Motorists' Reactions to Signing on a Beltway

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Limited-access highways in the form of closed loops (beltways) around urban areas are a relatively new addition to highway geometry and the standards for signing linear routes are not completely applicable to a beltway. Therefore, the principal objective of this study was to obtain and evaluate information from motorists on the kinds of sign messages they need and desire to drive a beltway safely and efficiently.

The Capital Beltway (I-495) around Washington, D.C., was chosen as a laboratory and the motorists who use it as test subjects. Questionnaires were circulated to various groups of motorists to collect comments on the existing signing. The comments were combined with information obtained in a meeting of highway engineers and from work done previously in California to develop three signing concepts.

The building of the Interstate system of highways is bringing into reality a highway form which has been the dream of road builders and motorists since the time of the first central city traffic jam. The through motorist or the man who lives on one side of the central city but works on the other has always believed there should be a bypass or loop around the congested area so that he could avoid it. Many states built bypass routes but, because they were not limited access, they soon became as congested as the primary route through the central city.

The passage of the 1956 Highway Act with its provisions for a system of Interstate and Defense Highways provided an opportunity to build bypass routes which could be protected from the debilitating effects of roadside development. Thus, the dream of high-speed, free-flowing bypass highways is rapidly becoming a reality in city after city. In some cases, the bypasses form a closed loop and have a distinctive route number. In other cases, separate bypass routes are connected by short sections of highway to form a continuous highway loop or beltway. In either case, the benefits are manyfold but there are also problems. The purpose of this paper is to explore one set of problems which the closed highway loop, hereafter referred to as the beltway, creates; namely, those related to signing.

The historical experience of the highway engineer has been with linear routes between major points or routes radiating from a central city. Rules and guidelines have grown from this experience and have been formulated into signing manuals such as the "Interstate Sign Manual" (7) and the "Uniform Manual" (10). Thus, when it came time to sign the first beltways, the same freeway signing practices used on linear routes were applied to the beltway. As the signing engineer soon learned, the combination of close interchange spacing, a multiplicity of communities around the urban center and a route with neither beginning, end, nor direction makes a beltway and its intersecting routes particularly difficult to sign using practices developed for linear routes.

The principal objective of this study was to obtain and evaluate information from motorists on the kinds of sign messages they need and desire to drive a beltway safely and efficiently. The Capital Beltway, I-495, around Washington, D.C., was selected

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as the laboratory and the motorist using it as test subjects. All signing on and leading to the Beltway was inventoried along with that on selected radial routes. This provided the study with a set of present conditions which are described in the section dealing with the laboratory.

The next step was to establish contact with Beltway users. After reviewing and discarding a number of methods, it was decided to use two variations of a basic questionnaire. One of these was directed at motorists who had used Citizen Band radios to call for help in finding their way. The other was to circulate a questionnaire to a typical cross section of area residents as found in a centrally located government office building. These two studies were then compared with a survey of Beltway users conducted by the D.C. Division of the American Automobile Association through its monthly magazine.

These three surveys combined produced over 900 written responses for compilation and review. Each study is described, and detailed results are presented, in a following section. Another phase of the study, in which field observations were made of driver behavior at selected interchanges, is also included.

A unique phase of the study was a meeting of six highway engineers who have responsibilities for, or close association with, freeway signing. This group provided a professional viewpoint with which user comments could be compared.

An effort was made to obtain accident information, but inquiries of state officials involved indicated that a correlation between signing and accidents had not been established from available accident reports. Specific reports examined by the researchers provided no clues directly relating signing with accidents. The inability to ascertain any valid connection through report interpretation caused abandonment of this approach.

The conclusions drawn from the collected data are set forth in the final section and summarized briefly below.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

If a single word could summarize the findings of this study, the one chosen would be "orientation." The comments from motorists, the statements of the experts and the observations of the study staff all lead to the same conclusion.

A motorist on a freeway is isolated from the world around him. He is rarely able to slow down safely to really deliberate about the decisions which face him and must, therefore, be led along in such a way that he is confident of where he is at all times. His landmarks are guide signs and on these he must rely for complete, accurate and understandable information. The challenge of freeway signing then is to keep the driver continuously informed of his general location with respect to destination and optimum routing. The principles of effective freeway signing are embodied in the following three concepts:

Concept 1: Provide orientation through the consistent application of a series of sign elements which will provide sequential and confirmatory information for the motorist. From all that could be learned as the investigation progressed, it appears that the interchange sequence sign is an effective means of achieving this required continuity. The interchange sequence sign should be made a standard element of freeway signing when the freeway is a beltway. It also has application on other freeway routes.

