industries, and in architectural design.

Digitizing tablets have been successfully used in source data entry applications such as inventory control, production control, order entry, and in other applications where untrained personnel enter data.

3.5.7 Advantages and Strong Points

. Digitizing tablets can be located in most source data entry locations.

. Their operation can be very simple, thus skilled operators are not required.

. Complex drafting or design jobs can be computer assisted at great cost savings.

3.5.8 Disadvantages and Limitations

. Digitizing tablets used for alphanumeric source data entry do not possess the capabilities of other similarly priced data entry devices.

. The data captured by the digitizing tablets is in the form of matrix coordinates. These coordinates must then be converted into the appropriate meanings by software on the host computer.

3.6 Equipment Category: Point-of-Sale (POS) - A POS system is basically a source data collection system designed for the retail trade. It is used to collect business data at the point of transaction and record it in computer-usable form, thereby eliminating the need for intermediary handling. Most POS systems are modularly designed and are usually configured in one of three ways: local recording systems, centralized or in-store controlled systems, or remote online interactive systems.

A local recording system typically includes stand-alone cash registers with a built-in processor and a magnetic tape recorder (cassette or cartridge). In this environment, the POS terminal operates very much like the conventional cash register, except that it can collect more business data faster and more accurately.

The centralized, or in-store, configuration includes a number of terminals sharing one controller (minicomputer or a preprogrammed hardwired processor). Centralized systems can perform many more sophisticated processing functions that are not feasible with stand-alone terminals. These

include credit verification, automatic price lookup, inventory control, extensive editing and formatting capabilities, generation of management reports, and data communications with a host computer.

The online system usually consists of several in-store subsystems which communicate with a central host computer. In this configuration, control originates from the host computer with the driving programs housed in the store-based controller (or minicomputer). The on-line system provides a further dimension of processing sophistication not possible with isolated in-store systems.

Regardless of the differences in system configuration and processing capabilities among these three alternatives, they are essentially the same with regard to data entry at the point of sale. Data entry is accomplished by the cash register keyboard supplemented by an optical character or bar-code reading device. Additional information on optical character and optical bar-code type devices may be found in sections 2.1 and 2.3 of this report.

3.6.1 Equipment Characteristics

3.6.1.1 Data Capacity/Speed

3.6.1.1.1 Transfer/Transmission Speed - Some POS systems are restricted to 2400 bits per second, while others can transmit up to 9600 bits per second.

3.6.1.1.2 Volume Per Unit of Time - The throughput of POS systems varies depending on the equipment configuration.

3.6.1.1.3 Operator Speed - The speed of operators using POS equipment was not found in the reference sources used in preparing this report.

3.6.1.2 Operational and Environmental Requirements

3.6.1.2.1 Temperature/Humidity Requirements - POS equipment is designed to operate in the environment commonly found in retail stores.

3.6.1.2.2 Area/Physical Location - The size and location of POS equipment vary depending on configuration.

3.6.1.2.3 Computer Interface - Local or stand-alone POS equipment interfaces with the computer by magnetic tape (cassette or cartridge). Some of the older equipment uses punched paper tape as the computer interface. Centralized or in-store POS systems are cable-connected to a minicomputer or hardwired processor. Online POS systems interface to the host computer via communication lines (usually leased or switched network telephone lines).

3.6.1.3 Input Characteristics

3.6.1.3.1 Record Sizes - This information was not available in the reference sources used in preparing this report.

3.6.1.3.2 Character Sets Available - POS equipment is designed primarily to capture numeric data. The keyboards of electronic cash registers, credit verifiers, etc., usually are limited to numeric and special function keys. Bar codes such as UPC (Universal Product Code), commonly found on food packages, represent numeric data and are read by fixed or hand-held bar code scanners (optionally available on some POS systems).

3.6.1.3.3 Special Form Requirements - Forms requirements vary depending on the equipment in making up the POS system. The most common forms required for POS systems are identification/price tags and rolled paper used for printing customer receipts.

