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Guideline

FOR SELECTION OF DATA ENTRY EQUIPMENT

ATEGORY: HARDWARE
IBCATEGORY: DATA ENTRY EQUIPMENT

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Foreword

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Abstract

This publication provides a guideline to be used by Federal agencies in the selection of data entry equipment. The objective is to make available information that will assist in the selection of more efficient and economical data entry systems. The guideline 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.

Key words: Data entry; economic considerations; keyboard; keypunch; optical character recognition; optical mark sensing; source data entry.

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Announcing the

GUIDELINE FOR SELECTION OF DATA ENTRY EQUIPMENT

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Applicability. This guideline is intended as a basic reference document for general use by Federal departments and agencies in the selection of data entry equipment. Its use is encouraged, but is not mandatory.

Implementation. When new or different data entry techniques or methods are contemplated, the use of this guideline should be considered.

Specifications. Federal Information Processing Standard 67 (FIPS PUB 67), Guideline for Selection of Data Entry Equipment (affixed).

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GUIDELINE FOR SELECTION OF DATA ENTRY EQUIPMENT

Contents

Executive Summary

The purpose of this Guideline is to provide Federal ADP managers an aid for selecting data entry equipment. The cost of data entry represents from 30 to 50 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 Guideline will make it easier for the Federal ADP manager to take advantage of these opportunities.

At the present time, almost all agency functions are influenced by automatic data processing (ADP). As more functions are performed wholly or partly by computers, the task of converting human-readable information to machine-usable data becomes more important.

Advanced data entry methods offer ways to:

(1) eliminate part of the keying,

(2) reduce the operations required to convert source data to computer-readable form,

(3) verify data more accurately, and

(4) reformat or otherwise edit data during data entry rather than during processing steps.

All of the newer devices are primarily electronic and are considered 20 to 50 percent faster than mechanical key entry devices in the typical use environment. Other benefits of the newer devices vary from manufacturer to manufacturer as well as from device to device, depending on the software (computer programs) that can be written for, or comes with, the equipment. Any data entry technique which depends on human keystroking for the bulk of the data is going to be limited to a very modest data input rate, no matter how sophisticated the equipment becomes in terms of special features. Increasingly, data acquisition equipment is being used to acquire data directly in machine-readable form from the source which generates the data.

For many data entry applications, there will be several alternative types or categories of devices that can successfully meet the performance requirements. Within each category there will certainly be equipment from a number of different manufacturers that can do the job. The final selection, then, will be based on an analysis of which device is most economical on a life cycle basis.

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 currently installed. Data entry system cost/performance comparisons are normally specified in terms of cost per character of input. 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.

Keyboard-to-disk, keyboard-to-tape, optical character readers and voice recognition systems are some examples of categories of data entry systems. Many different data entry systems are offered within each category by numerous vendors. Because of the large number of different systems available, it is necessary to use a systematic approach in the selection process to insure the selection of the data entry system best suited to a particular agency's operations.

The most logical approach is to first select the most appropriate category (or categories) of equipment that will meet the user's needs; then to select the most appropriate system within the selected category. A thorough analysis of an agency's data entry requirements is the first step in the category selection process. The data input area associated with the agency's applications must be

thoroughly defined. Next, those categories of equipment that do not meet the user's needs are removed from consideration. This is done by comparing the data entry equipment categories with the critical performance factors dictated by the user's requirements. The last step in category selection, after as many categories as possible have been eliminated, is to perform an economic analysis on the remaining categories. The construction of cost/volume graphs will indicate whether it is economically wise to consider certain categories of data entry equipment.

After determining which category (or categories) of data entry equipment meets the user's needs, a solicitation can be prepared and issued that details the agency's workload and requirements, the type of system that is sought, and the factors by which proposals will be evaluated. Evaluation of proposals must be according to these factors. Two common approaches are to compute a cost-performance ratio based on the weighted evaluation of the equipment on each factor, or to compute a feature-adjusted cost by assigning value to each feature above a set of mandatory requirements. Either approach permits accurate comparison of systems since all data are reduced to the same format.

