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Some Considerations in Using Optical Character Recognition Equipment

By Howard G. Rhile, Jr.

In this article, the author explores some of the factors which should be taken into consideration in reaching a decision to use Optical Character Recognition (OCR) equipment to prepare computer input. As used in this article, OCR consists of optical scanning equipment capable of reading typewritten and computer-printed material and converting it to a computer-acceptable code and media.

The OCR input method is distinguished from other automatic input conversion methods such as magnetic ink character recognition and optical mark reading (another type of optical scanning) in that the characters to be read are recognized by their images rather than magnetically or positionally. OCR works on the principle of light reflectance. A strong light is passed over the source document and the machine senses those areas which do not reflect the light. The areas not reflecting light (the character images) are compared with character images stored in the machine's memory. The matched character is then transferred to the computer for direct input or is written on a computer-acceptable medium such as magnetic tape.

Certain features are common to all types of OCR machines: a paper transport system to move the source documents through the machine; a recognition head to read the characters on the source documents; a memory to compare the characters read with those stored in memory; a code converter to convert the characters into computer-acceptable code; and a control unit.

It is estimated that there are 500 or more optical scanning machines in use in the United States at present. A survey of about 2,200 computer installations by *Business Automation* shows that only about 4 percent of the installations use optical scanning equipment as their basic input device and that keypunching is still the basic input method in about 85 percent of the installations.[1] *Electronic News* estimates that optical scanning input volume now equals about 1 percent of the present

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keypunch volume and that this is expected to increase to 5 percent of the present volume by 1970 and 25 percent by 1975. The National Bureau of Standards estimates that, by 1980, optical scanning input will equal the volume of keypunching and by 1985 will be four times the keypunching volume.[*]

There are 15 manufacturers of commercial-type optical scanning equipment in the United States at present. Eight of these manufacture OCR equipment. At least three other companies have OCR equipment in various stages of development. In 1955, sales of optical scanning equipment amounted to about $500,000. In 1965, sales had increased to $14.5 million. By 1972, however, sales are estimated to reach $400 million.

It is apparent therefore that the optical scanning input method (including optical mark and optical character readers) is not, at present, a significant factor in the total input volume of computer installations in the United States and that OCR input is only a portion of the optical scanning input. Optical scanning is, however, expected to be the major input method in about 15 years.

While each organization's decision to use OCR equipment should, of course, be based on a careful cost/benefit study of its own peculiar situation, there appear to be certain considerations which are present in varying weights in all decisions to use this equipment.

* Ron Schneiderman, "OCR: Pleasantly Painful Growing Pains," *Electronic News*, 13 (Dec. 9, 1968), p. 43.

OCR Cost Considerations

Perhaps one of the most inhibiting factors in a decision to use OCR equipment is the cost of the equipment itself. OCR equipment is many times more expensive than other input equipment. For example, a Philco General Purpose Print Reader capable of reading eight different type fonts and converting 2,600 characters per second to magnetic tape media rents for $14,500 per month (including maintenance) and sells for $530,000. Monthly maintenance cost thereafter is $3,000. An Electronic Retina Computing Reader Mod IV capable of reading up to eight different type fonts and converting 2,400 characters per second to magnetic tape rents for $15,000 per month (including maintenance) and sells for $621,400 with a monthly maintenance cost of $2,720.

In contrast, an IBM 026 keypunch rents for $63 per month, a Mohawk Model 1101 keyboard-to-magnetic-tape device rents for $149 per month. Even other optical scanning machines such as optical mark readers do not approach the cost of OCR machines. For example, an IBM 1231 Mark Sense Reader rents for $505 per month and sells for $26,700 with $42 monthly maintenance. A Digitek 70 Optical Mark Recognition System rents for $670 per month and sells for $29,750 with $148 monthly maintenance.

OCR State-of-the-Art

Another important consideration is the state-of-the-art of OCR input methods. These primarily involve forms quality control (which affects reject rates), reliability of the equipment, and accuracy of data conversion.

