TECHNICAL NOTE

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Examination of Magnetic Ink Character Recognition Impressions

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ABSTRACT: In theory, Magnetic Ink Character Recognition (MICR) impressions as all machine impressions, should be identifiable as to their source. Exemplars from various encoding machines are examined to determine whether alignment and typeface defects occur and lead to identification of a machine from its work. The MICR E-13B character development and nomenclature are discussed.

KEYWORDS: questioned documents, character recognition, machine coding, impressions, check encoding

Magnetic Ink Character Recognition (MICR) for check encoding was developed out of necessity. Estimates of the number of checks processed annually by commercial banks in the United States in the late 1930s was 3.5 billion. In the early 1960s, the same 14 000 commercial banks processed an estimated 12 billion checks per year [*1*, p. 2]. This increasing volume of bank items processed annually necessitated the development of an universal check routing system. The most current statistic available was for the year 1979 and estimates 32 billion checks were processed annually (Federal Reserve Bank, Atlanta, GA). Time-consuming manual sorting, in addition to human error, prompted various check routing systems which evolved into the development of MICR as the common machine language for automated check handling. Standardization of check size and format also contributed to the accomplishment of a truly universal check routing system.

Background

Various numerical systems for the processing of checks were in use by banks in the early 1900s, the purpose of which designated numbers in place of names to differentiate endors-

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ers and drawees. The lack of uniformity resulted in confusion in processing. A system of assigning all banks numbers and the publication of a book listing the corresponding names of banks was adopted in 1911 by the Executive Committee of the American Bankers Association (ABA) [*2*].

In 1945, the ABA and the Federal Reserve System introduced a check routing symbol plan. A symbol would appear in the upper right portion of the check, above the numerical amount line and appear in fractional form. The fraction was a combination of the existing Federal Reserve routing number (denominator) and the ABA number assigned to drawee banks (numerator) [*3*].

$$\frac{64\text{-}1}{610}\quad \begin{array}{l}\text{— institutional identifier}\\ \text{— Federal Reserve routing number}\end{array}$$

The Federal Reserve routing symbol consists of no less than three and no more than four consecutive digits. No hyphens or spacing are used. The first number of a three-digit symbol indicates one of nine Federal Reserve districts:

1. Boston	2. New York	3. Philadelphia
4. Cleveland	5. Richmond	6. Atlanta
7. Chicago	8. St. Louis	9. Minneapolis

The Reserve bank or branch serving the area in which the drawee bank is located is indicated by the second digit. The last number of a three-digit symbol designates items for immediate or deferred credit. Symbols containing four-digit symbols are the same as a three-digit in their interpretation, except the first two positions indicate the tenth, eleventh, or twelth Federal Reserve districts—Kansas City, Dallas, and San Francisco, respectively. (There are exceptions, however, further elaboration is not necessary.)

The numerator of the fractional Routing Symbol-Transit Number (RS-TN) consists of a prefix and a suffix separated by a hyphen. The prefix represents the city or state in which the bank is located. A suffix number identifies a particular institution within that city or state.

Natural evolution lead to the development of a mechanized system of check processing. The Bank Management Commission of the ABA announced its approval of magnetic ink character recognition as a common machine language for the encoding of checks and other bank items in July 1956.

Final approval of a type font to be used for encoding was achieved in December 1958. Numbers and symbols referred to as E-13B characters were adopted as the universal common machine language (Fig. 1). E-13B characters refers to: E—fifth proposed design; 13—the width of character, 0.33 mm (0.013 in.); and B—the second design revision [*1*, p. 3].

E-13B characters are printed on checks with magnetic ink, thus, enabling them to be "read" by high speed electronic processing equipment. Note that magnetic ink is somewhat

FIG. 1—*E-13B characters and symbols.*

of a misnomer. Iron oxide pigments give the ink its magnetic properties. The ink is temporarily magnetized and the configuration of the character is interpreted by the computer. The charge dissipates and characters must be re-magnetized for each scanning.

Three fields, corresponding to the RS-TN, ON US, and AMOUNT appear at the bottom of the check (Fig. 2). The most important of these from a collection standpoint, the RS-TN appears first. A condensed version of which would be encoded as follows:

$$\frac{64\text{-}1}{610} \quad \text{would be encoded 0610-0001}$$

The prefix has been eliminated and insignificant zeros have been included to comprise eight digits separated by a dash.

