ESD-TR-66-115

MTR-204

STUDIES OF DISPLAY SYMBOL LEGIBILITY

Part X. The Relative Legibility of Leroy and Lincoln/MITRE Alphanumeric Symbols

AUGUST 1966

D. J. Showman

Prepared for

DEPUTY FOR ENGINEERING AND TECHNOLOGY
DECISION SCIENCES LABORATORY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

Project 7030
Prepared by
THE MITRE CORPORATION
Bedford, Massachusetts
Contract AF19(628)-5165

ESD-TR-66-115

MTR-204

STUDIES OF DISPLAY SYMBOL LEGIBILITY

Part X. The Relative Legibility of Leroy and Lincoln/MITRE Alphanumeric Symbols

AUGUST 1966

D. J. Showman

Prepared for

DEPUTY FOR ENGINEERING AND TECHNOLOGY
DECISION SCIENCES LABORATORY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

Project 7030
Prepared by
THE MITRE CORPORATION
Bedford, Massachusetts
Contract AF19(628)-5165

FOREWORD

This report is one of a series describing symbol legibility for television display. Additional information on this topic may be found in the following reports: "Studies of Display Symbol Legibility: The Effects of Line Construction, Exposure Time, and Stroke Width," by B. Botha and D. Shurtleff, The MITRE Corp., Bedford, Mass., ESD-TR-63-249, February 1963; "Studies of Display Symbol Legibility, II: The Effects of the Ratio of Width of Inactive to Active Elements Within a TV Scan Line and the Scan Pattern Used in Symbol Construction," by B. Botha and D. Shurtleff, The MITRE Corp., Bedford, Mass., ESD-TR-63-440, July 1963; "Studies of Display Symbol Legibility, III: Line Scan Orientation Effects," by B. Botha, D. Shurtleff, and M. Young, The MITRE Corp., Bedford, Mass., ESD-TR-65-138, May 1966; "Studies of Display Symbol Legibility, IV: The Effects of Brightness, Letter Spacing, Symbol Background Relation, and Surround Brightness on the Legibility of Capital Letters," By D. Shurtleff, B. Botha, and M. Young, The MITRE Corp., Bedford, Mass., ESD-TR-65-134, May 1966; "Studies of Display Symbol Legibility, V: The Effects of Television Transmission on the Legibility of the Common Five-Letter Words," by G. Kosmider, The MITRE Corp., Bedford, Mass., ESD-TR-65-135, May 1966; "Studies of Display Symbol Legibility, VI: Leroy and Courtney Symbols," by D. Shurtleff and D. Owen, The MITRE Corp., Bedford, Mass., ESD-TR-65-136, May 1966; "Studies of Display Symbol Legibility, VII: Comparison of Displays at 945- and 525-Line Resolutions," By D. Shurtleff and D. Owen, The MITRE Corp., Bedford, Mass., ESD-TR-65-137, May 1966; and "Studies of Display Symbol Legibility, VIII: Legibility of Common Five-Letter Words," by G. Kosmider, M. Young, and G. Kinney, The MITRE Corp., Bedford, Mass., ESD-TR-65-385, May 1966. "Studies of Display Symbol Legibility, IX: The Effects of Resolution, Size, and Viewing Angle of Legibility," by D. Shurtleff, M. Marsetta, and D. Showman, The MITRE Corp., Bedford, Mass., ESD-TR-65-411, May 1966.

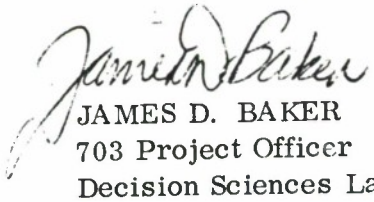
The author is grateful to Dr. G. C. Kinney and Dr. D. A. Shurtleff for their help in conducting and reporting this study.

ABSTRACT

The legibility of standard Leroy alphanumeric symbols was compared with a new font, the Lincoln/MITRE (L/M) font. Legibility was tested by having human subjects attempt to identify the symbols when seen one at a time for a brief exposure period. The results showed the L/M font to be more legible than the standard Leroy. It is recommended that the two fonts be compared in a similar test on a TV monitor; this study is presently being conducted.

REVIEW AND APPROVAL

Publication of this technical documentary report does not constitute Air Force approval of the reports findings or conclusions. It is published only for the exchange and stimulation of ideas.



JAMES D. BAKER
703 Project Officer
Decision Sciences Laboratory

ROY MORGAN
Colonel, USAF
Director, Decision Sciences Laboratory

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF TABLES (concluded)

SECTION I

INTRODUCTION

A set of alphanumeric symbols (letters and numerals) which is known to be legible in different kinds of visual displays would be useful in many systems. Such a symbol font, or style, would retain good legibility whether being displayed on a television monitor, a beam-writing cathode ray tube, a printer, or a large board display. The font's legibility is best tested by having human subjects attempt to identify the symbols, or otherwise read something printed with the symbols. One way of determining the legibility of a set of alphanumerics is to expose the symbols briefly to subjects one at a time, and to record the errors made for each symbol shown. The font's legibility is shown by the total errors made, and specific confusions of one symbol with another suggest design changes to improve symbol clarity.

SECTION II

TESTS

At MITRE, many such tests have been made of several different fonts[1,2,3], and an attempt is being made to develop a font of more universal application.

