EVALUATION OF DIAGRAMMATIC GUIDE SIGNS

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A laboratory evaluation was made of diagrammatic signs for a freeway cloverleaf intersection, a lane drop, a multiple-split ramp, a left ramp downstream from a right ramp, two right ramps in quick succession, and a major fork. The evaluation included a comparison of diagrammatic and conventional signs, based on the speed and accuracy of the subjects' lane selections. Conventional signs were found slightly more effective overall than the experimental diagrammatic signs. They produced fewer lane-placement errors and errors on exit lanes, and they were more quickly responded to than diagrammatic signs. The conventional signs were also preferred by the subjects. In none of the 6 types of interchanges tested did diagrammatic signs provide better performance than conventional signs. Of the diagrammatic signs tested, the one showing a large exit arrow gave the best performance. Consideration might be given to increasing the size of the conventional exit arrow. The major fork symbol also showed up fairly well. The results of this study apply only to the sign designs tested. Other diagrammatic signs on other types of road may possibly be more successful.

•RECENTLY, wide interest has been shown in the use of diagrammatic freeway signs. Diagrammatic signs have been installed on highways in New Jersey, Virginia, Wyoming, Maryland, Oregon, and Ohio. Twenty states now have such signs. Diagrammatic guide signs have also been recommended in the Manual on Uniform Traffic Control Devices for intersections at grade (5, p. 122), for cloverleafs (5, pp. 124, 139), and for directional interchanges (5, p. 139). Simple diagrammatic warning signs are also recommended for curves, winding roads, road crossings, side roads, and T- and Y-intersections.

Because diagrammatic signs are being considered for adoption on freeways, they should be given a thorough research assessment. They should be tested against the conventional designs now on the road. The laboratory assessment of diagrammatic signs described here was carried out during the summer of 1971, and the final report was submitted in September 1971. On-the-road studies of diagrammatic signs have been carried out by Hanscom (3) and Roberts (4) among others.

ADVANTAGES OF LABORATORY SIGN TESTING

Laboratory tests have several important advantages in sign evaluation. Such tests are inexpensive. The materials for this study were prepared from ordinary black and white photographs of the highway, on which artificial sign messages were superimposed. The presentation equipment included a simple slide projector and a reaction timer. Laboratory tests can be carried out rapidly. Results can be obtained in weeks; a highway study would require months, or even years. Another often overlooked advantage of a laboratory study is that conditions can be controlled. In field studies on the road, we must take drivers as they come. In the laboratory, drivers can be trained to any required level of experience, and precisely the same traffic problem can be presented to each subject. Nevertheless, it is important that results obtained in the laboratory be verified in the field to guard against the possible artificiality of the laboratory situation.

The present study is a follow-up of research carried out by Serendipity, Inc., for the National Highway Traffic Safety Administration (1). In that study, volunteer subjects

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recruited at the Smithsonian Institution were shown projected slides of conventional and diagrammatic freeway signs. They were asked to indicate on an answer sheet the highway lane they should be in to reach a preassigned destination. On 4 of the 6 interchanges tested, drivers selected the correct lane more frequently when diagrammatic signs were displayed. However, they reported more confidence in their choices when they viewed conventional signs in 18 of the 29 cases (signs) tested. Results of the Serendipity study have been widely interpreted as an endorsement of the use of diagrammatic signs.

In this study, a number of modifications were made to the Serendipity testing procedure. Drivers were tested individually rather than in groups. Single testing ensured that subjects were not distracted, that they understood the instructions, and that all subjects viewed from the same position. In the previous study, only one destination was selected for testing at each intersection. Because interchange signs show both left- and right-turn destinations, both destinations were studied here. Driver performance was more thoroughly rated. Times were taken of reactions to the signs. The speed of a driver's reaction to a sign is considered to be particularly important in closely spaced urban interchanges.

EQUIPMENT

Subject's Cubicle

The subjects viewed the signs in a 9- by 11-ft closed cubicle. At a distance of $8\frac{1}{2}$ ft, the 5.0-in. high letters of the projected signs subtended a visual angle of 17 min and could be easily read. The projector and reaction time equipment were housed in the experimenter's compartment adjacent to the subject's cubicle.

Signs

The subjects made lane-choice judgments on the following types of interchange: (a) lane drop (Wilson Bridge interchange going into Alexandria), (b) multiple-split ramp (Shirley Highway going north into I-495), (c) left ramp downstream from right ramp (I-495 going east into Shirley Highway), (d) 2 right ramps in quick succession (Glen Echo exit of I-495 going toward Virginia), (e) major fork (fork of I-495 and I-70 to Frederick), and (f) cloverleaf (exit of I-495 going east into the Baltimore-Washington Parkway). These interchanges include the more difficult freeway signing situations in the Washington, D. C., area.