3.6.1.4 Output Capabilities - Most of the POS terminals, such as cash registers, provide both visual output and hard copy printed output. In addition, data is usually either recorded at the station on magnetic tape or punched paper tape, or it is transmitted to the host computer.

3.6.1.5 Edit/Validate Capabilities - The stand-alone POS terminals have self-contained processors with limited capabilities. They are capable of automatically extending totals, adding sales tax, etc., but they are not capable of performing meaningful edit or validate routines. Centralized and online systems incorporate minicomputers or small business computers. With the processing capabilities of these computer- based systems, a wide range of edit and validate functions can be performed as data is captured at the POS terminals.

3.6.2 Options - Options available with POS systems include the following:

. Bar code scanners which read preprinted bar codes (such as the UPC code) are available. These scanners can be permanently attached to a surface. The operator (or conveyor belt) moves items past the window of the scanner and the bar codes are read. They may also be hand-held scanners which are small portable devices that can be manipulated by the hand of the operator to read preprinted bar codes.

. Temporary recording media such as magnetic tape cassettes (or cartridges) and paper tape are available. These options are commonly found on POS terminals and used for either back-up data storage or for primary data collection (when the terminal is not online with the host computer).

. Electronic weight scales

. Automatic change dispensers

. Voice response

. Optional memory sizes for minicomputer controller

. Software packages for edit/validation and data manipulation

. Many options available for the minicomputer controller

. OCR journal tape

3.6.3 Operator Requirements - Most POS systems include electronic cash registers. Experience/skill on these devices would be helpful, but training is not usually a problem.

3.6.4 Cost Ranges - Purchase prices range from approximately $5,000 to over $1,000,000 per complete system, depending on the degree of sophistication and the number of terminals involved.

Examples of prices of the three different configurations discussed in section 3.6 are the following:

| | |
|---|---|
| Local recording system | $5,100 |
| In-store controlled system (includes 30 terminals and minicomputer) | $200,000 |
| Remote on-line interactive system (includes 30 terminals and concentrator but does not include central host computer) | $123,500 |

3.6.5 Typical Data Entry Applications - POS systems have been designed for (and are used almost exclusively for) capturing data at the point-of-sale in retail sales establishments. Several large general merchandisers have installed POS systems. Grocery store chains are finding that POS systems increase the productivity of cashiers and provide better sales and inventory data than were available with standard cash registers.

3.6.6 Advantages and Strong Points - POS systems are designed to minimize key depressions and maximize throughput. The operator is guided by sequentially lit keys or a message panel to progress through each transaction. If an optical scanner is used to read product codes and/or prices, the number of key depressions is reduced even more. The results are fewer calculation errors, faster checkout time, fewer cashiers required for a given amount of

business, and better customer service. Sales receipts to customers are more detailed than those from cash registers.

Inventory data is captured at the point-of-sale quickly and accurately. This results in faster re-order actions and better buying decisions.

POS systems are capable of automatically verifying the credit status of customers. With the increased use of credit cards, this means less credit losses and a faster response to credit approval.

3.6.7 Disadvantages and Limitations - POS systems are expensive. Their use is normally restricted to the larger, high volume type of retail business. Examples are large department stores, fast food restaurants, and supermarkets.

One reference source lists the lack of application software as being a disadvantage. This problem should be solved as POS systems gain more popularity and POS vendors broaden their application base.

Acoustic coupler - A modem designed for operation over the public telephone network. A connection is provided between the data terminal and the communications line using a conventional telephone handset. Data to be transmitted is converted from a serial stream of binary digits to a sequence of tones (mark and space frequencies); at the receive end, the tones are converted back into a stream of binary digits corresponding to the original input data. It is connected to data terminal equipment by a cable which generally complies with some standard; e.g., EIA RS-232C.

ASCII - American Standard Code for Information Interchange (also known as USASCII). An American National Standard binary coding scheme consisting of 128 seven-bit patterns for printable characters and control of equipment. Also known as International Alphabet No. 5.

Audio answerback - Audio response (which can be in terms of tones or machine-generated speech) normally associated with an inquiry-response system.

