# CRITERIA FOR DESIGN AND DEPLOYMENT OF ADVANCED GRAPHIC GUIDE SIGNS

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This study was designed to determine the graphic sign characteristics that best communicated roadway-interchange and route-guidance information to the driver. Emphasis was placed on (a) developing laboratory sign-testing procedures for determining the effectiveness of signing alternatives and (b) developing analytical techniques for identifying interchange characteristics where graphic guide signs might be required and applicable. In the laboratory sign-testing procedure, one 35-mm slide projector showed a roadway scene in which the guide signs were blacked out and another projector showed a scale-model test sign in the blacked-out area for 1 sec. Characteristics of interchanges where graphic guide signs should be considered were identified by theoretical analyses. Laboratory tests indicated that route-guidance was provided significantly better by graphic signs than by conventional signs on certain interchanges. Graphic signs also convey relative exit speeds and lane-drop information effectively.

•THE IMPETUS for this study came largely from 2 sources. One was the contention that present guide signs are not doing all that they might to facilitate traffic flow and reduce accidents; the other was the experience of many people with the symbol and diagrammatic signing prevalent in Europe (1). These led to the belief that better signs are possible and that better signs may be diagrammatic.

Accordingly, the Office of Traffic Operations of the Federal Highway Administration initiated a series of demonstration projects (2, 3, 4) on diagrammatic guide signs. Each of these projects incorporated an evaluation program of the sign or signs that were erected under the project. Although several of the projects yielded significant results, the projects together were inconclusive. Perusal of the diagrammatics employed indicates that several conceptions of "diagrammatic" were employed and that this may be the reason for the inconclusiveness.

The study presented here was initiated by the Driver Performance Research Division of the National Highway Safety Bureau (now the National Highway Traffic Safety Administration) to address the questions raised by previous research. Specifically, the purpose of the study was to develop a laboratory test procedure, develop diagrammatic guide signs, analyze the effect of interchange characteristics, and use the laboratory procedure to test the signs and interchange characteristics.

## APPROACH AND FINDINGS

This study was undertaken to develop a laboratory sign-testing method and to apply this method to specify the parameters associated with effective graphic or map signing. The functions performed are discussed below.

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Function 1: Identify Interchange Characteristics Potentially Requiring Graphic Guide Signs

Guidelines were prepared for specifying the particular locations where graphic guide signs might be more effective than conventional signs and for selecting the interchanges for laboratory testing. These guidelines were developed from a conceptual analysis of those interchange characteristics associated with traffic flow and accident-producing problems. Both the severity of the traffic flow problems and the potential impact of graphic guide signs were considered in the development of the guidelines.

Where 2 or more of the following characteristics occurred within a particular interchange, it was suggested that the effectiveness of graphic guide signs be tested: heavy ramp volume, perceptual problems (e.g., inability to see gore), difficult and dangerous last-minute lane changes, unexpected geometrics (e.g., inconsistent configuration), and interchanges where a wrong decision is difficult to rectify.

Two or more of the preceding characteristics are often associated with the following types of interchanges: collector-distributor with lane drop, multiple-lane split ramp (close choice points or gores), left ramp downstream from right ramp, multiple gore (2 choice points or gores in quick succession), major fork, and cloverleaf (heavy volume and sight distance problems). Therefore, representative interchanges of each of the types given above were used in the study.

Function 2: Develop Sign-Effectiveness Criteria

Pilot studies were conducted to identify measures of guide-sign effectiveness. Only those measures that could be obtained in a laboratory setting were considered. The particular measures selected were as follows:

1. Lane choice (the selection of the most appropriate lane for a particular destination—right lane for right exits, left lane for left exits, and all but exit-only lanes for through destinations),
2. Confidence ratings (an indication of how confident subjects were in their lane choice—not at all confident, a little confident, somewhat confident, and very confident),
3. Interpretation of guide signs (a series of questions concerning the information conveyed by the guide sign including number of exits in the interchanges, number of lanes used for through traffic, location of exit of interest—first or second in the interchange, distance between exits, and estimated safe exit speed), and
4. Sign preference (selection of which sign configuration was preferred at different interchange types).