The projected slides viewed by the subjects showed black and white photographs of actual sign locations on which colored drawings of signs were superimposed (Fig. 1). The diagrammatic signs duplicated the Serendipity designs; the conventional signs were drawn in conformity with the U. S. Manual on Uniform Traffic Control Devices. The artificial destinations on the signs all contained exactly 9 letters. The same destinations were used on the 3 to 6 consecutive signs of each intersection. The photographs of the highway were taken on the center lane at a distance of 200 ft from the sign. Lane numbers were printed on the road surfaces of the slides to aid the subject in making his choices.

Scoring Key

A sign's effectiveness was evaluated on the basis of the subject's lane selections and reaction times to the sign. A great deal of attention was paid to the scoring key, which was used to grade the subject's lane choices.

The key finally developed was grounded on the following rules:

1. At the advance guide sign, the driver was judged correct if he selected either the first or the second lane (at this point it was not considered necessary for the driver to be in the exit lane);
2. The driver was expected to be in the exit lane when the sign indicated his exit; and
3. He was expected not to be in the exit lane when an exit destination other than his was on the sign.

The scoring key of the first interchange (Fig. 1) may be given as an illustration of these principles. Bladworth was given as the destination to be reached. The first advance warning sign indicated both Bladworth and Tabernash exits on the 3-lane highway. The first (right) and second (middle) lanes were graded correct. The next sign indicated a Roachdale exit. Because this was not the driver's destination, only the second lane was judged correct. The next 3 signs indicated the Bladworth exit. Only the first (exit) lane was correct.

The Grandview destination was given at the next interchange (Fig. 2). At the advance warning sign, either lane of the 2-lane highway was accepted. The next sign indicated an exit for Hornbrook. The Grandview driver was expected to be in the left, nonexit lane. At the third sign, showing a Grandview exit, the driver was expected to be in the exit lane.

Other interchanges are shown in Figures 3, 4, 5, and 6.

SUBJECTS

Subjects included housewives, students, and drivers obtained from the local state employment office. All subjects demonstrated 20/20 or better corrected vision in both eyes, and all held valid driving licenses. There were 28 men and 32 women (60 subjects in all) in the 2 phases of the study. The initial familiarity advantage of the conventional signs was offset by considerable practice on both types of signs. Familiarity with the Washington, D. C., Beltway (I-495) did not affect results. Subjects did not recognize the Beltway interchanges with the signs altered.

PROCEDURE

The experiment consisted of 2 phases, in each of which 30 subjects were tested, as follows:

Session	Phase 1	Phase 2
Practice	Destinations A	Destinations B
Test 1	Destinations B	Destinations A
Test 2	Destinations B	Destinations A

If the destination led to the right in phase 1, it was to the left in phase 2, and vice versa. In this manner, all sign destinations were tested. It was not necessary to test the straight ahead case.

At the start of a session, the subject sat viewing the screen in the isolation compartment. He was told to push the button indicating his lane choice as quickly as possible. The first destination (say, Bladworth) was presented on a preliminary slide. The subject repeated the destination aloud to ensure that he knew his goal. The first and succeeding road signs were then shown. In each case, the subject signified his lane choice by pressing the appropriate button. The experimenter tallied the subject's lane choice and reaction time and pushed the 2 buttons to clear the displays and project the next sign. After the subject had viewed all the signs of an intersection, testing continued on the next destination and intersection.

The practice session of phase 2 had the same destinations as the test sessions of phase 1; and, similarly, the practice session of phase 1 had the same destinations as phase 2. By this procedure, the subjects became familiar with the sign types but not with the particular problems asked in the test series. The first 15 subjects viewed diagrammatic signs in each series before conventional signs; the next 15 subjects viewed conventional signs first. Each subject went through 3 complete series of 58 presentations each and, therefore, made a total of 174 lane-choice judgments. It had been shown in preliminary studies that performance showed no improvement in longer experimental sessions.

RESULTS

General Comparison of Diagrammatic and Conventional Signs

Certain practical considerations must be kept in mind as one interprets the results of this evaluation. Before replacing a conventional sign, a diagrammatic sign must

Figure 1. Conventional signs (left) and diagrammatic signs (right) at interchange 1.

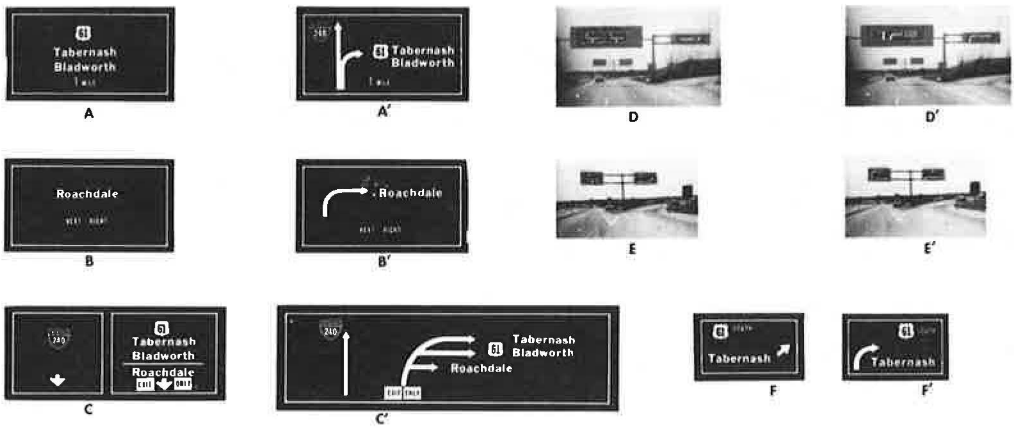


Figure 2. Conventional signs (left) and diagrammatic signs (right) at interchange 4E.