The tests are made by deteriorating the viewing conditions until errors occur, and then noting the number of errors and their distribution among the symbols[4]. Conditions can be deteriorated by reducing the brightness of both symbol and background, by reducing brightness contrast between symbol and background, by blurring the symbols, by reducing the size of the symbols, by reducing exposure time, and so on. If conditions were so deteriorated that the subject had no basis on which to identify symbols, the symbols called by the subject would be unrelated to the symbols shown, and the frequency with which each symbol was called would depend on the subject's guessing preferences. When viewing conditions are made a little better, a distribution of errors is often found in which a few specific confusions between symbols (for example, between B and 8) comprise a large proportion of the total number of errors. When this happens, the total number of errors often can be reduced by modifying the symbols[1]. Since the effects of symbol changes cannot always be predicted, the changed font must be tested[3]. A uniform distribution of error (with no specific confusion containing a large proportion of the errors) probably indicates that factors other than symbol style (for example, deteriorated viewing conditions) are more important than style in causing errors. When a low error rate with a fairly uniform distribution of errors is obtained, it may not be necessary, or even possible, to improve the font further. To improve the legibility of a set of alphanumerics, then, the designer tries to eliminate large specific inter-symbol confusions by test, hopefully obtaining a set of alphanu-

merics which, under deteriorated viewing conditions, gives a low error rate and a more uniform scattering of errors among symbols.

DEVELOPMENT OF ALPHANUMERICS

In an attempt to develop legible alphanumerics for displays, a font which has been successively modified in earlier work (see Figure 1) has been tested by comparing it with standard Leroy, a font known to have good legibility (see Figure 2). The font tested is similar to that designed by Harris, et al., at M.I.T.'s Lincoln Laboratory for the Charactron tube [5]. The font used in the Charactron was developed from one (Mackworth's) previously found to have good legibility. Later tests with the Charactron font produced an improved letter I [5]. In an unpublished study at MITRE, Sanders tested a similar font with a new Q and Z and the improved I [4]. The differences between the Charactron alphanumerics and the font tested in the experiment reported here (hereafter referred to as the Lincoln/MITRE, or L/M, font) include the new Q suggested at Lincoln Laboratory and tested by Sanders, an 8 similar to that suggested, but not tested, by Harris, et al., Lincoln Laboratory's improved I that was used by Sanders, and a new C, 2, and Ø whose designs were suggested by other work done at MITRE.

Some of this work was an evaluation of a set of alphanumerics which was formed from television lines controlled digitally [6]; changes in the C, D, O, P, S, 1, 5, 8, and Ø reduced the number of errors. The opening up of the C suggested a similar change in the Lincoln/MITRE font. In another experiment [2], eleven letters and numbers (B, C, G, I, O, Q, S, 1, 5, 8, Ø) and the dollar sign from the Leroy and the L/M fonts were tested under conditions similar to those of the experiment reported in this paper; many more errors were made with the Leroy than with the Lincoln/MITRE symbols. This result suggested

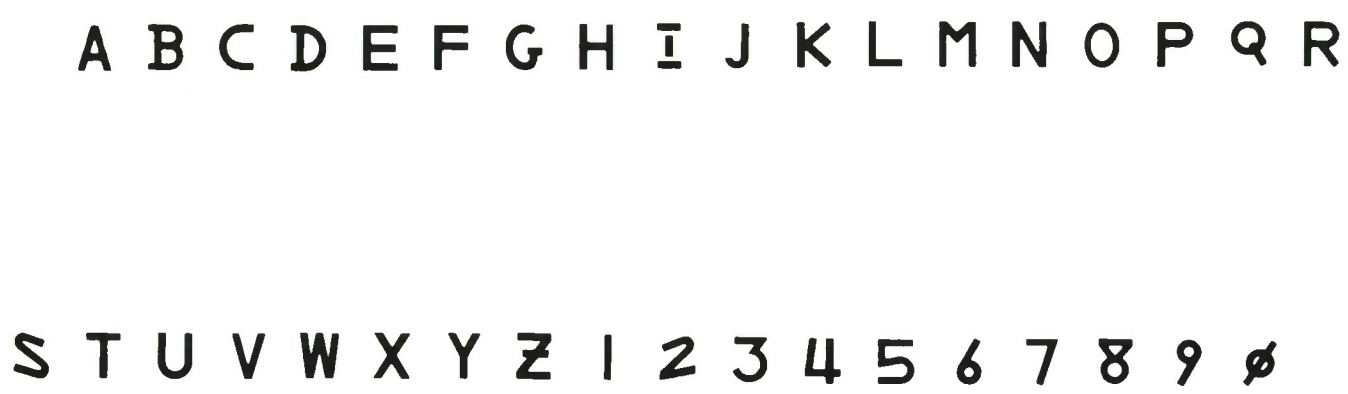


Figure 1. The Lincoln/MITRE Font Shown in the Experiment

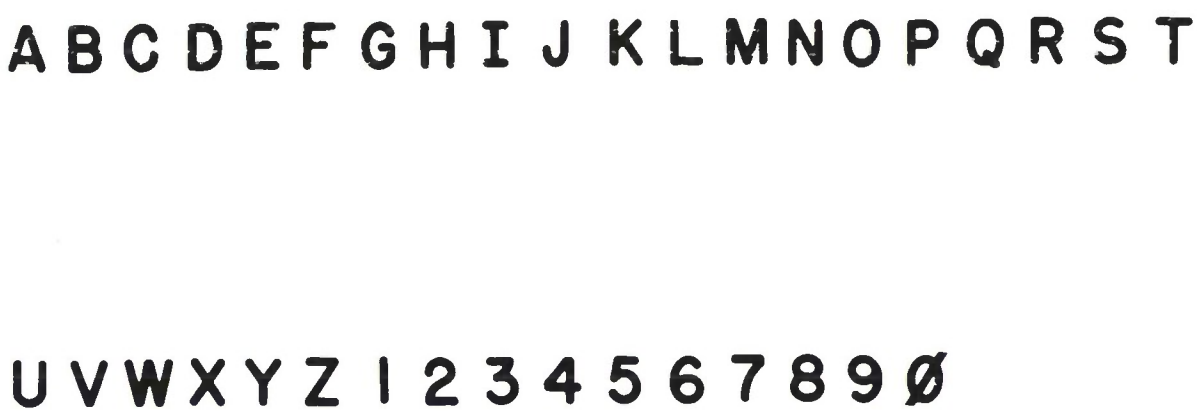


Figure 2. The Leroy Font Shown in the Experiment

that the two fonts be compared using all 36 alphanumerics, and that the Lincoln/MITRE font would be a good choice to begin with in designing a font legible in many kinds of displays.