Concept 2: Establish route numbers and route names as the primary elements of interchange guide signs and reserve the use of place names for selected locations where they give the motorist directional orientation which could not otherwise be provided. Although the investigation revealed a pattern similar to previous studies in regard to the items of directional information used, a willingness was detected to operate increasingly with the names and numbers of principal routes, particularly the Interstate system. This leads logically to an emphasis on route names and numbers as primary signing elements and a phasing out of place names on freeway signing, except under conditions where important place names can provide optimum directional orientation for the motorist.

Concept 3: At the interchange of a radial route with a beltway, limit signing destinations to route intersections, regional areas and identifiable physical features on the
beltway route, and exclude destination names except as a supplemental guide not nor-
mally repeated in the interchange signing sequence. This third concept developed from
the second and deals primarily with the problem of providing directional orientation
to the driver on a linear route intersecting a beltway. Closed loop facilities do not have
readily definable directional characteristics and thus cannot be signed effectively with
cardinal directions. Place names are not an effective alternate because the satellite
communities along the beltway are often little more than bedroom towns for a large
central city. However, the finding that motorists do recognize the Interstate system
route numbers reinforces this third concept which suggests the use of major route in-
terchanges around a beltway as destination points which the local stranger will recog-
nize and which the out-of-the-area driver can easily identify on a map. Rest areas on
major radials which are equipped with a large scale map, plus smaller printed ones
for motorist use, would be major aids in supporting a change to a route number desti-
nation system.

From these concepts, specific criteria can be drawn for each of the eleven elements
in freeway signing. The project revealed three areas where additional studies would
provide insight into motorists' needs in freeway signing. One deals with a means of
measuring motorist reaction to signing through field observations. The initial work
undertaken here indicates that relatively short periods of observation can reveal prob-
lem locations. The second study suggested by this research is an in-depth analysis
of driver behavior as affected by signing, under conditions of familiar surroundings
compared with unfamiliar surroundings. Such a study under controlled conditions would
help to verify the concepts developed in this paper. A third study which would help to
resolve many existing problems would be expanded research on the use of symbols on
freeway guide signs, particularly in conjunction with a beltway.

THE LABORATORY

One of the first interstate "beltways" to be completed was around Washington, D.C.
Designated the Capital Beltway (I-495), it forms a continuous 66-mile loop passing
through Maryland and Virginia and twice crosses the Potomac River, which separates
the two states. The loop is on a radius of 7 to 11 miles from mile zero on the south
lawn of the White House. Figure 1 shows Washington and the Beltway in relation to the
regional highway network. Figure 2 shows the route in relation to the central city.
Portions of this route were opened as early as 1962 but the final link was not opened
until November 1964. Specifically regarding signing, the Maryland sections were
opened with temporary signs which were replaced in a series of sign contracts ending
in mid-1965. Virginia, on the other hand, installed permanent signs with each roadway
contract but has been changing and installing additional signs throughout 1965 and early
1966.

Figure 2 shows that the loop is intersected by Interstate Routes 95, 66, 270, 70-S
and 295. Except for I-270, each of these will penetrate to the central city but as yet
none has been built and only I-95 on the south side of the city has been signed as an I-
route. US Routes 1, 50 and 29 pass through the central city and, except for US 29, in-
tersect the Beltway on each side of the loop. US 29 has an interchange on the north
(Maryland) side of the loop but not on the west (Virginia) side where routes US 50, US
29 and I-66 parallel each other. There is less than one mile between the two outside
routes (US 50 and I-66) and consequently no room for an interchange with US 29.

Three parkway routes intersect the Beltway. Two parallel the Potomac River, one
on each bank, and carry the same name—The George Washington Memorial Parkway.
The one on the Virginia side is a radial route to downtown; the one on the Maryland
side is not completed. The other parkway, the principal route between Washington and
Baltimore, is the Baltimore—Washington Parkway. None of the parkways are open to
trucks and none carry a route number.