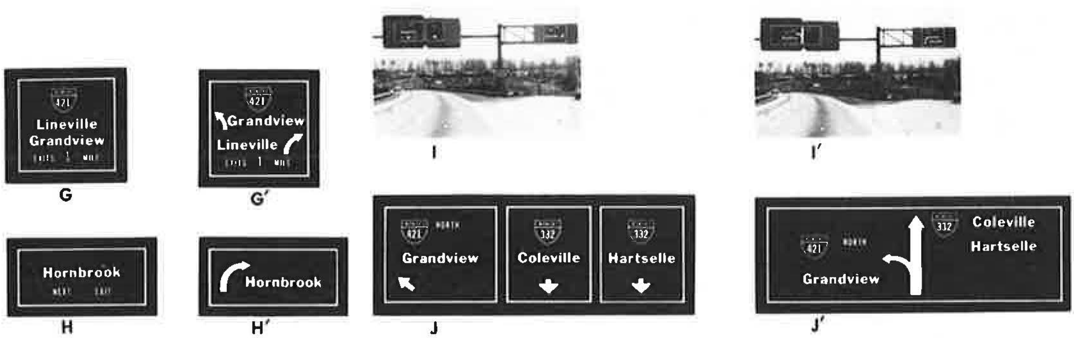


Figure 3. Conventional signs (left) and diagrammatic signs (right) at interchange 4N.

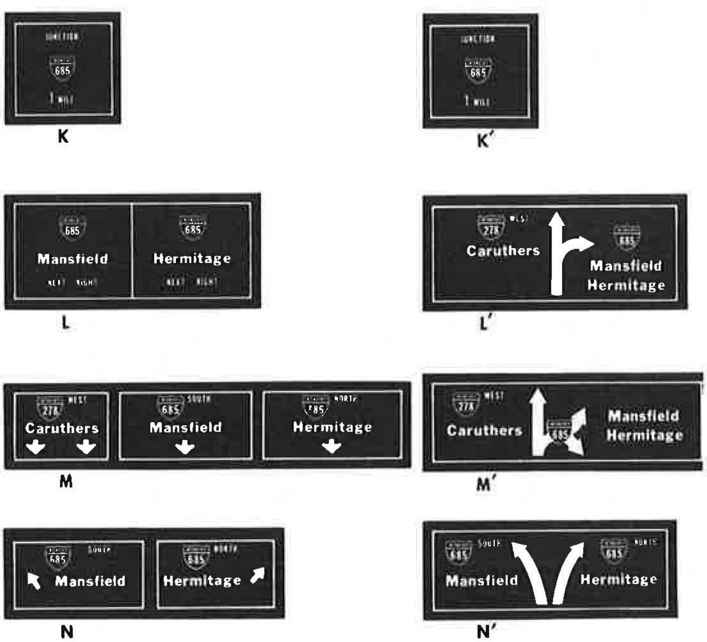


Figure 4. Conventional signs (left) and diagrammatic signs (right) at interchange 16.

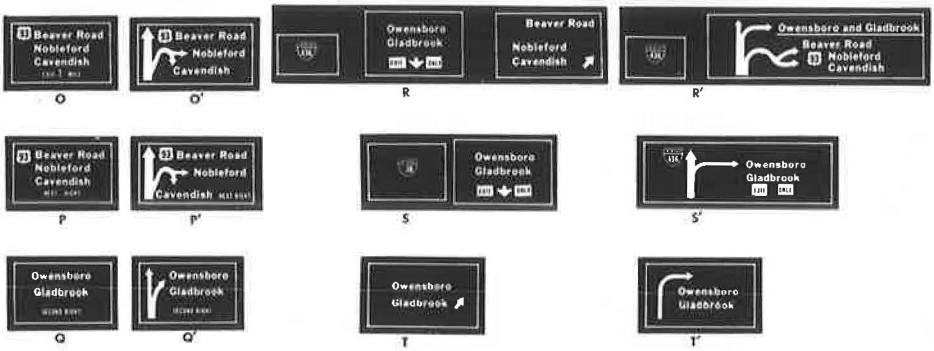


Figure 5. Conventional signs (left) and diagrammatic signs (right) at interchange 17.