Baudot - A system of coding for transmission of data in which five bits represent one character. Also known as International Telegraphic Alphabet No. 2.

BCD - Binary Coded Decimal. A binary notation in which individual alphanumeric characters are represented by a pattern of four or six bits.

Bit - The smallest unit of information in the binary number system. It is the abbreviation for "binary digit" where a bit is represented by a one or a zero. These states may in turn correspond to conditions within equipment such as on or off, the presence or absence of a voltage or flow of current, or a switch contact being open or closed.

BPS - Bits per second.

Card dialer - A unit that automatically dials telephone numbers by insertion of a plastic card that contain the numbers. It may also be used in a TOUCH-TONE (TM) data system to transmit constant numeric data to a computer.

Cathode-ray tube (CRT) - An electronic vacuum tube containing a screen on which input or output data may be displayed in graphic form or as character images.

Channel - A path along which signals can be sent; e.g., data channel, output channel.

Coding Form - Also called keypunching or data entry form. The form from which the keypuncher enters data. It may be

the same as, or separate from, the source document.

Cursor - A movable marker, visible on a CRT display, used to indicate the position at which the next operation (e.g., insertion, replacement, or erasure of a character) is to take place.

Document reader - A reader having the capability to read documents of less than standard 8.5 x 11 inches letter size. A document reader generally reads one or two lines per document, while "page readers" can read many lines from each document.

Dot Matrix - A method of generating characters utilizing a matrix of dots, each of which may be independently turned on or off. The combination produces a human readable character.

EBCDIC - Extended Binary Coded Decimal Interchange Code. An alphanumeric character code containing upper and lower case characters, and special symbols. EBCDIC is an 8-bit code.

Edit - To modify the format of data, including deleting unwanted data, selecting pertinent data, or input.

Font. A set of characters of a given size and style.

Hollerith code - A standard 12-channel punched card code in which a decimal digit, letter, or special character is represented by one or more rectangular holes punched (or marks entered) in a vertical column.

Impact Printer - An output unit which mechanically prints characters on the page by a fast-action hammer causing contact between the paper and a type slug at the exact moment the required character is in position.

Ink Jet Printer - A high-speed printer that produces images by discharging tiny droplets of ink in a stream from a row of nozzles. As these droplets are discharged, they pass through electrical fields which induce electrical charges on selected droplets. Those droplets that are not charged will impact the paper while the charged droplets are electrostatically deflected from the stream to be returned to the ink system.

Input - (1) The data entered into a computer for processing; (2) The process of entering data; (3) Pertaining to the devices that enter data.

Interface - A common boundary between automatic data processing systems or parts of a single system.

Light-pen - A photosensitive device that is used to point to a particular element on a display screen. The light-pen

causes an interrupt to be initiated and the computer or the display processor is able to identify the element by reading an address or identification buffer in the display processor.

Mark Sense - Sensing of marks on a page, document, or card, and transmission of the appropriate code (depending on the position of the mark on the page).

Matrix matching - A pattern recognition technique used by optical readers to recognize characters. It is based on comparisons between the predefined matrix representation of each character (in the character set(s) recognized by the optical reader) and a similar matrix representation produced by the reader as the character to be interpreted is scanned. When the matrices "match," the character is recognized.

Modem - A contraction of MOdulator DEModulator. A device that modulates and demodulates signals transmitted over data communications facilities.

Multi-font reader - A reader having the capability to read multiple fonts intermixed on the same page.

Multiple font reader - A reader having the capability to read several fonts, but only one at a time; i.e., fonts cannot be intermixed on a page, and special action must occur before changing to another font. Switching between fonts can be a manual or a programmed feature.

Omnifont - The capability to recognize characters printed in any type font. The user inputs the characteristics of his particular font thereby "teaching" the optical reader another "character set."

Page reader - An optical reader having the capability to read letter-sized (8.5 x 11 inches) or larger documents. Page readers can read many lines from each document (as opposed to "document readers" which are generally capable of reading only one or two lines per document).

Pooling - The combining of data records recorded at individual tape stations onto a single tape for entry into a computer system.

Single font reader - An optical reader equipped to read one type font only.