1.0 Introduction

1.1 The Data Entry Problem

It is well known that modern high-speed digital computers have prodigious appetites for data. Computers have always been able to process data internally at far greater speeds than it has been possible to get data in and out of them. Data entry is the process of preparing data in a suitable machine-readable form and entering it into a computer. Data, in this context, also includes computer programs. While there has been progress in the techniques and equipment for data entry, this progress has been modest in comparison with the dramatic gains in the rates at which data can be processed and transferred within the computer. The result is that data entry costs have long been disproportionately high and are the largest single cost factor in many data processing activities.In order to offset this imbalance, Federal ADP managers should seriously consider the introduction of advanced data entry techniques.

Advanced data entry methods offer ways to:

(1) eliminate part of the keying;

(2) reduce the operations required to convert source data to computer-readable form;

(3) verify data more accurately; and

(4) reformat or otherwise edit data during data entry rather than during processing steps.

The product of advanced data entry methods is normally tape, disk, or direct input to computers. Advanced data entry methods can reduce labor and the number of processing steps required and produce savings.

At the present time, almost all agency functions are influenced by automatic data processing (ADP). As more functions are performed wholly or partly by computers, the task of converting human-readable information to machine-usable data becomes more important. The data must be complete, accurate, and available when and where needed. The real success of an ADP organization is measured by (1) user satisfaction with the services it renders and (2) whether those services, including data entry, are supplied at reasonable cost.

This guideline describes the presently available spectrum of techniques and equipment and provides guidance in making a selection based upon performance requirements, together with technical and economic factors.

1.2 Automation of Data Entry

All of the newer data entry devices are primarily electronic and are considered 20 to 50 percent faster than mechanical key entry devices in the typical use environment. Other benefits of the newer devices vary from manufacturer to manufacturer as well as from device to device, depending on the software (computer programs) that can be written for, or comes with, the equipment. Such software can include programs with various functions including:

(1) automating some of the keying, such as storing tables of values (such as pay rates), so that they need not be keyed;

(2) rearranging data from the way it is shown on the source document to the format needed for the processing program;

(3) providing variable record length, which can vary from 125 to 4,096 characters on magnetic media;

(4) checking data entered for accuracy or for consistency with other data;

(5) storing helpful messages to the operators, such as what data is to be entered next;

(6) keeping operator and job statistical records, such as amount and rate of production; and

(7) balancing to control totals.

All key entry devices are labor intensive. Thus, a 20- to 50-percent increase in productivity can greatly reduce salary and overhead costs.

The use of computer programs to support the data entry process offers great advantages in terms of simplification of the operator's task, increased productivity, and enhanced accuracy. For example, accuracy can be enhanced by performing such checking operations as the following: An *edit check* can be used to assure that alphabetic characters are not entered where numbers are supposed to be. An example of a *limit check* is checking to see that a number is not over a certain maximum value. An example of a *range check* is checking to see that a number falls in a range, i.e., above a minimum and below a maximum. All three checks can be automated with edit programs--computer programs which scan data for, and report on, errors. These same checking operations should also be performed within the computer served by the data entry system in order to assure that no changes have occurred and to provide a higher degree of data accuracy.

Data intended for computer entry can originate in a great variety of forms. Traditionally, it has been presented in source documents, or on special data entry forms, in which the data is broken down into convenient units to meet the needs of the data entry

process. For example, where punched cards are being used as the data entry medium, data may be arranged on the source document in rows such that each row contains the data to be punched on one card. On the other hand, the source document may be some type of filled-in form in which the data appears in arbitrary locations throughout the form. This requires some mental dexterity on the part of the data entry operator to locate the items and enter them in the proper sequence.

Increasingly, data acquisition equipment is being used to acquire data directly in machine-readable form from the source which generates the data. Examples occur in such diverse forms as point-of-sale terminals, process control instrumentation, and environmental measuring equipment. This avoids the need for the data to be handled by a human operator, thereby allowing more immediate processing of the data, eliminating human-introduced errors, and achieving more economical operation. This eliminates not only the keying necessary for first entry, but also the second keying that would otherwise be needed for verification.

Any data entry technique which depends on human keystroking for the bulk of the data is going to be limited to a very modest data input rate, no matter how sophisticated the equipment becomes in terms of special features. Hence, in the long run, any major improvement will have to come from the use of automated data acquisition and entry techniques, rather than from enhanced operator work stations.

