

A METHOD FOR ANALYSIS OF THE EFFECTIVENESS OF HIGH-WAY SIGNS

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SOME traffic officials feel that the signs used on many of our highways are not as effective as they should be. And certainly, a trip across the United States will demonstrate the difference of opinion which exists as to the most effective method of handling this problem. This paper suggests a method of attacking the problem on a scientific basis and describes its use in a preliminary study which demonstrates its practicability.

The problem often arises in practice in connection with new types of signs or layouts, whose effectiveness must be compared with that of other types. Let us suppose that it has been decided to improve the effectiveness of the destination signs in a certain district. What happens? First some new sign designs are made up. These are set up in sample form, either somewhere on the highway or else just outside the sign shop. The various new layouts usually carry the same words or numerals for better comparison.

Then all those connected with the project come out to take a look at the new designs: First the designer, then his boss, and so on up the line. The designs are viewed from a distance and an opinion is formed by the various individuals as to which layout is most effective. The signs are then viewed at close range, after which a second observation is made from a

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more distant position and this time perhaps the first opinion is revised. One thinks the signs are no improvement over the old ones; another thinks one particular layout is a "honey"; and there is a general impasse. So the chief finally picks the one he happens to like best and lets it go at that.

Nothing could demonstrate better the need for some means of gauging or measuring the true effectiveness of destination signs. Now there have been similar problems in other fields which have been pretty well solved. Why not follow a generally similar procedure?

THE GENERAL PROBLEM

The traffic engineer wants to determine the over-all effectiveness of his signs in getting his message across to the motorist. For until the motorist has the message, observance of the regulation cannot be expected of him. Observance depends upon more complex factors and calls for other methods, but the effectiveness of a sign in imparting its information successfully can be analyzed in fairly simple fashion.

FUNDAMENTAL FACTORS IN HIGHWAY SIGN EFFICIENCY

By combing the experience of practical pioneers in the highway sign field with previous experimental work on highway signs (1, 3), and our demonstration technique, we arrived at the following analysis:—

- | | |
|-----------------------------|----------------------------|
| I. <i>Legibility</i> | II. <i>Attention Value</i> |
| a. <i>Pure Legibility</i> | a. <i>Target Value</i> |
| b. <i>Glance Legibility</i> | b. <i>Priority Value</i> |

Legibility is a well accepted term indicating the ease with which copy can be read when there are no distracting conditions. In the case of highway signs, the best practical measure of legibility is the distance at which the sign can be read. *Pure Legibility* is the distance at which a sign can be read with unlimited time. This corresponds to the ordinary condition where test signs have been set up outside of the sign shop. *Glance Legibility* is the term used for a similar

reading distance under rapid glance conditions. The most extreme illustration of glance reading is perhaps the plight of a driver in very heavy, rapid traffic who must read a sign as it flicks by in the instant at which it is not obscured by another car. Both of these terms are limited to the readability of the copy itself and can be measured in an experimental set-up.

Attention Value includes all factors which result in attracting the eye to the sign. *Target Value* is applied to the characteristic which makes a sign stand out as different from other objects and other signs. For instance, in one state extremely large "Slow" signs are used near construction projects in order to make these signs stand out from all other signs and objects. *Priority Value* is used to designate the qualities which result in one of the signs of a group being read first, even when all signs are of the same type and therefore have the same target value. On approaching a group of destination signs at a crossroad, which one will the driver read first? The sign which is consistently read first by a large number of drivers may be said to have greatest priority value. Attention values, in contrast to legibility, must be determined under actual road conditions of mounting and surroundings, although fundamental factors may be derived for general application.

If we are signing for through traffic on a high speed route, we desire for our more important warnings the greatest target and priority values. Further, they should have the greatest glance legibility to allow quick reading in order to eliminate excessive driver distraction or slowing down with attendant blocking of traffic.

TECHNIQUES FOR LEGIBILITY MEASUREMENTS

As pointed out above, legibility measurements may be made for various types of letter, spacing, and sign color in an experimental set-up. A preliminary tryout was given such a technique to demonstrate its practicability.