Function 3: Develop Laboratory-Testing Procedure

The primary concern of this phase was the development of reliable, sensitive, and efficient laboratory procedures for the evaluation of graphic and conventional guide signs. The subjects' task under each of the identified measures of guide-sign effectiveness was specified. The necessary methodology to measure the subjects' responses was devised. As an ancillary product of this function, alternative signing concepts were developed for later testing (modified conventional and performance constructed).

A dual-projection tachistoscopic method was developed and employed as the basic measuring technique. The procedure required the use of two 35-mm slide projectors. One projector presented slides of roadway scenes. The slides were taken from a vehicle positioned in one of the lanes on the road. An area of the roadway scene corresponding to the position of an actual road sign was blocked out. The second projector was equipped with a tachistoscopic shutter and projected slides of conventional and graphic signs. The graphic signs were projected into the blacked-out area of the background scene for 1 sec (a length of time derived from a series of pilot studies).

The double-projector tachistoscopic technique proved to be a sensitive method for measuring responses of subjects to signing variables both between and within interchanges. Because the method does not require expensive equipment (the purchase price for all of the equipment needed for the dual-projector tachistoscopic method was under \$1,000), has high reliability, and is portable and simple to operate, it is particularly appealing as a research tool. The sign-testing procedure is feasible for testing proposed new sign configurations by highway departments.

Function 4: Test Guide Signs for Complex Interchanges

Guide signs were constructed for each of the test interchanges selected in function 3. The types of signs constructed for each of the interchanges are shown in Figure 1. Tests were administered at the Smithsonian Institution to visitors who volunteered to serve as subjects.

Technique 1: Proper Lane and Confidence Testing—The initial experiment was designed to determine which of the concepts shown in Figure 1 enabled the majority of drivers to get confidently into the proper lane. The 102 subjects were shown a roadway scene; test signs were projected onto a blank sign panel within the scene (Fig. 2). Subjects were told how to identify the proper lane and indicate their degree of confidence. Prior to each test, they were given a destination. After the presentation of a test sign, they indicated which lanes they should be in and their degree of confidence in their choices.

The results of the subjects' lane choices are given in Table 1. The findings do not clearly favor any one signing concept. The plan concept was significantly better than the other graphic sign concepts but not better than the modified conventional for the collector-distributor. The driver's eye was better than conventional for close choice points. There were no differences for the left exit or multigore areas. All graphic guide signs were better than the modified conventional at a major fork. At a cloverleaf, the modified conventional was significantly better than the driver's eye or plan. Confidence ratings were not helpful in discriminating signs.

Because of the difficulties encountered with the conventional signs and because a series of signs are normally presented at an interchange, testing of conventional versus graphic guide signs was conducted. The same technique was employed. The results (Table 2) indicate significantly better performance when graphic guide signs are used for the collector-distributor ($p < 0.01$), close choice points ($p < 0.01$), and, to a less significant level, major fork ($p < 0.10$). The results generally are in agreement with the previous findings.

Technique 2: Preference Testing—A dual-projector technique was used to obtain driver preferences for guide signs at the various interchanges (Fig. 1). One projector presented a line-drawing map of the interchange, and another projected numbered sign concepts alongside the interchange (Fig. 3). The subjects selected the sign they "liked best" and "liked least" for each interchange. Subjects selecting the signs had previously performed under the lane-choice and confidence-testing technique.

Table 3 gives the preferred (liked-best) signs for each of the interchanges. Graphic guide signs received significantly higher preference ratings for all of the interchanges. The aerial or plan view received significantly higher preference ratings ($p < 0.05$) on all but the major fork, where the performance constructed was preferred (the performance constructed and the plan view were similar for the major fork). The conventional signs were least preferred.