In the experiment reported here (in which the symbols were light on a dark background), the brightness of the symbol was varied, with the background held constant, so that the brightness of the symbol and the brightness contrast between symbol and background varied simultaneously. Capital letters and the numerals were presented briefly in a tachistoscope one at a time to each subject, and errors were recorded. Each subject was tested with both fonts. From the recorded errors, confusion matrices (which show errors called out for each symbol shown) were constructed for each font. Fewer errors were made at each symbol brightness level on the L/M font than on the Leroy font. It is concluded that the L/M font may be better for display use than a standard font such as Leroy, and that it is a more promising font to develop further for use in different kinds of displays. The details of this experiment are reported below.

The confusions found in the experiment reported here should indicate which symbols to modify in order to make the font more legible. After modifications are made, the new font will be compared with the present font to see if the changes reduce errors. In addition, the present font will be tested on television to see if it is still more legible than a conventional font, and to suggest design changes for television use. The nature of these tests and their results is made clearer in the details which follow.

APPARATUS FOR TESTS

The tachistoscope has been described in detail previously [2] (see Figure 3). Each set of alphanumerics was photographed on a 35mm strip of film, with one symbol per frame. One film strip with 180 symbols was made for each

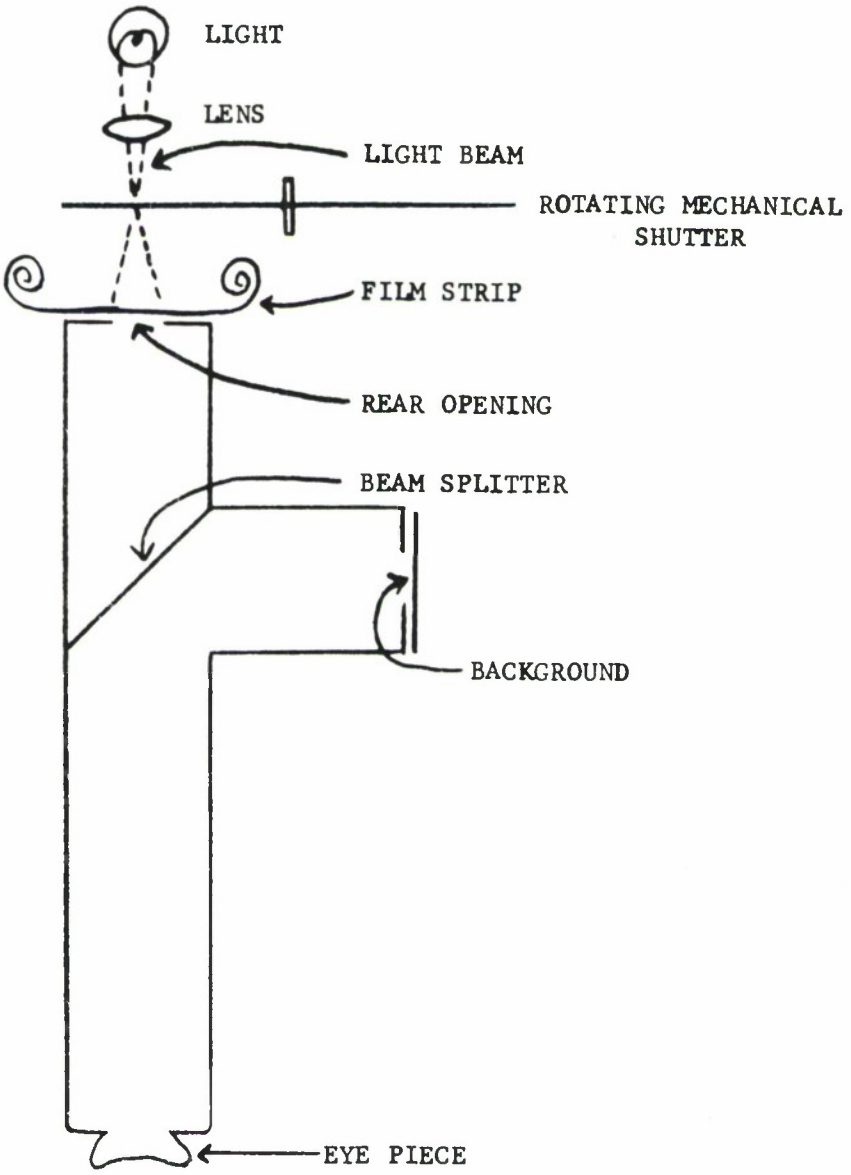


Figure 3.

Sketch of the Tachistoscope Used to Expose the Symbols to the Subjects

font (see Figures 1 and 2). The symbols had a height to stroke-width ratio of approximately 6 to 1, and a height-to-width ratio of approximately 4 to 3. Symbols were clear with the rest of each frame opaque. At one end of the tachistoscope, the film passed from one reel to another behind an opening just large enough to expose one symbol. A mechanical shutter was mounted between the film and a battery operated, incandescent light. The shutter was activated when the subject pressed a button, and allowed a 10 msec. exposure of the symbol. Each symbol subtended approximately 16 inches of arc at the subject's eye. The image of the background (which was a rectangle of white styrofoam) was reflected by a beam-splitter through which the subject could see the symbol; the symbol thus appeared to be superimposed on the background. The background brightness was held constant at 1 ft. L, and the brightness of the symbol was either 10, 8, 6, or 4 ft. L. The symbol brightness was held constant throughout each session. The brightness of symbol and background were measured through the eyepiece of the tachistoscope with a calibrated Spectra Brightness Spot Meter before and after each experimental session. Symbol brightness did not vary more than ± 0.4 ft. L, nor the background brightness by more than ± 0.1 ft. L, from the stated values.

PROCEDURE

The subjects were nine MITRE employees who scored at least 20/20 for both near and far acuity, either corrected or uncorrected, in the Bausch and Lomb Ortho-Rater. The Ortho-Rater includes tests of near and far acuity, lateral and vertical phoria, color sensitivity, and depth perception. No subject had an extreme phoria score or was color blind.