Source document - The user's application document, which is a source of data eventually processed by the computer program. Examples include time cards, vouchers, and bills of lading.

Store-and-forward - Data (in the form of cards, tape, etc.) is temporarily stored at some location for later transmittal

to the computer site. An example is the generation of magnetic tape from a remote key-to-tape station. The tape is stored temporarily until it can be later carried or transmitted to the main computer facility.

Thermal printer - A printer which uses heated electrodes to selectively darken the surface of multi-layered paper in such a way as to reproduce the desired image(s) on a hard copy.

Throughput - The total amount of productive work performed by a data processing system during a given period of time.

Auerbach Computer Technology Reports. Product Class Report--Intelligent Terminal Systems; Philadelphia, PA (now Pennsauken, NJ); Auerbach Publishers, Inc.; 1972 May; 770.0000.100. 9 p.

Auerbach Computer Technology Reports. Specification Chart--Industrial Data Collection; Philadelphia, PA (now Pennsauken, NJ); Auerbach Publishers, Inc.; 1972 October; 292.0000.510. 3 p.

Auerbach Computer Technology Reports. Systems Design--Communications Facilities Overview; Philadelphia, PA (now Pennsauken, NJ); Auerbach Publishers, Inc.; 1973 July; 705.0000.210. 4 p.

Auerbach Computer Technology Reports. System Design--Equipment Selection Checklist; Philadelphia, PA (now Pennsauken, NJ); Auerbach Publishers, Inc.; 1973 July; 705.0000.230. 4 p.

Auerbach Computer Technology Reports. Systems Design--Error Control in Data Communications Systems; Philadephia, PA (now Pennsauken, NJ); Auerbach Publishers, Inc.; 1973 July; 705.0000.220. 6 p.

Auerbach Computer Technology Reports. Specification Chart--Point-of-Sale Systems; Philadelphia, PA (now Pennsauken, NJ); Auerbach Publishers, Inc.; 1973 October; 290.0000.500. 8 p.

Auerbach Computer Technology Reports. Specification Chart--Intelligent Terminals; Philadelphia, PA (now Pensauken, NJ); Auerbach Publishers, Inc.; 1974 October; 770.0000.500. 2 p.

Auerbach Computer Technology Reports. Product Class Report--Industrial Data Collection Systems; Pennsauken, NJ; Auerbach Publishers, Inc.; 1975 March; 292.0000.200. 5 p.

Auerbach Computer Technology Reports. Product Class Report--Key-to-Storage; Pennsauken, NJ; Auerbach Publishers, Inc.; 1975 March; 275.0000.200. 9 p.

Auerbach Computer Technology Reports. Specification Chart--Key-to-Magnetic Storage A-F; Pennsauken, NJ; Auerbach Publishers Inc.; 1975 March; 275.0000.510. 8 p.

Auerbach Computer Technology Reports. Specification Chart--Key-to-Magnetic Storage G-L; Pennsauken, NJ; Auerbach Publishers, Inc.; 1975 March; 275.0000.520. 6 p.

Auerbach Computer Technology Reports. Specification Chart--Key-to-Magnetic Storage M-Z; Pennsauken, NJ; Auerbach Publishers, Inc.; 1975 March; 275.0000.530. 9 p.

Auerbach Computer Technology Reports. Product Class Report--Multi-Media Systems; Pennsauken, NJ; 1975 April; 283.0000.200. 6 p.

Auerbach Computer Technology Reports. Search Chart--Intelligent Terminals; Pennsauken, NJ; Auerbach Publishers, Inc.; 1975 June; 770.0000.010. 2 p.

Auerbach Computer Technology Reports. Product Class Report--Punched Card Equipment; Pennsauken, NJ; Auerbach Publishers, Inc.; 1975 October; 255.0000.200. 12 p.

Auerbach Computer Technology Reports. Product Class Report--Modems and Telephone Couplers; Philadelphia, PA (now Pennsauken, NJ); Auerbach Publishers, Inc.; 1975 December; 725.0000.200. 8 p.