Figure 1 shows the equipment which was used for pure

legibility and glance legibility measurements. It consisted essentially of a universal sign board fitted with racks into which could be slid the test letters. This signboard was 4 × 6 feet in height and stood 30 inches from the ground. A shutter was devised to be placed a couple of feet in front of the universal

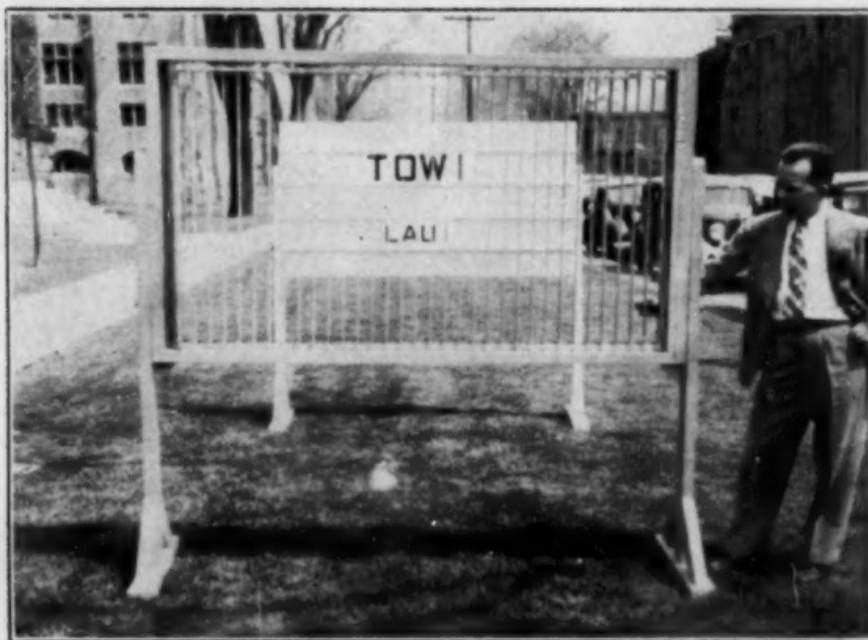


FIG. 1. Test signboard and shutter.

sign board. Thus the different letter combinations could be set up out of sight of the observers.

The shutter consisted of a Venetian blind with the slats mounted vertically instead of horizontally and with a handle attached so that the vanes could be rotated through 90° and thus open to give a clear view of the signboard behind. The fastest manual operation of this device gave an effective exposure of from .2 to .3 seconds since this is the approximate reaction time of a double arm movement. Longer times were timed with a stopwatch. Three exposures were used in the study, *i.e.*, minimum exposure, 1 second, and unlimited time.

Six experimental series of letters were used. These consisted of 2, 4, and 6 inch letters of the standard series B and E.* These letters were black on a white background, and each individual letter was mounted on a metal plate cut to such dimensions that placing plates edge to edge gave a fixed spacing. The signboard background was painted white to match the letter background so that greater spacing could be obtained by spreading the plates, and smaller spacing by overlapping the plates.

PRINCIPLES OF TESTING LEGIBILITY

Certain broad principles for the testing of legibility have been derived by others in connection with work on type-faces and in the testing of vision by means of legibility. These may be summarized as follows:

1. Different observers will read signs at different distances and therefore must not be allowed to influence each other.
2. Enough different observers must be used to get a reliable measure of the differences in eyes which occur among an average group of drivers.
3. Several observations per person are preferable, if possible, in order to overcome accidental factors such as guessing or the misinterpretation of one particular letter.
4. To obtain the true legibility of letters the observers must not know ahead of time what letter combinations are going to be seen.

PROCEDURE

A. Rapid Practical Procedure

Distances were marked off in 25 foot units with the signboard as reference point. The letter combinations were set up behind the closed shutter. The observers were stationed in a group at a distance greater than that at which the test letters were legible. When the shutter was opened, the observers then walked up toward the signboard, each man ad-

* As specified in drawings listed in the Manual on Uniform Traffic Control Devices and available through the Bureau of Public Roads, Washington, D. C.

vancing until he was able to read the letter combination exposed. Each observer then recorded this distance and the letters he saw and advanced further to verify the reading which he had given the sign. The first point at which consistent correct reading was obtained gave the legibility distance for the individual.

