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DIAGRAMMATIC GUIDE SIGNS FOR USE ON CONTROLLED ACCESS HIGHWAYS

Vol. 1. Recommendations For Diagrammatic Guide Signs

T.M. Mast and G.S. Kolsrud

December 1972
Final Report

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16. Abstract The purpose of the diagrammatic signing research project was to develop warrants and standards for the use of diagrammatic guide signs on controlled access highways. Volume 1 summarizes the entire diagrammatic signing research program objectives sponsored by the Federal Highway Administration. It presents the recommended warrants, standards and guidelines for diagrammatic guide signs and the research basis for the recommendations, and suggests techniques and measures for the evaluation of highway signing. This volume was prepared jointly by the Office of Research, Federal Highway Administration, and BioTechnology, Inc.

Research findings obtained under the project indicate that drivers require more time to read and interpret information on diagrammatic signs in comparison with conventional signs. Moreover, as the graphic component on the sign becomes more complex, driver information interpretation time increases. Accordingly, in those cases where diagrammatic signs have been recommended, the standards specify that simple graphic designs must be used. Research results clearly indicate that diagrammatic guide signs will produce a benefit to motorist performance at interchanges where traffic must exit to the left of the through route. Such interchanges include major forks where exiting traffic must take the left fork. Also included are interchanges where there is a single left exit from the roadway and where there is a left exit in combination with a right exit.

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Office of Development

Office of Highway Operations

Office of Highway Safety

Office of Traffic Operations

Maryland State Highway Administration

Maryland State Police

VOLUME I

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Executive Summary

The objective of the diagrammatic signing research project was to develop warrants and standards for the use of diagrammatic guide signs on controlled access highways. A secondary objective was to recommend techniques and measures which could be used by State highway departments for the evaluation of highway guide signs. Research was carried out in the laboratory and in the field. However, field studies form the primary basis for the recommendations developed under the project. In the course of the search effort, two new sign evaluation techniques were developed. Both are designed for use under field conditions. One technique utilizes the Traffic Evaluator System and enables researchers to study a wide range of traffic parameters, some of which were not previously measurable. The other technique employs an instrumented vehicle equipped with an in-vehicle sign display system. It is used to test individual drivers on their reaction to signs under controlled but real field conditions.

Research findings obtained under the project indicate that drivers require more time to read and interpret information on diagrammatic signs in comparison with conventional signs. Moreover, as the graphic component on the sign becomes more complex, driver information interpretation time increases. Accordingly, in those cases where diagrammatic signs have been recommended, the standards specify that simple graphic designs must be used. Research results clearly indicate that diagrammatic guide signs will produce a benefit to motorist performance at interchanges where traffic must exit

to the left of the through route. Such interchanges include major forks where exiting traffic must take the left fork. Also included are interchanges where there is a single left exit from the roadway and where there is a left exit in combination with a right exit.

Interchanges with left exits exhibit high accident rates in comparison to other types of interchanges. Moreover there is typically a high incidence of hazardous maneuvers found at these interchanges. Operational efficiency is further impaired by a high frequency of counter-productive lane changing by exiting traffic. Research results indicate that diagrammatic signs can be expected to produce sizeable reductions in hazardous maneuvers and improve lane placement of both exiting and through traffic. Therefore, it is recommended that diagrammatic signs be deployed at interchanges with left exits on a national basis. Recommended design standards for these signs are presented in Chapter II, Volume I of the report.

It is apparent from study findings that diagrammatic guide signs should not be deployed at all interchanges in the United States nor should they be considered as the general solution for problem interchanges. Except at left exits, evidence indicates that most interchanges will not be benefited by diagrammatic signs. Moreover, there are instances where operating problems may actually be further aggravated by such signs. It is recommended that diagrammatic signs not be deployed at interchanges which exhibit single right exits, common cloverleaf interchanges, or very complex interchanges where it is virtually impossible to design graphics that will be simple and yet accurately portray the geometry of the interchange. In isolated cases where extraordinary factors indicate that making an exception to these recommendations may be justified, the decision to use a diagrammatic sign at such a location should be made on the basis of an engineering study.

Chapter I

INTRODUCTION AND SUMMARY OF RESEARCH FINDINGS

The importance of human factors considerations in highway design and operations has received increased recognition in recent years. In 1968, hearings held by the House of Representatives Committee on Public Works entitled "Highway Safety Design and Operations: Freeway Design and Related Geometrics" pinpointed some of the problems drivers were having on Freeways. It was apparent from films and testimony that driver confusion and uncertainty in the vicinity of interchange areas had to be resolved. One of the outcomes from these hearings was that improvement of highway guide signing became an area of primary concern.

Officials within the Federal Highway Administration (FHWA) and the American Association of State Highway Officials (AASHO) increased their efforts to find ways to improve highway guide signing in the United States. Diagrammatic guide signs were viewed as a possible means for improving traffic operations at highway interchanges. But because installation of diagrammatic signs throughout the United States would cost millions of dollars, work was initiated to study the efficacy of diagrammatic signs before commitment to any major change was made.

Evaluation of diagrammatic signs began through provision of funds under the Federal-Aid Highway Program. Demonstration projects were encouraged by the Federal Highway Administration. States were requested to design diagrammatic guide signs, install them on highways at experimental locations, and perform an evaluation of their effectiveness. In addition, Serendipity, Inc. under contract with the Department of Transportation, provided guidelines for the use of graphic guide signs, based on laboratory findings. These guidelines were distributed by FHWA to State Highway Departments in 1970.

In 1971 the Federal Highway Administrator requested that warrants and standards for diagrammatic guide signs be developed. To meet this objective, the first major human factors research effort in the area of highway guide signing was initiated under the direction of the Office of Research, FHWA. It was a coordinated program involving support from FHWA operating offices and research contributions from State Highway Departments and private industry. Many different research methodologies were employed by various investigators. Studies were conducted in the laboratory and in the field. Field work consisted of instrumented vehicle or controlled field studies and traffic behavior evaluations.

Laboratory and controlled field work was conducted by staff in the Office of Research and the major traffic evaluation effort was carried out under contract by BioTechnology, Inc. In-house laboratory and field work as well as work reported by State Highway Departments is presented in detail in Volume II of this report. Volume III describes the traffic evaluation phase of the project conducted on the Maryland portion of the Capital Beltway (I-495). The latter also discusses cost effectiveness considerations and preliminary applications of traffic modeling to signing evaluation.

Summary of Research Findings

Approximately twenty studies form the basis for the recommendations in this report. Eight States participated substantially in the program by contributing empirical results from field studies. These States were Arizona, Connecticut, Illinois, Michigan, New Jersey, Virginia, Wisconsin and Wyoming. Moreover, the major traffic evaluation study, conducted on the Capital Beltway (I-495), could not have been initiated or completed without the extensive support received from the Maryland Highway Administration.

The most comprehensive studies conducted under the research program were the controlled field studies conducted by the Office of Research and the Capital Beltway field study carried out by BioTechnology, Inc. Because these studies were both broad in scope and rigorously controlled, they have received the greatest weight in developing the recommendations presented in this Volume.

The controlled field studies employed an instrumented vehicle with an in-vehicle sign display system. Test drivers were required to navigate a test route and seek out prescribed destinations using signs displayed inside the vehicle. Destination information was fictitious; however, the test route utilized real highways and interchanges open to normal traffic operations. Measures of driver performance consisted of sign information interpretation time, velocity control, hazardous maneuvers, and exiting errors. The controlled field study technique combines the advantages of both the laboratory and the field. Many sign variables can be quickly studied and confounding variables can be controlled (typical of the laboratory) yet the driving and navigation tasks are real (typical of the field).

In the Capital Beltway study conventional and diagrammatic guide signs at six interchange approaches were evaluated over a one year period. Three data collection methods were used: the Traffic Evaluator System, time-lapse photography and motorist response to questionnaires. The Traffic Evaluator System is a newly developed traffic evaluation tool which enables the study of several traffic parameters not previously measurable. A detailed description of this system, procedures for deploying it, and software for data analysis is presented in Appendix A, Volume III of the report. Performance measures used in the Capital Beltway study included erratic maneuvers, lane placement of exiting and through traffic, proportions of vehicles traveling at low speeds, and the proportion of vehicles with headways of one second or less. Evidence that erratic maneuvers relate to driver route negotiation difficulty was gathered in the course of the study, thus validating this measure.

Three general findings have emerged from the research which are stated here as a framework for the discussion which follows. These are:

(1) More time is required to read, understand and react to diagrammatic signs in comparison with conventional signs with the same number of legends. This has been shown in the laboratory (Gordon, 1971) and in controlled field studies (Bhise & Rockwell, 1972; Mast,

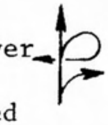
Chernisky & Hooper, 1972). Because the graphic increases the information content of the sign, this finding is not unexpected. However, it is important to note that the increase in information interpretation time is not constant but becomes greater when the graphic is more complex. The importance of making the graphic as simple as possible is therefore obvious. Complex graphics such as "full crossovers" or "implied crossovers" should be avoided. These kinds of designs confuse the motorist and greatly increase information processing time.

(2) Drivers have certain expectancies as they drive along a highway. Because exits are usually to the right, through traffic generally uses the median-most lanes while exiting traffic tends to cluster in the right lane. A left exit violates the expectancy of both exiting and through traffic. It is at such exits where unusual maneuvers are required that diagrammatic signs benefit driver performance, <u>provided</u> a <u>simple</u> graphic can adequately depict the choice point(s). An example is a left-exit major fork, which can be simply shown by two arrows, one curving to the left, the other curving to the right. In addition to the clear portrayal of the roadway inherent in the graphic, there is an attentional value derived from the novelty of the sign which in itself is useful in alerting the driver to an unusual situation.

(3) Benefits from diagrammatic signing at the gore area of an interchange derive from the effect of such signs on driver lane positioning near the advance and exit direction signs. In other words, because drivers decide earlier on the appropriate path to reach their destination and position themselves accordingly, there is less indecision at the gore proper. This is reflected in reduced erratic maneuver rates and smoother traffic flow in the gore area. Relatively little benefit, if any, derives from diagrammatic gore signs. Therefore, at those locations where diagrammatic signs are recommended, they should be erected at the advance and exit direction sign locations. Conventional signing at the gore is adequate.

Further discussion of research findings is organized by interchange geometric characteristics.

Single right exit. Many interchanges provide the driver with a single right exit from the through roadway. The diamond and single right exit to a collector-distributor are examples. Both exiting and through traffic paths conform to driver expectancy. Research is consistent in showing no benefit from diagrammatic signing at such exits as measured in the field (Kolsrud, 1972; Snyder & Crossette, 1969), in the instrumented vehicle (Mast, Chernisky & Hooper, 1972) and in a driving simulator (Breda, Kirkpatrick & Shaffer, 1972).

Two exit cloverleaf. Several different graphic designs have been evaluated for two-exit cloverleafs. In increasing complexity, these are: two simple curved arrows from the main road  ; showing the wraparound 270° ramp as an implied crossover  ; and showing it as a full crossover  . Instrumented vehicle studies of the simplest design showed no difference from conventional signing (Mast, Chernisky & Hooper, 1972). Results with the implied crossover have shown little effect or have been inconclusive (field-Graham & Volk, 1972; Kolsrud, 1972, laboratory-Berger, 1970; Breda, Kirkpatrick & Shaffer, 1972) or negative effect (instrumented vehicle-Mast, Chernisky & Hooper, 1972, laboratory-Gordon, 1971). With the full crossover graphic, the general experience of State highway departments in the field has been negative.