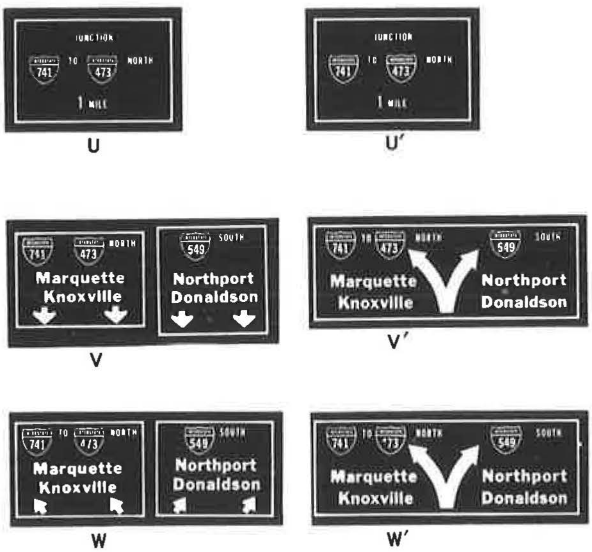
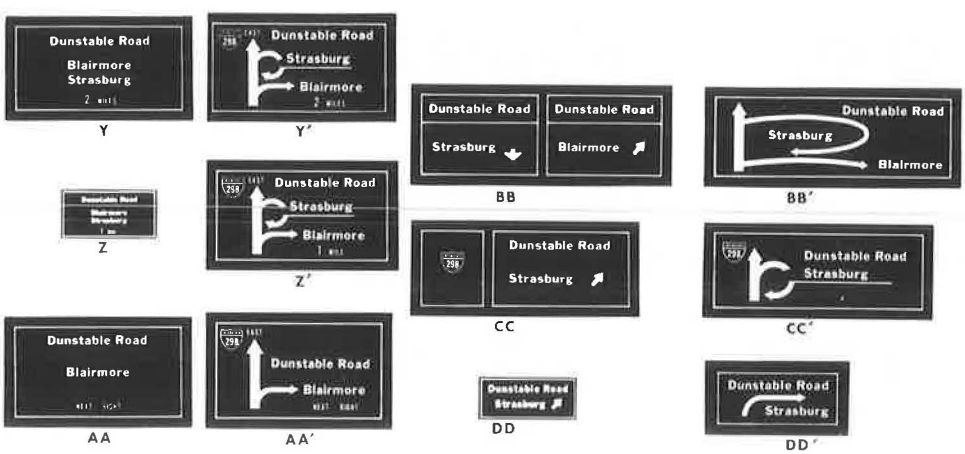


Figure 6. Conventional signs (left) and diagrammatic signs (right) at interchange 29.



provide a convincingly better performance. If a novel sign is merely as good as its conventional counterpart, there would be little reason to undergo the expense and loss of time of the changeover and the inconvenience of reeducating the public to the new system. To warrant adoption, a new signing system must demonstrate a clear superiority over the one in use.

A detailed analysis of errors and reaction times to the signs is given in Tables 1, 2, 3, and 4. Phase 1 results refer to one set of destinations; Phase 2 refers to the alternate destinations. Each number given in Tables 3 and 4 represents the mean reaction times of 30 subjects to the 3 to 6 signs at an interchange. The destinations used in the practice trials of phase 1 were used in the test trials of phase 2, and vice versa. The average column summarizes the results of the 2 phases. The final test (test 2) represents practiced driver performance.

The overall comparison of errors and reaction times of diagrammatic and conventional signs is shown in Figure 7. The error scale is given on the left; reaction time is given on the right. The points shown in Figure 7 are totals and averages given in the last columns of Tables 1 and 3. Each point represents 29 responses for each of the 60 subjects, or 1,740 reactions in all. The slope of the functions, both diagrammatic and conventional performance, improved with practice. The improvement in conventional signs may be ascribed to the subjects' adjustment to the test routine. The format of conventional highway signs was, of course, familiar to the subjects. Improvements in diagrammatic sign performance reflect both adjustment to the test routine and familiarization with the format of the signs. Although performance on both types of signs improved, lane selection is superior, and reaction time is, on the average, shorter on the conventional signs in all series. At the end of the session, each subject was asked which kind of sign he found easier to use. The answers are given in Table 5. Of the 60 subjects, 26 (43 percent) preferred the conventional signs, and 16 (27 percent) preferred the diagrammatic signs.

Signing for Particular Interchanges

Although the diagrammatic signs tested were on the average not so effective as conventional signs, the possibility remains that some may be more suitable for a particular interchange type.

The results given in Tables 1, 2, 3, and 4 would not support use of diagrammatic signs on any of the interchanges tested. On the second test, which represents practiced driver performance, diagrammatic signs excelled conventional signs on only the following 4 (of 24) comparisons: On interchange 16, 48 errors were made on diagrammatic signs and 49 on conventional signs; on interchange 29, no errors were made on the diagrammatic exit sign, and 1 was made on the conventional exit sign; on interchange 1, average reaction time to diagrammatic signs was 2.48 sec and 2.58 sec to conventional signs; and on intersection 2, diagrammatic signs required 2.54 sec and conventional signs 2.55 sec. None of these differences is large enough to achieve statistical or practical significance.