For Pure Legibility, the shutter was opened and left open continuously until all the observers had reached their legibility distance. For Glance Legibility, 1 second exposures were given at intervals until all observers had reached their own legible distance.

The process was repeated for each letter type and spacing. The new test combination of letters was set up behind the closed shutter, and the observers started again from the distant location toward the sign.

B. Accurate Procedure

A more accurate procedure was also used, but this involves the use of an amount of time which is not practical for most purposes. This procedure was similar to the previous one except that after each exposure, whether long or short, the test word was altered. Thus the group of observers moved nearer to the test sign by 25 foot intervals, seeing a different letter combination at each point, until each had reached his own legibility distance. This procedure is more accurate in that each presentation is absolutely new to the observers. However, the cost in time is great and the difference in results for practical purposes negligible. For this reason the more rapid procedure is recommended.

RESULTS ON LEGIBILITY

Nineteen observers only were available for this preliminary study and the results presented are therefore essentially a demonstration of the practical utility of the method. A more extended study has since been carried out jointly with a highway organization and will be reported elsewhere.

A. Interference from the Shutter

The interference experienced due to the vertical edges of the gray shutter vanes was slight as indicated in Table 1. Median

TABLE 1

Effect of Shutter

Comparison of Pure Legibility Distance with and without Shutter

Median Legibility Distance for Indicated Letter

19 Observers—6 Letters, Scrambled

Long Exposure—Fixed Spacing

	4" E	4" B	2" E	2" B
Without shutter	287	205	170	69
With shutter	275	187	120	100*

* This figure is questionable since some observers indicated incomplete observations after the observations were terminated.

legibility distances for the group of observers are here compared with, and without, the shutter in front of the signboard. To obtain the latter condition, the whole shutter was simply moved aside.

It will be noted that there was apparently some slight interference with the 4 inch letters, but it was not of any magnitude with letters of that size or larger. The results on the 2 inch letters indicate that for a test of small letters, the shutter should be removed entirely.

B. Pure Legibility

Results on the 2, 4, and 6 inch letters of series B and series E are shown in Table 2 for spacing fixed by the plate widths and for the $\frac{1}{2}$ fixed spacing. Six letter test words or combinations and the more accurate method were used here, i.e., the test letters were changed after each exposure. Each vertical column in the table shows the number of observers who reported correctly the test sign at the distances shown in the left-most column. Thus each column represents a distribution of the reading distance by different people for a given letter and

TABLE 2

*Legibility with Long Exposure through Shutter*Fixed (F), $\frac{1}{2}$ Fixed ($\frac{1}{2}$ F)

Spacing

6 Letters Scrambled—Letters Changed for Each Exposure at Each Distance*

Distance	6" E		6" B		4" E		4" B		2" E		2" B	
	F	$\frac{1}{2}$ F	F	$\frac{1}{2}$ F	F	$\frac{1}{2}$ F	F	$\frac{1}{2}$ F	F	$\frac{1}{2}$ F	F	$\frac{1}{2}$ F
450	2	1										
425	0	1										
400	1	0										
375	4	0										
350	7	5	2	1								
325	2†	3	5	4								
300	1	5	5	4	5	1						
275	1	1†	3	4	5	4						
250	1	3	4†	4†	1	1	1					
225				2	6†	7	2					
200					1	4†	1	2				
175					1	1	9	6	3		1	
150						1	2†	3	4	9	2	
125							4	8†	2	3	2	
100									9†	6†	4	4
75									1	1	9†	15†
50												

* Longest distance at which word was seen correctly by each individual.

† 80 percentile point.

spacing, and the median or middle person might be used as an index of legibility. However, for practical reasons it is desirable to have signs legible to at least 80 per cent of the drivers. Therefore the heavy black numerals in the table enable the reader to perceive the general range of the 80 percentile values, i.e., the distances at which 80 per cent of the observers reported legibility.