Thus, no evidence has been found that even the simplest graphic design is beneficial at two-exit cloverleafs and diagrammatics are not recommended at such locations. In no case should crossover ramps, either shown or implied be used on graphic signs. This position is compatible with research findings and also with the type of graphic employed by other countries.

Left-exit. The left exit may occur alone, as part of a major split or in combination with a right exit ramp as at directional interchanges. The left exit violates the expectancy of both exiting and through drivers. Exiting drivers frequently make improper lane selections in preparing to exit and unexpected maneuvering is required in the vicinity of the interchange gore area. A simple graphic can effectively convey the choice point(s) to the driver at such interchanges. Significant benefits from diagrammatic signs have been found in the field (Connecticut Department of Transportation, 1972; Kolsrud, 1972; Orne, 1966; Roberts, 1971) and in the instrumented vehicle (Mast, Chernisky & Hooper, 1972). However, benefits were <u>not</u> found in laboratory settings (Berger, 1970; Gordon, 1971). Benefits found in the field have been sizeable, including reductions in erratic maneuvers to 1/2 or 1/3 that observed with conventional signs. Furthermore, greatly improved lane placement of exiting and through vehicles was found at the gore as a result of earlier correct lane positioning at more upstream locations. Diagrammatic signs are highly recommended at left exits.

<u>Very complex interchanges (such as the multiple split ramp type at I-495/I-95 near Washington, D.C.)</u> This interchange was studied in two independent laboratory investigations which reached opposite conclusions (benefit-Berger, 1970; decrement-Gordon, 1971). Instrumented vehicle research, however, was clear in showing definite performance decrement with diagrammatic signs.

Simplified conventional signing with lane assignment arrows provided the best performance and is recommended at such locations. The problem appears to lie in the virtual impossibility of designing a graphic which is at the same time simple and yet capable of accurately portraying the interchange geometry.

Comment. The simplest description of the current understanding of diagrammatic signs is that such signs will provide a significant benefit at interchanges where an unusual or unexpected maneuver is required and where a simple graphic can portray all choice points. The primary instance of an unexpected maneuver is the left exit where diagrammatics have been shown to produce sizeable benefits. However, there are other instances of unexpected maneuvers where the evidence is less clear. Examples are right exits associated with lane drops, very limited sight distance of the exit ramp, at the inclusion of the interchange which is unique for a particular facility or location (an example is a two exit cloverleaf from a facility which otherwise consists of single right exits). The little evidence available on these situations is mixed. Continued evaluation of graphic signs by States with problem interchanges of these types is urged.

Diagrammatic Signs in Foreign Countries

Diagrammatic signs have been used in other countries with apparently successful results. Why not, then, use them more extensively in the United States? There are several reasons. One is that limited access highways in other countries are different in geometric design than those in the United States. Interchanges are more uniform and standardized. For example, exits are always to the left in England and to the right in Germany. Moreover, the interchanges are uniform in that there is a single exit at a given interchange. Thus, motorists do not face the diversity of interchange geometrics found in the United States where exits may be either to the left or to the right and any given interchange may offer the driver a choice between two or more exits from the through roadway. In foreign countries the graphic on the sign serves only as a cue that an exit is upcoming. In the United States, the graphic must not only serve this purpose, but it must also provide information as to the type of exit the motorist will encounter.

Finally, it is important to note the Japanese experience. Japan's recent construction of limited access highways has been accompanied by an increasing tendency to utilize diagrammatic signing. However, such signs are not used on an unlimited basis but rather at problem interchanges where a diagrammatic sign appears useful. Such usage is compatible with the results of the recent concentrated research program on diagrammatic signing.

Summary. The only location where erection of diagrammatic guide signs is recommended on a national basis is left exits. Left exits may occur alone, as part of a major fork, or in combination with right exits as at directional interchanges. Research supports the use of diagrammatic signs at the exit direction and advance sign locations for all such interchanges.

Diagrammatics are not recommended at diamonds, two-exit cloverleafs or the simple right exit to a collector-distributor. The effect of diagrammatics at such locations is either no benefit or driver performance decrement.

Diagrammatics are also not recommended at very complex interchanges such as multiple split ramps. At such locations, diagrammatics cannot be designed which are simple and which accurately portray all choice points.

Chapter II

WARRANTS, STANDARDS, AND GUIDELINES FOR THE USE OF DIAGRAMMATIC GUIDE SIGNS

In this chapter recommended specifications are presented for the deployment and design of diagrammatic guide signs for use on controlled access highways in the United States. Deployment recommendations are given on the basis of interchange geometric characteristics. Recommendations for sign design standards are also specific to interchange geometric type. However, a few general guidelines, nonspecific in terms of interchange geometry, are also offered. The latter are presented to assist States that may wish to continue experimentation with diagrammatic guide signs.

Research findings clearly indicate that diagrammatic guide signs should not be deployed at all interchanges in the United States. Furthermore, they should not be considered as the general solution for problem interchanges. Evaluation findings show that most interchanges will not be benefited by diagrammatic signs. In fact, operating problems at some types of interchanges may actually be further aggravated by graphic signs. Diagrammatic signs will produce substantial benefits to the motoring public only when they are installed under special operating conditions. These conditions may be recognized by the nature of the route navigation maneuver imposed upon the motorist. The use of diagrammatic guide signs should be restricted to interchanges where an unusual directional maneuver is required of the motorist. An unusual maneuver is one which violates the driver's expectancy. The left exit interchange is an example which clearly meets this criteria. It is the only interchange type where deployment of diagrammatic guide signs is recommended as a national standard.

When diagrammatic signs are deployed, considerable attention must be given to the design characteristics of the graphic components on the sign. Subtle format factors may produce dramatic effects on the way the sign is perceived by the motorist and the ease with which he is able to extract information from it. Therefore, under the general design standards section below, examples of correct as well as incorrect graphic designs are presented.

Warrants for Diagrammatic Guide Signs

Diagrammatic guide signs should be deployed at advance and exit direction locations at interchanges where exiting traffic must exit to the left of the through route. Such interchanges include major forks where through traffic lanes continue on the right portion of the fork and exiting traffic must take the left fork. Also included are interchanges where there is a single left exit from the roadway and where there is a left exit in combination with a right exit.

Studies have shown that left exit interchanges exhibit higher accident rates than other types of interchanges. Moreover, there is typically a high incidence of hazardous maneuvers found at these interchanges. Operational efficiency is further impaired by a high frequency of counter-productive lane changing by exiting traffic.

Several factors account for this. Drivers expect to exit from the right of the roadway. This response tendency is so strong that conventional signing techniques have not been effective enough in providing route navigation information at these interchanges. The left exit is rare. Although some parts of the country have a greater number of these interchanges than others, there is still a preponderance of right exits.

Nonautomobile traffic traveling in the right most lane particularly needs early warning of a left exit. Trucks and buses are easily trapped in the right lane under heavy traffic volume conditions and require adequate roadway distances for performing lane change maneuvers. In addition, high speed through automobile traffic traveling in the left most lane is often trapped into making an undesired exit. This is particualrly true at left exit major forks or where one or more lanes are dropped at the left exit.

Clearly, special signing is required to alert both through and exiting motorists to the left exit type of interchange. A diagrammatic sign can be expected to quickly command the attention of most motorists. Moreover, properly designed, it will simply and accurately depict the maneuvers required for both exiting and through traffic.

The recommendation for the deployment of diagrammatic guide signs at left exit interchanges should not be construed as an endorsement for the building of left exit interchanges. It is the authors' view that the construction of this type of interchange should definitely be discouraged. Although diagrammatic signs can be expected to ameliorate the operating problems at the left exit interchange, it is highly unlikely that operational safety and efficiency will approach that of right exiting interchanges.

It is recommended that diagrammatic guide signs not be deployed at:

(1) Interchanges which exhibit single right exits such as diamond interchanges.

(2) Common cloverleaf interchanges without collector distributors.

(3) Interchanges with collector distributors which exhibit a single right exit from the main roadway.

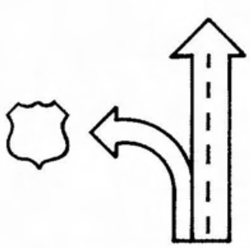
(4) Interchanges with double lane drops to the right followed by a fork (sometimes referred to as multiple split ramp interchanges).

Research evidence indicates that diagrammatic guide signs deployed at these types of interchanges will not produce a benefit to motorist route navigation performance. In some cases they may in fact impair motorist performance. In addition, general employment of diagrammatic signs on a national basis at some, much less all, of these interchanges will only attenuate the impact of diagrammatic signs at locations where they are warranted. In other words, proliferation of diagrammatic guide signs at these locations will only serve to reduce the attention gaining qualities of the sign.

General Design Standards

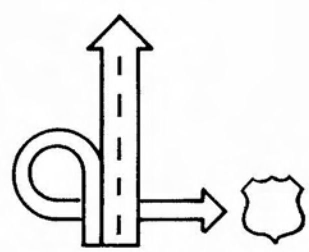
Simplicity in the design of the graphic component on a diagrammatic sign is of key importance. This applies both to the graphic and to the sign as a whole.

1. The graphic component should portray only what is necessary for the driver to understand the required exit maneuver relative to the main roadway. Elaboration of the exiting path characteristics beyond the exit point only serves to unnecessarily complicate the sign and increases driver confusion and information processing time. For example:



This (A)

Not This (B)



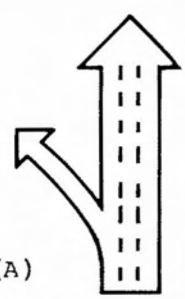
Nor This (C)

Each of the above might be used to show a left exit with a wrap around ramp. The recommended graphic design is depicted in example (A). It is simple and limited only to the information the driver needs to make the exit maneuver. Example (C) is especially poor. Many drivers are likely to interpret graphic (C) as indicating a right exit.

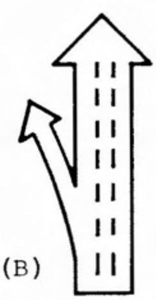
2. The quantity of information on the diagrammatic sign must be limited. Not more than one place name, one route shield and cardinal direction should be located next to the emanating arrowhead. The through arrow should point to only the through route shield. The limitation of number of place names is of particular importance. On a diagrammatic sign the burden of route navigation information must rest with route shields and cardinal direction information. Addition of graphic components to guide signs inherently increases sign complexity. Therefore, the effect must be counterbalanced by a reduction in the number of place names. Place names should not be positioned at the through arrow location. The route shield is sufficient.

3. Graphics should basically adhere to the "plan" or "aerial" view but be modified where necessary so as to ensure that the components of the graphic are clearly discernable.

This (A)



Not This (B)

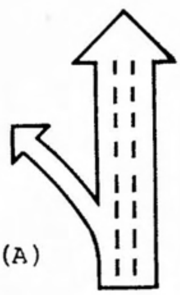


Although graphic (B) may more accurately represent the angle of departure of the exit ramp, the driver will have difficulty distinguishing the exit ramp relative to the through portion of the graphic. A separation angle of 30 degrees between the through and exit ramp components is recommended.

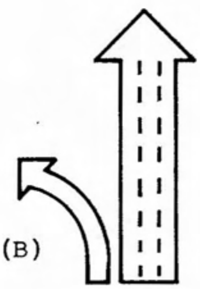
4. <u>Deceleration lanes should not be depicted on the graphic components</u>. Although lane drops should be depicted in the graphic components as in 1. (A) above, deceleration lanes only add unnecessary complexity to the sign.