For many data entry applications, there will be several alternatives types or categories of devices that can successfully meet the performance requirements. Within each category there will certainly be equipment from a number of different manufacturers that can do the job. The final selection, then, will be based on an analysis of which device is most economical on a life cycle basis.

1.3 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 currently 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/performance 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.

$$C = (E + P + S + F + H) / T$$

Where
C = Cost per Character of Input
E = Equipment Costs
P = Personnel Costs
S = Cost of Supplies
F = Facilities Costs
H = Error Handling Costs
T = 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 supplies

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

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, 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 extensive error-control facilities to decide just how much protection against errors is really necessary.

1.4 Equipment Category Selection

Keyboard-to-disk, keyboard-to-tape, optical character readers and voice recognition systems are some examples of categories of data entry systems. There are several categories, all described in Section 2.1.

Many different data entry systems are offered within each category by numerous vendors. Because of the large number of different systems available, it is necessary to use a systematic approach in the selection process to insure the selection of the data entry system best suited to a particular agency's operations.

The most logical approach is to first select the most appropriate category (or categories) of equipment that will meet the user's needs; then to select the most appropriate system within the selected category.

A thorough analysis of an agency's data entry requirements is the first step in the category selection process. The data input area associated with the agency's applications must be thoroughly defined.

Next, those categories of equipment that do not meet the user's needs are removed from consideration. This is done by comparing the data entry equipment categories with the critical performance factors dictated by the user's requirements.

The last step in category selection, after as many categories as possible have been eliminated, is to perform an economic analysis on the remaining categories. The construction of cost/volume graphs (discussed in Section 2.3) will indicate whether it is economically wise to consider certain categories of data entry equipment.

1.5 Competitive Equipment Selection

After determining which category (or categories) of data entry equipment meets the user's needs, systems within that category (or categories) manufactured by various vendors should be investigated. This involves consulting sources of information such as those listed in Section 1.6 as well as various manufacturers' sales representatives.

After the number of candidate systems has been pared down, benchmarks should be run on candidate systems. Also it is of the utmost importance to talk to other users of the manufacturer's equipment.

Finally, a cost effectiveness analysis for each vendor's equipment should be performed. This permits accurate comparison of systems since all data is reduced to the same format. It makes system selection easier and more accurate.

1.6 Information Sources

There are several reference sources (such as Auerbach and Datapro) which cover specific data entry devices in considerable detail. Some other sources of information about data entry are:

Publications such as **Data Entry Today** and **Data Management**

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.

2.0 Category Selection

2.1 Categories of Equipment

A wide variety of different types or categories of data entry equipment are available to meet different users' needs. The selection of the best category of equipment to meet particular requirements is recommended as an important step prior to the selection of specific equipment (by make and model).

This chapter deals only with the selection of the best category of equipment for particular needs. This requires both a thorough understanding of what these user needs are, as well as an understanding of the general capabilities and limitations of equipment in each of the categories.

Listed below are the different categories of data entry systems and a short description of each. Table 1 contains a general summary of the characteristics of equipment in each category. For more detailed treatment the reader is referred to NBS Special Publication 500-55, "Selection of Data Entry Equipment."

2.1.1 Keying Equipment

Keypunch

A keypunch is an electromechanical device which converts operator keystrokes into machine-readable holes on cards.

Typical Data Entry Applications

Punched cards have 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.

Advantages and Strong Points

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

Equipment cost is low (1/2 to 1/3 of the cost of key-to-tape equipment).

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

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.

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.

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.

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.

	Transfer Speed	Volume Per Unit Time	Operator Speed Possible	Environment	Approximate Area Required
Keypunch	18-65 characters per second	125 eighty character cards per hour	10,000 keystrokes per hour	normal office	20 sq. ft.
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.
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.
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.
Teleprinters	up to 9600 bps	limited by speed of operator	less than other keyboard devices	normal office	slightly more than typewriter
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.
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.
Optical Bar Code Readers	depends on the device reading speed	8-480 forms per minute	N/A	normal office (some harsh)	up to 15 sq. ft.
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.
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.
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.
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.
Point-of-Sale	up to 9600 bps	depends on configuration	500-3500 keystrokes per hour	retail store environment	depends on configuration