In spite of the small number of observers, it will be noted that the wider letters, and the greater spacing of the two used, showed consistently greater legibility. The results suggest

Time to read and fixation will require from 0.4 seconds as an extreme minimum to about 1.2 seconds. The driver will further reduce the legibility distance accordingly. Other investigators have reported that from 0.1 to 0.3 seconds may be necessary for the eye to come to rest upon a letter, and another similar interval is necessary to transfer the eye from one letter to the next. The latter glances (movement, fixation, transfer) may require from 0.1 to 0.2 seconds. The driver will therefore require from 0.2 to 0.3 seconds to read a sign. The driver will also require from 0.1 to 0.2 seconds to transfer the eye from the sign to the road. On B-243 50 to 187 ft. (15 to 57 m) is required to reduce slightly the legibility distance. This reduction appeared to be negligible since it was found that the driver could read the sign from 160 to 180 ft. (49 to 55 m) on B-243. In fact, it is reducing the second time TABLE 3 Comparison of Pure and Chance Legibility Distances Including of Per Cent of Observers Fixed Signs on Scrambled Letters Lower than Legality Distance (lower exposure) Chance legibility distance (lower exposure) Minimum exposure, 0.2-0.3 sec. (approx. group of observers) or obtain a fair sample of eyesight of the driving public. C. Chance Legality vs. Time The effect of reduced reading time on legibility was demonstrated by reducing the shutter exposure to correspond to a single glance. Six letter combinations of nonsense or scrambled letters were used. EFFECTIVENESS OF HIGHWAY SIGNS 677 an interesting relationship to the rule of thumb often heard of 50 feet of legibility for 1 inch of letter height. The wider letters (Series E) showed somewhat more, the narrower some, while less legibility than indicated by the rule. Describable values, however, must await a much

b. *Familiarity*

In order to demonstrate the effect of familiarity or recognition value on glance legibility, 3 and 4 letter combinations were presented as indicated in Table 4. The factor of legibil-

TABLE 4

Effect of Familiarity on Number of Words Seen at a Glance
All Observations within Easily Legible Distance (125 ft. using
4-inch series E and 6-inch series B letters) and with Mini-
mum Exposure (approximately 0.2 to 0.3 seconds)

Combination _____	Unfamiliar		Familiar	
	A	B	C	D
Number of syllables or words in combination _____	3	4	3	4
Number of syllables or words read				
0 _____		1		
1 _____	5	3	1	4
2 _____	13	12	6	10
3 _____	1	3	12	3
4 _____				2

Combinations

A—HOL WAN

C—SLAP THE POST

TESP

B—LANS THEP

D—HAUL PEST

WOV WEH

NEW STOP

ity was held constant by presenting 4 and 6 inch letters at a distance of 125 feet where both were easily read. The first two combinations were definitely unfamiliar and, as shown in columns A and B, of Table 4, only two of the syllables were seen correctly by the majority of the observers during a minimum exposure. Combination D on the other hand consisted of familiar words but in an unfamiliar order. Although a few individuals saw this more correctly, for the majority of the observers the effect was no better than with the unfamiliar

symbols. Combination C involved familiar words in a familiar order and the majority read all three words.

This constitutes a rough demonstration that in order to produce the most rapid seeing, a sign should contain not more than three familiar words. It should be pointed out here that the use of symbols enhances the glance value by virtue of familiarity and by reducing the amount of text.

ATTENTION VALUES—THE PROBLEM

Now a sign may be quite legible and yet it may not be seen at all simply because the driver has his attention attracted by another object or sign. Or, he may notice it so late that there is not sufficient time to act in response to the warning. Lack of priority value and target value may be said to be responsible.

Let us view an example of the priority value problem. Take for instance the destination signs at a junction on a main route leading to several large cities as well as several smaller intermediate towns. In one jurisdiction the farthest destination will appear at the top and nearer ones in order underneath it. Thus, let us say, Chicago might appear at the top and four or five nearer towns and cities below. In other locations the nearest towns will be found placed at the top. Or again, the major through destination alone appears, or sometimes the through destination and nearest intermediate town.

These various methods are an attempt to obtain *priority value* for the destination, or destinations, which will direct the largest proportions of the traffic and therefore send it through with the least delay.

For an illustration of the target value problem assume a location fitted with standard symbol and warning signs at which the traffic engineer is "shooting trouble." He finds a bad right angle turn on a high speed highway with a number of roadside stands preceding the turn. The turn warning is completely swamped among the stands and their advertising signs.