5. <u>Graphic components must not be separated</u>. The exit ramp arrow and through arrow should be one unit. Separation of exit and through arrows destroys the depiction of the exit ramp relative to the main through roadway, and will neutralize the effectiveness of the signs.

This (A)

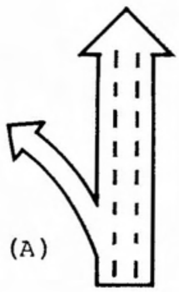
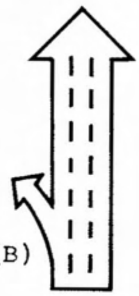
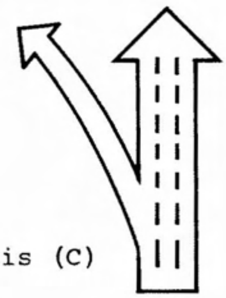


Not This (B)

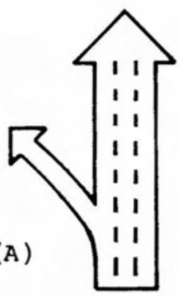
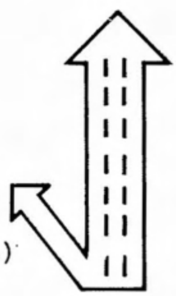


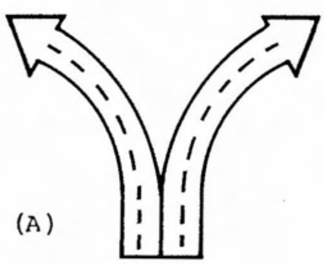
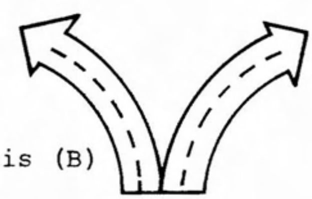
6. <u>The through graphic component should be designed so that it is the visually dominant portion of the graphic (major fork is an exception)</u>. The length of the emanating arrow depicting the exit ramp must be long enough

to be clearly discernable, but short relative to the through component so that it will be visually subordinate.

This (A)  Not This (B)  Nor This (C) 

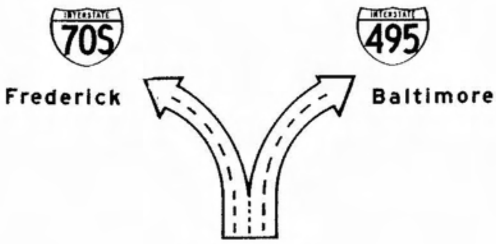
7. <u>The length of the graphic stem must be adequate</u>. This is primarily to insure that the relationship of the exit ramp(s) to the through route is clear

This (A)  Not This (B) 

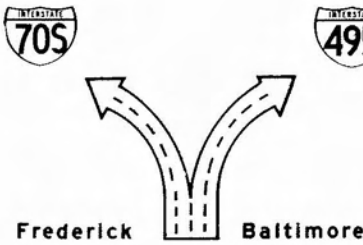
This (A)  Not This (B) 

8. <u>Destination information must be clearly related to the appropriate arrow head</u>. Unless the destination information is proximal to the arrow

heads, drivers will have difficulty correctly associating arrows with legend information.

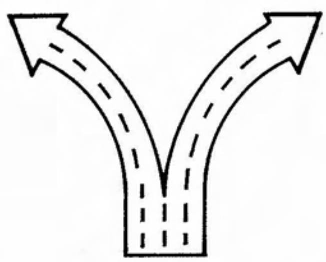


This (A)

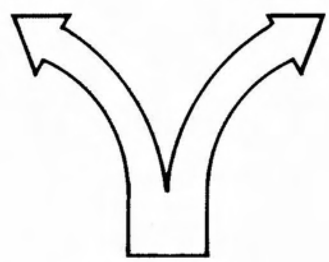


Not This (B)

9. Lane lines should be present on graphic components. Lane lines assist in the presentation of lane drop information. They particularly clarify the division of the highway in the case of the major fork.



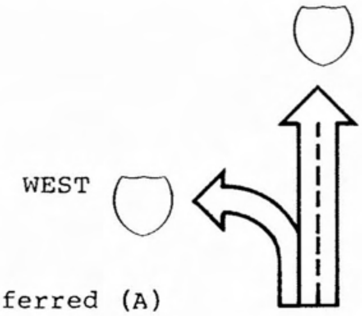
This (A)



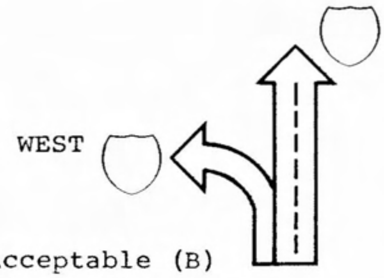
Not This (B)

10. The route shield must not be substituted for the arrowhead. On the shoulder mounted sign, the through shield should be at the top of the arrowhead. Where vertical size of the sign panel is a problem, the through route shield may be positioned to the side of the arrowhead. However, no portion of the through shield should fall below the barb of the arrowhead,

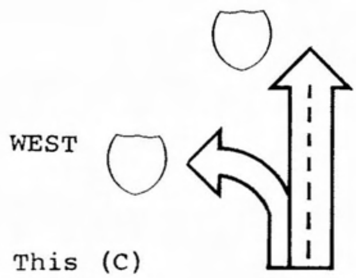
and it must be positioned on the opposite side of the closest exiting arrow.



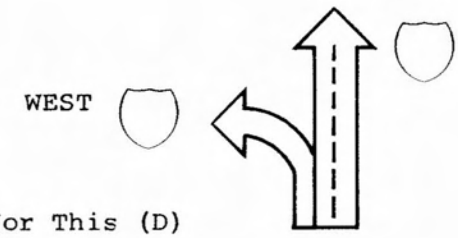
?referred (A)



Acceptable (B)

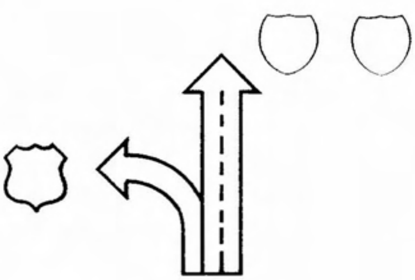


Not This (C)

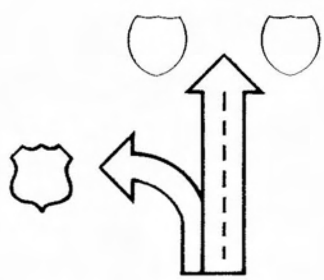


Nor This (D)

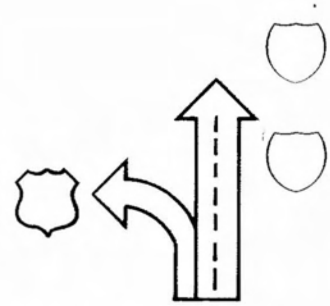
11. <u>When two through route shields are required, the second shield should be positioned in line with the first</u>.



This (A)



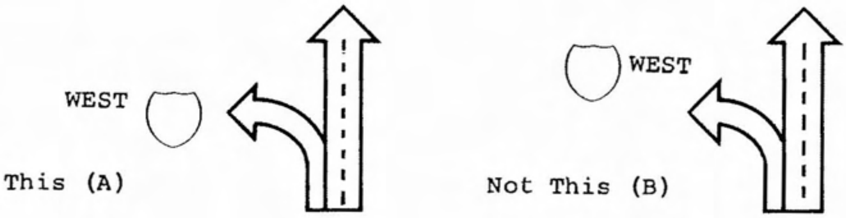
Not This (B)



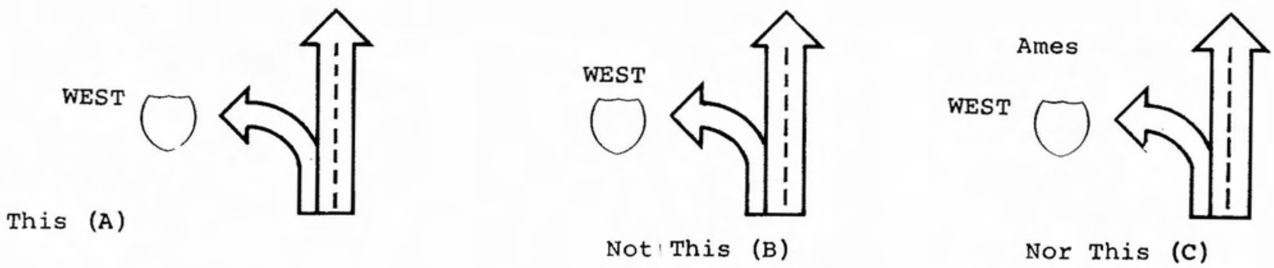
Nor This (C)

12. <u>Route shields should be used as the reference points for formating exiting information</u>. Projection of the exiting arrow should first intercept

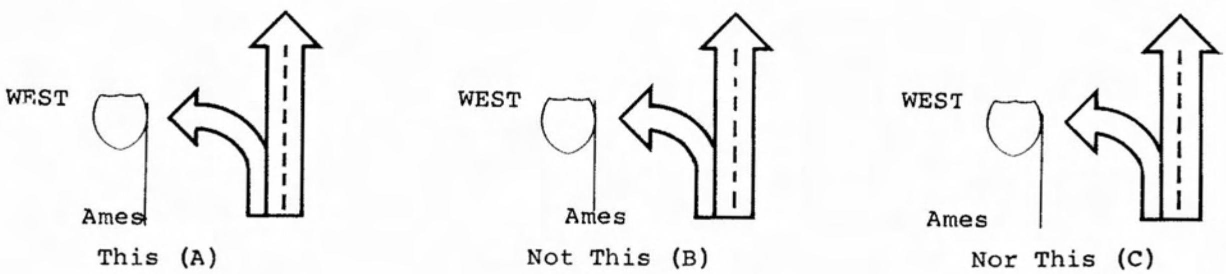
the route shield. No information should be inserted between the shield and the arrowhead. Interception should be at a point approximately 20 percent of the shield height below the top of the shield.



13. <u>Exiting information should not be placed so that it extends above the top of the route shield.</u> This applies to cardinal direction information as well as place names.



14. <u>Place names should be justified with the graphic side of the route shield.</u> This applies to information on the left as well as on the right of the graphic component.



15. A left off-ramp tangential to the beginning of a curve in the through road should be shown as such. Graphic (A) indicates that failure to make a positive turn to the right will result in exiting.

This (A) 

Not This (B) 

16. When the exit is accompanied by a single lane drop, the graphic on the diagrammatic sign should not be solely relied on to depict this condition. Supplementary overhead signs with lane drop "exit only" panels should also be installed over the lane which will drop.

17. Addition of graphics cannot be accompanied by decreasing letter sizes. With the addition of graphic components, diagrammatic signs require a substantial increase in the overall size of the sign panel. In addition, research findings indicate that sign information interpretation time increases with diagrammatic signs. Because of the latter, it is important that there is strict adherence to the letter size standards as outlined in the Manual on Uniform Traffic Control Devices.

The large increase in the overall size of the sign panel in comparison with conventional signs could create severe structural problems with cantilever and sign-bridge type overhead signs. However, many of these problems may be accomodated by louvered signs. Studies have shown that louvered signs can reduce sign wind loads by as much as 50 percent. This does not necessarily imply that a solid sign can be replaced with a louvered sign of twice the size. It does suggest, however, that in some cases the size of sign panels may be increased without replacing structural supports and without sacrificing safety.

18. Exit panel should be located above destination information and be aligned with right or left edge of main sign as appropriate, e.g. Figure 2-1.