Auerbach Computer Technology Reports. Product Class Report--Teleprinters; Pennsauken, NJ; Auerbach Publishers, Inc.; 1975 December; 755.0000.100. 14 p.

Auerbach Computer Technology Reports. Search Chart--Alphanumeric Display Terminals; Pennsauken, NJ; 1976 February; 760.0000.010. 6 p.

Auerbach Computer Technology Reports. Basic System Design Concepts; Pennsauken, NJ; Auerbach Publishers, Inc.; 1976 March; 705.0000.020. 7 p.

Auerbach Computer Technology Reports. Specification Chart--Alphanumeric Display Terminals; Pennsauken, NJ; 1976 April; 760.0000.500. 2 p.

Auerbach Computer Technology Reports. Specification Chart--Alphanumeric Display Terminals; Pennsauken, NJ; 1976 April; 760.0000.510. 49 p.

Auerbach Computer Technology Reports. Product Class Report--Alphanumeric Display Terminals; Pennsauken, NJ; 1976 May; 760.0000.200. 10 p.

Auerbach Computer Technology Reports. Product Class Report--Magnetic Ink Character Recognition; Pennsauken, NJ; Auerbach Publishers, Inc.; 1976 May; 285.0000.200. 11 p.

Auerbach Computer Technology Reports. Product Class Report--Optical Character Recognition; Pennsauken, NJ; Auerbach Publishers, Inc.; 1976 November; 280.0000.200. 13 p.

Auerbach Computer Technology Reports. Product Class

Report--Retail Point-of-Sale Systems; Pennsauken, NJ; Auerbach Publishers, Inc.; 1976 December; 290.0000.200. 8 p.

Auerbach Computer Technology Reports. Search Chart--Key-to-Magnetic Storage; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 March; 275.0000.010. 3 p.

Auerbach Computer Technology Reports. Search Chart--Multi-Media Systems; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 April; 283.0000.010. 1 p.

Auerbach Computer Technology Reports. Specification Chart--Multi-Media Systems; Pennsauken, NJ; 1977 April; 283.0000.500. 2 p.

Auerbach Computer Technology Reports. Search Chart--Optical Character Code and Mark Readers; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 October; 280.0000.010. 3 p.

Auerbach Computer Technology Reports. Specifications Chart--Optical Character and Mark Readers; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 October; 280.0000.530. 28 p.

Auerbach Computer Technology Reports. Product Class Report--Optical Character Recognition Report Update; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 November; 280.0000.200. 1 p.

Auerbach Computer Technology Reports. Serach Chart--Card Preparation and Handling; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 December; 255.0000.010. 1 p.

Auerbach Computer Technology Reports. Search Chart--Industrial Data Collection Systems; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 December; 292.0000.010. 1 p.

Auerbach Computer Technology Reports. Search Chart--Point-of-Sale Systems; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 December; 290.0000.010. 2 p.

Auerbach Computer Technology Reports. Specification Chart--Keypunches and Verifiers; Pennsauken, NJ; Auerbach Publishers, Inc.; 1977 December; 255.0000.530. 3 p.

Auerbach Computer Technology Reports. Search Chart--Magnetic Ink Character Recognition; Pennsauken, NJ; 1978 February; 285.0000.010. 1 p.

Auerbach Computer Technology Reports. Specification Chart--Magnetic Ink Character Recognition; Pennsauken, NJ; Auerbach Publishers, Inc.; 1978 February; 285.0000.510. 5 p.

Datapro Reports on Data Communications. Alphanumeric Display Terminals-Basic Characteristics; Delran, NJ; Datapro Research Corporation; 1978 April; C25-010-101 to C25-010-161.

Datapro 70 the EDP Buyer's Bible. All About Graphic Digitizers; Delran, NJ; Datapro Research Corporation; 1977 March; 70D-010-92a to 70D-010-92r.

Datapro 70 the EDP Buyer's Bible. All About Data Collection Equipment; Delran, NJ; Datapro Research Corporation; 1977 June; 70D-010-85a to 70D-010-85r.

