

# Predicting the Effectiveness of Highway Signs

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A new highway sign may be in place for several years before a sufficient feedback from motorists has accumulated to permit adequate evaluation of its effectiveness. A study is described in which a film technique was utilized to predict the comparative effectiveness of several signs proposed for use in locations where a lane is to be dropped. Each sign was properly installed on the highway and filmed from a moving vehicle. The filmed drives thus obtained were presented (in random order) to groups of drivers who responded, after each, to questions designed to determine how accurately the intended sign message was perceived. Analysis of these responses permitted the signs to be ranked on several dimensions, and conclusions were then drawn as to the relative effectiveness of the signs.

• **ONE MAJOR DIFFICULTY** in evaluating the effectiveness of highway signs is that several months or years may be required to determine (through accident experience and/or complaints by motorists) whether the signing is adequate. Further, over a period of years changes are likely to occur in the signing needs of a given location. For example, realignment of the highway or the erection of billboards may affect the prominence of the signs\* which will necessitate reevaluation and possibly resigning.

Because of these and other reasons, it would be of considerable practical advantage to be able to perform quickly an evaluation of the effectiveness of a sign. At the request of the California Division of Highways, the Institute undertook to devise a rapid technique for predicting the potential influence of a sign on motorist behavior. Specifically, the study concerned a comparative evaluation of several signs, each warning the driver that the multilane highway on which he is traveling is about to drop a lane. The four signing configurations studied were the following:

- |   |                            |
|---|----------------------------|
| Sign A—Two 40- by 40-in. diamond-shaped signs mounted on posts 400 ft apart,<br>the first sign reading  | "Pavement<br>Narrows"      |
| and the second  | "Squeeze<br>Left."         |
| Sign B—Same as Sign A, except second sign reads   | "Merge<br>Left."           |
| Sign C—A single 40- by 40-in. diamond-shaped sign reading<br>underneath which are four vertical arrows, with the one on the right having<br>a slash drawn through it. | "3 Lanes"                  |
| Sign D—A single rectangular sign, 4- by 8-ft reading  | "Lane Ends<br>Merge Left." |

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\*Prominence is one of the six basic principles of freeway signing set forth by Schoppert et al (1).

In addition to the four primary signing configurations listed above, a fifth sign, Sign E, was added for limited evaluation. This diamond-shaped sign, similar to the European standard, was entirely symbolic, and consisted of a representative line drawing of the impending lane-drop situation. Figure 1 shows all of the signing installations used in the study, all of which had black figures on a yellow background.

To obtain results based on a large sample and in a relatively short period of time, a film technique was devised by means of which groups of drivers could be exposed to the test signing as it actually would appear when installed on the highway. Experience with a similar filmed-ride technique in an earlier study of highway signs (2) had demonstrated its feasibility for studies where actual on-the-road experimentation would be too costly, time-consuming, and dangerous.