19. Diagrammatic signs should not be positioned at the interchange gore location or at the beginning of the deceleration lane taper (if deceleration lane present) but should be placed at all locations in advance of these points.

Specific Design Standards

Specific design standards are presented in the tables and figures that follow. Specific recommendations are provided for the size and spacing dimensions of letters, shields, and graphic components. Pictures of examples of diagrammatic guide signs for three different types of interchanges with left exits are also presented. These examples represent the design standards and guidelines provided in this chapter.

Figure 2-1. Single Left Exit (First Advance Sign).

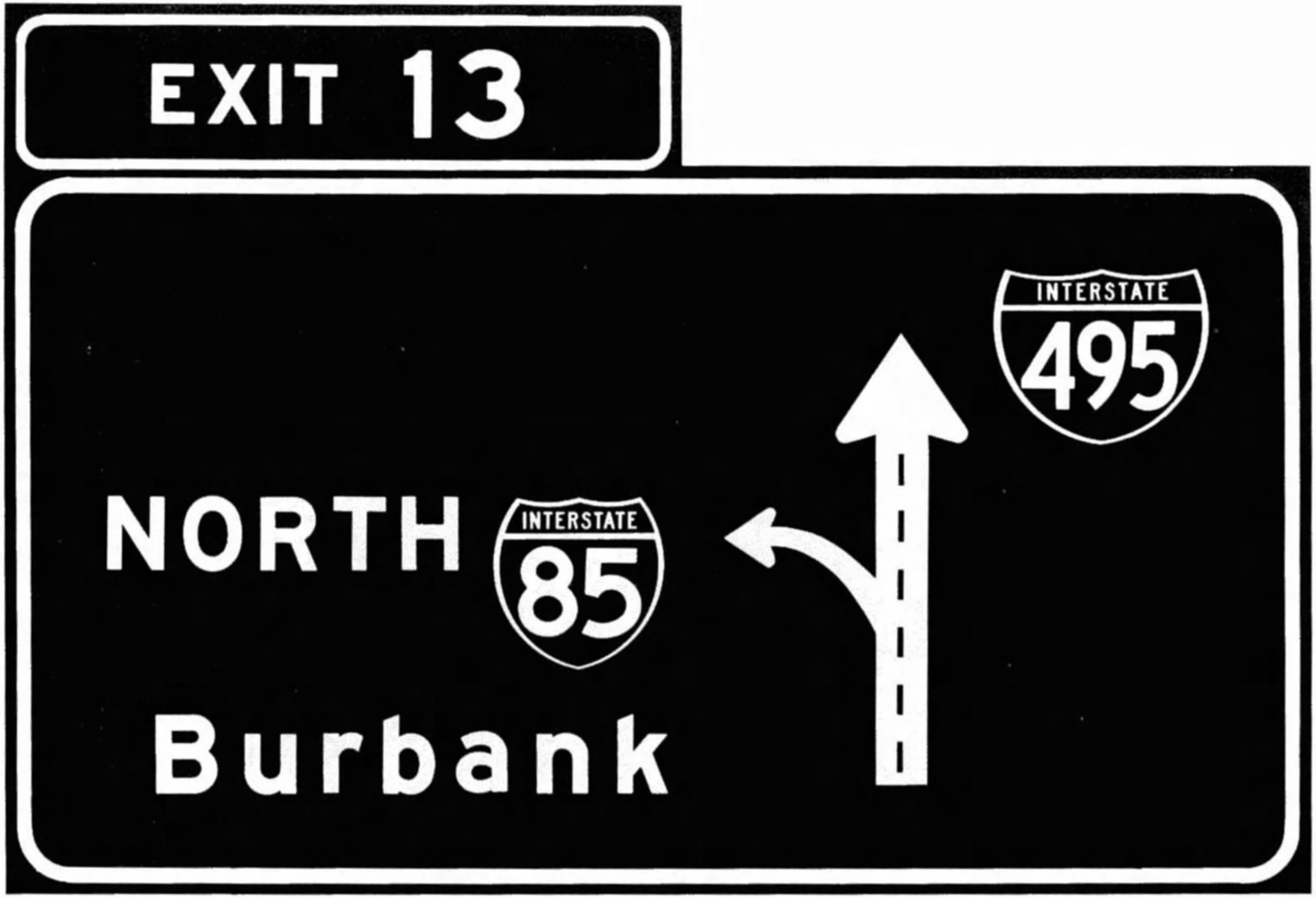


Figure 2-2. Single Left Exit (Second Advance Sign).

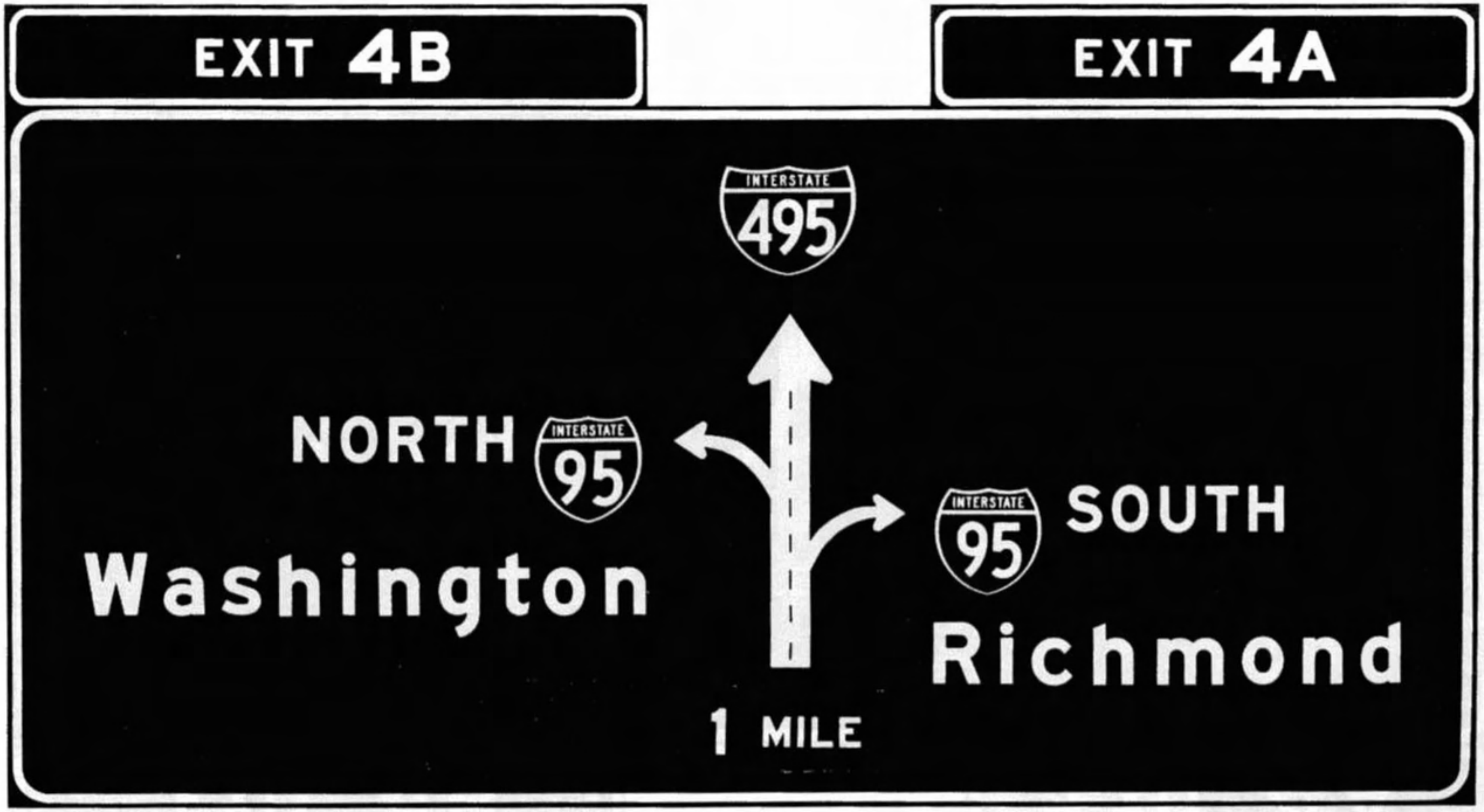


Figure 2-3. Combination left and right exits (First Advance Sign).

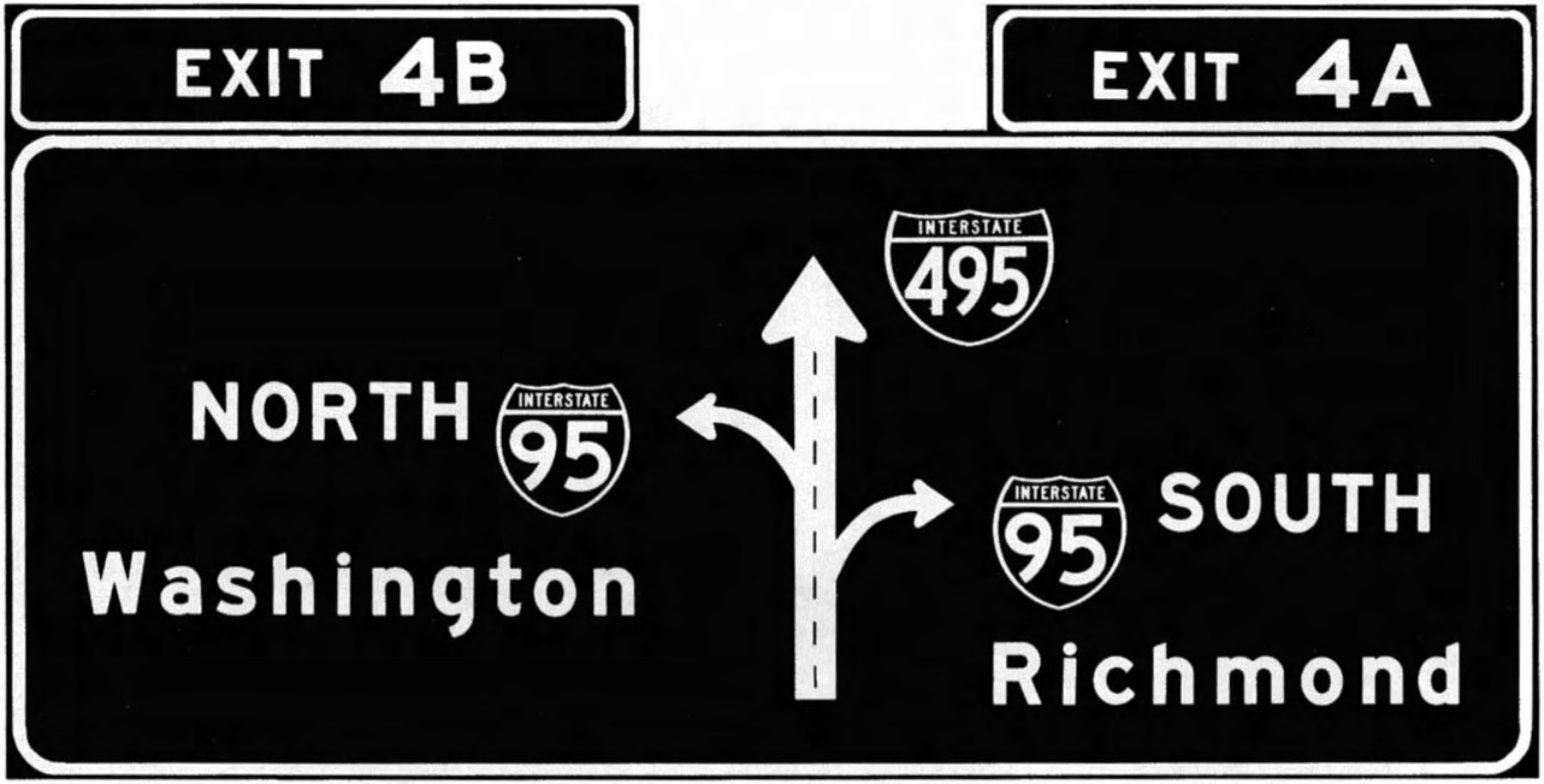


Figure 2-4. Combination left and right exits (Second Sign).