Discussion

In theory, MICR E-13B character impressions from encoding machines maintained at bank teller stations should be identifiable from their work. This discussion will center on one aspect of encoding, the manual imprinting of account numbers on counter checks and other bank forms.

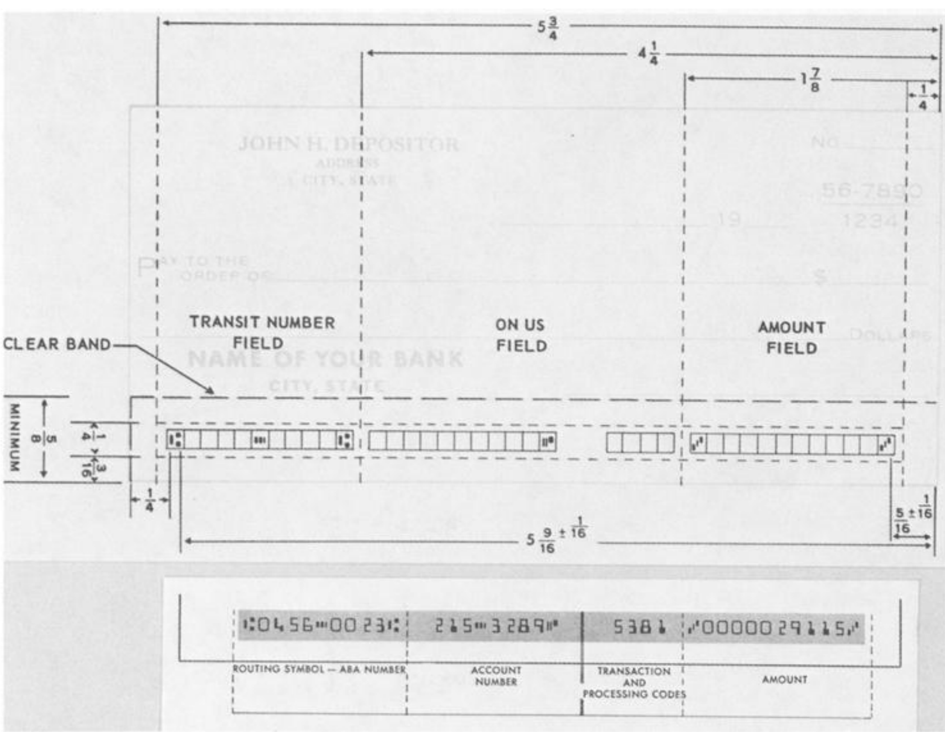

FIG. 2—*Shows boundaries for a 152-mm (6-in.) check. The ON US field varies in the number of digits, spaces, and symbols according to banks and equipment manufacturers. Note: the dash in the Routing Symbol-Transit Number field has been deleted. As of July 1978, a check digit in the ninth position is used for mathematical verification of this number* [4].

Initially, exemplars were obtained from encoding machines at branch banks in the Atlanta area. The machines are used for customer convenience and are operated on a daily basis. The sampling, although limited, was sufficient to preclude the necessity of additional exemplars. It became evident from only a cursory examination that alignment and possible typeface defects were present. This initial observation was proved by subsequent detailed study. The machines examined were manufactured by the Burroughs Corp. and by the National Cash Register Co. (NCR), the latter being the largest and, from bank personnel accounts, one of the oldest in use. It would appear from its size that it was intended to withstand heavy usage. Standards from this machine lacked observable alignment or typeface defects and appears to have accomplished its intended purpose. The NCR utilized push buttons similar to older cash registers for the selection of the desired character to be imprinted. The only further comment concerning this machine is how it additionally differed from the Burroughs machines examined. Encoding is accomplished by inserting a form into a slot which activates a trip mechanism similar to a time clock.