These 11 routes account for 13 of the 37 existing interchanges on the 66-mile loop.
Two additional interchanges have been provided for in the exit numbering scheme, one
of which will be for I-95 on the north side of the loop in Maryland. The other inter-
change will be used by either the North-Central Freeway or the proposed Northern
Figure 2. The Capital Beltway (I-495) and its relationship to Washington, D.C.

Parkway or by both, depending on development of these two proposed systems. Thus, of the total of 39 interchanges, 25 have been allocated to state primary and secondary routes.

The 37 interchanges now open to traffic embrace a wide variety of types and a broad range of signing problems. The most commonly used interchange type is the cloverleaf, but there are some with direct connections, others with collector-distributor roads, a few diamonds and trumpets and 11 where there are ramps missing or the interchange does not otherwise permit travel in both directions between all of its legs. Table 1 gives the number of each type.

In summary, the Capital Beltway, as a laboratory, provides a route which is under the jurisdiction of two state highway departments (except for 800 feet which is in the District of Columbia) and embraces a wide variety of signing problems due to varying interchange types and adjacent land uses.
### Table 1

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<th>Diamond</th>
<th>Direct or Semi-Direct</th>
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<td>Full Partial</td>
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**NOTES:**

1. Incomplete is defined as an interchange where one or more of 8 possible turning movements is omitted.

**Sign Inventory**

In order to evaluate the existing signing, an inventory of all guide signs on the Beltway and on each cross route where there was an interchange was conducted between mid-July and mid-August 1965. Several methods to accomplish the inventory were explored. Photography was finally selected on the basis of the accurate reproduction of the messages and their relationship as well as relative size and location of the sign boards. This method was also felt to present the least exposure to hazardous situations, because the photographer could stop his car, take the picture and be on his way again in a matter of a minute or two.
The photographs obtained were enlarged so that the letter height on each sign was a uniform size. They were then collated by interchange and all the signing for a particular interchange spotted on a plan view obtained from either the Virginia State Highway Department or the Maryland State Roads Commission. Figure 3 shows a typical diamond interchange after all the photographs were mounted and the relative sign locations spotted.

Evaluation

Each interchange was then evaluated for conformance to the Interstate sign manual and for agreement with the six principles of signing set forth in a 1958 study of freeway signing in California by Schoppert, Moskowitz, Hulbert, and Burg (1). As for the Interstate signing standards, the signing could be classed as being in reasonable conformance if all the options and alternatives were considered. However, it was also readily apparent that each state had used different alternatives and the uniformity from state to state left much to be desired.

The six principles of freeway signing set forth in the 1958 study are as follows:

1. Interpretation—All possible interpretations and misinterpretations must be considered in phrasing sign messages (words and symbols).
2. Continuity—Each sign must be designed in context with those which precede it so that continuity is achieved through relatively long sections of highway.
3. Advance Notice—Signing must prepare the driver ahead of time for each decision he has to make.
4. Relatability—Sign messages should be in the same terms as information available to the driver from other sources, such as touring maps and addresses given in tourist information and advertising.
5. Prominence—The size and position, as well as the number of times a sign or message is repeated, should be related to the competition from other demands on the driver's attention.
6. Unusual Maneuvers—Signing must be specially designed at points where the driver has to make a movement which is unexpected or unnatural.

The review of the signing on the basis of these six principles pointed up numerous violations which the questionnaire studies later confirmed to be problem locations. The following are examples of some of the kinds of problems encountered.

Interpretation—
1. Two adjacent interchanges, one in Maryland and the other in Virginia, intersect roads with the same name and no indication of the state. Neither road has a route number. (The situation has been partly corrected by removing the road name from one set of signs.)
2. An interchange was signed for Va. 7 eastbound but the motorist was left to discover at the next interchange that there was no exit for Va. 7 westbound. (A supplemental guide sign has now been installed to overcome this situation.)

Continuity—
3. Mileage signs in Maryland use the destination "Richmond" but those in Virginia use "Route 95" to give guidance to the same interchange.

Relatability—
4. Road maps of the Beltway do not show all interchanges or, if the scale is large enough to show interchange ramps, do not show them accurately. This is particularly confusing at partial interchanges.