The published literature on the use of OCR suggests that an intensive quality control program must be maintained over the documents to be read. TV Guide, which uses a Farrington Model 3010 Multifont Document Reader to read names and addresses from computer-generated subscription renewal turnaround documents, test scans 500 documents every 2 hours during the time the computer is printing the documents. If the reject rate exceeds one-half of 1 percent, the ribbon on the printer is changed. Also, the printer type bars are cleaned every hour when printing turnaround documents.[3]

Alan Drattell, in an illuminating article in the January 1968 issue of *Business Automation*, points out that United Air Lines, which uses an Electronic Retina Computing Reader to read about 4 million airline tickets, airbills, and refund checks per month, experiences a character reject rate of from 0.5 percent to 0.8 percent. He also points out that American Airlines monitors its OCR rejects and has found that most rejects can be traced to improper preparation of tickets by its field agents and other airlines. The experience of these users indicates that, with stringent quality control over the documents, document reject rates of OCR equipment can probably be kept down to approximately 1 percent. This need for high quality control over documents, however, has probably been a discouraging factor in many companies' consideration of OCR equipment.

Reliability of OCR equipment does not appear to be much of a problem.

The experience of one user, United Air Lines, suggests however that maintenance time may be higher for OCR equipment than for other data processing machines and a long-term breakdown of a high volume OCR machine could create an insurmountable backlog unless backup capability were available. United's Electronic Retina Computing Reader has experienced maintenance downtime of about 20 percent of in-service time as opposed to about 10 percent average maintenance downtime experienced by Federal Government computers. United has arranged for backup capability with another user about 15 miles from its OCR installation in the event of a long-term downtime.

There appear to be two major factors which affect accuracy of data conversion on OCR equipment. The first is the accuracy with which raw data is converted to OCR-readable form; the second is the accuracy with which the OCR equipment converts the OCR-readable documents to computer-acceptable code and media.

In converting raw data to OCR-readable form, turnaround documents probably have an error rate of almost zero since the turnaround documents are generally prepared by computer-driven high-speed printers or some other highly accurate device. The problem of accuracy arises when a non-automatic method such as typing is used. Case histories in the literature (which may be biased) generally agree that typing for OCR is more accurate than keypunching/verifying. Studies, however, bear this out. A study prepared by the Institute of Management

[3] Anthony J. Rizzo, "OCR for Handling Publication Subscriptions," *Datamation*, 15 (December 1968), p. 70.

Science[4] shows that the error rate encountered in typing for OCR input is the lowest of all other manual data conversion methods at 0.9 percent with keypunching/verifying at 2.0 percent and keyboard to magnetic tape at 2.0 percent.

The accuracy of OCR equipment in converting characters to computer-acceptable code and media appears to be very high. For example, Northwestern National Insurance Group reports an accuracy rate of 99.5 percent with its CDC 915 Page Reader. The Institute of Management Science study states that an accuracy rate of 99.9 percent can be achieved with good quality input (clean, well-adjusted typewriters, good ribbon, clean paper); 98.5 percent with medium quality input (manual typewriters in good condition, good ribbon, clean paper); and 96.5 percent with poor quality input (old poorly adjusted typewriters, dirty paper). The fact that OCR equipment is programmable and has memory and control devices much like a computer allows editing such as computation of check digits and hash totals to ensure the equipment's accuracy.

Application Considerations

In addition to these state-of-the-art considerations, there are some general application characteristics which should be taken into account before reaching a decision to use OCR equipment.

[4] William B. Moore, "The Input Problem" (The First Lecture of a Four Part Series Presented in October 1968), Institute of Management Science, p. 62.

It is generally agreed that OCR equipment should not seriously be considered unless it is necessary to input alphanumeric information. If only numeric data is to be inputted, optical mark readers, which are much less expensive to operate than OCR equipment, should be considered.