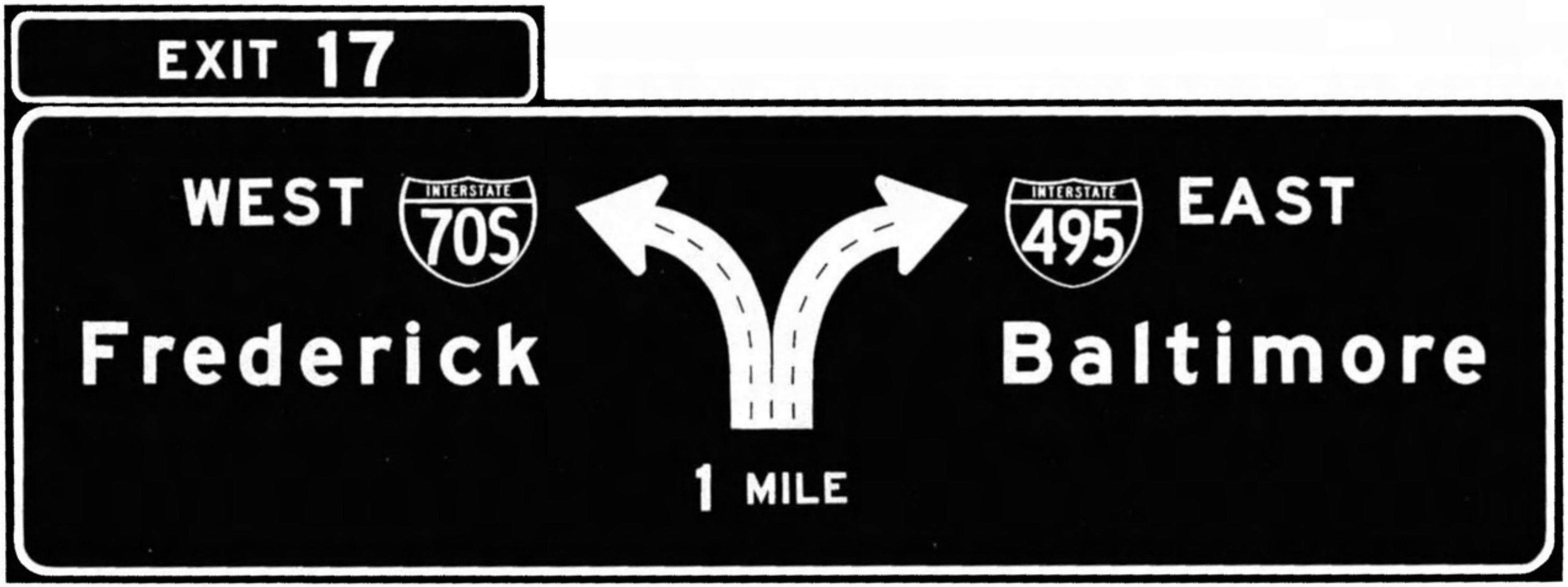


Figure 2-5. Major Fork with left exit (First Advance Sign).

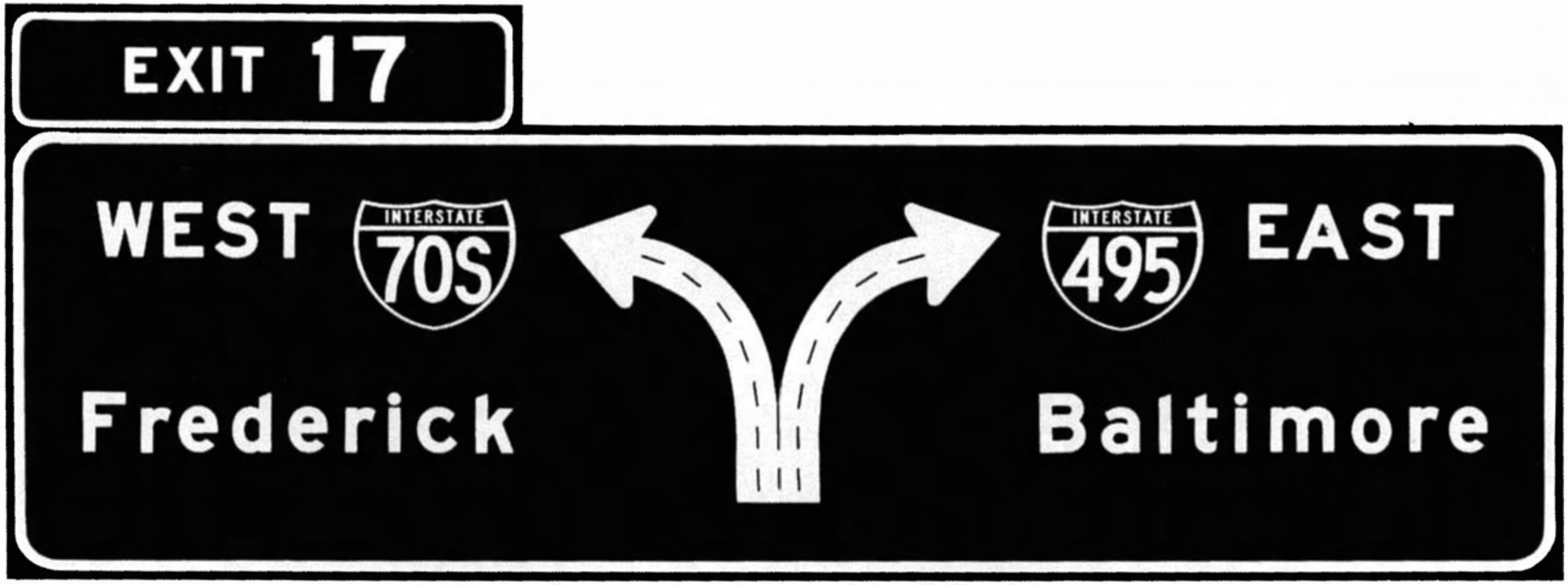


Figure 2-6. Major Fork with left exit (Second Advance Sign).

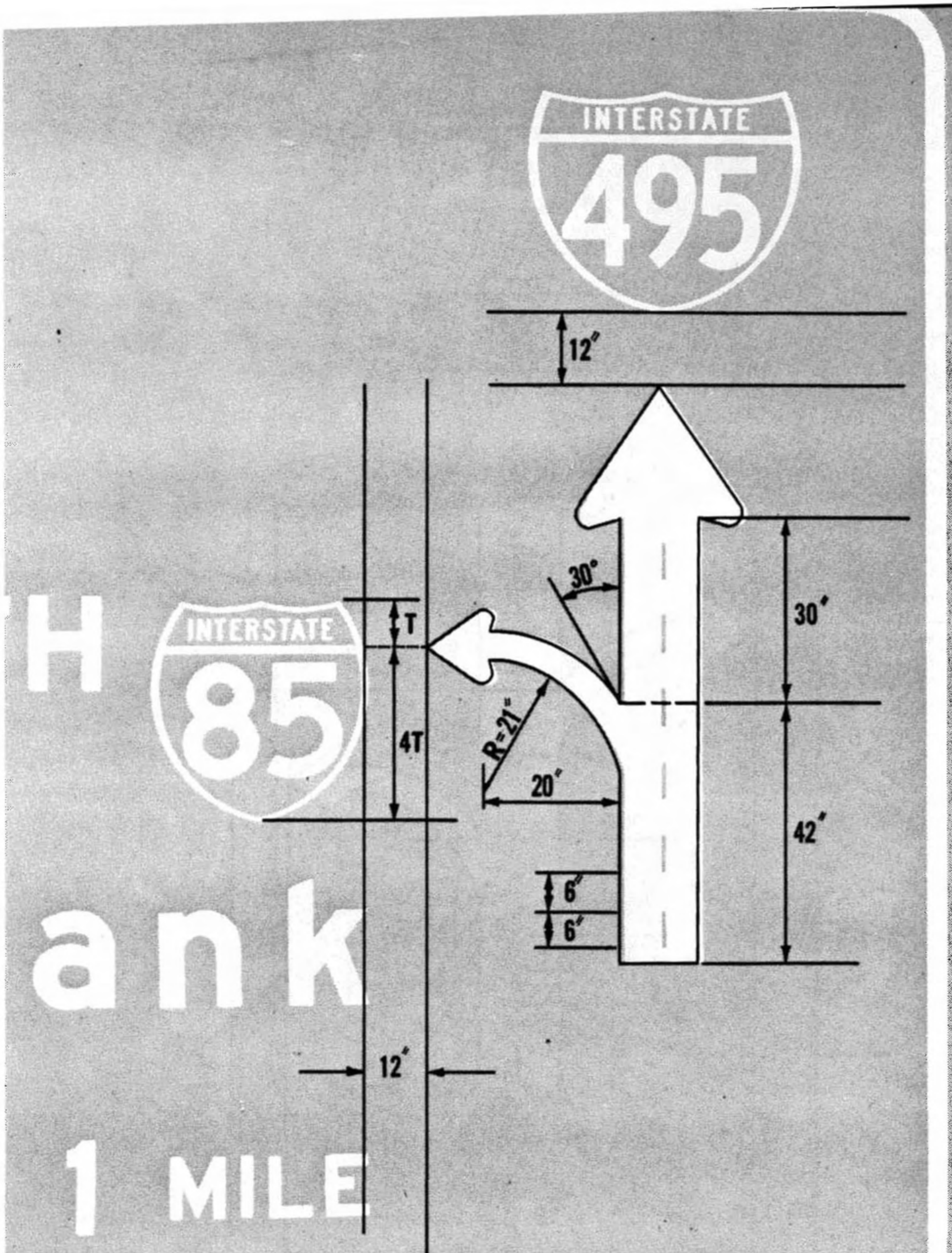


Figure 2-7. Detailed drawing of graphic for Advance Sign (Single left exit)

