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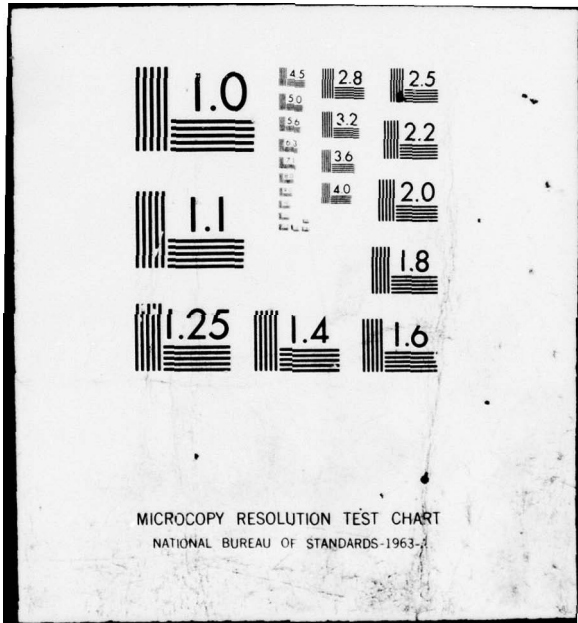
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AN EVALUATION OF PICTOGRAPHIC SYMBOLS FOR CONTROLS
AND DISPLAYS IN ROAD VEHICLES

Dieter Wiegand
Monica M. Glumm



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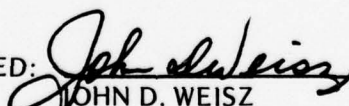
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AND DISPLAYS IN ROAD VEHICLES

Dieter Wiegand
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February 1979

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AN EVALUATION OF PICTOGRAPHIC SYMBOLS FOR CONTROLS AND DISPLAYS IN ROAD VEHICLES

INTRODUCTION

The quick and accurate identification of controls and displays by the vehicle operator is essential to safe driving. Language independent pictographs have been developed in order to facilitate recognition and orientation to controls and displays, and simplify transition between different vehicles. Examples of such symbology systems are the FORD system composed of 21 symbols, and the DIN 73002 system with 48 symbols, both of which are used by industry. Military systems include the FINABEL-Agreement 15E2 with 36 symbols, and the STANAG-4050 composed of 40 symbols. The discordant variety of symbol systems is particularly evident between industry and the military, where differences between comparable symbols are most apparent. Particular difficulties exist in the application of the STANAG-4050. This system was accepted by only four of the 14 signed NATO states. A study using German military drivers points out that 32 of the 40 STANAG symbols were accurately identified by less than 50 percent of the subjects (Wiegand 1976).

A symbol set has been proposed by the International Standard Organization (ISO). Preliminary studies using the selected symbols from this set indicate that they may provide a broad application to both industry and the military. Twelve of the 25 ISO symbols relate to the STANAG-symbols; this set, therefore, will be of particular interest to the military.

The following investigation was conducted to examine the entire set of ISO symbols and the ability to associate these symbols with the names of those controls and displays they are intended to represent.

It is recognized that the ability to associate a symbol with the appropriate control or display may differ when identifying such controls in a vehicle versus when making such a selection from a word list.

METHOD

Subjects

The subjects were 125 native US citizens (75 males and 50 females) with one year or more of driving experience. Seventy subjects were employees of the US Army Human Engineering Laboratory; the remaining subjects were 35 enlisted men of Aberdeen Proving Ground, and 20 students of Harford Community College. Those subjects who participated in Shoemaker's study (1976) were not drawn in the present investigation so as to avoid the influence of learning.

Table 1 provides information relative to the mean age and years of driving experience within the male and female sample groups.

TABLE 1
Age and Driving Experience

	Male (N=75)			Female (N=50)		
	n	Range	\bar{x}	n	Range	\bar{x}
Age (years)	75	18-67	38.1	75	18-62	34.3
Civilian Driving Experience (years)	75	1-48	22.5	75	1-36	10.7
Military Driving Experience (years)	50	1-42	12.4	Not Reported		

Test Material

The test stimuli consisted of 25 pictographic symbols from the current International Standard (ISO 2575, 1976). In the upper portion of the test sheet (Appendix A) were 25 symbols arranged in 5 columns, 5 symbols to each column. Each symbol was marked with a letter (A to Y). In the lower portion of the test sheet were 35 names, numbered 1 to 35. Twenty-five of the 35 names related to the given 25 ISO-symbols; the remaining 10 names had no relation to the pictographs.