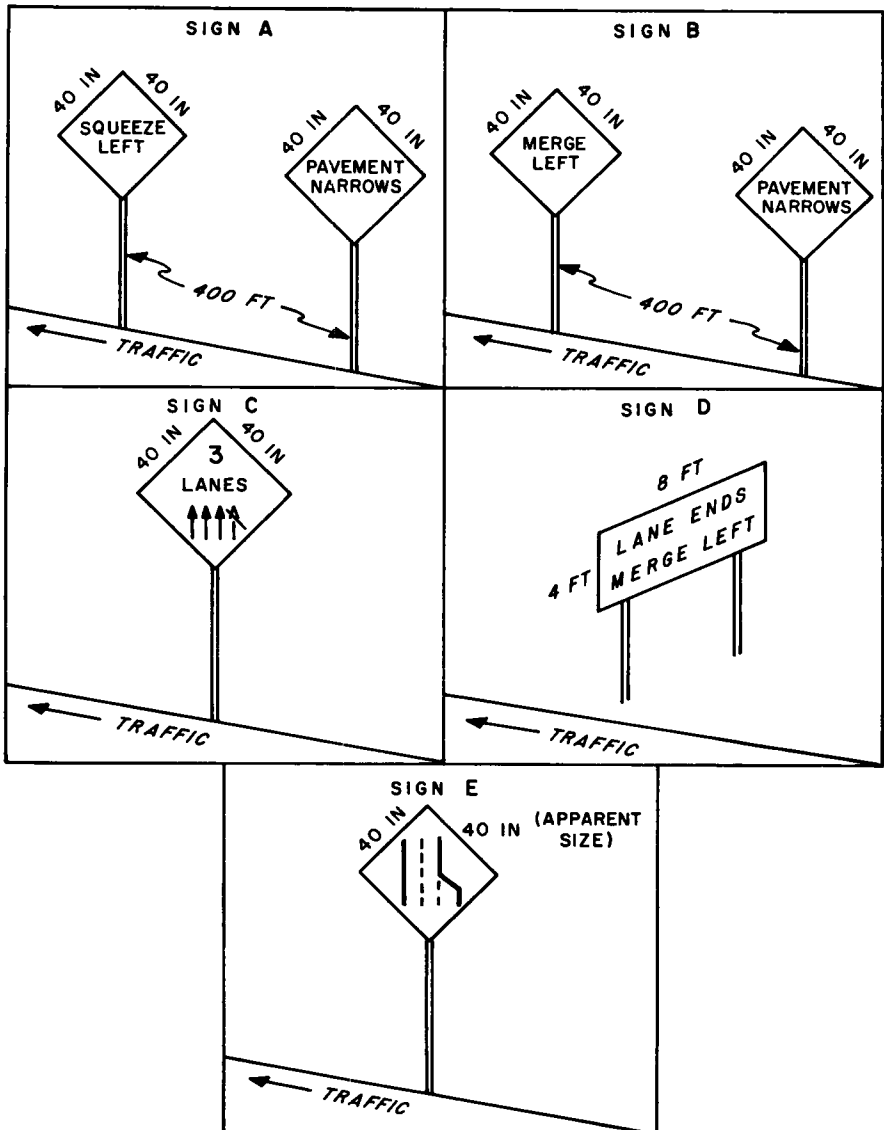


Figure 1. Signing installations.

## METHOD

Signs were installed in a standard manner, motion pictures were taken from the driver's position in a moving vehicle, and these films were shown to the subjects.

A completed but unopened section of freeway in Los Angeles was chosen as the film site. The signs were placed just in advance of a curve, so that in viewing the film it would not be apparent to the subject that there was, in fact, no actual lane drop ahead.

Each of the four primary sign configurations, in turn, was installed on posts in a completely standard way. (The signs, as well as their installation (and removal), were provided by the California Division of Highways, District VII.) A 16-mm motion picture camera was mounted on a vehicle (from which the top and windshield had been removed) in such a way that it was in the position normally occupied by the driver's head. With the camera operating at a speed of 24 fps, the vehicle was then driven in the outside lane, at approximately 35 mph, for over 1 mi before approaching and passing the signing installation. This produced a filmed ride of approximately 2½-min duration (at 24 fps) for each sign, and all of the filmed rides thus started with a period of travel along an identical stretch of highway. Standardized conditions were maintained for the production of all four filmed rides, so that they differed only in the sign message. In addition, still photographs were taken of each sign installation, and lantern slides made for later use in the study.

Sign E was added to the study for evaluation after the above-mentioned filmed rides had been produced. Because the freeway section had been opened by this time, a drawing of the sign was photographed and a lantern slide made for viewing by a limited number of subjects. This slide was a composite, so that it matched the other slides as to background.

### Subjects

In order to obtain a large sample of subjects in as short a time as possible, group testing was decided on. A total of 833 individuals was tested during a one-week period in the Los Angeles area, and 47 additional subjects were subsequently tested in Washington, D. C., as a check on regional differences in response to the signs.

In Los Angeles, the two major sources of subjects were (a) 560 students on the Campus of UCLA, and (b) 273 attendees at the Western Safety Congress, April 1960. The former are referred to as the "Student" group, and the latter as the "Safety" group. In many instances these two groups were analysed separately because of their markedly different compositions (see Table 1), in other analyses the two groups were combined. The "Washington" group is analysed separately throughout, for purposes of comparison.

The nine subgroups of the Student group ranged from 22 to 154 persons, while the four Safety subgroups ranged from 23 to 173. The two Washington groups were 20 employees of the American Automobile Association and 27 employees of the District of Columbia.

As is evident from Table 1, the subject population consisted almost entirely of drivers (of both sexes), with a considerable range of both age and driving experience. As was to be expected, most of the subjects were California residents.

### Procedure

Each of the UCLA Student groups was tested in its own classroom, and each of the four Safety groups was tested in a large meeting room at the hotel at which their conference was being held. The two Washington groups were tested at their respective places of employment.