Prominence—
5. In a few cases, the route name completely overpowers the destination and the motorist is left wondering where his desired exit is.

Unusual Maneuvers—
6. Collector-distributor roads are used at only a few locations and thus become places where unusual maneuvers are required. The distinctions in the signing between these interchanges and the standard cloverleaf are minimal.
7. The left exit and entrance are rare events in the same sense as the C-D road, but their treatment does not give the motorist the information he needs to be properly located for his exit maneuver.

STUDIES Conducted

Questionnaire Survey by AAA

Shortly after the project was started, it was learned that the D.C. Division of the American Automobile Association was going to conduct a questionnaire survey on the Capital Beltway. The survey form was to be printed in "American Motorist," the monthly publication of the D.C. Division. The magazine has a circulation of 170,000, with 110,000 of these being heads of households or the principal AAA members. Approximately 37 percent of the readers reside in the Maryland counties and 30 percent in the Virginia counties adjacent to the District of Columbia. The remaining 33 percent are located in the District of Columbia.

An arrangement was made with the editor of "American Motorist" to permit the researchers to review responses to the questionnaire printed in the September 1965 issue of the publication. Figure 4 is a reproduction of the questionnaire.

Survey of Requests for Road Directions by Radio

A national organization of citizens' band radio operators provides emergency aid to persons who call in on their CB radios. The organization, known as Radio Emergency Associated Citizens' Teams (REACT), has a chapter in Washington, D.C., which monitors emergency calls on Channel 9 on a 24-hour basis. Since these units are often mounted in vehicles of all types, they are a convenient means of requesting road directions when the motorist with such a unit becomes lost.

Through the cooperation of the local REACT chapter, a review of emergency call log books was made. This showed a monthly average of 50 direction assistance calls from persons driving on the Beltway. To tap this potential source of information, a mail questionnaire was sent to those persons who made contact between mid-June 1965 and March 1, 1966. Figure 5 shows the letter and questionnaire which were sent. A map was also enclosed for reference. The questionnaire is very similar to the one used in the AAA survey in order to provide comparability.

A total of 312 persons were contacted. Of these, 51 lived in states other than Maryland and Virginia, and 44 lived in these two states but more than 10 miles beyond the Beltway. The remainder had local addresses.

Questionnaire and Interview Study in BPR

As the driver survey proceeded, it became obvious that some means would have to be found to contact and talk personally with those who used the Beltway. Several schemes were explored but the complexity and cost of contacting a wide audience which would represent all sections of the metropolitan area were serious drawbacks. Finally, the large concentration of government offices in the District of Columbia triggered the idea of conducting interviews in one of these. It was reasoned that such an office would draw in reasonable proportion to the distribution of population in the metropolitan area. After consideration of what agency might be used, the U.S. Bureau of Public Roads' offices in the Matomic Building in downtown Washington were selected on the bases of easy access and least cost.

The questionnaire shown in Figure 6 was prepared using questions similar to those in the REACT survey and the AAA survey. Four hundred of these were circulated in mid-April 1966 to BPR personnel in the administrative, legal, contract and other divisions which do not have direct responsibility for roadway signing. Figure 6 also shows the cover letter which was circulated with the questionnaire.

Ten percent of the respondents to this questionnaire were then selected for a 20-minute personal interview.
Your participation in this survey by describing a recent trip that you took which utilized the Beltway around Washington, D.C. (Interstate 495), or a portion of it will provide us with a basis for a thorough analysis of the signing and usefulness of this facility. Both successes and failures are important. Therefore, even if you have had no difficulty in using the Beltway we would like you to fill in and return this survey form to Public Relations, D. C. Division—AAA, 1712 G Street, N.W., Washington, D.C. 20006.

To describe your trip as it actually occurred, please answer the following questions (use the accompanying map to aid you in answering the questions).