The Burroughs machines examined used a push-button or lever system for selection of the desired character or symbol. Activation is achieved by depressing an imprinting bar. A

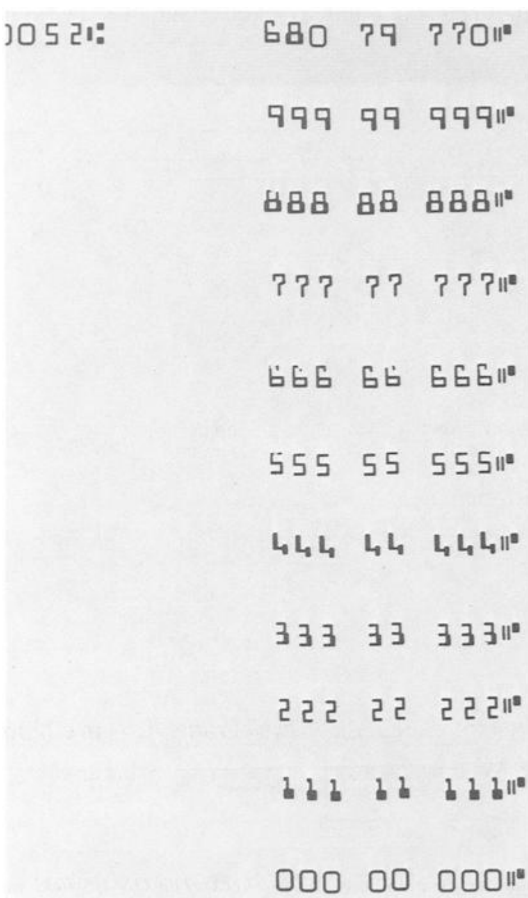

FIG. 3—*Exemplars taken from Burroughs' encoding machine.*

"clear" lever is incorporated in these machines to eliminate incorrect character selections.

All of the machines examined used carbon film ribbons coated with magnetic ink. Figure 3 shows the impressions taken from a Burroughs machine. The obvious misalignment of the numerals is evident even without the aid of a horizontal reference line. In addition, the absence of inking in figure lines for Numbers 3, 5, 6, and 8 suggests possible defects to the corresponding fonts. A section of the film ribbon obtained from this machine shows the majority of these "defects" to be transitory in nature (Fig. 4). The inking ribbon used is similar to those used in electric typewriters and at times shatters or flakes in a similar man-

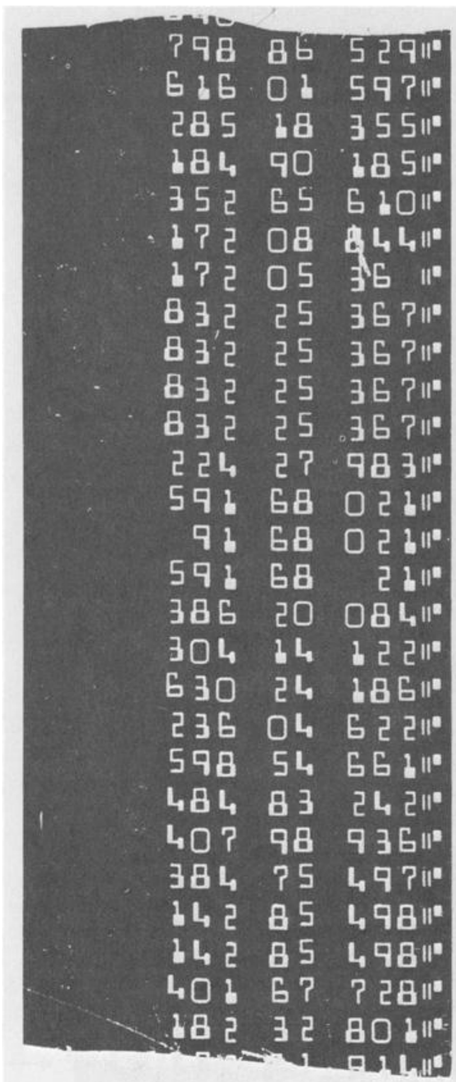

FIG. 4—*Section of carbon film ribbon.*

ner. This could give the impression that a character is damaged when actually it is the result of the inking process. Confirmation that typeface defects do occur is demonstrated in Fig. 5. Corresponding damage can be seen in the lower left portion of the Number 3 in the last column in both the exemplar and ribbon section from the same machine.