Technique 3: Roadway Characteristics—The third technique was designed to determine whether graphic signs can convey information about the roadway (safe exit speed, distance between exits, and location of the motorist's exit). Two variables were selected to determine whether graphic guide signs can supply this information: the curvature of the exit arrows and the distance between the exits. Two interchanges were selected to display the characteristics. The 4 signs for each interchange (3 graphic, 1 conventional) are shown in Figure 4. The distance between the exits in the second concept is twice that in the third and fourth concepts; the third concept displays one or more curved exit arrows. The 2-projector, tachistoscopic technique was again used.

The results from 48 driver subjects (Table 4) indicated that the curved exit arrow resulted in significantly lower estimates ($p < 0.05$) of safe exit speed. Greater exit speeds were estimated for the conventional sign than for any of the graphic signs. The distance between the exits for graphic sign 1 was judged as significantly greater

**Figure 1. Graphic and conventional sign concepts and interchanges used in tests.**

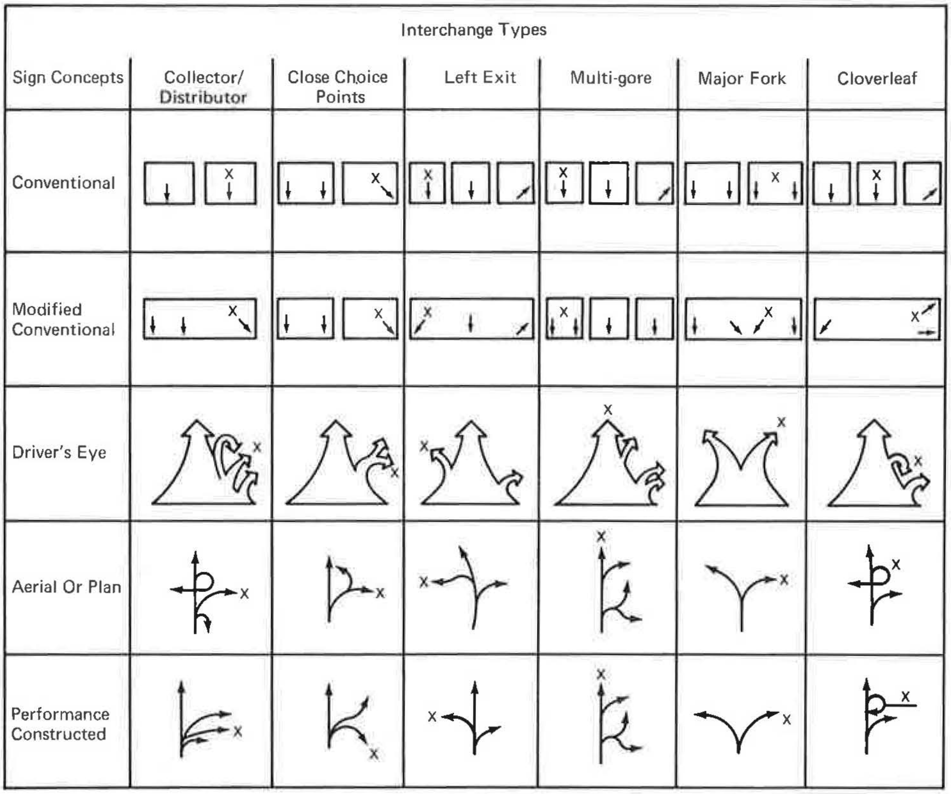


**Figure 2. Roadway scene without and with guide-sign information on panel.**

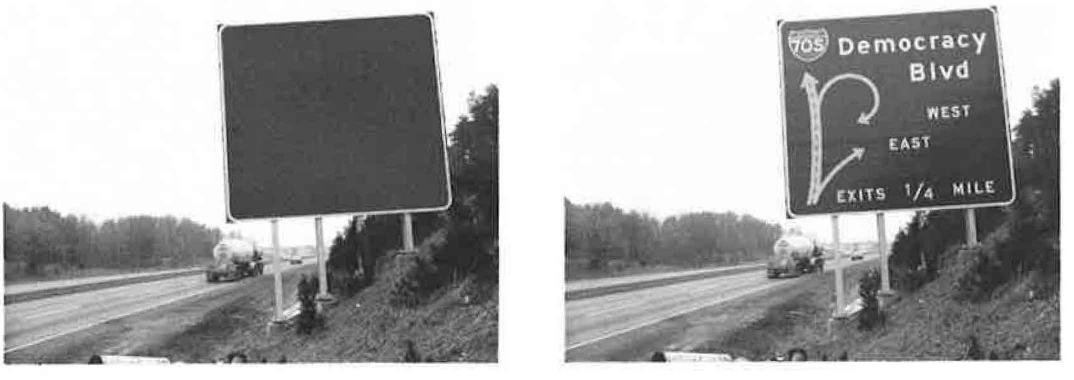


**Table 1. Percentage of proper lane choices based on various sign concepts.**

| Interchange | Conventional | Modified Conventional | Driver's Eye | Aerial or Plan | Performance Constructed | $S_{D_p}$ |
|---|---|---|---|---|---|---|
| Collector-distributor | —[a] | 54 | 50[b] | 70[b] | 49[b] | 0.098 |