Procedure

A test sheet (Appendix A) and an answer sheet (Appendix B) were given to each of the subjects. Instructions for completing the test were included on the answer sheet; the investigator additionally provided a brief explanation of the procedures to assure comprehension.

RESULTS

Response to the ISO-Symbols

A "correct" response, for the purpose of this study, is defined as one in which a symbol is matched with the control or display name which it is intended by ISO to represent.

Table 2 gives the number and percentage of correct responses to the individual symbols within both the male and female samples, and the combined subject group. In general, the male subjects were slightly better than the females in correctly identifying the symbols. However, a

TABLE 2
Recognition of ISO-Symbols

Symbol/Name	Male No.	(N=75) Percentage	Female No.	(N=50) Percentage	Combined No.	(N=125) Percentage
A Upper Beam	72	96.0	46	92.0	118	94.4
B Lower Beam	74	98.7	44	88.0	118	94.4
C Turn Signals	74	98.7	49	98.0	123	98.4
D Hazard Warning	71	94.7	46	92.0	117	93.6
E Windshield Wiper	69	92.0	41	82.0	110	88.0
F Windshield Washer	71	94.7	40	80.0	111	88.8
G Windshield Wiper and Washer	72	96.0	44	88.0	116	92.8
H Ventilating Fan	72	96.0	48	96.0	120	96.0
I Parking Lights	69	92.0	43	86.0	112	89.6
J Front Hood	75	100.0	48	96.0	123	98.4
K Rear Hood	75	100.0	48	96.0	123	98.4
L Choke	42	56.0	15	30.0	57	45.6
M Horn	75	100.0	47	94.0	122	97.6
N Fuel	73	97.3	48	96.0	121	96.8
O Engine Coolant Temperature	60	80.0	40	80.0	100	80.0
P Battery Charging Condition	72	96.0	48	96.0	120	96.0
Q Engine Oil	68	90.7	46	92.0	114	91.2
R Seat Belt	71	94.7	47	94.0	118	94.4
S Headlamp Cleaner	70	93.3	39	78.0	109	87.2
T Lighter	50	66.7	27	54.0	77	61.6
U Rear Fog Light	16	21.3	18	36.0	34	27.2
V Front Fog Light	16	21.3	19	38.0	35	28.0
W Master Lighting Switch	21	28.0	11	22.0	32	25.6
X Windscreen Demisting and Defrosting	66	88.0	43	86.0	109	87.2
Y Rear Window Demisting and Defrosting	71	94.7	43	86.0	114	91.2

comparison of responses (Table 3) to individual symbols indicates that there are only four symbols which differentiate significantly between these subgroups: LOWER BEAM (B), WINDSHIELD WASHER (F), and HEAD LAMP CLEANER (S) with a $P < .05$; and CHOKE (L) with a $P < .01$.

TABLE 3

Test of Significance Between Responses of Male and Female Subjects
 Given for Each Symbol
 (Chi^2 - Test with Correction for Continuity (df = 1))

SYMBOL	Chi^2	Level of Significance
A Upper Beam	0.31	
B Lower Beam	4.59	.05
C Turn Signals	0.19	
D Hazard Warning	0.05	
E Windshield Wiper	1.97	
F Windshield Washer	5.09	.05
G Windshield Wiper and Washer	1.80	
H Ventilation Fan	0.22	
I Parking Lights	0.60	
J Front Hood	1.04	
K Rear Hood	1.04	
L Choke	7.15	.01
M Horn	2.40	
N Fuel	0.53	
O Engine Coolant Temperature	1.52	
P Battery Charging Condition	0.22	
Q Engine Oil	0.01	
R Seat Belt	0.06	
S Headlamp Cleaner	5.02	.05
T Lighter	1.54	
U Rear Fog Light	2.56	
V Front Fog Light	3.35	
W Master Lighting Switch	0.77	
X Windscreen Demisting and Defrosting	0.00	
Y Rear Window Demisting and Defrosting	1.83	

An examination using the 75 percent criterion for acceptance of a symbol indicated that only five symbols did not meet the criterion of recognition: these five symbols were identical for both male and female subjects. In declining order of recognition they are: LIGHTER (T), CHOKE (L), MASTER LIGHTING SWITCH (W), REAR FOG LIGHT (U), and FRONT FOG LIGHT (V). Eighteen symbols within the male sample and 11 symbols within the female sample were correctly identified by over 90 percent of the subjects.