The experimenter started by stating to the group that they were about to see some short films of traffic signs, following each of which they would be asked to answer some questions. They were then told that detailed instructions would be found on the sheets to be handed to them. Each member of the group was then given an instruction sheet and two or four answer sheets. After the subjects had finished reading these, the instructor commented on them briefly, emphasizing the salient points and answering

any questions. Appendix A contains samples of the instruction and answer sheets.

TABLE 1  
DESCRIPTION OF SUBJECT POPULATIONS

Item	Student Group (N = 560)		Safety Group (N = 273)		Total Los Angeles Group (N = 833)		Washington, D C , Group (N = 47)	
	No.	%	No.	%	No.	%	No.	%
Males	88	32.8	223	86.4	311	59.1	36	76.6
Females	180	67.2	35	13.6	215	40.9	11	23.4
Drivers	523	93.4	257	99.2	780	95.2	47	100.0
Nondrivers	37	6.6	2	0.8	39	4.8	0	0.0
Calif residents	273	96.8	-	-	273	96.8	0	0.0
Non-Calif residents	9	3.2	-	-	9	3.2	47	100.0
Driving experience (yr)								
Total								
None	37	7.4	2	0.7	39	5.1	0	0.0
Less than 1	11	2.2	0	0.0	11	1.4	1	2.1
1 to 3	92	18.5	2	0.7	94	12.2	2	4.3
3 to 6	216	43.5	2	0.7	218	28.3	6	12.8
6 to 11	88	17.7	19	7.0	107	13.9	3	6.4
11 or over	49	9.9	231	84.6	280	36.4	35	74.5
Not specified	4	0.8	17	6.2	21	2.7	0	0.0
Local								
None	25	10.0	0	0.0	25	4.8	1	2.1
Less than 1	13	5.2	1	0.4	14	2.7	2	4.3
1 to 3	80	32.0	8	2.9	88	15.8	3	6.4
3 to 6	93	37.2	17	6.2	110	21.0	6	12.8
6 to 11	7	2.8	39	14.3	46	8.8	9	19.1
11 or over	3	1.2	181	68.3	184	35.2	19	40.4
Not specified	29	11.6	27	9.9	56	10.7	7	14.9

TABLE 2  
ANALYSIS OF FIRST IMPRESSIONS, LOS ANGELES SAMPLE

Apparent Message Interpretation or Comment <sup>1</sup>	Percent Making Comment <sup>2</sup>											
	Student Group (N = 560)				Safety Convention Group (N = 273)				Combined Groups (N = 833)			
	Sign A	Sign B	Sign C	Sign D	Sign A	Sign B	Sign C	Sign D	Sign A	Sign B	Sign C	Sign D
Seems to get message	63.7	70.2	72.4	79.1	45.3	63.0	66.0	60.0	57.7	69.1	70.4	77.0
Not sure whether subject got message	18.8	15.0	17.1	12.3	41.7	32.9	24.0	20.0	26.2	17.7	19.2	13.2
Seems not to have gotten message	17.5	14.8	10.6	8.6	13.0	4.1	10.0	20.0	16.0	13.2	10.4	9.9
"First (or only) sign con- fusing or dangerous"	16.6	16.5	30.5	7.1	14.8	8.2	14.5	4.0	16.0	15.2	25.6	6.8
"Second sign confusing or dangerous"	41.3	11.6	-	-	33.6	13.7	-	-	38.8	11.9	-	-
Driver's mistaken impres- sion liable to cause trouble	14.7	12.6	8.4	8.4	9.4	1.4	8.0	12.0	13.0	10.9	8.3	8.8
Driver "would slow down" upon seeing sign	17.1	17.0	7.1	15.3	6.7	12.3	5.0	22.0	13.7	16.3	6.8	16.0
Driver's impression is that lane drop will occur very soon	4.3	1.5	4.8	8.4	0.4	-	1.0	-	3.1	1.3	3.6	7.5
Driver thinks "pavement" means shoulder	1.7	2.5	-	-	1.3	1.4	-	-	1.6	2.3	-	-
"Sign should be larger"	8.6	7.1	6.0	0.7	8.1	11.0	9.0	2.0	8.5	7.7	6.9	0.9
Number of people seeing each sign	463	406	463	406	223	73	200	50	686	479	663	456

<sup>1</sup>Comments in quotes.

<sup>2</sup>Based on the number of people seeing each sign.