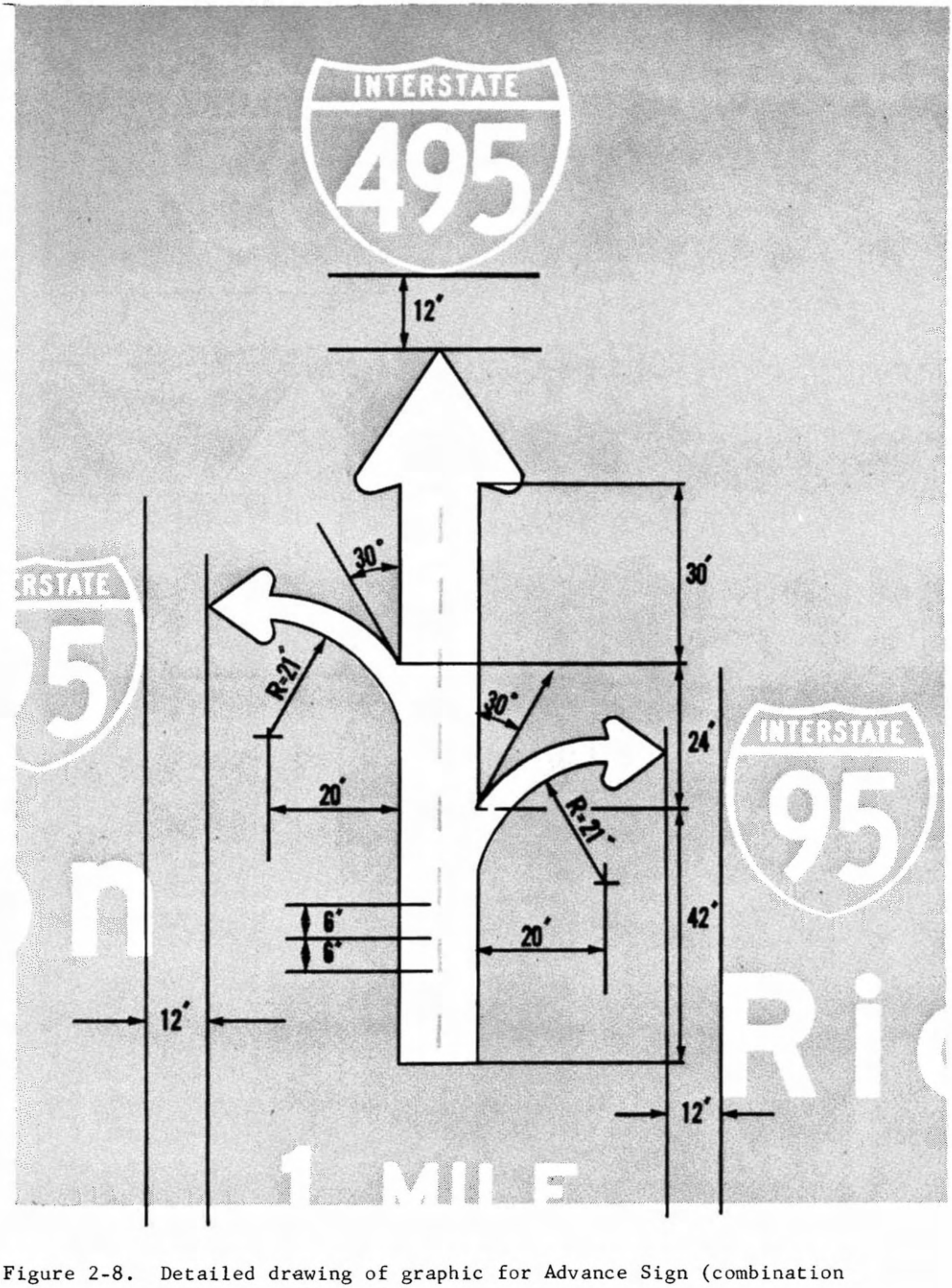


Figure 2-8. Detailed drawing of graphic for Advance Sign (combination left and right exits).

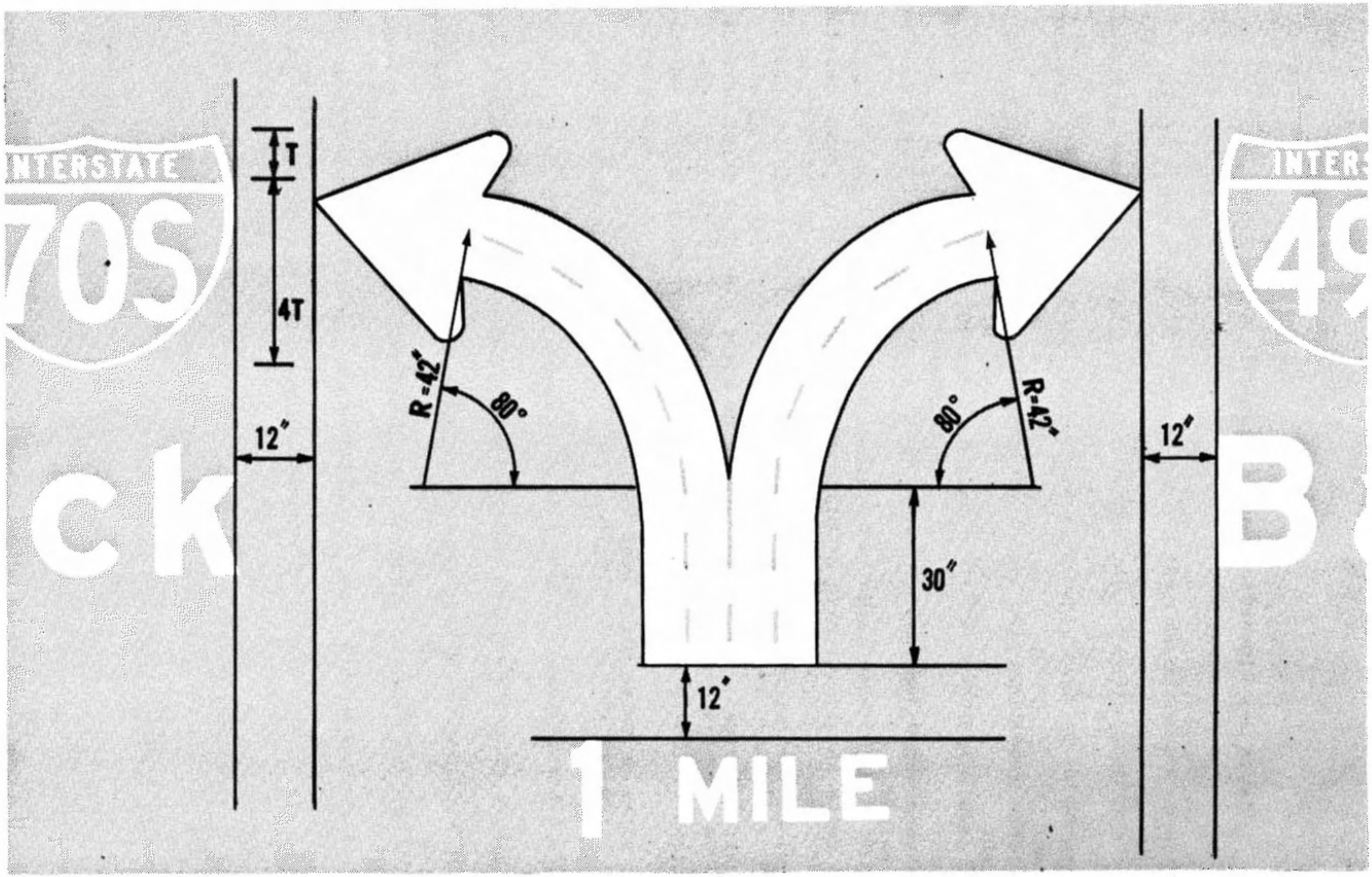


Figure 2-9. Detailed drawing of graphic for Advance Sign (Major Fork with left exit).

Table 2-1 Dimensions for Diagrammatic Guide Signs

Component	Size
Graphic	
Lane width	6"
Lane lines	1" x 6"
Space between lane lines	6"
Stem height	42"
Angle of departure	30°
Arrow head	(standard "up" arrow)
Space between arrow head and route shield	12"

In no cases should the size of other sign components (e.g. route shields and letters) be smaller than the standards set forth in the Manual on Uniform Traffic Control Devices. Because diagrammatic signs placed at first advance sign locations typically exhibit long information interpretation time values, the letter sizes on these signs must be large (e.g. 20"/15").

Summary

Warrants and standards for the use of diagrammatic signs on a national basis have been presented for interchanges which require traffic to exit from the left of the through route. It is at this type of interchange where the evidence clearly shows that diagrammatic signs will produce a substantial benefit to motorist performance. Moreover, it is recommended that diagrammatic signs not be deployed at interchanges which exhibit common interchange geometrics such as diamonds and cloverleafs. Diagrammatic guide signs cannot be expected to solve all operating problems due to unusual interchange geometrics or other factors. Proliferation of diagrammatic signs where they are not warranted will only serve to reduce their effectiveness at the recommended locations.

It is recognized, however, that isolated situations may exist now or in the future where a diagrammatic sign, properly designed and deployed, may produce a benefit to motorist performance. The decision to use a diagrammatic sign at a particular location should be made on the basis of an engineering study of the location. The chapter which follows offers recommendations concerning sign evaluation techniques and measures that might be used by State Highway Departments.

Chapter III

RECOMMENDED TECHNIQUES AND MEASURES FOR THE EVALUATION OF HIGHWAY GUIDE SIGNING

The purpose of this Chapter is to recommend a procedure which may be used by traffic engineers to assess the relative benefit to motorists of changes in route guidance signs on controlled access highways. Several criteria were used to select between candidate techniques and associated measures of motorist driving behavior. Foremost was that the procedure have practical significance. In other words, the procedure had to provide results which have been shown to relate to motorist route negotiation difficulty. Secondary criteria were that the recommended method be relatively inexpensive without sacrificing data quality, that equipment requirments be minimal and that the equipment be reliable and that use of the procedure not require large numbers of personnel with highly specialized skills.

Only one procedure met these criteria. It is a field evaluation method with a particular approach to the data collection procedure. However, many other methods have been used to evaluate highway guide signs. They are mentioned in the discussion below. Future development of these methods may result in one of them supplanting the procedure which is recommended now.

The methods discussed are divided into three basic categories:

(1) Laboratory -- in which the study is conducted in an artificial setting.

(2) Controlled field -- in which drivers are studied while driving on an actual roadway but conditions are otherwise artificial (e.g., drivers use an instrumented vehicle): and

(3) Field -- in which the setting is completely natural but experimental control is limited.

Laboratory Methods

A variety of laboratory methods have been used to evaluate alternate configurations of route guidance signing. Unfortunately, none of these methods has yielded results which completely agree with the findings of field studies. For this reason, a laboratory method cannot be recommended at the present time.

However, the development of a valid and reliable laboratory technique is clearly of paramount importance. Laboratory methods do not require the actual erection of test signs on the highway, permit control of variables which frequently confound field studies, and enable evaluation of many different signing configurations in a short period of time.

There is an opportunity for the States to assist in the development of a feasible laboratory method. Signing improvements are frequently made by State highway departments. Field and laboratory results using the same signs must be compared if an adequate low-cost laboratory method is to be developed. Inclusion of small laboratory studies of new and old signs where a field evaluation is also planned would contribute substantially to laboratory sign evaluation methodology. The following list provides techniques and references for those wishing to pursue this topic. (Further information may also be found in Volume II and Volume III, Part 3 of this report.)

(1) Slide or film presentation methods: Berger (1970), Fegan (1971), Gordon (1971), King and Lunenfeld (1972). The method used by Berger may be of particular interest. The technique is characterized by: 1) groups of subjects are used rather than individuals so large sample sizes are readily obtained; 2) the method is very inexpensive and is not demanding in terms of equipment or experimenter special skills; and 3) some of the results obtained were verified in the field.

(2) UCLA Sign Tester: Hayden (1972).

(3) Driving simulator: Breda, Kirkpatrick and Shaffer (1972).

Controlled Field Methods

In the category of controlled field techniques are the instrumented vehicle (see Volume II) and the eye mark camera used to record eye movements as the driver negotiates a roadway (Bhise & Rockwell, 1972). The eye mark camera is useful for studying dwell time and reading patterns for various signing conditions. It is a sophisticated instrument and requires personnel skilled in its use and evaluation of the results. As a tool for general evaluation of relative effectiveness of guide signs for operational purposes, it is not recommended. However, it is a potentially powerful research tool for studying sign characteristics.