To assist in examining the exemplars a Nichols Test Plate for IBM Executive—1/32 in. typewriter was used. It was found that by turning the test plate 90° from its normal examining position the height of each digit occupies four units and assists in judging alignment. The now vertical line can be positioned along the face of a numeral forming an additional reference as shown in Fig. 6.

Additional study resulted in the discovery of a class feature in *all* Burroughs' encoding machines examined. An apparent machine defect occurs causing vertical class misalignment, to varying degrees, in the first three numerical positions of an account number (Fig. 6). Other more individual alignment problems do occur as observed in Fig. 3.

In conclusion, it is apparent that typeface defects occur, although probably infrequently, on MICR manual encoding machine fonts. In addition, misalignment problems, class and individual, that would further isolate a particular machine are at times also present. A combination of the above can lead to the identification of an MICR encoded account number to a particular machine as its source.

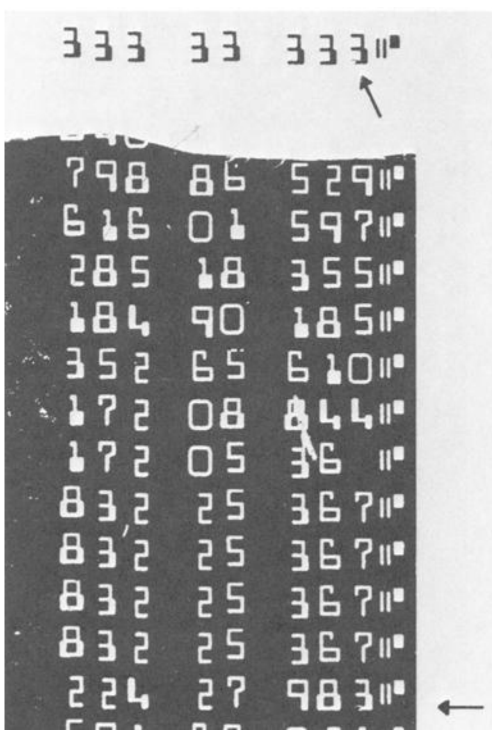

FIG. 5—*Exemplar and ribbon shows corresponding damage to Numeral 3 in last column.*

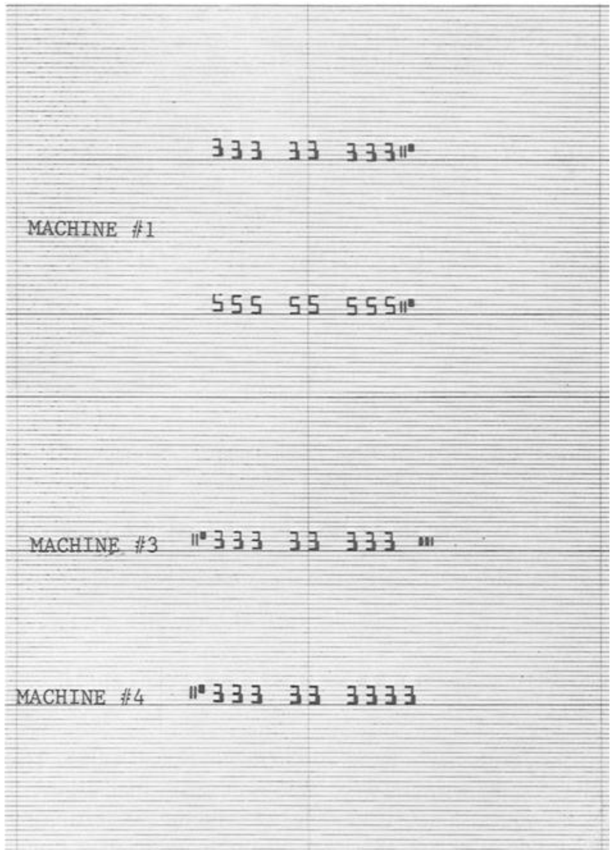

FIG. 6—*Exemplars from Burroughs' machines showing "stair step" effect in first three numerical positions.*

References

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[2] American Bankers Association, "Key to American Bankers Association Routing Numbers," 1973, p. K4.
[3] American Bankers Association, "Routing Numbers Specifications and Guide," 1976, pp. 11-13.
[4] American Bankers Association, "Final Report ABA/FRS Check Digit Task Force," 1977, pp. 21-24.

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