Particular Diagrammatic Designs

The question remains whether any of the diagrammatic signs tested were outstanding. Results of the second test after practice, sorted by design, are given in Table 6. Symbol 1, the single-arrow design that indicated an exit, appeared in 6 cases. Symbol 2, the double arrow with 1 alternative straight ahead, appeared 6 times, and so on. Table 6 gives the total number of errors made on diagrammatic and conventional signs, the average reaction times, and the significance level of the difference in average reaction times among signs.

The single arrow showed up best of the diagrammatic symbols tested. Thirty-seven errors were made on the diagrammatic arrow, and 52 were made on corresponding conventional signs. In 6 of the 10 cases listed, the reaction time to diagrammatic signs was shorter. Of these, 2 reached significance at least to the 0.05 level (t-test for correlated measures, N = 30, 3). Consideration might be given to increasing the size or prominence of the arrow symbol on freeway exit signs.

Table 1. Errors made at each interchange.

Session	Sign	Interchange 1	4E	4N	16	17	29	Total
Practice								
Phase 1	Diagrammatic	0	5	0	2	2	1	10
	Conventional	0	0	0	0	2	0	2
Phase 2	Diagrammatic	0	0	0	1	1	4	6
	Conventional	0	0	0	0	0	0	0
Total	Diagrammatic	0	5	0	3	3	5	16
	Conventional	0	0	0	0	2	0	2
Test 1								
Phase 1	Diagrammatic	0	0	0	0	0	0	0
	Conventional	0	2	0	0	0	0	2
Phase 2	Diagrammatic	0	3	1	0	1	0	5
	Conventional	0	0	0	0	0	0	0
Total	Diagrammatic	0	3	1	0	1	0	5
	Conventional	0	2	0	0	0	0	2
Test 2								
Phase 1	Diagrammatic	0	0	0	0	0	1	1
	Conventional	0	0	0	0	0	0	0
Phase 2	Diagrammatic	0	5	2	0	0	0	7
	Conventional	1	1	0	0	0	0	2
Total	Diagrammatic	0	5	2	0	0	1	8
	Conventional	1	1	0	0	0	0	2

Table 2. Errors made at critical exits.

Session	Sign	Interchange 1	4E	4N	16	17	29	Total
Practice								
Phase 1	Diagrammatic	16	19	12	32	4	40	123
	Conventional	17	17	11	56	3	18	122
Phase 2	Diagrammatic	29	13	2	38	1	4	87
	Conventional	15	14	3	30	1	5	68
Total	Diagrammatic	45	32	14	70	5	44	210
	Conventional	32	31	14	86	4	23	100
Test 1								
Phase 1	Diagrammatic	27	15	4	33	0	4	83
	Conventional	19	14	6	38	0	6	83
Phase 2	Diagrammatic	24	26	17	21	3	39	130
	Conventional	13	29	7	17	2	14	82
Total	Diagrammatic	51	41	21	54	3	43	213
	Conventional	32	43	13	55	2	20	165
Test 2								
Phase 1	Diagrammatic	21	16	9	28	1	4	79
	Conventional	21	14	4	28	0	7	74
Phase 2	Diagrammatic	29	27	12	20	0	29	117
	Conventional	19	23	4	21	1	15	83
Total	Diagrammatic	50	43	21	48	1	33	196
	Conventional	40	37	8	49	1	22	157

Table 3. Reaction times (sec) at each interchange.

Session	Sign	Interchange 1	4E	4N	16	17	29	Avg
Practice								
Phase 1	Diagrammatic	3.94	3.55	4.06	3.94	3.81	4.11	3.90
	Conventional	3.32	3.32	3.46	3.54	3.51	3.01	3.36
Phase 2	Diagrammatic	3.65	3.10	2.85	3.24	2.82	2.90	3.14
	Conventional	3.13	3.06	2.62	2.89	2.79	2.81	2.90
Avg	Diagrammatic	3.80	3.33	3.46	3.59	3.32	3.51	3.50
	Conventional	3.22	3.19	3.04	3.22	3.15	2.91	3.12
Test 1								
Phase 1	Diagrammatic	2.94	2.84	2.81	3.01	2.78	2.97	2.89
	Conventional	2.69	2.82	2.43	2.83	2.71	2.51	2.67
Phase 2	Diagrammatic	2.89	2.77	2.85	2.73	2.87	3.34	2.93
	Conventional	2.51	2.53	2.69	2.57	2.61	2.45	2.55
Avg	Diagrammatic	2.92	2.81	2.83	2.87	2.83	3.16	2.91
	Conventional	2.60	2.68	2.56	2.70	2.66	2.48	2.61
Test 2								
Phase 1	Diagrammatic	2.41	2.50	2.28	2.59	2.25	2.41	2.41
	Conventional	2.84	2.59	1.94	2.45	2.25	2.21	2.38
Phase 2	Diagrammatic	2.54	2.57	2.53	2.53	2.30	2.84	2.58
	Conventional	2.32	2.50	2.31	2.52	2.18	2.23	2.35
Avg	Diagrammatic	2.48	2.54	2.41	2.56	2.28	2.63	2.48
	Conventional	2.58	2.55	2.13	2.49	2.22	2.22	2.36

Table 4. Reaction times (sec) at critical exits.

