A NEW TRINARY CODE COMPARED WITH EXISTING CODES FOR PUNCHED CARDS

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Even though the alphabet may be considered as a numerical system of order 26, the majority of alphabetical codes for punched cards find their basis in numerical systems of a lower order. Standard IBM type cards use a code having 12 punches or an order of 12 for codifying the alphabet. Keysort type cards having a single or double row of holes, however, are restricted to numerical codes of order 2 or 3, respectively. By placing the alphabet in correspondence with numerical systems of the same order as the code, the ease of setting up the punch patterns is enhanced and an increase is noted in the efficiency of the sort.

SINGLE HOLE CODES

Two common single hole codes, the OIECB [1] and the N-Z,[2] are based upon a modified binary numerical system. Table I gives the decimal value, the binary number and the corresponding letter assignment for each of the systems. The binary numbers are then represented in code with a single punch for the 1 digit and no punch for the 0 digit. In the OIECB code the binary sequence is deviated from only slightly by adding the combined letters Mc and Sch and splitting the M's and S's into the fractions appearing before and after these combined letters in the alphabet. This modification has the advantage of assigning only one punch to the high frequency letter O. In the N-Z code the binary system is modified by assigning the second digit from the left the value of 7 instead of 8. This has the effect of eliminating the binary combinations for the values 7, 15, 23 and 31, all of which require maximum punching. An increase in the efficiency of the code results from such a modification.

Comparison of the single hole codes in Table III indicates that there is no appreciable difference between the two. Personal preference therefore is left as the determining factor in one's choice. The slight efficiency of the OIECB code over the N-Z code in the weighted average of holes punched results from the minimum punching required for the high frequency letters A, E, I and O.

DOUBLE HOLE CODES

Among existing double hole codes the N-Z code, the triangle code,[3] and the recently proposed code of Aronoff [4] are briefly described and compared with a newly proposed trinary code. The N-Z code is based on the same principle as the corresponding single hole code with the first row of holes used for A to M and the second row used for N to Z. Triangle numerical codes are based upon a binary numerical system in which all combinations involving more or less than two 1 digits are forbidden. Figure 1 gives a typical triangle code with examples of the letters G and O.

TABLE I BINARY SINGLE HOLE CODES

Decimal Value	Binary Number	OIECB Code	N-Z Code
0	00000	A	–
1	00001	B	A
2	00010	C	B
3	00011	D	C
4	00100	E	D
5	00101	F	E
6	00110	G	F
7	00111	H	–
8	01000	I	G
9	01001	J	H
10	01010	K	I
11	01011	L	J
12	01100	M_1	K
13	01101	Mc	L
14	01110	M_2	M
15	01111	N	–
16	10000	O	–
17	10001	P	N
18	10010	Q	O
19	10011	R	P
20	10100	S_1	Q
21	10101	Sch	R
22	10110	S_2	S
23	10111	T	–
24	11000	U	T
25	11001	V	U
26	11010	W	V
27	11011	X	W
28	11100	Y	X
29	11101	Z	Y
30	11110	–	Z
31	11111	–	–

Aronoff's code claims the advantage of simplicity and ease of memory but lacks the efficiency of the complete alphabetization of the numerical sort. This code is not based upon any simple numerical system.

A set of double hole punched cards can be separated into three groups by sorting on one column. This distinction is made on the basis of a double, a single, or a no punch which may represent the 2, 1, or 0 digit, respectively, in a trinary numerical system. As a three digit trinary number can assume 27 different values, three pairs of holes are sufficient to codify the alphabet. Table II gives a code based on such a numerical system.

The trinary number having the value of 13 is omitted because of its low isolation efficiency. One may choose to use it for the combined letter, Mc, but no further value is left for distinguishing between the M's before and after Mc. Cards receive a single or double punch for the 1 or 2 digits respectively and are not punched for the 0 digit. Starting with the least significant digit alphabetization is accomplished by sorting

TABLE II TRINARY DOUBLE HOLE CODE

Decimal Value	Trinary Number	Letter	Decimal Value	Trinary Number	Letter
0	000	A	13	111	–
1	001	B	14	112	N
2	002	C	15	120	O
3	010	D	16	121	P
4	011	E	17	122	Q
5	012	F	18	200	R
6	020	G	19	201	S
7	021	H	20	202	T
8	022	I	21	210	U
9	100	J	22	211	V
10	101	K	23	212	W
11	102	L	24	220	X
12	110	M	25	221	Y
			26	222	Z

on the double and then the single hole taking six passes of the sorting needle to transverse to the most significant figure. The desire to order the deck in more than one letter is satisfied by alphabetizing the least significant letter first.

Isolation of any one letter requires one pass of the needle for either the 0 or 2 digit and two passes for the 1 digit, the first pass being employed to eliminate all doubly punched cards. In the isolation of any letter 3.9 passes as a weighted average are required to make the separation. This figure is obtained by averaging the number of passes for each letter properly weighted with its corresponding occurrence frequency as calculated by Luhn[5] for the initial four letters of English words.

Presented in Table III is a comparison of the several codes mentioned above. The efficiency of the proposed trinary system in each of the listed items establishes it as an excellent double-hole code. In rapidity of complete alphabetization and in economy of space the trinary code ranks first among double hole codes whereas in ease of isolation and punching no significant deficiency is noted. Each weighted average in Table III is calculated in the manner described above.

TABLE III COMPARISON OF CODES FOR PUNCHED CARDS

	Space required (columns)	Complete alphabetization (passes)	Wt. av. of passes to isolate a letter	Wt. av. of number of holes punched per letter
		Single Hole		
1. OIECB	5	5	5	2.1
2. N-Z	5	5	5	2.2
		Double Hole		
3. Trinary	3	6	3.9	1.8
4. N-Z	4	8	5.0	1.8
5. Triangle	6	12	3.1	2.0
6. Arnonoff's	4	25	3.9	1.6

REFERENCES

[1] R. S. Casey and C. F. Bailey, J. Chem. Ed., 23, 495 (1946).
[2] R. S. Casey, et al., Editors, "Punched Cards," 2nd ed., Reinhold Publishing Corp., New York, N. Y., 1958, pp. 20-21.
[3] Ref. 2, p. 21.
[4] S. Aronoff, J. Chem. Ed., 36, 581 (1959).
[5] Ref. 2, p. 501.

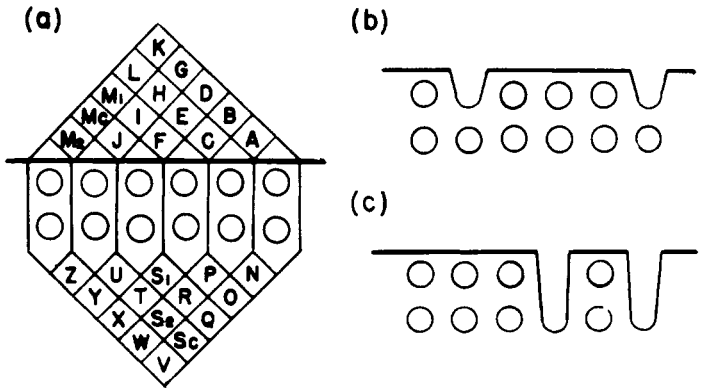

Fig. 1. – (a) Representative Triangular Code. (b) The Letter G.
(c) The Letter O.