What happens? Our trouble shooter decides that the warn-

ing sign does not stand out well. In other words, it does not have sufficient *target value*. He therefore may order more signs, a larger sign, or possibly a change of mounting locations, all in an attempt to make the sign stand out and thereby attract attention. Again there seems to be little agreement among engineers as to the effectiveness of different methods.

Analysis of Attention Values

How then may we analyze the factors of effectiveness relating to priority and target values? Although the magazine ad problem is somewhat less complicated, it may furnish us valuable clues. It was found that the attention value of magazine advertisements could be measured by setting up test ads in which the legibility factor was held constant. Other factors such as placement, color contrast, size, and certain special features were varied. A large number of people were then required to leaf through the dummy magazines as if leafing through ordinary commercial magazines, after which they were required to recall or recognize a number of test layouts.

In similar fashion it is possible to use test locations on the highway. In order to test for priority value a nest of similar signs, such as standard destination signs, mounted on the same post, may be used. In order to test for target value, the test locations should be selected where the highway signs must compete with other signs or interesting objects.

A technique of this sort has been tried out in a preliminary way. First a squad of three observers was made familiar with the layout of the test locations and furnished with a means of rapid recording. After this the drivers (who had not been over the route) drove the observers over the test route. The driver's instructions were given in terms of route numbers and destinations as if he were going on a trip through unfamiliar territory. The drivers were instructed to call out all warning, route marker, and destination signs which seemed pertinent to their driving and were told to drive as if they were in a "moderate hurry."

It is important that the driver does not slow down and give greater attention to signs than he would in a normal case. One observer on the front seat was assigned to ask questions and engage the driver in conversation, the latter being instructed to join in as far as permissible in his operation of the car.

The few preliminary observations which have been obtained in this fashion suggest factors of attention which probably operate with highway signs.

PRIORITY VALUE

Under priority value the following factors would be expected to be operative from work by others. The habit of reading from left to right and from top to bottom would be expected to hold and apparently did, as indicated by the fact that the top position showed priority of call in roughly 4 out of 5 cases where all signs were almost identical. (See Figure 2 for a sample layout.)

Prior position on the highway and nearness to other attention compelling objects or signs would also be expected to influence priority value.

TARGET VALUE

Judging from the work on advertisements, it would be expected that relative size, color contrast, location, and the simplicity of message and layout would affect target value.

It is of interest in connection with the question of target value that in a small sample obtained for standard 24 inch symbol warnings, the calls occurred at from 200 to 400 feet from the sign. This contrasts with the 800 or more feet at which the same observers reported *legibility* for similar symbol signs in previous tests. The calls therefore suggest that, at least under conditions of brown bare winter terrain, only about 50 per cent of the legibility distance of the symbol sign is effective, i.e., it is seen only 50 per cent as far, due to lack of target value.