Due to limitations in time for some of the groups, only two film strips were shown, while for the other groups, all four films were presented. For every group, however, the order of presentation of the signs (film strips) was randomly chosen in advance. Because group sizes varied, at the conclusion of the study each sign had not been seen by equal numbers of subjects; however, this fact was taken into account in the data analysis.

The experimenter then showed the first film, and immediately upon its conclusion turned the lights back on and requested the subjects to put down their first impressions as well as an indication of the clarity of these impressions. Once this was done, the procedure was repeated for the next film, and so on.

After the subjects had finished writing their responses to the last sign, they were asked to express their personal preference among the signs they had seen. For those groups who had seen all four signs, the signs were shown to them again by means of the previously mentioned slides, in the same order in which the film strips had been presented. When only two film strips had been shown to the group, no slides were shown. For one of these groups (Group DB, which had been shown Sign D followed by Sign B), the 23 subjects chose one or the other as their preference, and then were shown all five slides, in the order D, B, A, C, E, and then asked to choose the one they preferred. One of the Washington groups (N=27) was also shown the composite slide of Sign E and rated it in comparison with the other signs for both clarity of meaning and personal preference. Thus, a total of 50 subjects saw Sign E, and each of the other signs was viewed by at least 500 subjects.

## RESULTS

### Analysis of First Impressions

Table 2 gives the results of an analysis of the Los Angeles subjects' first impressions of the sign messages. (Due to time limitations, first impressions were not analysed for the Washington groups.) These first impressions were studied in an attempt to judge whether the driver was actually "getting" the message as it was intended. Other response categories were established to study these subjects' behavior as it might have occurred after seeing such signing situations in real life. This potential behavior was either explicit in the subject's comments or estimated by the rater from the implications of these comments. The left-hand column of the table gives the ten classifications used. Explicit comments by the subjects are given in quotation marks, and the remaining categories represent rater judgments. With the exception of the first three, the categories are not mutually exclusive.

In addition, a number of subjects made suggestions for improving the signing for a lane drop situation. These suggestions were tallied and are listed in Appendix B.

### Analysis of Clarity Ratings

Immediately after giving his first impressions of a sign, each subject was asked to judge whether these impressions were Clear and Immediate, Confused, Obvious, Complex, and/or Slow in Forming. Table 3 summarizes these clarity ratings, distinguishing between the Los Angeles and Washington, D. C., populations. Table 4 combines "favorable" and "unfavorable" ratings to provide a more meaningful comparison among the signs.

### Analysis of Preferences

1. Of the 307 Los Angeles subjects (all students) who saw all four signs and who expressed a preference,

- 19 (6.2 percent) preferred Sign A,
- 54 (17.6 percent) preferred Sign B,
- 57 (18.6 percent) preferred Sign C,
- 177 (57.7 percent) preferred Sign D.

TABLE 3  
SUMMARY OF CLARITY OF IMPRESSIONS<sup>a</sup>

Sign	Number of Subjects Rating Impressions as				
	Clear and Immediate	Confused	Obvious	Complex	Slow in Forming
A	241(26)	196(24)	167(14)	76(4)	135(12)
B	263(29)	108(14)	177(14)	40(4)	95(14)
C	210(11)	168(27)	171( 6)	95(16)	150(14)
D	269(32)	67( 9)	180(13)	28(3)	90( 8)
E	---( 3)	---(14)	---( 1)	--(9)	---(12)

<sup>a</sup>Washington sample data in parentheses.

TABLE 4  
SUMMARY OF CLARITY OF IMPRESSIONS COMBINING  
"FAVORABLE" AND "UNFAVORABLE" RATINGS<sup>a</sup>

Sign	Clear and Immediate and/or Obvious (no.)	Confused and/or Complex and/or Slow in Forming (no.)
A	408 (40)	407 (40)
B	440 (43)	243 (32)
C	381 (17)	413 (57)
D	449 (45)	185 (20)
E	--- ( 4)	--- (35)

<sup>a</sup>Washington sample data in parentheses.

Seven groups composed this total of 307. Each group saw all four signs but in a different order, so as to avoid the possibility that the subjects' responses would be affected by the order in which they saw the signs. In every group Sign D was preferred over the other three signs by a wide margin, Sign A was always last choice, and Signs B and C fell somewhere in-between.

Comparable percentages are not available for the Washington subjects, but the rank order of their preference was (in decreasing order) D, B, A, C. For the 27 Washington subjects who also saw sign E, it was ranked last. (No Washington subject actually preferred Sign E over any of the other four, but one individual stated that it would be his preference if it could be used widely and motorists were educated to its meaning.)