| Close choice points | 88[b] | 94 | 98[b] | 96 | 92 | 0.048 |
| Left exit | 86 | 96 | 86 | 96 | 94 | 0.055 |
| Multigore | 88 | 88 | 78 | 82[c] | 82[c] | 0.072 |
| Major fork | 82 | 72[b] | 88[b] | 92[b] | 92[b] | 0.070 |
| Cloverleaf | —[a] | 78[b] | 50[b] | 54[b] | 64 | 0.096 |

Note: Sample size = 51.

[a]Signs were discarded because they did not strictly conform to current standards.

[b]Higher percentage represents significantly better performance at 0.05 level compared to other sign similarly marked for that interchange.

[c]Only 1 sign tested because both were practically identical.

**Table 2. Percentage of proper lane choices based on conventional and plan concepts.**

| Interchange | Conventional | Aerial or Plan | $S_{D_P}$ |
|---|---|---|---|
| Collector-distributor | 65 | 94[a] | 0.08 |
| Close choice points | 54 | 92[a] | 0.09 |
| Left exit | 69 | 80 | 0.09 |
| Multigore | 54 | 40 | 0.10 |
| Major fork | 64 | 80[b] | 0.09 |
| Cloverleaf | 50 | 44 | 0.10 |

Note: Sample size = 50.
[a]$p < 0.01$. [b]$p < 0.10$.

**Figure 3. Graphic and conventional sign concepts and interchange used in preference test.**

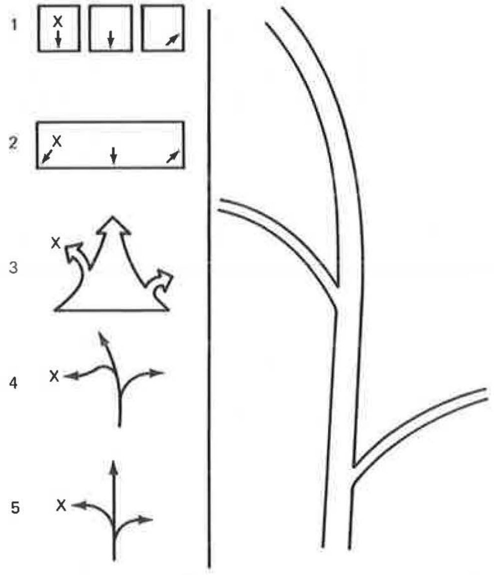


**Table 3. Sign concept preferences.**

| Interchange | Conventional | Modified Conventional | Driver's Eye | Aerial or Plan | Performance Constructed |
|---|---|---|---|---|---|
| Collector-distributor | 6 | 2 | 16 | 63 | 12 |
| Close choice points | 5 | 1 | 12 | 60 | 21 |
| Left exit | 12 | 8 | 13 | 43 | 25 |
| Multigore | 18 | 11 | 21 | 28 | 21 |
| Major fork | 8 | 8 | 25 | 18 | 42 |
| Cloverleaf | 8 | 1 | 3 | 74 | 14 |