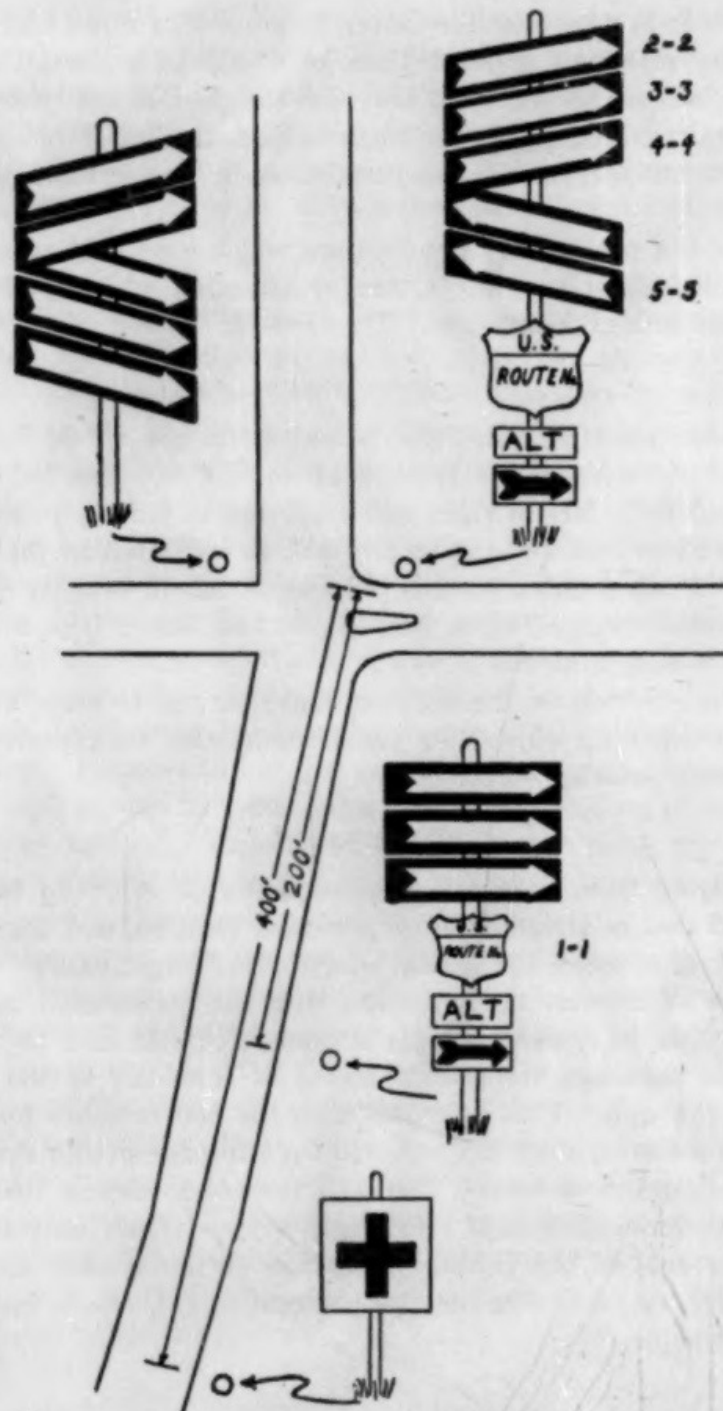


FIG. 2. Sample priority value layout. (Numerals indicate the order in which the signs were called by two drivers.)

Amount and type of reflectorization obviously should be a major factor in night target value (as well as in night legibility).

SUMMARY

(1) A method for the analysis of the effectiveness of highway signs was tried out. Applications to practical shop and field problems were indicated. The analysis was based on the experience of those in the highway sign field, and also previous work by others on the effectiveness of signs and advertisements, with modifications for the present problem.

(2) Sign effectiveness was analyzed into Legibility (pure legibility and glance legibility) and Attention Values (priority value and target value).

(3) Test equipment for the measurement of the two types of legibility was devised. It consisted of a universal sign-board with interchangeable letters, and a shutter to allow short presentations of the test signs.

(4) A technique was tried out also for checking the target and priority value of signs in their actual highway location.

(5) Legibility distances were obtained for a small group of observers for standard Series B and E letters for different sizes and spacing. The results showed an interesting relationship to the rule of thumb in use by practical sign experts, but a more extensive study is necessary.

(6) Short time or "glance legibility" distance appeared to be slightly less than the corresponding pure legibility distance for a given letter and spacing.

(7) The increase of glance value from familiarity was demonstrated with 3 and 4 letter combinations. Symbols derive their advantage from simplicity of layout and familiarity value.

(8) It was demonstrated that not more than 3 or, at most, 4 words are seen at a single glance. On high speed highways where rapid or glance legibility is most desirable, therefore, sign text should be limited to this number of words or symbols.

(9) The following factors would be expected to affect target

value; color contrast, relative size, simplicity and contrast of layout (as in the symbol sign), placement and, at night, reflectorization. Certain of these factors were demonstrated.

(10) Factors expected to be fundamental for priority value were reading habits, prior position on the highway, and proximity to another attention compelling sign or object. Observations were suggestive.

(11) The observations were very few in number, but they illustrate the practicability of the approach, *i.e.*, the analysis of the effectiveness of highway signs into fundamental factors which may be measured.

(12) The technique described may be used in the sign yard and on the highway respectively to check in an objective manner the effectiveness of signs and sign installations. A more extensive investigation of the factor of pure legibility has been conducted on a joint basis since this preliminary work and will be reported later. Similar extensive studies of the other factors are to be hoped for.

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