TABLE 1. GENERAL SUMMARY OF CHARACTERISTICS

	Record Sizes	Character Sets Available	Edit/Validate Capabilities	Operator Requirements
Keypunch	80 or 96 characters	BCD, Hollerith, EBCDIC, or ASCII	limited	skills higher than those for typists
Keyboard-to-Tape	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	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	80-1920 characters	ASCII, BCD, or EBCDIC	extensive	limited skills may be adequate - depends on the application
Teleprinters	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	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	typically, up to 1,000 marks per side per page	N/A	most are limited	limited skills are adequate
Optical Bar Code Readers	usually 12 numeric characters	UPC, CODABAR, Distribution Symbol, Telexon codes & others	limited	limited skills are adequate
Magnetic Ink Character Recognition	up to 60 characters	numerics 0 thru 9 plus 4 or 5 control characters	moderate	limited skills are adequate
Pushbutton Telephone	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	N/A	usually a vocabulary of alphanumeric and command words	moderate to extensive	limited skills are adequate
Digitizing Tablets	N/A	N/A	None	drafting skills preferable only in inputting mechanical or graphic drawings
Point-of-Sale	Typically, 18-26 characters	numeric and control characters	limited to moderate	cash register experience is helpful

TABLE 1. GENERAL SUMMARY OF CHARACTERISTICS (CONTINUED)

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, to computer systems is much faster than punch cards.

Operators can concentrate on keying data with no interruptions for card handling.

Keying operation is quiet and generally acceptable in office environments.

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.

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.

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.

Advantages and strong points

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.

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.

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

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 eliminates operator noise-fatigue.

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 they can be from the processor, unless standard protocols are used in conjunction with telecommunications links for batch tranmissions from stand-alone diskette systems.

Keyboard-to-disk units are even more expensive than key-to-tape units.

Portable Keyed Devices

Portable data recorders are small, lightweight, 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.

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.

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.

The portable keyed devices are less expensive than most other data entry equipment.

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.

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 is the cathode ray tube (CRT) display.

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.

Advantages and Strong Points

Speed - An alphanumeric display is an electronic device that is inherently faster than its electromechanical competitors. Teleprinters typically operate at 30 characters per second. During input, a CRT can display as fast as the operator types; during output it can display a full screen in a fraction of a second.

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.

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.

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.

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.

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.

Advantages and Strong Points

Teleprinters are low cost data entry terminals.

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.

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.

Pushbutton Telephone

Pushbutton telephones are telephones which use pushbuttons ("touchtone" pads) for entering the dialing information, rather than rotary dials.

Typical Data Entry Applications

Typical data entry applications for pushbutton telephones include sales ordering, remote inquiry such as credit authorization, bank balance, etc., production control and inventory control

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.

Disadvantages and Limitations

Data entry is slow (typically only on the order of 1.5 characters per second).

Generation of alphabetic 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.

2.1.2 Automatic Readers

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).

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. The ability of Optical Character Readers to read handprinted numerals should make the OCR a prime candidate for applications where small amounts of numeric data need to be collected from many locations.

Advantages and Strong Points

OCR's convert human-readable and human-prepared data directly into computer-readable codes. The solution 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.

When the OCR is used as a keypunch replacement, data can be entered with a typewriter, the operation of which 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.

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.

In contrast to results with handprinted numeric input data, OCR readers still experience relatively high error and reject rates with handprinted alphabetic characters.

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.

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 or item of information.

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.

Advantages and Strong Points

OMR equipment is somewhat 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 an appropriate pencil or pen.

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.

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.

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.

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).

The bar code labels are mass produced as part of the product packaging process

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.

Magnetic Ink Character Recognition (MICR)

MICR readers are electronic reading devices that recognize characters by analyzing the magnetic patterns of the individual characters and identifying them.

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.

Advantages and Strong Points

They allow the direct reading of magnetic ink encoded characters which are insensitive to pencil or ink overmarkings and difficult to modify.

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").

Disadvantages and Limitations

MICR readers require special forms preparation and read a limited character set (14 characters).

Ultimately, the development of inexpensive, flexible, fast, and reliable optical character readers will probably replace most MICR readers (except where security is a major factor).

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.

Remote Scanners

Remote scanners are optical readers (either OMR, OCR, 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.