1) Where did your trip start?  
   Street Address  
   Name of Community

2) Where did you go?  
   Street Address  
   Name of Community

3) Where did you get on the Beltway?  
   Interchange No.  
   Route No.  
   Street Name

4) Where did you get off the Beltway?  
   Interchange No.  
   Route No.  
   Street Name

5a. Was this a trip which you had made on a previous occasion? □ Yes □ No.  
   b. If yes, how often do you make this trip?  
   Number of times per day, or week, or month

6) In selecting the route for this trip did you:  
a) Use a map  
b) Ask someone who had made the trip before  
c) Call the AAA for directions  
d) Other: Specify

7) What was the purpose of this trip?  
   a) Work  
   b) Recreation  
   c) Social  
   d) Emergency  
   e) Other: Specify

8) What time of day did you make this trip?  
   □ Daytime □ Nighttime

9) Did you have any trouble locating the place where you wanted to:  
a) Get on the Beltway? □ Yes □ No  
b) Get off the Beltway? □ Yes □ No

10) If your answer to either or both parts of Question 9 is "yes" please describe in your own words what problems you encountered. Include the following specific points in your description:  
a) The entrance to and exit from the Beltway you planned to use if they were different from the interchanges you actually used (questions 3 and 4).  
b) The cues you looked for to tell where to get on and/or off the Beltway.  
c) Signs which you saw which were misleading or different from what you expected.

Use additional sheets if necessary to complete your answer to Question 10 or to present other comments and ideas.

Figure 4. AAA questionnaire.
CAPITAL BELTWAY SURVEY

Please describe your trip as it actually occurred, by answering the following questions. You may use the accompanying map to aid you in answering.

1) Where did your trip start?  
   STREET ADDRESS OR NEAREST INTERSECTION NAME OF COMMUNITY

2) Where did you go?  
   STREET ADDRESS OR NEAREST INTERSECTION NAME OF COMMUNITY

3) Where did you get on the Beltway?  
   INTERCHANGE NO. ROUTE NO. STREET NAME

4) Where did you get off the Beltway?  
   INTERCHANGE NO. ROUTE NO. STREET NAME

5a. Was this a trip which you had made on a previous occasion?  
   Yes No

b. If yes, how often do you make this trip?  
   NUMBER OF TIMES PER DAY, PER WEEK, OR MONTH

6) In selecting the route for this trip, did you:  
a) Use a map  
b) Ask someone who had made the trip before  
c) Ask a service station for directions  
d) Other: Specify

7) What was the purpose of this trip?  
a) Work  
b) Recreation  
c) Social  
d) Emergency  
e) Other: Specify

8) What time of day did you make this trip?  
   Daytime Nighttime

9) Was the trouble which you had in relation to the place where you wanted to (please check appropriate boxes)?  
a) Get on the Beltway?  
b) Get off the Beltway?  

10) Please describe on the reverse side what problems you encountered. Include the following specific points in your description:  
a) The entrance to and exit from the Beltway you planned to use if they were different from the interchange you actually used (questions 3 & 4).  
b) The cues you looked for to tell where to get on and off the Beltway.  
c) Signs which you saw which were misleading or different from what you expected.

Upon completion, please return this form in the enclosed, postpaid, addressed envelope. Thank you for your cooperation.

Figure 5. Survey form and cover letter used in survey of REACT group.
OFFICE OF HIGHWAY SAFETY

TO: Bureau Employees

We would like to have your response to this questionnaire on the adequacy of beltway signing. Please complete the heading giving your telephone number and room number because a limited number of personal interviews will be held to obtain further information.

If your answer to question No. 1 is "No", you are finished. Please return the questionnaire, nevertheless.

If you have had experience in driving the beltway the answers to the other questions will be helpful in developing future policy on signing for similar situations.

Please return the completed questionnaire to your administrative office the same day you receive it. Your cooperation will be sincerely appreciated.

CAPITAL BELTWAY SURVEY

None ____________________________ Telephone extension ________

Room number ____________________________ Telephone extension ________

Home address ____________________________ Telephone extension ________

1. Have you ever driven on the Capital Beltway (1-495)? Yes ____ No ______

2. If answer to #1 is "Yes", please answer the following questions:

A. When was the last trip you made on the Beltway? ____________________________

B. How often do you use the Beltway? ____________________________

C. What was the purpose of the most recent trip you made on the Beltway? Circle one of the following:
   a) To shop  e) On business
   b) Go to work  f) To attend a meeting
   c) Go to a place of recreation  g) For medical care
   d) To visit (social)  h) Other (specify) ______

D. How did you select your route the first time you used the Beltway? Circle one of the following:
   a) Asked a friend  d) Followed signs
   b) Asked along the road  e) Used a map
   c) Knew the route  f) Other (specify) ______

E. Have you ever had problems finding your way at any time when you used the Beltway? Yes ____ No ______

F. Do you have any suggestions which would make the Beltway easier to drive on? Yes ____ No ______

Thank you for your cooperation.