Symbols were shown in a tachistoscope one at a time to each subject. Each of the 36 symbols appeared 5 times at random with respect to alphabetic

or numeric order on each film strip. In each experimental session the subject saw all of the 180 symbols on one film strip. By advancing the film either one or two frames at a time, and by beginning at either end of the film strip, the experimenter showed the symbols of each font in four different random sequences in the four sessions with that font. The subject was given a photograph of the alphanumerics to be seen in each session, and could refer to it at any time during the session. Three short rests were given in each session, dividing the session into quarters. Four subjects saw the L/M font at 10, 8, 6, and 4 ft. L in four successive sessions, and then the Leroy at 10, 8, 6, and 4 ft. L; five subjects saw Leroy first, and then L/M. Each subject, therefore, was tested in eight experimental sessions, with no more than two sessions for each subject per day. For each font at each symbol brightness value, there were 1620 symbol exposures (one session with each of nine subjects, and 180 symbols per subject per session).

SECTION III

EVALUATION

RESULTS AND CONCLUSIONS

Table I shows the total errors (for all nine subjects) and the percent error (of the total number of responses) at each value of symbol brightness. Figure 4 shows the percent error plotted against symbol brightness for both fonts. At each value of brightness, fewer errors were made with the Lincoln/MITRE font than with the Leroy font. At each brightness value, each subject's error score on L/M was subtracted from his socre on Leroy, and for each brightness value, a one-tailed, correlated t test of the difference in errors between fonts was done. At 4 ft. L the difference in errors between Leroy and L/M was not statistically significant. At 6 and 8 ft. L, the differences were significant at the 5 percent level. At 10 ft. L, the difference was significant at the 1 percent level.

The distribution of errors for both fonts at each brightness value is shown in Tables II through IX. At the lowest brightness, 4 ft. L, the most frequently occurring confusions for Leroy (Table II) were C-G (including both C-called-G and G-called-C), B-8, O-Q, S-5, C-O, 8-called-6, and 6-called-G. These confusions, which involved nine symbols, contributed 41 percent of the total error. For L/M (Table III), the most frequently occurring confusions were Z-2, F-P, O-Q, S-5, O-called-G, T-called-I, and I-1; these confusions, involving twelve symbols, contributed 29 percent of the total error. It appears that a larger proportion of the total error at 4 ft. L was concentrated in fewer symbols for Leroy than for L/M.

With Leroy at 6 ft. L, Table IV shows that the O-Q, B-8, C-called-G, and S-called-5 confusions, involving eight symbols, comprised 79 percent of the total error, while with L/M (Table V) nine symbols in the Z-2, 4-called-Q,

Table I.

Total Errors and Percent Error for Nine Subjects for Both Fonts and Four Symbol Brightness Values in Ft. Lamberts

Symbol Brightness	Number of Errors		Percent Error	
	Leroy	L/M	Leroy	L/M
10	32	4	2.0	.2
8	27	10	1.7	.6
6	53	33	3.3	2.0
4	198	162	12.2	10.0

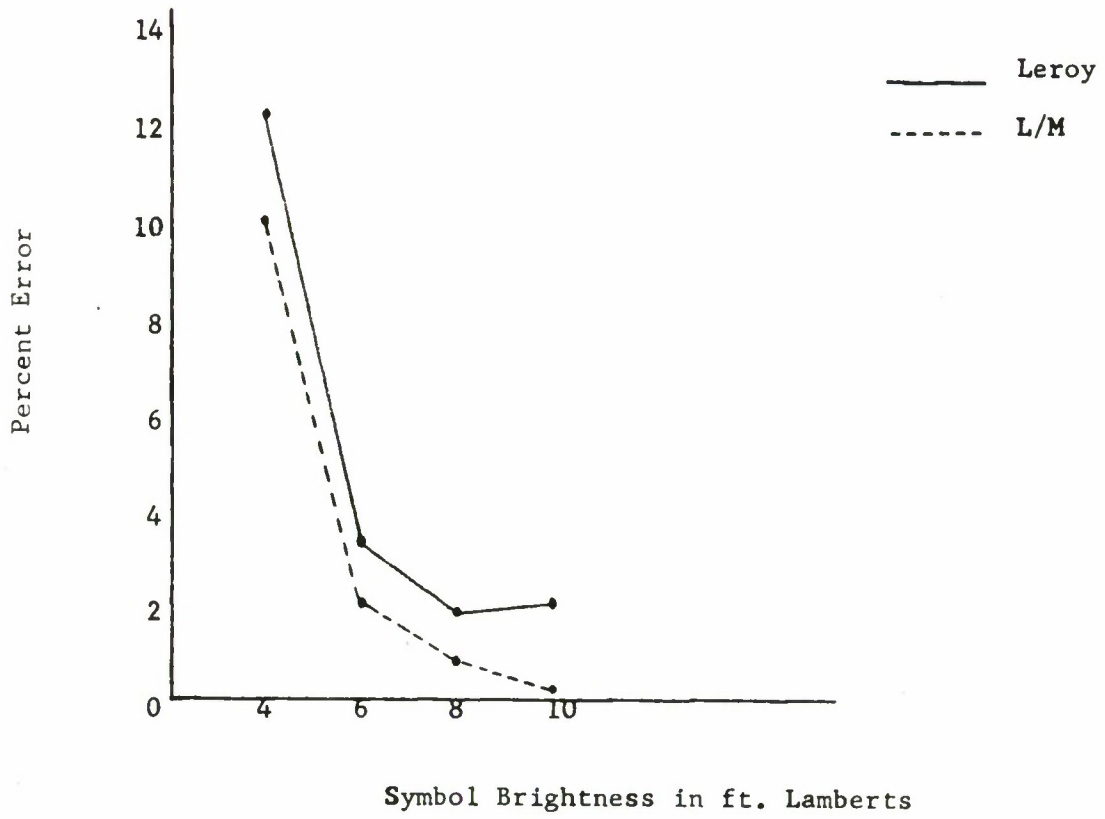


Figure 4. Percent Error Plotted Against Symbol Brightness. There Were 1620 Observations for Each Point.