Instrumented vehicles may assume a variety of forms. Most useful for signing evaluation is a vehicle in which various sign configurations are displayed to the driver inside the car. A broad variety of signing alternatives can thus be evaluated without the costly expenditures required for actual roadway signing. Subject variables (e.g., age, sex, familiarity with the route) can be more rigorously controlled than in a field study. Drivers easily make the transition of using the in-car sign display (which provides fictitious destinations) rather than the roadway signs, and the driving task is realistic in that it is conducted under actual traffic conditions.

At a minimum, such a vehicle should be equipped to measure the time the driver requires to read and understand each sign displayed (information interpretation time) and the track of the vehicle as it traverses the test section of highway (which may be recorded by a camera attached to the rear of the vehicle trained on the roadway). In addition, the experimenter must have a means to input particular information to the recording system (such as roadway debris which may necessitate sudden lane changes, thus confounding the results). Additional variables may be measured with suitable instrumentation such as velocity, accelerator and brake pedal movements and various physiological changes (GSR, heart rate, etc.).

The key measures used to date are information interpretation time and the appropriateness of vehicle lane changing maneuvers (scored similar to erratic maneuvers as discussed under Field Methods).

In general, the results obtained with the instrumented vehicle as used by Mast, Chernisky and Hooper (see Volume II) have been verified by field studies. However, interpretation of results may require trade-offs between negative effects of increased information interpretation time and positive improvement as measured by driver lane placement.

There are some disadvantages to the instrumented vehicle as an evaluation tool. It is questionable whether older drivers would adapt as readily to the vehicle as younger drivers. Certainly those with visual accommodation difficulty would have trouble with the in-car display unless it were modified to a head-up display. Only one subject can be tested at a time, requiring many runs and significant time to collect large samples. In addition, the technique requires personnel skilled in electronic instrumentation. Finally, few investigators will have access to an instrumented vehicle. For those planning to evaluate a large number of signing alternatives, however, developing an instrumented vehicle may well be justified.

Field Methods

The traffic engineer is most likely to employ one of the field techniques for evaluating guide sign change. This is often because existing signs are clearly inadequate and there is public pressure to rectify signing deficiencies.

Laboratory and controlled field methods may be inappropriate or there may be inadequate time to employ them before an actual sign change becomes necessary.

The need for continued evaluation of sign changes in the field cannot be overemphasized. Many unanswered questions remain with regard to guide signing. Some field evaluation methods require little expense, but the value of the results is great. However, it is most important that the experiments be carefully designed. Otherwise the results will be difficult or impossible to interpret. Therefore, this section is followed by guidelines on experimental design for field research.

There are two basic categories of field evaluation. These are motorist preference for various sign types and motorist performance. Preference measures may be obtained by 1) stopping motorists and asking them their opinion about the new signs; or 2) asking them to complete a questionnaire; or 3) using an indirect measure of motorist opinion such as the number of letters of complaint (or praise) submitted to a State Highway Administration or motorist organization (e.g., AAA) under each signing condition in a given period of time. Unfortunately, a motorist may indicate that he prefers a new sign but this does not necessarily mean that his performance when using the new sign will be any better than under the old sign. In fact, his performance may be worse. While some believe that the motorist should be given what he says he likes, cost limitations will usually not allow such a procedure unless some other benefit (such as fewer lost drivers or a reduction in accidents) can also be demonstrated.

Finally, there are strong methodological reasons for caution with regard to preference measures. For example, the "halo" or "Hawthorne" effect is a real phenomenon in which something new is preferred simply because it is different and/or the motorist perceives that particular attention is being paid to his needs at a particular location.

For these reasons, motorist preference data should never be used as the sole basis for a field evaluation. Preference measures may, however, be used along with performance measures. A particularly productive procedure in collecting motorist opinions is to ask not only which type of sign is preferred but also why it is preferred. Aspects of a sign which are particularly confusing (or helpful) may be identified in this way. The information may also assist in the interpretation of performance data.

Performance measures describe the way in which drivers negotiate an interchange under different types of guide signing. A number of different measures have been used in field research, and several different methods have been employed to obtain them. Methods, measures, and references are listed below:

(1) Human observers -- erratic (or hazardous or unusual) maneuvers (Graham & Volk, 1972; Mitchell & Davidson, 1972; Orne, 1966; Wyoming State Highway Department, undated) and lane placement by means of lane volume counts (Connecticut Department of Transportation, undated).

(2) Pneumatic tube counts -- erratic maneuvers (Connecticut Department of Transportation, undated; Graham & Volk, 1972).

(3) Radar -- spot speed (Connecticut Department of Transportation, undated; Snyder & Crossette, 1969).

(4) Time-lapse photography -- erratic maneuvers (Hanscom, 1971; Kolsrud, 1972 (see Volume III, this report).

(5) Traffic Evaluator System -- erratic maneuvers, lane placement of exiting and through traffic, proportions of vehicles traveling at low speeds, headway violations (1 second or less headway) (Kolsrud, 1972, (see Voluem III, this report)).

Of the above methods, the Traffic Evaluator System is by far the most sophisticated. It provides the greatest variety of data and data reduction and analysis is done with computer software, thus avoiding very tedious procedures such as scoring time-lapse films. However, the System is very expensive to use and requires a great many diverse skills on the investigative team.

Videotape tape recording is similar to time-lapse photography but more difficult to use. There are problems associated with operating and maintaining video equipment under harsh field conditions. Malfunctions are frequent. Electrical power requirements create more logistical problems in the field in comparison with other techniques. In addition, color video tape recording is not practical at this time. Thus, this technique is not recommended.

The relationship between speed and driver route negotiation difficulty has not been established which argues against using radar speed measurements.

as an evaluation tool. Also, radar coverage is limited to a very small section of roadway making selection of location important. This selection is difficult in view of the lack of knowledge concerning the relationship between speed trajectories and signing effectiveness.

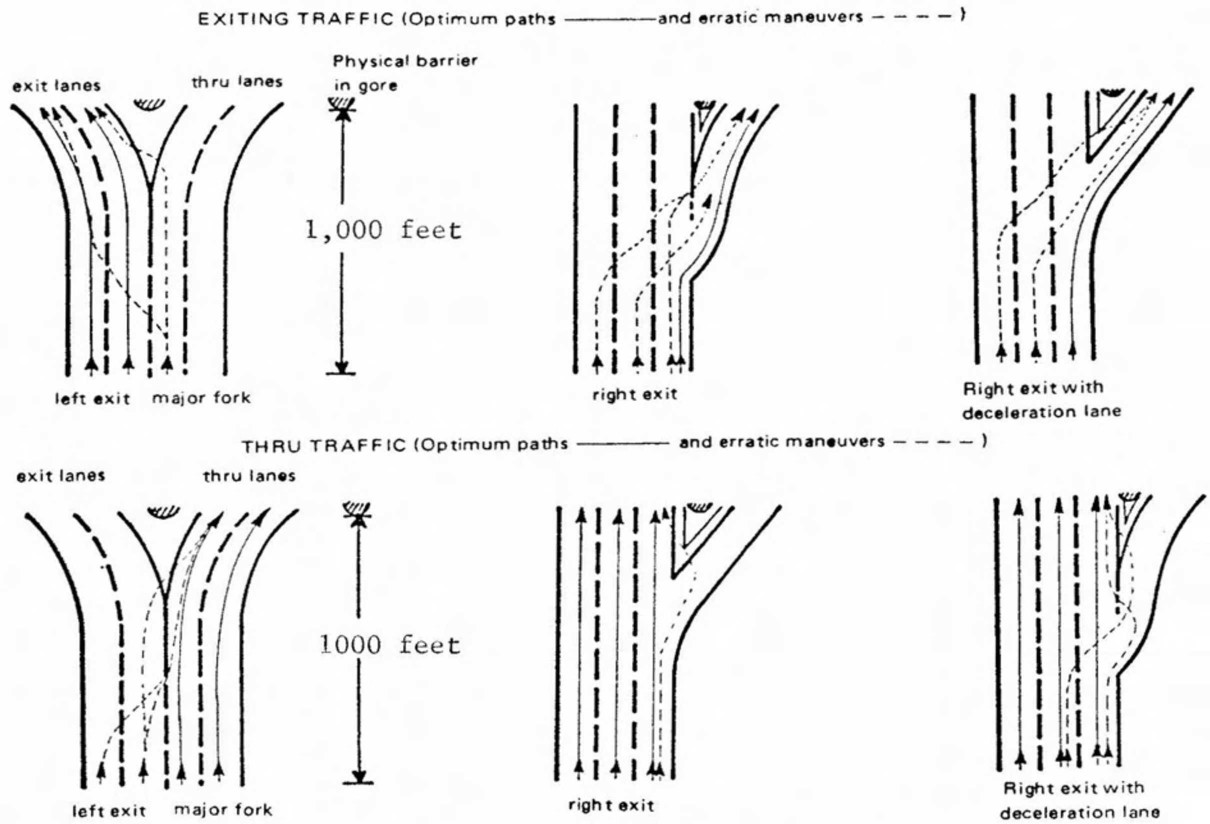
The recommended method for operational evaluation of sign changes in the field is time-lapse photography. This technique is recommended over human observers counting erratic maneuvers or critically placed pneumatic tubes to obtain the same counts because the film provides a permanent record of traffic behavior which can later be reduced and analyzed. Also, a broader spectrum of maneuvers can be counted than with pneumatic tubes. Because there is a permanent record scored at leisure, fewer judgmental errors occur than with human observers scoring maneuvers directly in the field.

The technique is relatively inexpensive. A Super-8 time-lapse camera (which provides better definition than 8 mm but is less expensive to acquire and use than 16 mm) is recommended. The camera should be equipped with variable frame speed and a zoom lens. Cost of a typical high-quality camera such as the Minolta Auto-pak 8 D-10 is about $500 with intervalometer and battery pack. Color film (which assists in scoring) may be obtained in cassettes which last for 30 minutes at two frames/second (a good frame speed for highway data collection). Operation of the camera is simple, a matter of changing the film and ensuring that the field of view remains unchanged. There is no problem in providing electrical power for camera operation. A small battery pack comes self-contained within the camera.

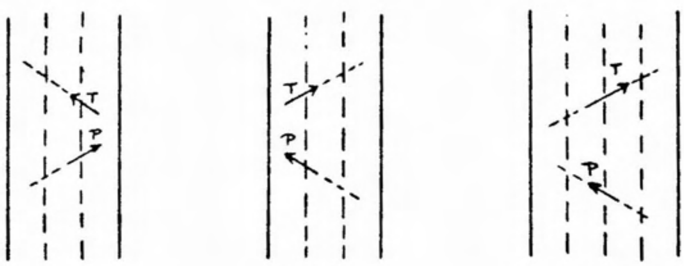
Selection of the field of view is very important. The best location is above and behind the area to be filmed with the camera centered at the mid-line of the field of interest. Overpasses about 1200 feet upstream from the beginning of the area to be filmed are excellent. The maximum area which can reasonably be filmed and easily scored is about 800 feet. The location of the camera to the rear makes the camera and operator inconspicuous, critically important in field work. Cameras may also be mounted on trees, lamppoles, sign standards or, if necessary, on heavy duty tripods. The mount should be rigid because the field of view must remain constant throughout the filming process. The same field of view must, of course, be used under each signing condition evaluated.

From the processed film, total traffic volume or, at gore areas, volume of exiting and through traffic is counted. A variety of erratic maneuvers may then be scored such as stopping in the gore, stopping and backing or last minute lane changes. The last are recommended as they have been related to driver route negotiation difficulty (Kolsrud, 1972; See Volume III, this report).