Session	Sign	Interchange 1	4E	4N	16	17	29	Avg
Practice								
Phase 1	Diagrammatic	2.70	3.80	3.82	2.40	4.07	2.36	3.19
	Conventional	2.15	3.02	2.91	2.06	3.88	1.73	2.63
Phase 2	Diagrammatic	2.04	2.12	2.28	1.84	2.40	2.78	2.24
	Conventional	1.72	2.12	2.03	1.66	2.52	1.89	1.99
Avg	Diagrammatic	2.37	2.96	3.05	2.12	3.24	2.57	2.72
	Conventional	1.94	2.57	2.47	1.86	3.20	1.81	2.31
Test 1								
Phase 1	Diagrammatic	1.90	2.51	2.36	1.98	2.61	2.72	2.35
	Conventional	1.67	2.11	1.91	1.71	2.89	1.64	1.99
Phase 2	Diagrammatic	1.83	2.87	2.50	1.78	3.04	1.85	2.31
	Conventional	1.60	2.53	2.46	1.62	2.67	1.50	2.06
Avg	Diagrammatic	1.87	2.69	2.43	1.88	2.83	2.29	2.33
	Conventional	1.64	2.32	2.19	1.67	2.78	1.57	2.03
Test 2								
Phase 1	Diagrammatic	1.52	1.93	1.85	1.75	2.21	2.13	1.90
	Conventional	1.57	1.72	1.58	1.49	1.97	1.64	1.66
Phase 2	Diagrammatic	1.96	2.80	2.40	1.59	2.40	1.69	2.14
	Conventional	1.66	2.00	2.10	1.61	1.99	1.28	1.77
Avg	Diagrammatic	1.74	2.37	2.13	1.67	2.31	1.91	2.02
	Conventional	1.62	1.86	1.84	1.55	1.98	1.46	1.72

Figure 7. Improvement in subjects' performance with practice.

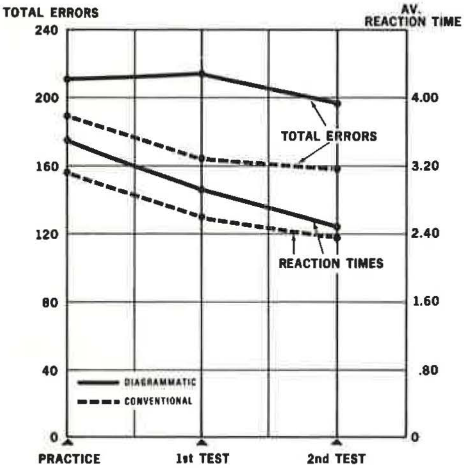


Table 5. Preferences for diagrammatic and conventional signs.

Phase	Conventional Sign Number	Conventional Sign Percent	Diagrammatic Sign Number	Diagrammatic Sign Percent	No Preference Number	No Preference Percent	Total Number	Total Percent
1	14	46	8	27	8	27	30	100
2	12	40	8	27	10	33	30	100
1 and 2	26	43	16	27	18	30	60	100

There is some support for the use of symbol 3, the forked-arrow, at interchange 17, sign V′. Only 1 error was made on the diagrammatic and on the conventional sign, and the diagrammatic sign gave shorter reaction times.

DISCUSSION OF RESULTS

These results, which do not generally favor substituting diagrammatic for conventional signs, appear in contradiction to the findings of the Serendipity study, and some explanation of the discrepancy seems called for. It will be recalled that in the Serendipity study the correct lane was considered to be the right (exit) lane in all cases, although the scoring method is not given in the report. The scoring key used here, which was worked out after considerable discussion, may perhaps be more defensible than the Serendipity key. (See the discussion given above on the scoring key.)

Although the scoring of a "correct" lane may be controversial, the other assessment measures are less so. There can be little question that a sign that exits the driver at his destination ramp is superior to one that does not. A good sign should also permit the driver to quickly extract the essential information. The driver's preference for one sign over another should also be considered when sign designs are evaluated. On these additional measures, conventional signs generally showed up as more effective than diagrammatic signs.

The reaction time results may be explained in terms of how the driver makes his lane-choice decision. In the case of conventional signs, it may be suggested that the driver must (a) find his destination on the sign and (b) select his lane by observing which lane his destination arrow points to. Usually the lane pointed to by the arrow was clearly and easily recognized. For diagrammatic signs, the driver must (a) locate his destination on the sign, (b) interpret the road geometry represented by the lines and arrows, and (c) make a lane choice based on the geometry.

If this interpretation is accepted, lane-choice selection is simpler and more direct and rapid when conventional signs are viewed. However, the diagrammatic display of road geometry may have advantages in certain situations, particularly when the geometry violates the drivers' expectations. Such might be the case at a T- or Y-intersection or at a left off-ramp where visibility is poor.