2.1.3 Source Data Sensing

Voice Recognition Systems (Speech Recognition Systems)

Voice recognition systems are electronic systems which are capable of interpreting spoken words according to predefined meanings.

At present, voice recognition systems have only a limited capability for 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.

Typical Data Entry Applications

Voice recognition systems are typically used in applications where it is important that the operator's hands be free for other activities. Examples include baggage handling in airlines and manufacturing production lines. Voice recognition can be used remotely through telephone handsets. Voice recognition systems have also been used successfully in security applications for speaker verification and identification.

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.

Telephone handsets can be used as an input device for some (but not all) commercially available voice recognition systems. In such situations, audio response is typically provided with a voice synthesizer. Portable microphones and radio transmitters can be used to eliminate wired connections.

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. However, there are not yet sufficient voice recognition systems in commercial use to provide error rates based on extensive practical use.

Industrial Data Collection Equipment

This equipment category covers specialized data entry systems designed to capture data in an industrial (factory) operating environment. Some common devices are badge readers, time clocks, keyboards, remote scanners and hand-print recognition equipment.

2.1.4 Miscellaneous

Mixed-Media (Keyboard/Reader) Systems

A mixed-media system is an electronic data entry systems which incorporates both keyboard-to-disk and optical scanning equipment.

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.

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 also apply to the mixed-media systems.

Disadvantages and Limitations

Most of the disadvantages and limitations that apply to the categories of optical character readers and keyboard-to-disk systems 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.

Digitizing Tablets

Image digitizers (of which digitzing 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.

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 for use by numerically controlled machine tools and the generation of input from rough sketches to produce accurate drawings.

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.

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.

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.

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.

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.

Advantages and Strong Points

POS systems are designed to minimize key depresssions 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.

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

Disadvantages and Limitations

POS systems are expensive. Their use is normally restricted to the larger, high volume type of retail business.

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.

2.2 Factors in Data Entry Equipment Category Selection

Before the fine differences between competitive equipment (from different manufacturers) can be evaluated, a coarser selection must be made of the type or category of equipment best suited for the particular task. Equipment categories are selected on the basis of cost and efficiency as compared with other alternatives. Even this coarse selection process is complex, especially in large agencies with many departments originating transactions in multiple locations.

Three levels of category selection factors are briefly discussed here and are identified as primary, secondary, and tertiary factors according to their relative importance.

2.2.1 Primary Factors

The four primary considerations regarding input data are:

Transaction volume
Point of data origin
Transaction class
Form in which the data are available

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 form in which the data are available prior to data entry can be an important factor in selecting data entry equipment. If the data are in such a form that direct entry is possible (without intermediary handling or transcription), significant benefits can be obtained. The most important benefit of eliminating intermediary handling or transcription are the reduction in errors, saving of time and reduction of costs.

Some examples of situations where direct data input is possible include the following:

If the application is such that the data consist of only one or two lines on a "turn-around" document, then the selection of a document reader for direct input might be considered.

If the data consist of a large volume of typed pages that are prepared under controlled conditions in a well disciplined environment, then selection of a page reader might be considered.

A variety of special coding forms exist for mark-sense readers that can be used if input volume justifies.

If the data can be obtained by observation in an environment where a small vocabulary of spoken words could be used for input, selection of a voice recognition system might be considered.

2.2.2 Secondary Factors

The secondary factors in equipment selection are accuracy controls and administrative controls for ensuring proper administration. Accuracy controls are 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.

2.2.3 Tertiary Factors

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 data storage.When converting from one data entry system to another, a system should not be arbitrarily chosen without proper concern for the recording media it uses. If the recording media is not given proper consideration, there is the risk of added expense and operational complications. A special conversion unit may even be required to transform the data into a form suitable for input to the computer.

General characteristics and requirements of the different categories of data entry equipment are provided in Table 1 of this document and in NBS Special Publication 500-55. Some of the more important ones will now be presented.

Keying Category

Keyboards - Keyboard layout can either be a keypunch keyboard style or a typewriter keyboard style. The typewriter keyboard style is found on many of the text-oriented systems.