Erratic lane change maneuvers are deviations from an idealized track or trace through an interchange given a particular destination. The theoretical paths must be defined for both exiting and through traffic (both groups should be studied) and differ for different types of interchange geometry. The following figure shows optimum paths (solid lines) for exiting and through traffic at three types of exit and some of the maneuvers which may be defined as erratic or deviating from these ideal paths (dotted lines). At gore areas, the frequency of erratic maneuvers made by exiting vehicles may be expressed per thousand <u>exiting</u> vehicles and the frequency of erratic maneuvers by through vehicles may be expressed per thousand <u>through</u> vehicles. Such expression permits comparison of these measures across interchanges whereas expression per thousand total traffic volume does not (because the likelihood of an erratic maneuver being made by an exiting vehicle is to some extent a function of the proportion of traffic which actually does exit).



At guide signs upstream from the gore area, different maneuvers must be defined. Such definition should be done in terms of the behavior which will be required at the gore. Two types can be distinguished: "preparatory" and "through" maneuvers. A preparatory maneuver means preparation for exiting. This is movement into the right-most lane for an upcoming right exit or into the left lane for an upcoming left exit. A through maneuver is one which could be related to proceeding through the interchange without exiting. For a right exit interchange, a through maneuver is a lane change out of the right lane. For a left exit interchange, a through maneuver is a move out of the left-most lane. At major forks, preparatory and through maneuvers are movements across the midline from the lanes which will fork in either direction. The figure below shows preparatory and through maneuvers for right exit, left exit and major fork interchanges at an advance or exit direction sign location.



P = preparatory

T = through

— = crossing that must occur for the maneuver to be counted

Right Exit Left Exit Left Exit Major Fork

(At right exits, the lane change must involve the right-most lane but may involve one or more adjacent lanes. At left exits, the lane change must involve the left-most lanes. At major forks, the lane change must involve crossing the midline. No scoring zone is shown since this is partly a function of available camera locations. About 800 feet of roadway can generally be covered which may extend from the sign upstream or from the sign downstream or may be arrayed symmetrically around the sign.)

Since the actual vehicles which will exit are unknown at upstream sign locations, the incidence of preparatory and through maneuvers should be expressed per thousand total traffic volume.

Guidelines For The Design

Of Field Evaluation Studies

1. Before initiating a guide signing improvement project, the investigator should try to be sure that the existing signs are really contributing to the problem.

A high accident rate is not necessarily indicative of inadequate or confusing guide signing. High accident rates may arise from excessive road curvature, perceptual illusions arising from peculiarities of roadway geometry or the surrounding topography, low coefficients of friction of the roadway surface under wet conditions or many other factors. Before considering a change in guide signing, other causes should be evaluated. Helpful in determining the causal factors underlying a problem interchange are:

(1) The particular types of accidents found and the conditions under which they occur.

(2) The reports or complaints filed by motorists about the interchange.

(3) A pilot evaluation of erratic maneuvers and motorist behavior at the interchange concerned. This can be done with paper and pencil. Last minute lane changes across the gore or from outer through lanes into the exit ramp at levels of 3% or more are suggestive of route negotiation difficulty. If possible, a few such motorists might be stopped and asked the reason for their apparent difficulty.

2. Design the study to avoid confounding variables.

Confounding variables arise frequently in field studies. Different weather conditions, construction, and changes in pavement markings can all make results difficult to interpret. There are two confounding conditions which most frequently arise, however. These are a change in traffic population characteristics (proportions of familiar and unfamiliar drivers) and novelty effects.

Clearly, if there are more unfamiliar drivers under one signing condition than the other, there are likely to be more erratic maneuvers under that condition whether or not the signs are changed. To avoid this problem, the recommended procedure is to separate the data collection periods by exactly one year on a day specific basis with sign change well before the after phase data collection period. Weekday specificity is important. If measures are made on Wednesday and Thursday under one signing condition and Saturday and Sunday on the other, there are likely to be more unfamiliar drivers in the last group because more people travel long distances on Saturday and Sunday. The one-year separation also controls for climatic effects and seasonal changes in the traffic population (more people travel in summer than winter).

Novelty refers to short term changes. A sudden change in signs is likely to be noticeable to a driver who frequently drives a particular route. He may react with increased attention to his surroundings, making fewer errors than usual. Alternatively, his performance may degrade because he is devoting excessive attention to the new sign(s). These performance changes are transient and do not reflect the actual value of the signs. The one year separation between measures tends to control for novelty effects, allowing the new sign to fade into the perceptual background of the familiar motorist and making the effects of the new sign on unfamiliar drivers more detectable.

On the other hand, waiting one year has significant risks. A new shopping center may be built changing the driver population, weather conditions may be different one year later, or other variables may intervene. Several days of data should be collected under each signing condition to ensure comparability of at least some days with regard to such aspects as weather. Considerable effort should be expended to ensure that there is no construction, remarking of the pavement, etc. over the intervening year.

It is also recommended that vehicles be counted and coded by manual observers. Coding should divide vehicles into at least two groups: those with local license plates (within the State where the study is being conducted) or an immediately adjacent State if the test facility serves both and drivers from both States use the facility frequently) and nonlocal (all other States). If desired, vehicles may also be coded by type - e.g., autos, trucks. Trucks (especially large ones) are frequently driven by professional drivers. Such drivers may react differently to changes in guide signs than automobile drivers.

3. Experimenter bias should be avoided.

If possible, films should be scored by means of a "blind" procedure. That is, the person scoring the film should not know what experimental condition (before/after) is in effect. This technique is easily implementable when sign changes are not within the camera's field of view.

4. Study the effects of sign change on both exiting and through vehicles.

   Benefits may result for one subgroup, no effect or negative effects for the other.

5. Optimize conditions so that target populations are truly under test.

   The drivers who most use guide signs are those who are unfamiliar with the route. If there are very few unfamiliar drivers in the population, the effect of the change in guide signs on this group will require extremely large samples. The situation can be improved by conducting the study at a time of the year and week when there are proportionately more unfamiliar drivers. Weekends and holidays (e.g., July 4th, Labor Day weekend) especially in summer (when more people travel) are particularly favorable times for measuring changes in guide signs on unfamiliar drivers seeking guidance information.

6. Include a control interchange in the study.

   A control interchange is one where no change in signs is made. When a significant change in motorist behavior is found at the interchange(s) where a change in signs is made, a demonstration of "no change" in performance measures at the control interchange adds considerable strength to the conclusion that the change in performance at the test interchange can be attributed to the change in signs.

7. Even if a change in signs is made only at an advance or exit direction location, be sure to include a study of traffic behavior at the exit or gore location.

   Changes in traffic behavior at upstream signing locations must be carried into the gore as benefits before it can be concluded that route negotiation at the actual choice point has been improved.

8. Detailed study of a change in signs at one interchange is more valuable than collecting data on a number of interchanges and collapsing the results across interchanges.

   Signs, interchanges, and driver populations form an interactive whole. Because of the varying characteristics of interchanges, it is necessary to study each one separately until understanding is sufficient that comparable sites can be defined. Combining results at several sites to reach a general conclusion is likely to obfuscate the real meaning of the results at each individual interchange.

   Related to the above is that adequate data should be collected at each site to permit statistical testing of any differences found in motorist behavior under each signing condition. A z test is useful for comparing the significance of a difference between proportions of vehicles performing erratic maneuvers under each signing condition.

Summary

Time-lapse photography using Super-8 film at two frames per second is the recommended technique for evaluating the relative effectiveness of alternate configurations of guide signs in the field. There should be a one year separation between before and after signing conditions with collection of several days of data in each phase. To maximize the proportion of unfamiliar drivers, data collection on weekends, especially those including holidays in summer is recommended. Erratic maneuvers for both exiting and through vehicles have been defined and both types of vehicles should be studied. Counts of vehicles coded as local and nonlocal (defined by license plate) and by type (auto, nonauto) should be made during the same time intervals as the time-lapse films are made. Adequate data should be collected to permit statistical tests of the results obtained. A z test is useful for testing the significance of a difference between proportions of vehicles performing erratic maneuvers under two different signing conditions.

References

Berger, W. G. Criteria for the design and deployment of advance graphic guide signs. Final Report. Prepared under Contract FH-11-7284, for the National Highway Safety Bureau, Department of Transportation, Washington, D.C., September 1970.

Bhise, V. D. and Rockwell, T. H. Development of a methodology for evaluating road signs, Report No. EES-315-B, Ohio State University, March 1972.

Breda, P. E., Kirkpatrick, M., & Shaffer, C. L. A study of route guidance techniques. Final Report NR72H-229. North American Rockwell Company, Columbus, Ohio, September 1972.

Connecticut Department of Transportation. The study of motorist reaction to diagrammatic signing (Abstract). Bureau of Highways, Office of Traffic, unpublished data, 1972.

Fegan, J. C. A laboratory comparison of conventional and diagrammatic signing using subsidiary tasks. In Diagrammatic Guide Signs for use on Controlled Access Highways Volume II. Laboratory, instrumented vehicle, and State studies. Office of Research, Federal Highway Administration, December 1972.

Gordon, D. A. A laboratory study of diagrammatic guide signs. In Diagrammatic guide signs for use on the national system of interstate and defense highways. Interim research report prepared by Traffic Systems Division, Office of Research, Federal Highway Administration, Washington, D.C., 1971.

Graham, G. A., and Volk, W. N. Evaluation of diagrammatic signing. Wisconsin Department of Transportation, July 1972.

Hanscom, F. R. Evaluation of diagrammatic signing at Capitol Beltway Exit No. 1 Virginia Highway Research Council, Charlottesville, September 1971.

Hayden, C. M. Evaluation of the UCLA sign tests as a design tool. Demonstration Project No. 3. Interim report on a comparison of diagrammatic and conventional signs on the Capitol Beltway. Research and Development Demonstration Projects Division, Federal Highway Administration, Region 15, July 1972.

King, G. F., & Lunenfeld, H. Urban area highway guide signing. Final Report (AIL Report 6566). Prepared for the Highway Research Board, National Cooperative Highway Research Program by AIL, Farmingdale, New York, May 1972.

Kolsrud, G. S. Diagrammatic Guide Signs for use on Controlled Access Highways Volume III. Traffic Engineering Evaluation of Diagrammatic Guide Signs, BioTechnology, Inc., Falls Church, Virginia, December 1972.

Mast, T., Chernisky, J. and Hooper, F. Diagrammatic Guide Signs for use on Controlled Access Highways Volume II. Laboratory, instrumented vehicle and State traffic studies. Office of Research, Federal Highway Administration, December 1972.

Mitchell, R. H., & Davidson, J. N. An investigation of diagrammatical signing to control turning movements at a major intersection. Final Report, Project IHD-6. Illinois Division of Highways in cooperation with Illinois Division, unpublished data, 1972.

National Joint Committee on Uniform Traffic Control Devices. Manual on uniform traffic control devices for streets and highways. U.S. Government Printing Office, Washington, D.C., 1971.

Orne, D. E. Rural freeway operational surveillance used to evaluate symbol signs. Paper presented at the Annual Meeting of the Highway Research Board, Washington, D.C., January 1966.

Roberts, A. W. Diagrammatic sign study. Final Report. Bureau of Safety and Traffic, New Jersey Department of Transportation, in cooperation with the Federal Highway Administration, March 1971.

Snyder, J., & Crossette, J. G. Test of diagrammatic sign at Interstate 30 and S.R. 93. Arizona Highway Department, Traffic Engineering Division, June 1969.

Wyoming State Highway Department. Evaluation of diagrammatic signing. Traffic Engineering Department, undated.

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