DIRECTION OF FUTURE RESEARCH

In future research, the requirements of directional guide signs should be detailed. The requirement of the first sign, called advance guide, is to alert the driver of the coming intersection. At this point, the driver is asking, "Does the intersection concern me?" An advance guide sign must, therefore, be large and clear and must present the choices ahead in simple, direct fashion. It need not place the drive in the outermost lane, unless intersections are closely spaced. An ideal advance warning might be a loud auditory signal; although such a signal may be impractical for other reasons.

The second advance guide sign tells the driver what he is expected to do. The sign should place the driver in the correct lane and tell him the distance to the intersection. Finally, the critical exit sign should get the driver off the road. It should be placed before the exit, and the required action should be clearly indicated. Results of this study suggest that a large arrow may be effective.

Whatever the requirements of the various types of signs—and one may disagree with the requirements stated above—they must be explicitly stated if research is to be effective. A clear statement must be made of what the sign design is intended to accomplish. Otherwise, design after design will be tested without a clear idea of the improvement accomplished.

SIGN CONTENT AND ROAD GEOMETRY

The problem of sign content is related to the problems of sign format considered here. When asked what destination should be on a sign, drivers usually name their own: "Seven Corners," "Bethesda," "Wheaton," and so forth. If every local destination is listed, the sign will be cluttered. On the other hand, if a very limited number of destinations and routes are given, the sign will fail to give the required information.

Because the number of messages that can be placed on a sign is limited, the driver must adapt to the signing system. In unfamiliar areas, he must look up intermediate towns and routes and otherwise do his "homework." A certain amount of frustration seems built into the system. In some cases, the attractiveness of diagrammatic signs seems to have been based on the difficulty of providing information on conventional signs. An enormous amount of information can be placed on a map (diagrammatic) display, but a sign with too much information is difficult to read. There is no evidence that the driver's ability to absorb and respond to information is increased when he views a diagrammatic sign. A cluttered sign is cluttered, regardless of its format.

Signing problems are also related to problems of road geometry. A difficult intersection is usually difficult to sign. Closely spaced interchanges, left exits, and unusual movements of traffic are all difficult to sign. Changing a sign is cheaper than constructing a road, but the fact remains that correcting the geometry may be a better and more fundamental solution to a traffic problem.

EUROPEAN APPLICATIONS OF DIAGRAMMATIC SIGNS

The extensive use of diagrammatic signs on European roads has encouraged the search for applications to U. S. freeways. Examples of European diagrammatic signs, observed by the author in a recent trip, are shown in Figure 8. The first Dutch sign (sign A) indicates that Amsterdam, Schiphol Airport, and the town of Utrecht are ahead and that Schalkwuk is to the right. Sign B indicates that the driver should take the right lane if he is going to the center of the city and the left lane if he is going to Zandovoort or Den Haag. Sign C says that there is a road to the right to Sassenheim and Amsterdam, and the driver should stay in the right lane. These signs do not contain route or road name information. They seem simpler and less cluttered than many American diagrammatic signs.

The French sign showing the road to Orleans (sign D) also presents a simple choice. The lane separations are suggested by white slashes. A British circle or "roundabout" is shown in sign E. The break in the ring indicates that the driver should not turn in that direction. The horizontal road intersections to Bagshot and Windsor are neatly shown. A more complex British circle is shown in sign F. Although route numbers appear, the overall effect is neat and interpretable.

The French circle (sign G) shows the Paris and Orleans destinations in large letters; the Rambouillet exit and the center of town are in smaller letters. Signs H and I warn the driver of complex turns ahead. These signs are simple and easy to read.

It is helpful to remember that European roads originated as carriageways leading from one town to the next. The amount of information needed to be displayed is limited, and traffic is slow enough to permit the driver time to read the signs. In contrast, American freeways cross prominent routes that themselves go toward large towns. Route, city, and road name information are often shown on the sign, and the driver reads the sign at high speed. There is a temptation to place a great deal of information on our diagrammatic signs and thereby to solve the designer's rather than the driver's problems.

SUMMARY AND FINDINGS

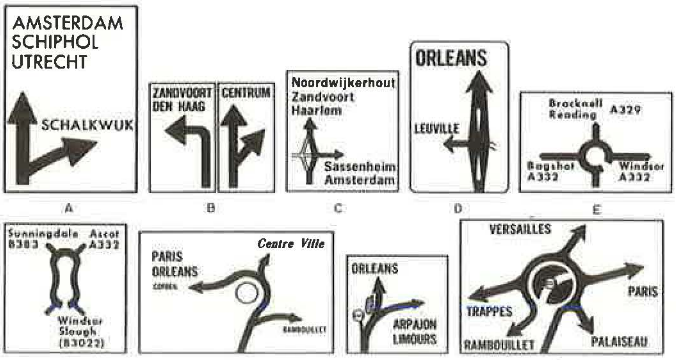
This paper presents a laboratory assessment of diagrammatic sign designs being considered for use on U. S. freeways. Diagrammatic signs were compared with the conventional guide signs now on the road. The subjects viewed projected scenes of the Capital Beltway and indicated as quickly as possible the proper lane to be in to reach a preassigned destination. The signs tested were made by superimposing diagrammatic and conventional sign drawings on actual photographs of the highway. The road scenes presented the signs of a cloverleaf intersection, a lane drop, a multiple-split ramp, a left ramp downstream from a right ramp, 2 rights in quick succession, and a major fork. The study is a follow-up of one carried out by Serendipity, Inc., under contract to the Highway Traffic Safety Administration. Certain improvements have been made here in the Serendipity procedure. Drivers were individually tested, and the effectiveness of the signs was more thoroughly assessed.