2. Of the 833 Los Angeles subjects, 683 expressed a preference. Taking into consideration the various orders of presentation and the different number of subjects seeing each sign, it is possible to equate the signs for exposure. Table 5 shows comparisons between the number of subjects expected to prefer a given sign by the laws of chance alone and the number actually preferring each sign. Utilizing the  $\chi^2$  test of statistical significance, it is found that these differences between the expected and observed numbers would be expected to occur by chance fewer than one time in a thousand.

3. For Safety subgroup DB (N=23), which was the only Los Angeles group to be exposed to Sign E, the results were as follows:

- a. In the first preference asked for (that between D and B), 14 preferred D, 6 preferred B, and 3 did not specify.
- b. In the second preference asked for (between all five signs, as shown to the group on slides), 2 preferred A, 1 preferred B, 4 preferred C, 6 preferred D, 7 preferred E, and 3 did not specify.

TABLE 5  
EXPECTED VS ACTUAL SIGN PREFERENCES,  
LOS ANGELES SAMPLE

Sign	Expected Preference (no.)	Actual Preference (no.)
A	194.25	110
B	157.25	149
C	184.25	169
D	147.25	255
Total	683.00	683

## DISCUSSION

### First Impressions

The first impression a driver receives from a traffic sign is important because the sign message may call for immediate action, or, at least, immediate planning for action. Equally important to the driver who is planning action is an awareness of just where this action is to take place. Making a called-for maneuver too soon or too late may result in a situation as dangerous as though no action had been taken.

It is for this reason that analysis of the subjects' first impressions took into account implicit or explicit indications of improper timing of the called-for action; i. e., preparing to move to the next left lane. Thus, several categories of response were derived which can be labelled as "potentially dangerous lane-merging actions," such as "immediately slowing down" or "immediately moving into the next left lane" on seeing the sign.

From Table 2, several conclusions seem apparent:

1. For the combined group, Sign D is most successful in conveying the intended message, is considered least confusing, is of adequate size, and is about average in leading to potentially dangerous behavior.
2. For the combined group, Sign A is least effective in conveying its message and is about average in leading to potentially dangerous behavior.
3. For the combined group, Signs B and C fall close together, somewhere between Signs A and D in effectiveness.

4. Marked differences exist between the Student group and the Safety group responses. This is not surprising, considering the disparity in age ranges, total driving experience, and California driving experience; however, due to the relatively small number of the Safety group seeing Signs B and D, as opposed to the larger (and relatively equal) numbers of the Student group seeing all four signs, firm conclusions about the differences between the two groups cannot be drawn. In general, however, the Safety group seemed "happier," or more at home, with the signs more commonly used in California up to that time (Signs B and C) than with the relative newcomer (Sign D) or the complete stranger (Sign A).

### Clarity

To establish a comparison of the clarity of the impressions given by the different signs, favorable/unfavorable ratio for each sign can be derived from the data given in Table 4. Thus, Sign D ranks highest in this respect, followed in order by Signs B, A, and C. This rank order of clarity obtains for both the Los Angeles and Washington samples. Sign E was ranked last in clarity by the Washington group that evaluated it on this dimension.

### Preference

The results of the preference analysis clearly indicate the following:

1. For both the Los Angeles and Washington samples, Sign D is first choice. This was true most strongly for the Student group and somewhat less emphatically for both the Safety group and the Washington sample.
2. Sign A ranks last for the Los Angeles sample (which is not exposed to this sign on California highways), while it ranks third for the Washington sample, which may have had some exposure to it in the East. Sign E ranks for the last-named group.

An explanation for such rankings may be found in the comments prevalent in the groups. Throughout there was an indicated acceptance of known messages and a rejection of new or different ones. This is perhaps an obvious observation, but nevertheless one of considerable importance to highway engineers who should take this resistance into account when planning to adopt new or drastically different signs.

### SUMMARY

A laboratory study was conducted comparing the effectiveness of several types of signs, all attempting to convey the fact that a lane was to be dropped from the road ahead. A total of 880 persons saw motion pictures and slides of the signs. The written responses of these subjects revealed a consistent and statistically significant superiority for a sign reading

"Lane Ends  
Merge Left."

### ACKNOWLEDGMENT

The authors gratefully wish to acknowledge the efforts of David W. Schoppert, Highway Transport Engineer, Automotive Safety Foundation, Washington, D. C., who was responsible for testing these subjects, analysing the responses, and forwarding the compiled results to the authors.