Table II. Confusion Matrix Showing Errors with Leroy at 4 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

Character Shown

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	1	2	3	4	5	6	7	8	9	0	Σ
A																		1										1									2
B							1										2															2		5		1	11
C							21								2		2												1								26
D			1												4		2				1															1	9
E																													1			1					2
F																																					0
G			4												1																						5
H																		3			2																5
I																				1				1		1										1	4
J																												1									1
K																		2						1													3
L																																					0
M											2			1								1	2													1	7
N								1									1	1			1		1														5
O			4				3										10																				17
P						1																														1	2
Q			1	1			1								4														1							1	9
R						1																															1
S							1																								6						7
T									2																		1		1								4
U			1																																		1
V																											2										2
W																					1																1
X											1																										1
Y																				1													1				2
Z																												3									3
1									2																									1			3
2																											1						1			1	3
3															1				1												1					1	4
4																													1								1
5		3																	1										2			2				2	10
6			4				7										1										1									1	14
7																																					0
8		12					1								1				2													6				1	23
9							2		1						1		1												1							1	7
Ø																												2				1					3
Σ	0	15	15	1	0	2	37	1	5	0	3	0	0	0	1	14	0	19	7	4	2	5	1	3	2	3	2	2	7	7	0	7	12	3	5	1	12	198

Table III. Confusion Matrix Showing Errors with L/M at 4 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

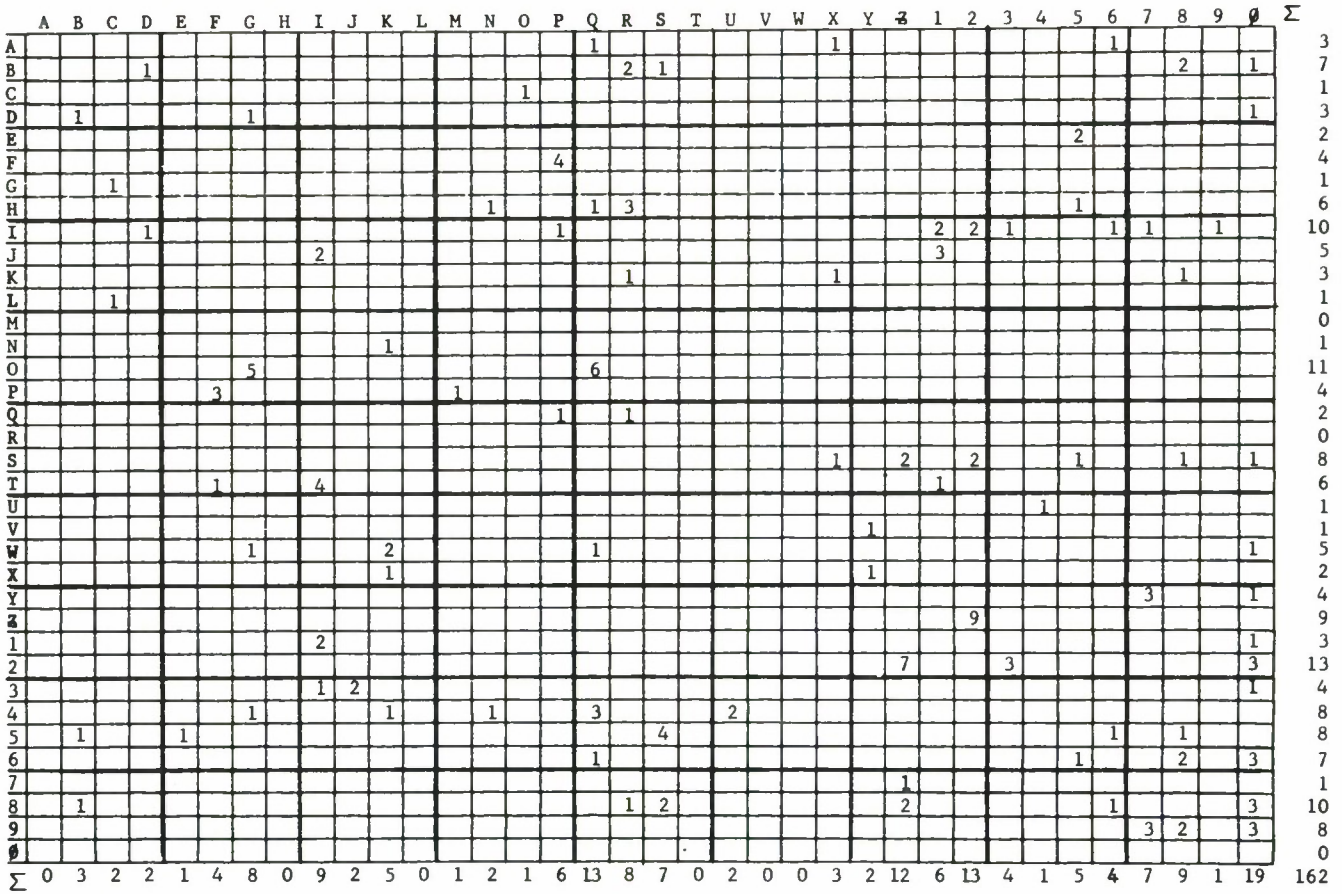


Table IV. Confusion Matrix Showing Errors with Leroy at 6 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