Datapro 70 the EDP Buyer's Bible. How to Analyze Your Data Communications Needs; Delran, NJ; Datapro Research Corporation; 1977 October; 70G-050-01a to 70G-050-01ff.

Datapro 70 the EDP Buyer's Bible. All About Modems; Delran, New Jersey; Datapro Research Corporation; 1978 February; 70G-500-01a to 70G-500-01zz.

Datapro 70 the EDP Buyer's Bible. How to Select and Use Data Entry Devices; Delran, NJ; Datapro Research Corporation; 1978 February; 70D-010-70a to 70D-010-70m.

Datapro 70 the EDP Buyer's Bible. All About Teleprinter Terminals; Delran, NJ; Datapro Research Corporation; 1978 March; 70D-010-21a to 70D-010-21pp.

Datapro 70 the EDP Buyer's Bible. All About Alpahnumeric Display Terminals; Delran, NJ; Datapro Research Corporation; 1978 April; 70D-010-15a to 70D-010rrr.

Datapro 70 the EDP Buyer's Bible. All About Data Communications Facilities; Delran, NJ; Datapro Research Corporation; 1978 May; 70G-100-01a to 70G-100-01ff.

Datapro 70 the EDP Buyer's Bible. User Ratings of Key Entry Equipment; Delran, NJ; Datapro Research Corporation; 1978 September; 70D-010-72a to 70D-010-72e.

Datapro 70 the EDP Buyer's Bible. All About Optical Readers; Delran, NJ; Datapro Research Corporation; 1972 October; 70D-010-78a to 70D-010-78ff.

MacCormack, Robert D., "Evaluating Data Entry Systems," Data Management, 14:10 (October 1976), 6p.

Management Information Corporation. Pathways Through Data Processing -- Data Entry; Cherry Hill, N.J., 1978, 201p.

Meadow, Charles T.; Man-Machine Communications; New York; Wiley and Sons; 1970; 422 p.

Martin, James; Introduction to Teleprocessing; New Jersey;

Prentice-Hall Series; 1972; 267 p.

Martin, Thomas B.; Applications of Limited Vocabulary Recognition Systems; Invited papers presented at the 1974 IEEE Symposium; New York; Academic Press; 1975; 55-72.

Martin, Thomas B.; Practical Applications of Voice Input to Machines; Proceedings of the IEEE; 1976 April; 64(4); 487-501.

Operations Research Report. Source Data Entry Guide; Gunter AFS, Alabama; Data Systems Design Center, Operations Research Division, Directorate of ADP Management; no date (approximately 1975); 88 p.

Schantz, Herbert F.; Optical Character Recognition--The Impact of a Maturing Technology on Future User Applications; OCR Today; 1977 November; 1(3); 6-7.

Schantz, Herbert F.; Economic Considerations in the Selection of OCR Systems; OCR Today; 1978 May; 2(1); 19-22.

Sippl, Charles J.; Computer Dictionary and Handbook; Indianapolis, Kansas City, New York; Howard W. Sams & Co., Inc., The Bobbs-Merrill Co., Inc.; 1967; 766 p.

United States General Accounting Office. New Ways of Preparing Data for Computers Could Save Money and Time and Reduce Errors; Washington, DC; 1978 July; 41 p. FGMSD-78-39.

Van Brimer, Russell H.; High Speed Ink Jet Technology; Digest of Papers COMPCON 74; 1974 February; 137-139.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1979 O—303-706

NBS-114A (REV. 9-78)

| U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET | 1. PUBLICATION OR REPORT NO. NBS SP 500-55 | 2. Gov't. Accession No. | 3. Recipient's Accession No. |
|---|---|---|---|

4. TITLE AND SUBTITLE
Computer Science & Technology:
Selection of Data Entry Equipment

5. Publication Date
November 1979

6. Performing Organization Code

7. AUTHOR(S)
Steve A. Recicar

8. Performing Organ. Report No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, DC 20234

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

Same as item 9.