**Figure 4. Graphic and conventional signs used in roadway characteristic test.**

Right then left

Two rights in quick succession

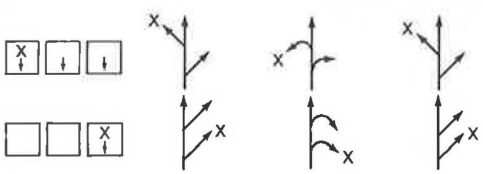


**Table 4. Estimates of exit speed, exit distance, and correct exit based on sign concept.**

| Characteristic | Sign Concept | Exit Speed (mph) Mean | Exit Speed (mph) Standard Deviation | Miles Between Exits Mean | Miles Between Exits Standard Deviation | Respondents Identifying Their Exits (percent) |
|---|---|---|---|---|---|---|
| Right then left | Conventional | 51 | 13.2 | ½ | 0.56 | 6 |
| | Graphic 1 | 43 | 8.9 | ¾ | 0.59 | 79 |
| | Graphic 2 | 31 | 6.7 | ½ | 0.49 | 77 |
| | Graphic 3 | 42 | 9.5 | ½ | 0.49 | 58 |
| 2 rights in quick succession | Conventional | 52 | 13.2 | ⅗ | 0.59 | 48 |
| | Graphic 1 | 44 | 9.4 | 1 | 0.56 | 69 |
| | Graphic 2 | 27 | 4.7 | ⅗ | 0.40 | 79 |
| | Graphic 3 | 43 | 8.3 | ¾ | 0.45 | 69 |

($p < 0.05$) than for any of the other signs. A significantly greater percentage of the subjects correctly identified their exits (as the first or second exit) when they were shown the graphic guide sign rather than the conventional signs.

Interpretation of Performance Versus Preference Results—The mean preference ratings for the liked-best signs, the percentage choosing the correct lane, and the mean confidence ratings of subjects choosing the correct lane were pair-wise correlated over the tested signs. Preference and proper lane performance were not significantly related ($r = 0.07$). However, the dependencies inherent in the preference rating method and the small variance in proper lane performance would severely attenuate the correlation. Nevertheless, comparisons between the 2 sets of means reveal discrepancies that cast serious doubts on the use of preference ratings for selecting guide signs.

Mean preference and confidence rating were not significantly related ($r = 0.26$; $p < 0.2$). Again the correlation is restricted by the rating method employed.

The proper lane performance percentages were significantly related ($r = 0.53$) to mean confidence.

## Function 5: Establish Guidelines for Graphic Guide Signs

Based on the preceding, a series of guidelines was established for graphic guide signs. The general guideline is that graphic guide signs have some application for depicting geometric limitations of an interchange. This is exemplified most clearly in their application to lane drops. They also appear to have utility in communicating exit speed if the curvature of the exit is indicated by the graphic. In addition, graphic guide signs can improve lane positioning where there are close sequential choice (gore) points and, possibly, major forks.

A characteristic that is worthy of consideration for evaluation under highway conditions is the utilization of graphics at interchanges where it is difficult to rectify a mistake.

# CONCLUSIONS AND RECOMMENDATIONS

A laboratory technique to measure highway guide signs was developed. This technique can differentiate signs by determining whether individuals can select the proper lanes for their destinations. A sign interpretation technique indicated that graphic guide signs can communicate roadway characteristics (such as lane drops and exit speeds) to the driver. Sign preference data should be used with caution because the preference data did not relate to proper lane positioning data.

Graphic guide signs can improve lane positioning where there are close choice points (gores) and, possibly, for collector-distributor and major fork interchanges. They can provide information on the relative speed of exit ramps and the distance between ramps and can facilitate the identification of the driver's exit.

It is recommended that the findings and guidelines developed in this study be verified with on-the-road studies. There is a need to develop techniques to determine the quantitative and qualitative characteristics of interchanges requiring graphic or other improved guide signs. If the laboratory techniques for measuring sign effectiveness are verified in the field, the traffic engineer will have a quick, inexpensive technique to evaluate new sign concepts without the expense and possible danger of on-the-road installations.

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