Character Shown

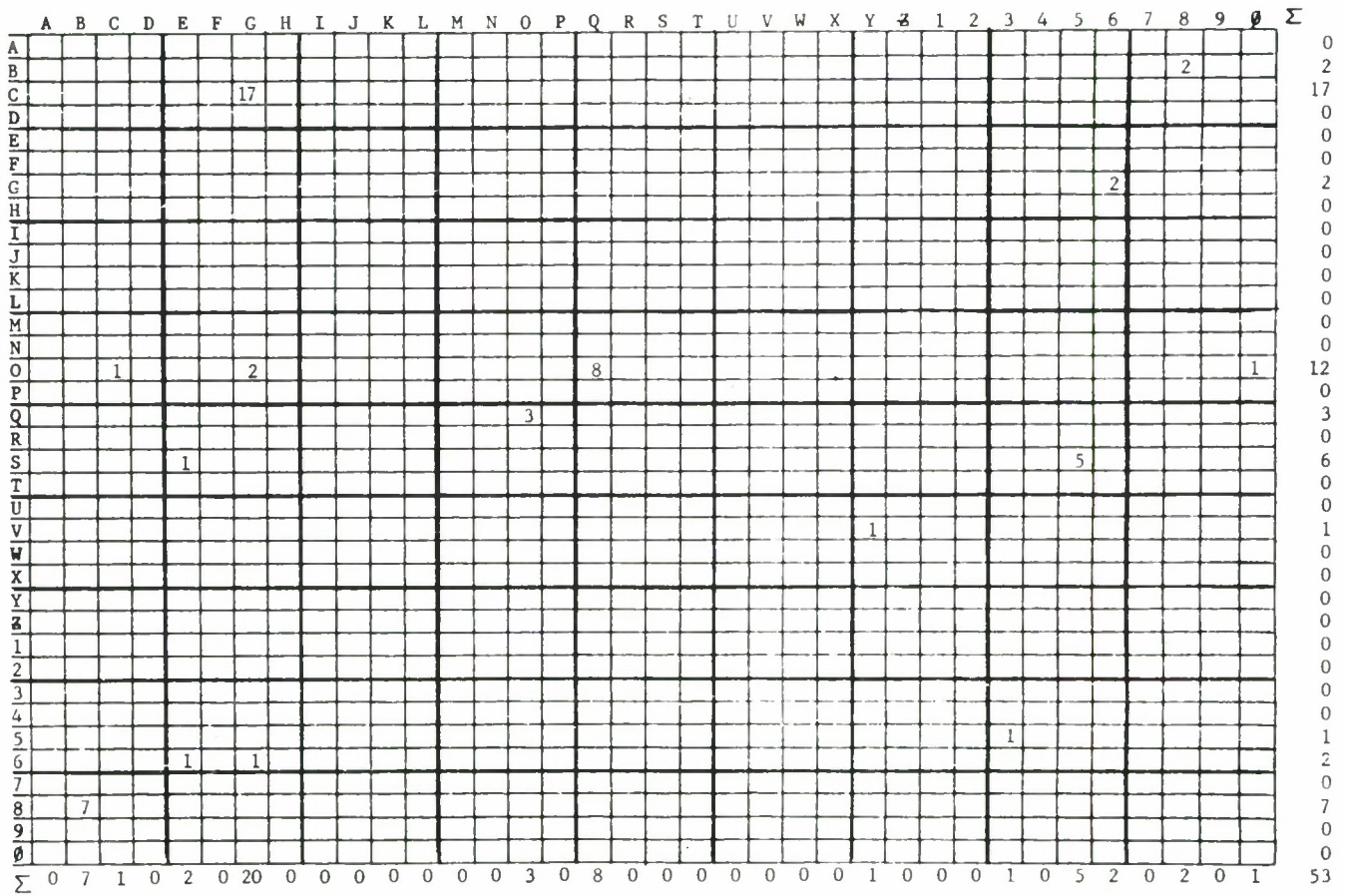


Table V. Confusion Matrix Showing Errors with L/M at 6 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

Character Shown

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	1	2	3	4	5	6	7	8	9	0	Σ
A																																					0
B																																					0
C																																					0
D																																					0
E																2																					2
F																																					0
G																																					0
H																																					0
I																																					0
J															1																						1
K																																					0
L																																					0
M																																					0
N																																					4
O							2										2																				0
P																																					0
Q																																					0
R																																					1
S																											1										2
T																									1								1				0
U																																					0
V																																					0
W																																					0
X																																					0
Y																																					0
Z																												5									5
1																																					0
2																											5										5
3																	1																				1
4																	4																				4
5					1		1																						1								3
6																														1							1
7																																					0
8		1																																		1	2
9																									1								1				2
0																																					0
Σ	0	1	0	0	1	0	3	0	0	0	0	0	0	0	1	2	7	0	0	0	0	0	0	0	2	6	0	5	1	1	0	0	2	0	0	1	33

F-called-P, O-called-G, and O-called-Q confusions comprised 61 percent of the error. Again, a larger proportion of the total error was concentrated in fewer symbols for Leroy than for L/M. Tables VI and VII, for 8 ft. L, and Tables VIII and IX, for 10 ft. L, also show that the error was greater and concentrated in fewer symbols for Leroy than for L/M. It is concluded that the L/M font is more legible than the Leroy.

The errors made with the L/M font with brightnesses of 8 ft. L and lower involved, first, the Z and 2 at 8 ft. L (Table VII). The O-called-Q, F-called-P, and O-called-G confusions appeared at 6 ft. L (Table V). (The 4-called-Q confusion in Table V is probably an anomaly, and is not discussed further.) Finally, at 4 ft. L (Table III), the 5-S confusion appeared. It seems that the Z, 2, F, P, O, Q, G, S, and 5 may need to be modified in the L/M font if errors are to be reduced further. This point is discussed later.

The results of this study agree with the finding of the 12-symbol study[2], described earlier, that performance is better with L/M than with Leroy. A direct comparison of the results of the two studies shows that the percent error for each font at each brightness value was slightly lower in this experiment, probably due to the inclusion of the easier alphanumerics. The four worst confusions with Leroy were the same in both studies, but the two worst confusions with L/M in this study included symbols not among the twelve in the earlier study.

In summary, the results were as follows:

1. Fewer errors were made at each symbol brightness value with L/M than with Leroy.

2. At 8 and 10 ft. L the error rate with L/M was very low; with Leroy it was higher, and was no better at 10 than at 8 ft. L.