### REFERENCES

1. Schoppert, D. W., Moskowitz, K., Hulbert, S. F., and Burg, A., "Some Principles of Freeway Directional Signing Based on Motorists' Experiences." HRB Bull. 244, 30-87 (1960).
2. Hulbert, S. F., and Burg, A., "The Effects of Underlining on the Readability of Highway Destination Signs." HRB Proc., 36: 561-574 (1957).



## Appendix A

### INFORMATION SIGN INSTRUCTION SHEET

\_\_\_\_\_ Total yrs. driving experience  
 \_\_\_\_\_ Years driving in Calif.

Male  
 Female  
 Driver  
 Non-driver

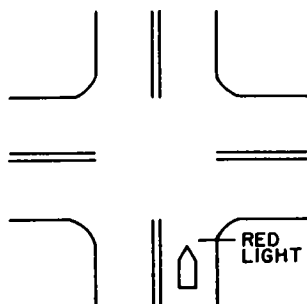
You are about to see a brief motion picture taken from a moving car. As you view this film, we ask you to assume that you are driving down a newly-opened, multi-lane highway, and you are paying the normal amount of attention to the various signs which are posted along the edge of the highway.

In the film, several such roadside highway signs, or combinations of signs will be shown, and we are interested in determining what your interpretations of these signs are, in terms of the decisions and actions, if any, you feel you are called upon to make as a result of the message given on the signs.

The film will be stopped after each signing situation, at which time please make a note in the space provided on the attached sheet of your FIRST impressions of the meaning that the sign message conveyed to you as a driver. Use one sheet for each signing situation.

Draw a sketch of the highway situation if it will aid you in adequately describing these first impressions. Try to describe in several ways what the traffic situation was like. Finally, give your opinion of the clarity of these impressions by checking one or more of the alternatives given below. As an example, below is a possible response to a traffic situation involving an approach to an intersection with the traffic signal turning red:

#### DRAWING OF TRAFFIC SITUATION:



#### DESCRIPTION OF FIRST IMPRESSIONS:

"I will be delayed for a moment; if I try and run the light I may have an accident, or get a ticket. I, and the drivers behind me, must come to a stop at the intersection; cars on the cross street get the green light and can proceed across the intersection. Also, pedestrians may cross in front of me. When the light turns green I can proceed again".

WERE THESE IMPRESSIONS AND MEANINGS:  
(please check appropriate descriptions)

- a. CLEAR AND IMMEDIATE?  
 b. CONFUSED?  
 c. OBVIOUS?  
 d. COMPLEX?  
 e. SLOW IN FORMING?

NOW PLEASE TURN THE PAGE AND BE PREPARED TO GIVE YOUR IMPRESSIONS OF THE FIRST SIGNING SITUATION. USE ONE SHEET FOR EACH SITUATION. YOU WILL BE GIVEN ENOUGH TIME TO WRITE YOUR RESPONSE IN EACH CASE.

INFORMATION SIGN ANSWER SHEET

Signing Situation# \_\_\_\_\_

DESCRIPTION OF FIRST IMPRESSIONS:

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DRAWING OF TRAFFIC SITUATION:

WERE THESE IMPRESSIONS AND MEANINGS:  
(please check appropriate descriptions)

- a. CLEAR AND IMMEDIATE?
- b. CONFUSED?
- c. OBVIOUS?
- d. COMPLEX?
- e. SLOW IN FORMING?

## *Appendix B*

### Miscellaneous Suggestions for Signing Improvement

<u>SUGGESTION</u>	<u>NUMBER OF PEOPLE MENTIONING</u>
1. The signing situation should indicate how far ahead the lane drop occurs.	34
2. For signing situations A and B, the distance between the two signs should be greater.	10
3. For signing situations A, B and D, there should be an indication of how many lanes will remain after the lane drop occurs.	8
4. Arrows should be painted on the pavement showing the direction in which the driver should merge.	8
5. Sign D should read "Right Lane Ends, Merge Left".	6
6. For signing situations A and B, the first sign should read "Lane Narrows".	2
7. For signing situation B, the second sign should read "Merge to Left".	2
8. Suggested combination of "Pavement Narrows" sign followed by sign C.	2
9. Sign D should read "Lane Ends, Squeeze Left".	1
10. One-line, rather than two-line signs should be used.	1
11. Suggests a single sign saying "Lane Conversion".	1