Table 6. Speed and accuracy of reactions to types of sign symbols.

Sign Symbol	Inter-change	Sign	Phase	Total Errors: Diagrammatic	Total Errors: Conventional	Avg Reaction Time (sec): Diagrammatic	Avg Reaction Time (sec): Conventional	Statistical Significance[a]
1	1	B′	1	7	10	2.26	2.24	
			2	13	13	2.21	2.68	0.05
	1	E′	1	0	0	2.18	2.28	
			2	0	1	1.96	1.66	0.05
	1	F′	2	0	0	1.52	1.57	
	4E	H′	1	14	14	2.55	2.60	
			2	3	14	2.04	2.47	0.05
	16	T′	1	0	0	1.75	1.49	
			2	0	0	1.59	1.61	
	29	DD′	2	0	0	1.69	1.28	0.01
2	1	A′	1	0	0	2.44	2.16	
			2	0	0	2.63	2.18	0.01
	4N	L′	1	3	3	2.40	2.09	
			2	3	4	2.58	2.48	
	16	Q′	1	15	12	2.52	2.49	
			2	11	13	2.69	2.39	
	16	S′	1	4	5	2.78	2.89	
			2	3	5	2.67	3.24	
	29	AA′	1	0	0	1.87	1.89	
			2	6	12	2.71	2.87	
	29	CC′	1	0	0	3.30	3.25	
			2	13	3	3.96	2.36	0.01
3	4N	N′	1	0	0	1.85	1.58	
			2	2	4	2.40	2.10	0.05
	17	V′	1	1	0	2.42	2.75	
			2	0	1	2.36	2.40	
	17	W′	1	0	0	2.21	1.97	
			2	0	0	2.40	1.99	0.05
4	4E	J′	2	5	1	2.80	2.00	0.01
5	4E	G′	1	2	0	2.22	2.42	
			2	1	0	2.75	2.30	0.05
6	4N	M′	1	6	1	2.86	2.04	0.01
			2	7	0	3.09	2.46	0.05
	16	O′	1	3	3	2.57	2.47	
			2	0	1	2.43	2.75	
	16	P′	1	2	3	2.10	2.05	
			2	0	0	2.13	2.12	
7	29	Y′	1	0	1	2.57	2.17	0.05
			2	1	0	3.38	2.68	0.05
	29	Z′	1	3	6	2.10	2.16	
			2	8	0	2.44	2.29	
	29	BB′	1	1	0	2.13	1.64	
			2	1	0	3.06	1.92	0.01
8	1	D′	1	5	5	2.76	3.25	
			2	1	3	2.98	2.05	0.01
9	16	R′	1	4	5	3.80	3.34	
			2	6	2	2.67	3.02	0.01
10	1	C′	1	9	6	3.33	3.34	
			2	15	2	2.98	3.07	
11	4E	I′	1	0	0	1.93	1.72	
			2	18	8	2.69	3.23	0.05

[a]If no value is given, not statistically significant.

Figure 8. European diagrammatic signs.



On the basis of the subject drivers' reactions, the following findings are reported.

1. The conventional signs tested were on the whole slightly more effective than the experimental diagrammatic signs. They produced fewer errors and were more quickly responded to than diagrammatic signs. The conventional signs were also preferred by the subjects to diagrammatic signs.
2. In none of the six types of interchanges tested did the diagrammatic signs provide better lane placement or shorter response times than the conventional signs.
3. The diagrammatic symbol showing a large exit arrow showed up best of the diagrammatic signs tested. Consideration might be given to increasing the size of the conventional exit arrow.

The problems of sign content and road geometry were briefly discussed in their relation to sign format. It is suggested that thought be devoted to determining the driver's requirements in dealing with signs. To make a valid evaluation of signs, one must have a clear idea of what the sign is intended to accomplish.

Several cautions must be observed in the interpretation of the results of this study. The findings are limited to Serendipity sign designs applied to freeway intersections. We know that diagrammatic signs such as arrows and T- and Y-intersection signs are widely used on American roads and are endorsed in the Manual on Uniform Traffic Control Devices. The diagrammatic signs illustrated in the text are well accepted in Europe. European low-speed highways and clear destinations may lend themselves to diagrammatic applications better than U. S. freeways do. European diagrammatic signs also appear less cluttered than many American designs.

Finally, it must be remembered that these results have been obtained in the laboratory. They should be checked, if possible, against the results of field evaluations of diagrammatic signs.

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