Table VI. Confusion Matrix Showing Errors with Leroy at 8 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

Character Shown

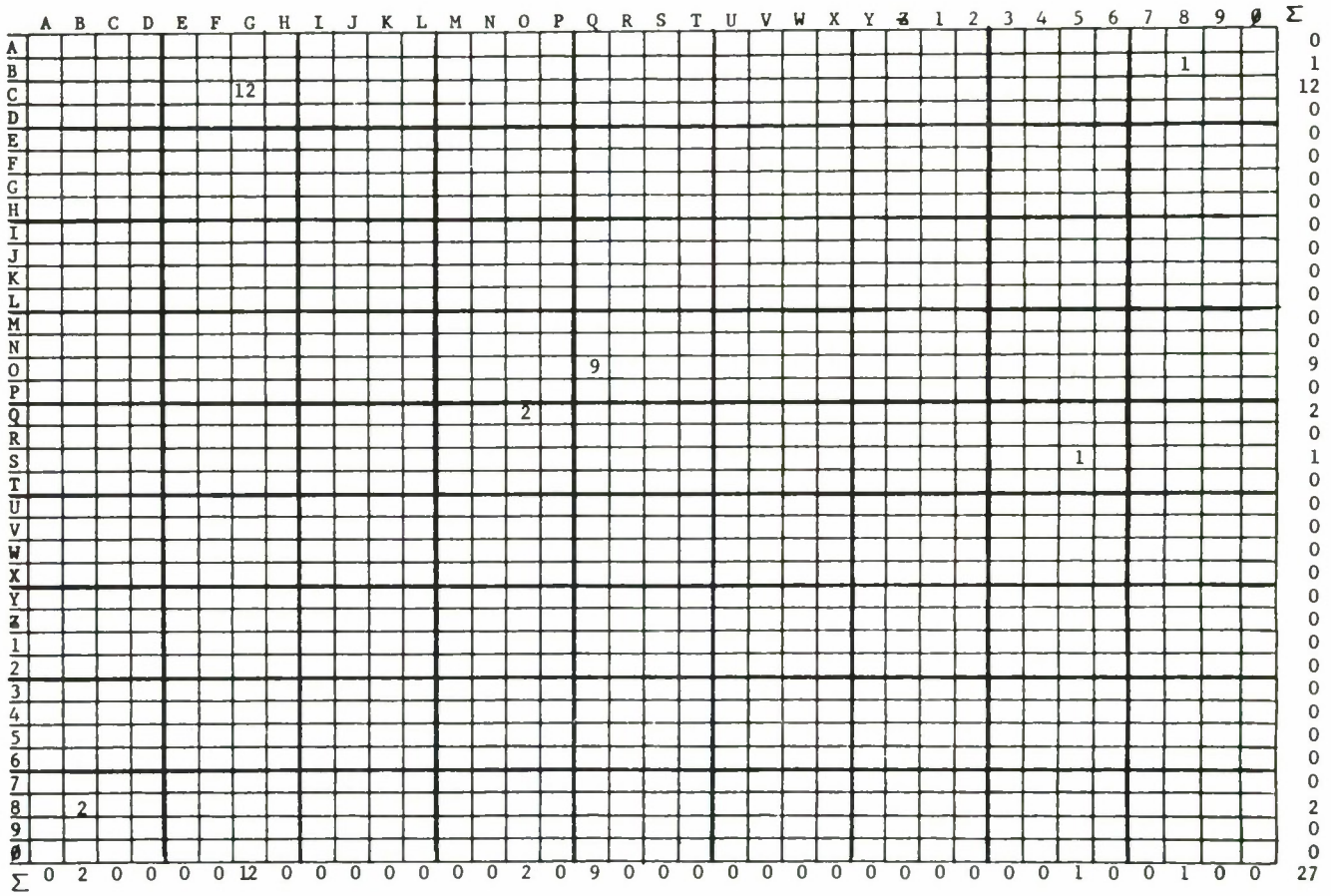


Table VII. Confusion Matrix Showing Errors with L/M at 8 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

Character Shown

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	1	2	3	4	5	6	7	8	9	0	Σ
A																																					0
B																																					0
C																																					0
D																																					0
E																1																					1
F																																					0
G													1																								1
H																																					0
I																									1												1
J																																					0
K																																					0
L					1																																1
M																																					0
N																																					0
O																																				1	1
P																																					0
Q																																					0
R																																					0
S																																					0
T																																					0
U																																					0
V																																					0
W																																					0
X																																					0
Y																																					0
Z																												2									2
1																																					0
2																																					0
3																			1																		1
4																	1																				1
5																																					0
6																																					0
7																																					0
8																																				1	1
9																																					0
0																																					0
Σ	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	2		10

Table VIII. Confusion Matrix Showing Errors with Leroy at 10 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

Character Shown

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	1	2	3	4	5	6	7	8	9	0	Σ
A																																					0
B																																		1			1
C							11																														11
D																																					0
E																																					0
F																																					0
G																																					0
H																																					0
I																				1							1										2
J																																					0
K																																					0
L																																					0
M																																					0
N																																					0
O			1				2										1																			1	5
P																																					0
Q															1																						1
R																																					0
S																															4						4
T																																					0
U																																					0
V																																					0
W																																					0
X																																					0
Y																																					0
Z																																					0
1						1																															1
2																																					0
3																																					0
4																																					0
5																																		1			1
6																																					0
7																																					0
8		5																																			5
9																																					0
0																																		1			1
Σ	0	5	1	0	0	1	13	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	4	0	0	3	0	1	32

Table IX. Confusion Matrix Showing Errors with L/M at 10 ft. Lamberts for Nine Subjects, one Session each. Each Symbol was Shown 45 Times (5 times to each of 9 subjects).