Edit/validate capabilities - A limited range of capabilities including printing, field definition, zero insertion, skipping, check digit generation, and character inhibition are found in the keypunch but a much wider range is found in other devices in the keying category. Other equipment has capabilities such as zero balancing, range values, logical checks, format checks, and table lookup to insure the numeric correctness of keyed-in data. In addition, some systems, if they are of the shared-processor variety, are quite flexible and perform many user-defined edit/validate functions.

Operator requirements - Personnel with typewriter skills can be easily trained to operate these systems.

Operator speed - Speeds of from 12,000 to 20,000 keystrokes per hour are possible, but an average of approximately 7500 keystrokes per hour can be expected for a typical application.

Volume per unit of time - Based on an average 7,500 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. Because of the absence of mechanical card movement, other systems in the keying category have a greater volume per unit of time. In shared-processor systems, such as key-to-disk, many software features may be implemented providing the system the ability to insert constants, justify, skip, and duplicate. This results in a 25-50% increase in throughput over keypunch units.

Number of keying stations - Stand-alone units are available in most categories of keying equipment. A larger system, such as a shared processor 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.

Automatic Reader Category

Edit/validate capabilities - Because the control component of any OCR system is a minicomputer, the capability to manipulate and edit or validate data in local storage is therefore an inherent feature of all OCR equipment. However, most OMR and OBR readers have very limited edit/validate capabilities.

Operator requirements - Except in OCR, operator requirements are not a critical factor in the automatic reader category of systems. If the OCR system uses a keyboard device for error correction, keying skills are beneficial. If the input will be handprinted, the personnel preparing the OCR input should be thoroughly familiar with the rigid requirements of OCR handprinting. Also, if the OCR input is prepared on a typewriter, the typist should be specifically trained in the preparation of the OCR forms.

Volume per unit of time - Typical speeds are as follows:

	Pages/Minute
page readers	up to 400
document readers	up to 1600
OMR readers	up to 1500
OBR readers	up to 480

Special forms requirements - Forms are probably the most critical requirement of an OCR operation. The design of the form, the quality and thickness of the paper are critical factors. Data usually must be in predefined locations and the characters must be properly registered, crisp, and well defined with very little skew. Forms requirements for OMR and OBR are less stringent than for OCR.

Source Data Sensing Category and Miscellaneous Category

The equipment in these two categories includes a broad range of devices, in most cases specialized, such that their characteristics are quite diverse. It is suggested that Table 1 and NBS Special Publication 500-55 be referred to in order that they need not be covered here.

2.3 Category Selection Procedures

STEP ONE:

The first step in selecting the type of data entry equipment best-suited to a particular agency's operations is to perform a thorough analysis of its data entry requirements. The following should be defined for each application:

Present workload requirements

Type of source data

Quantities and types of documents, if any, including the amount of data per document to be entered

Present manual procedures (clerical tasks that could be handled by the system)

Personnel requirements

System consideration in terms of interface, types of documents and document handling requirements

Input and output formats desired

Response time requirements

Special needs and requirements such as information redundancy

Conversion procedures required, if any

Implementation schedule requirements

After establishing the data entry requirements, the next step is determining which data entry equipment category will provide the requisite capabilities to meet these requirements. After selecting the appropriate category (i.e., keyboard-to-disk, keyboard-to-tape, OCR, etc.), it will then be possible to complete the process by selecting the appropriate device within the selected category.

STEP TWO:

User needs and cost of the data entry systems that satisfy those needs are the two basic considerations in the selection process. It is suggested that first an attempt should be made to eliminate those categories of equipment that do not have attributes that satisfy the requirements of the intended applications (the users needs). This is done by comparing the data entry equipment categories with the critical performance factors (factors such as environmental conditions, hardcopy requirements, data validation requirements, data formatting requirements, etc.) dictated by the user's requirements. After as many categories as possible have been eliminated, an economic analyses should be performed on the remaining categories.

STEP THREE:

Economic considerations were discussed in Section 1.3 of this document. It is suggested that cost/volume graphs be constructed for each data entry category that has not already been eliminated. A typical cost/volume graph is illustrated in Figure 1. Based upon current and expected data entry volumes, the graphs will indicate whether it is economically judicious to consider certain categories of data entry equipment. The construction of accurate curves depends upon having detailed and accurate knowledge both of the specific application and typical costs and performance of equipment in that class; any changes in equipment configurations or data preparation procedures will result in a change in the curves.