Distribution of Responses

Figures 1 and 2 show the distribution of responses to the symbols for the combined male/female sample. The corresponding data for the male and female subgroups are given in Figures 3 through 6.

The distribution of incorrect responses to the following four symbols should be noted:

REAR FOG LIGHT (U) and FRONT FOG LIGHT (V). The symbol for REAR FOG LIGHT was correctly identified by 27.2 percent of the combined sample; and FRONT FOG LIGHT correctly identified by 28.0 percent. The low percentage of correct responses is primarily attributable to confusion between these two symbols; that is, "rear" versus "front." For example, if selection of either of these symbols was considered a correct response to REAR or FRONT FOG LIGHT, the responses of over 85 percent of the combined sample would have been correct. If one symbol selection had been provided to depict FOG LIGHTS, a significantly greater percentage of the combined sample would have correctly identified the symbol, although presentation of two like-symbols paired with two like-symbol names may have assisted the subjects in discriminating between other singularly presented pictographs.

CHOKE (L). The symbol was correctly identified by 45.6 percent of the subjects. A considerable percentage of the subjects who incorrectly identified this symbol selected either the ignition switch (18.4 percent) or the starter (14.4 percent): neither were included in the ISO-pictographs.

MASTER LIGHTING SWITCH (W). This symbol had the lowest recognition value (25.6 percent) of all the ISO-symbols. Interior lighting, which was not included in the ISO-symbology, was the more frequently selected response (36.0 percent).

When considering the total number of incorrect responses given by each subject to the given symbols, it was found that the mean number of these incorrect identifications within the male group was $\bar{x} = 4.1$ with a range from 1 to 14; this mean within the female group was $\bar{x} = 5.2$ with a range of 0 to 15. The difference in wrong answers between both subgroups, however, was not significant ($\text{Chi}^2 = 5.25$, $\text{df} = 2$, n.s.).

A comparison of the distribution of wrong answers within the male group between those with and without military driving experience showed that the subgroup with the additional military driving experience produced a mean of 4.1 wrong answers with a range of 1 to 14, while the subgroup without this additional experience produced a mean of 4.3 wrong answers with a range of 1 to 10. The difference between these subgroups was not significant ($\text{Chi}^2 = 1.80$, $\text{df} = 2$, n.s.).

INCORRECT SELECTIONS: NOT ISO*

ISO-SYMBOLS	01	04	08	12	16	20	23	25	29	32	00
A	1										1
B											1
C	1										5
D	1	1	1	1							1
E		1	1								2
F											2
G											2
H							1			1	2
I	5	1	1			2					3
J							1				
K											1
L	1			2	3	5	18	23			8
M						2					1
N											3
O	1	2			1			2	2	6	3
P								1			2
Q											5
R											3
S	1		1					2			5
T		1			2	8	2	4	1	6	15
U	2										8
V			1								11
W	8		45			5	6			1	9
X					1				2		9
Y				1						2	5

* Names which are not related to ISO-Symbols:

- 01 Instrument panel light
- 04 Spark advance
- 08 Interior lighting
- 12 Winch brake
- 16 Parking light
- 20 Radio
- 23 Starter
- 25 Ignition switch
- 29 Clutch
- 32 Heater switch
- 00 No answer

Figure 2. Distribution of incorrect responses to ISO-symbols of combined sample (N=125).

PICTOGRAPH SELECTED

ISO-SYMBOLS	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	
A	72	1																								
B	1	74																								
C			74	1																						
D				71																						
E					69	2	1																			
F					1	71	1																			
G					1		72																			
H								72																		
I									69																	
J										75																
K											75															
L												42														
M													75													
N																										
O																										
P																										
Q																										
R																										
S																										
T																										
U																										
V																										
W																										
X																										
Y																										

Figure 3. Distribution of responses of male sample (N=75).

ISO-SYMBOLS	INCORRECT SELECTIONS: NOT ISO*										
	01	04	08	12	16	20	23	25	29	32	00
A											1
B											
C											
D											4
E											1
F											2
G											2
H											2
I											2
J											
K											
L											5
M											
N											2
O											3
P											1
Q											3
R											2
S											4
T											10
U											4
V											6
W											6
X											6
Y											3

*Names which are not related to ISO-Symbols:

01 Instrument panel light	16 Parking light	29 Clutch
04 Spark advance	20 Radio	32 Heater switch
08 Interior lighting	23 Starter	00 No answer
12 Winch brake	25 Ignition switch	

Figure 4. Distribution of incorrect responses to ISO-symbols of male sample (N=75).