13. Type of Report & Period Covered
N/A

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

Library of Congress Catalog Number: 79-600173

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This publication provides information to be used by Federal organizations in the selection of data entry equipment. It serves as a supplement to the Federal Information Processing Standards Publication (FIPS PUB) 67, "Guideline for Selection of Data Entry Equipment." The objective is to make available information that could lead to the selection of more efficient and economical data entry systems. This report provides information about economic and general operational considerations, steps to be followed in acquisition and training, and other factors pertinent to data entry equipment selection. Equipment profiles for the different data entry methods are also provided.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Application; character set; computer interface; cost; data entry; edit; operator speed; record size; transaction volume; transfer speed; validate; verify.

18. AVAILABILITY ☒ Unlimited

☐ For Official Distribution. Do Not Release to NTIS

☒ Order From Sup. of Doc., U.S. Government Printing Office, Washington, D.C. 20402, SD Stock No. SN003-003-02133-4

☐ Order From National Technical Information Service (NTIS), Springfield, VA. 22161

| 19. SECURITY CLASS (THIS REPORT) | 21. NO. OF PRINTED PAGES |
|---|---|
| UNCLASSIFIED | 77 |
| 20. SECURITY CLASS (THIS PAGE) | 22. Price |
| UNCLASSIFIED | $3.50 |

USCOMM-DC

## ANNOUNCEMENT OF NEW PUBLICATIONS ON COMPUTER SCIENCE & TECHNOLOGY

Superintendent of Documents,
Government Printing Office,
Washington, D. C. 20402

Dear Sir:

Please add my name to the announcement list of new publications to be issued in the series: National Bureau of Standards Special Publication 500-.

Name _____

Company _____

Address _____

City _____ State _____ Zip Code _____

(Notification key N-503)

# NBS TECHNICAL PUBLICATIONS

## PERIODICALS

**JOURNAL OF RESEARCH**—The Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent Bureau publications in both NBS and non-NBS media. Issued six times a year. Annual subscription: domestic $17; foreign $21.25. Single copy, $3 domestic; $3.75 foreign.

NOTE: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

**DIMENSIONS/NBS**—This monthly magazine is published to inform scientists, engineers, business and industry leaders, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on work at NBS. The magazine highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, it reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing. Annual subscription: domestic $11; foreign $13.75.

## NONPERIODICALS

**Monographs**—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

**Handbooks**—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

**Special Publications**—Include proceedings of conferences sponsored by NBS, NBS annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

**Applied Mathematics Series**—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

**National Standard Reference Data Series**—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NBS under the authority of the National Standard Data Act (Public Law 90-396).

NOTE: The principal publication outlet for the foregoing data is the Journal of Physical and Chemical Reference Data (JPCRD) published quarterly for NBS by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

**Building Science Series**—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

**Technical Notes**—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

**Voluntary Product Standards**—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NBS administers this program as a supplement to the activities of the private sector standardizing organizations.

**Consumer Information Series**—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

*Order the* **above** *NBS publications from: Superintendent of Documents, Government Printing Office, Washington, DC 20402.*

*Order the* **following** *NBS publications—FIPS and NBSIR's—from the National Technical Information Services, Springfield, VA 22161.*

**Federal Information Processing Standards Publications (FIPS PUB)**—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

**NBS Interagency Reports (NBSIR)**—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Services, Springfield, VA 22161, in paper copy or microfiche form.

# BIBLIOGRAPHIC SUBSCRIPTION SERVICES

**The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:**

**Cryogenic Data Center Current Awareness Service.** A literature survey issued biweekly. Annual subscription: domestic $25; foreign $30.

**Liquefied Natural Gas.** A literature survey issued quarterly. Annual subscription: $20.

**Superconducting Devices and Materials.** A literature survey issued quarterly. Annual subscription: $30. Please send subscription orders and remittances for the preceding bibliographic services to the National Bureau of Standards, Cryogenic Data Center (736) Boulder, CO 80303.

**U.S. DEPARTMENT OF COMMERCE**
**National Bureau of Standards**
Washington, D.C. 20234

OFFICIAL BUSINESS

Penalty for Private Use, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215

SPECIAL FOURTH-CLASS RATE
BOOK