3.0 Competitive Equipment Selection

3.1 Solicitation Preparation

After the type of equipment neeeded has been identified, selection of particular equipment can be made from the various vendor offerings in that

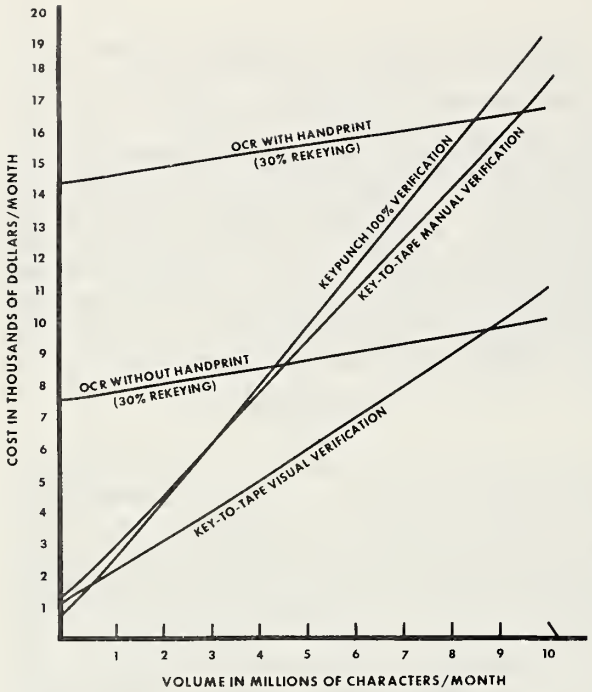

FIGURE 1: AN EXAMPLE OF A COST/VOLUME GRAPH

category. Normally this would be accomplished through a competitive selection, involving the issuance of a request for proposals to meet the particular requirements that have been identified, quantified and documented.

The solicitation document should detail the data entry requirements that the equipment must meet. In specifying these requirements, factors to be considered would include keyboard operator facilities, verification and validation features, output control features, programming flexibility, data formatting and reformatting capabilities, error handling procedures and system management features. The solicitation must specify the factors by which proposals will be evaluated.

Federal procurements are governed by the Federal Procurement Regulations (FPR) published under Title 41 of the Code of Federal Regulations (CFR) as Chapter 1. Government-wide Federal Property Management Regulations (FPMR) applicable to Automatic Data Processing are published as Subchapter F of Chapter 101 of Title 41 CFR. In addition to Government-wide rules, many agencies have their own supplementary regulations and procedures. Consultation with the procurement authority in the particular agency is recommended prior to initiating a procurement action to ensure compliance with all applicable rules, regulations and procedures.

3.2 Evaluation Factors

Few users have exactly the same requirements, so few solicitations will specify the same requirements and evaluation factors. The following factors should typically be considered in the preparation of the solicitation document:

Performance relative to cost and effectiveness

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 in 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 special conventions be required?

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.

3.3 Equipment Selection Procedures

Selection of particular data entry equipment for lease or purchase results from evaluation of proposals submitted in response to the solicitation. It is important to remember that the proposals must be evaluated on the basis of the requirements and evaluation factors presented in the solicitation. In addition, it should be understood that only a person designated by an agency as a Contracting Officer is authorized to enter into and administer contracts. The Contracting Officer, when exercising this authority, is subject to all applicable requirements of law, Executive Orders and regulations. The Contracting Officer is responsible for making the selection of that responsible offeror whose offer will be the most advantageous to the Government on the basis of lowest overall cost, price and other factors considered.

Normally, the person or team who prepared the technical specifications for the solicitation will evaluate how well each proposal meets these specifications. Technically unacceptable proposals will be identified (along with the basis for that determination) and the acceptable proposals will be scored according to a procedure identified in the solicitation. The Contracting Officer will then make the selection based on the technical evaluations and the offered prices.

Consultation with the appropriate procurement authority during the solicitation preparation and proposal evaluation planning phases is strongly recommended.

4.0 Summary and Conclusions

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
   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.

Glossary

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.

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.

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.

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.

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 punches (or marks entered) in a vertical column.

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.

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).

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

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).

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.

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

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