PICTOGRAPH SELECTED

ISO-SYMBOLS	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
A	46	1							1												1				
B	2	44														1					1				
C			49																		1	2			
D				46																					
E					41	1		1						1	1	2	1								
F					2	40	1							1	1	1	1							1	
G					1	1	44							1	1								1		1
H								48																	
I	1								43																
J										48															
K											48														
L									1			15			1										1
M													47												
N														48											
O															40										
P																48									
Q																	46								
R																		47							
S																			39						
T																			1	27					
U	4	1																	1		18	20			
V																			1		21	19	1		
W																				7		11			
X																							43		
Y																								43	43

Figure 5. Distribution of responses to ISO-symbols of female sample (N=50).

ISO-SYMBOLS	01	04	08	12	16	20	23	25	29	32	00
A	1										
B											1
C	1										1
D	1	1									
E		1	1								
F		1	1								
G											
H							1			1	
I	1	1	1			2					
J							1				
K					1	3	14	9			1
L	1			2		2					3
M											1
N											1
O	1	2						1	1	2	
P											1
Q											2
R											1
S	1		1					2			1
T		1			1	4	1		1	5	5
U	2										4
V											5
W	6		17			2	1				3
X					1				1		3
Y				1						2	2

*Names which are not related to ISO-Symbols:

- 01 Instrument panel light
- 04 Spark advance
- 08 Interior lighting
- 12 Winch brake
- 16 Parking light
- 20 Radio
- 23 Starter
- 25 Ignition switch
- 29 Clutch
- 32 Heater switch
- 00 No answer

Figure 6. Distribution of incorrect responses to ISO-symbols of female sample (N=50).

DISCUSSION

The data obtained in this investigation demonstrate a high recognition value of 20 of the current 25 ISO-symbols which, in general, is not influenced by sex or additional military driving experience.

No time limit was imposed for completion of the test. It is possible that the recognition value of the ISO symbols may be influenced, in part, by the ability of the subjects to arrive at the correct response through a process of elimination. However, a number of assumptions can be made based upon the trend of the data, and the comparatively high recognition achieved by many of the ISO-symbols.

Only five of the 25 ISO-symbols failed the acceptance criterion of a minimum 75 percent recognition. It is assumed that the symbol for LIGHTER is of less importance and will be recognized after its initial use. The symbols for FOG LIGHT are generally identified as such. Problems, however, do exist relative to recognition of the symbols for CHOKE and MASTER LIGHTING SWITCH.

Those symbols which passed the 75 percent recognition criterion in the current study also passed in the studies of Shoemaker (1976) and Green and Pew (1978). However, because the latter investigations operated with a reduced or partial symbol-set, a point-to-point comparison is not possible. In general, the order of identification of the symbols in the referenced studies followed the same trend as in the current study but with comparatively lower percentages of recognition. This, in Shoemaker's study, may be attributed to the small sample size and the method of data collection using an open-ended questionnaire; however, no reasonable explanation can be found for this difference in the study by Green and Pew.

CONCLUSIONS AND RECOMMENDATIONS

1. The following ISO-symbols are easily recognized and understood even by untrained populations; therefore, there appears to be little reason for STANAG use of different symbols for these functions.

- UPPER BEAM
- LOWER BEAM
- TURN SIGNALS
- WINDSHIELD WIPER
- VENTILATING FAN
- PARKING LIGHT
- HORN
- FUEL
- FOG LIGHT (FRONT)

2. Discrimination between FRONT FOG LIGHT and REAR FOG LIGHT can be improved by rotating the symbol for REAR FOG LIGHT 180°. However, consideration should be given to use of one symbol for FOG LIGHTS because under fog conditions both front and rear will be turned on.