Character Called

Character Shown

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	1	2	3	4	5	6	7	8	9	0	Σ
A																																					0
B																																					0
C																																					0
D																																					0
E																																					0
F																																					0
G																																					0
H																																					0
I																																					0
J																																					0
K																																					0
L																																					0
M																																					0
N																																					0
O																																					0
P																																					0
Q																																					0
R																																					0
S																																					0
T																																					0
U																																					0
V																																					0
W																																					0
X																																					0
Y																																					0
Z																												1									1
1																																					0
2																										1											1
3										1																											1
4																					1																1
5																																					0
6																																					0
7																																					0
8																																					0
9																																					0
0																																					0
Σ	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	4

3. The differences in number of errors between fonts were statistically significant (according to t tests) at 6, 8, and 10 ft. L.

4. A higher proportion of the error was concentrated in fewer confusions with Leroy than with L/M.

The conclusions are as follows:

1. The L/M font is more legible than the Leroy font, and
2. The L/M symbols Z, 2, F, P, O, Q, G, S, and 5 are most often confused.

RECOMMENDATIONS

The lower error rate and the greater scattering of errors suggest that, for different displays, the L/M font may be a better choice than a standard font similar to Leroy. At the same time, the concentrations of errors found for L/M indicate that the font may be improved further by changing the symbols most often confused. It may not be necessary to change all of these symbols in order to reduce confusions among them. Nevertheless, in improving the font, it seems reasonable to begin with the symbols in the worst confusions. A test of the improved font will then be made. Before any symbols are modified, it seems wise to collect more data on inter-symbol confusions when the font is tested under conditions that occur in different types of displays.

Television, for one, presents many unique problems, such as the cutting up of symbols by the television lines. Therefore, the L/M font should be compared with a conventional font, such as Leroy, on television. This study is presently being done.

It is recommended that the L/M font be used when improved legibility is desired in displays using solid-stroke numerals and capital letters.

REFERENCES

1. G. C. Kinney, Studies in Display Legibility, The MITRE Corporation, Bedford, Mass., MTP-21, 1965.

2. G. C. Kinney, Studies in Display Symbol Legibility, XI: The Relative Legibility of Selected Alphanumerics in two Fonts, The MITRE Corporation, Bedford, Mass., ESD-TR-66-116, August 1966.

3. D. Shurtleff and D. Owen, Studies of Display Symbol Legibility, VI: A Comparison of the Legibility of Televised Leroy and Courtney Symbols, The MITRE Corporation, Bedford, Mass., ESD-TR-65-136, May 1966.

4. D. Shurtleff, Design Problems in Visual Displays, I: Classical Factors in the Legibility of Numerals and Capital Letters, The MITRE Corporation, Bedford, Mass., ESD-TR-66-62, June 1966.

5. W. P. Harris, B. F. Green, E. A. Wilson, and L. H. Liaudansky, The Design of Characters for the Charactron, M.I.T. Lincoln Laboratory, Lexington, Mass., TR-117, May 1956.

6. G. C. Kinney, M. Y. Marsetta, and D. J. Showman, Studies in Display Symbol Legibility, XII: The Legibility of Alphanumeric Symbols for Digitalized Television, The MITRE Corporation, Bedford, Mass., TR-66-117, August 1966.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*

The MITRE Corporation
Bedford, Massachusetts

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE

STUDIES IN DISPLAY SYMBOL LEGIBILITY: Part X. The Relative Legibility of Leroy and Lincoln/MITRE Alphanumeric Symbols

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(Last name, first name, initial)*

Showman, Diana

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
August 1966	29	6

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
AF19(628)-5165	ESD-TR-66-115
b. PROJECT NO. 7030	
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	MTR-204

10. AVAILABILITY/LIMITATION NOTICES

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Deputy for Engineering and Technology, Decision Sciences Lab., Electronic Systems Div., L. G. Hanscom Field, Bedford, Mass.

13. ABSTRACT

The legibility of standard Leroy alphanumeric symbols was compared with with a new font, the Lincoln/MITRE (L/M) font. Legibility was tested by having human subjects attempt to identify the symbols when seen one at a time for a brief exposure period. The results showed the L/M font to be more legible than the standard Leroy. It is recommended that the two fonts be compared in a similar test on a TV monitor; this study is presently being conducted.

DD FORM 1 JAN 64 1473

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Computers Displays Display Design Psychology Human Characteristics Legibility Readability						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and addresa of the contractor, aubcontractor, grantee, Department of Defense activity or other organization *(corporate author)* iaauing the report.

2*a*. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking ia to be in accordance with appropriate security regulationa.

2*b*. GROUP: Automatic downgrading ia apecified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital lettera. Titles in all caaea ahould be unclassified. If a meaningful title cannot be aelected without claasification, ahow title clasaification in all capitals in parentheaia immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a apecific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(a) aa ahown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an abaolute minimum requirement.

6. REPORT DATE: Enter the date of the report aa day, month, year; or month, year. If more than one date appeara on the report, uae date of publication.

7*a*. TOTAL NUMBER OF PAGES: The total page count ahould follow normal pagination procedurea, i.e., enter the number of pagea containing information.

7*b*. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8*a*. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8*b*, 8*c*, & 8*d*. PROJECT NUMBER: Enter the appropriate military department identification, such aa project number, subproject number, system numbera, task number, etc.

9*a*. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. Thia number muat be unique to this report.

9*b*. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbera *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by aecurity claasification, using atandard atatements auch as:

(1) "Qualified requeaters may obtain copiea of thia report from DDC."

(2) "Foreign announcement and diaaemination of thia report by DDC is not authorized."

(3) "U. S. Government agenciea may obtain copiea of this report directly from DDC. Other qualified DDC usera ahall request through

_____."

(4) "U. S. military agencies may obtain copies of thia report directly from DDC. Other quallfied uaera shall request through

_____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through

_____."

If the report has been furnished tc the Office of Technical Services, Department of Commerce, for aale to the public, indlcate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory aponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional apace is required, a continuation aheet ahall be attached.

It is highly desirable that the abstract of claasified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation cn the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification ia required. Identifiers, such as equipment model designation, trade name, mllitary project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The aasignment of links, rules, and weighta is optional.

GPO 886-551