Perhaps the most important application characteristic is the volume of input to be converted. It appears that, for OCR to be economically feasible, a very large volume of data must be converted. The Institute of Management Science OCR study cited above compares the cost of the OCR input method with five other methods: keypunch/verify, keyboard to paper tape, keyboard to magnetic tape, optical mark reader, and a keyboard/display system. In the OCR method, it is assumed that the input data must be typed to prepare it for the OCR equipment as opposed to inputting turnaround documents.

The study shows that, while the OCR method can convert much more data to computer-acceptable code and media for a given staffing level, the unit cost (the cost of converting one typewritten word) for OCR is the highest of all methods at 0.6507 cent per word when the monthly volume is 4.4 million typewritten words. This is about one and one-half times the unit cost of keypunching the same volume and nearly twice the cost of optical mark reading. This higher OCR unit cost is nearly all attributable to the high cost of OCR equipment. As the monthly volume of work increases, however, OCR clearly becomes the most economically attractive input method. When the OCR

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volume reaches 17.2 million words per month, the unit cost is 0.3411 cent or about three-fourths the unit cost of keypunching.

Since the above estimates are, as stated, based on the assumption that the input data must be typed to prepare it for the OCR equipment, it appears that another application consideration should be the extent to which the input to the OCR equipment could be prepared either in whole or part as a byproduct of another process or on a turnaround basis. If this could be done, the OCR input method would become economically feasible at a lower volume than if the input had to be typed.

Personnel Considerations

There are several personnel factors to be considered in using OCR.

The first is that skilled keypunch operators are apparently hard to find. The 1968 EDP salary study performed by *Business Automation* shows that about 15 percent of the approximately 2,200 companies surveyed indicated that keypunch operators were the most difficult positions to fill. A cursory glance at the classified section of nearly any newspaper confirms this. For example, the *Washington Post* of March 2, 1969, lists 26 advertisements for keypunchers. Most of these need more than one keypuncher and one advertisement stated that 50 openings were available. In my opinion, this apparent shortage of keypunch operators could therefore be a powerful influence toward using OCR input methods in a situation where volumes are rising dramatically.

A second personnel consideration is that, by using OCR input methods, a broader segment of the clerical labor force is available to prepare input for the OCR equipment. United Air Lines has stated that the use of OCR has broadened the market for jobs since they can now use typists in their input section instead of trained keypunch operators.

A third consideration, discussed above, is that the error rate encountered in typing for OCR input is the lowest of all other manual methods of data conversion.

Finally, it appears that the input rate for typing OCR input is higher than for any other method. For example, the Institute of Management Science OCR study previously cited states that the input rate for OCR typing is about 20 words per minute while the corresponding rates for keyboard to magnetic tape, coding for optical mark readers, and keypunching/verifying are about 14, 12, and 11 words per minute, respectively.

Summary

In my opinion, a decision to use OCR equipment should be reached as the result of a rigorous cost/benefit analysis. Some of the areas to be considered in this study should be the high cost of OCR equipment and the willingness and practicability of instituting an intensive forms quality control program. Additionally, a rigid maintenance program must be initiated over the OCR equipment itself and the equipment (typewriters or high-speed printers) used to prepare input to the OCR equipment. Accounting controls such as

check digits and hash totals should be used as much as necessary to ensure accurate conversion of the input data by the OCR equipment. Consideration should also be given to the availability of backup equipment in the event of long-term downtime.

With regard to applications, I believe that a very high volume of alphanumeric input data such as names and addresses is needed to justify OCR equipment unless equipment costs can be brought down to more nearly the level of other input devices or unless a substantial amount of turnaround documents are used as input to the OCR equipment.

Also, even though any of the above criteria for use of OCR equipment may be absent in a given situation, a real shortage of competent keypunch personnel in times of rising input volumes may force a company to consider OCR, not because it is economically desirable, but because of a need to process its increasing workload on a timely basis thereby avoiding huge backlogs due to lack of personnel.