3. The symbol for MASTER LIGHTING SWITCH should be redesigned. Confusion with INTERIOR LIGHTING should be avoided.

4. The symbol for CHOKE should be redesigned. A verbal label "CHOKE" may be preferable to a pictograph.

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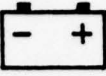
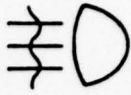




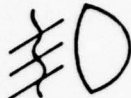
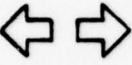
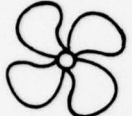













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SYMBOLS FOR CONTROLS, INDICATORS AND TEST LAMPS

APPENDIX A
TEST SHEET

Symbol No.	Description	Symbol No.	Description
1	Engine oil pressure indicator	11	Engine oil level indicator
2	Battery level indicator	12	Engine oil temperature indicator
3	Engine oil level indicator	13	Engine oil pressure indicator
4	Engine oil temperature indicator	14	Engine oil level indicator
5	Engine oil pressure indicator	15	Engine oil temperature indicator
6	Engine oil level indicator	16	Engine oil pressure indicator
7	Engine oil temperature indicator	17	Engine oil level indicator
8	Engine oil pressure indicator	18	Engine oil temperature indicator
9	Engine oil level indicator	19	Engine oil pressure indicator
10	Engine oil temperature indicator	20	Engine oil level indicator

ROAD VEHICLES
ISO-SYMBOLS FOR CONTROLS, INDICATORS AND TELL-TALES

A 	F 	K 	P 	U 
B 	G 	L 	Q 	V 
C 	H 	M 	R 	W 
D 	I 	N 	S 	X 
E 	J 	O 	T 	Y 

DO NOT WRITE ON THIS SHEET

PLEASE USE ANSWER SHEET

NUMBER	NAME
1	Instrument panel light
2	Hazard warning
3	Ventilating fan
4	Spark advance
5	Windshield wiper
6	Parking lights
7	Rear fog light
8	Interior lighting
9	Battery charging condition
10	Turn signals
11	Front fog light
12	Winch brake
13	Windshield wiper and washer
14	Front hood (bonnet)
15	Windshield washer
16	Winch
17	Master lighting switch
18	Headlamp cleaner

NUMBER	NAME
19	Choke (cold starting aid)
20	Radio
21	Upper beam
22	Horn
23	Starter
24	Lower Beam
25	Ignition switch
26	Seat belt
27	Fuel
28	Windscreen demisting & defrosting
29	Clutch
30	Lighter
31	Engine coolant temperature
32	Heater switch
33	Engine Oil
34	Rear hood (boot)
35	Rear window demisting & defrosting

ANSWER SHEET WITH SOLUTION

1. Find words A and B in the grid.
 2. Look for the letter A in the grid.
 3. Write the letter A in the grid.
 4. Make the word A in the grid.
 5. Write the word A in the grid.
 6. Write the word A in the grid.

AGE ... YEARS OF MILITARY SERVICE ...
 NATIONALITY ...
 MILITARY JOB ...
 MILITARY DRIVER LICENSE ... YES ... NO ... YEARS ...
 CIVILIAN DRIVER LICENSE ... YES ... NO ... YEARS ...
 YES ... WHIPPED ... YEARS ...

APPENDIX B

ANSWER SHEET WITH SOLUTION

NUMBER	SYMBOL	NUMBER	SYMBOL	NUMBER	SYMBOL
18	Z	19	I	24	A
20	T	25	K	25	B
7	U	26	L	26	C
11	V	27	M	27	D
17	W	28	N	28	E
21	X	29	O	29	F
32	Y	30	P	30	G
		31	Q	31	H
		32	R	32	I
		33	S	33	J
		34	T	34	K

=====

AGE YEARS OF MILITARY SERVICE NATIONALITY

RANK MILITARY JOB

CIVILIAN DRIVER LICENSE : YES () NO () YEARS

MILITARY DRIVER LICENSE : YES () NO () YEARS

IF YES: WHEELED () TRACKED ()

=====

Please match the 25 symbols (A-Y) with the 35 names (1-35). The matching procedure is as follows:

- Find symbol A on the photograph.
- Look over the list of 35 names.
- Decide which one of the 35 names is best represented by the symbol A.
- Mark the number of the name in the blank for symbol A on this sheet.
- Go on to symbol B and repeat the procedure.

NOTE : GIVE ONLY ONE ANSWER FOR EACH SYMBOL.
THERE ARE 10 MORE NAMES THAN SYMBOLS. SO, WHEN YOU ARE FINISHED YOU SHOULD HAVE 10 UNUSED NAMES.

SYMBOL	NUMBER	SYMBOL	NUMBER	SYMBOL	NUMBER
A	..21..	J	..14..	S	..18..
B	..24..	K	..34..	T	..30..
C	..10..	L	..19..	U	..7..
D	..2..	M	..22..	V	..11..
E	..5..	N	..27..	W	..17..
F	..15..	O	..31..	X	..28..
G	..13..	P	..9..	Y	..35..
H	..3..	Q	..33..		
I	..6..	R	..26..		

REMARKS :

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