Figure 6. Survey form and covering memorandum used in survey at U.S. Bureau of Public Roads.

Field Observations of Driver Actions

To determine the kinds and approximate number of unusual actions that drivers may be making on a typical day of Beltway traffic, field observers were stationed at selected interchanges on the Beltway over a period of 2 weeks in late August and early September 1965. Two men were stationed at a point where they could observe the entire interchange area. They were instructed to record the action observed, the time of its occurrence, the direction of movement, and the location within the interchange. A typical entry read: "10:45 a.m.—vehicle stopped on shoulder beyond gore in Area H. Driver looked at map, backed up, took ramp H to I."

The letters were used to designate each merging and diverging area so that observations could be translated in the office into specific locations. Where two observed interchanges were close together, an eight-hour observation day was split between them, for example: Interchange A—10:30 to 12:00; Interchange B—1:00 to 2:30; Interchange A—3:00 to 4:30; Interchange B—5:00 to 6:30. Allowance was made for travel time over
TABLE 2
STUDY SITES FOR FIELD OBSERVATIONS

<table>
<thead>
<tr>
<th>Interchange No.</th>
<th>Route No.</th>
<th>Hours of Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>US 1 (Va.)</td>
<td>3½</td>
</tr>
<tr>
<td>4</td>
<td>I-95 (Va.)</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>US 50 (Va.)</td>
<td>3½</td>
</tr>
<tr>
<td>9</td>
<td>I-86 (Va.)</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>I-270 (Md.)</td>
<td>5</td>
</tr>
<tr>
<td>19</td>
<td>I-706 (Md.)</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>Md. 193</td>
<td>2</td>
</tr>
<tr>
<td>23</td>
<td>US 29 (Md.)</td>
<td>3½</td>
</tr>
<tr>
<td>27</td>
<td>US 1 (Md.)</td>
<td>3½</td>
</tr>
<tr>
<td>29</td>
<td>Baltimore-Washington Parkway (Md.)</td>
<td>6</td>
</tr>
<tr>
<td>31</td>
<td>US 50 (Md.)</td>
<td>3½</td>
</tr>
<tr>
<td>38</td>
<td>I-295 (Md.)</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL 12 Interchanges</td>
<td></td>
<td>47½</td>
</tr>
</tbody>
</table>

Much work has been done over the years to bring about the present high quality of freeway signing in size of lettering, shape of letters, color, placement, reflectivity and illumination. These achievements are the result of countless tests and observations of driver reactions both in the laboratory and in the field.

The combination of all these elements results in a series of messages which should tell the driver, in such a way as to be understood in a matter of seconds, how to get from place A to place B. On a local road, if the motorist gets lost or makes a wrong turn, he can always ask directions, back up or turn around. On a freeway there is no such readily available information source nor can backing and turning be done indiscriminately and without hazard.

It might be expected that studies of what sign messages should say would be almost as prolific as other technical studies, but such is not the case. Those which have been made have advanced the state of knowledge, but there is still much to be done.

RESULTS OF STUDIES

"I have no problems now that I have driven the road a few times." This statement was repeated many times both in written comments and the personal discussions which are reviewed in the following paragraphs. It is also a perfect statement of the problem with which this report deals; namely, what is the motorist looking for in roadway signing?

Summary and Comparison of Collected Data

Comparison of the places where deficiencies were noted from the inventory with field observations at selected interchanges showed that inadequately signed locations generated higher percentages of error. Field observation suggests a "normal" level of motorists experiencing difficulty of approximately 0.2 percent of all traffic entering a specific interchange approach. If the number having problems exceeds this level, there is an indication that signing needs review.

Briefly, the three surveys of motorist opinion tapped different strata of users. The REACT survey produced responses which were relatively "earthy" in that there was little effort to analyze the "why" but simply an expression of problems encountered. The BRP study group was not specifically asked for comments but those who volunteered them were more inclined to suggest a solution than to pinpoint a specific problem location. While some were quite knowledgeable about road design, others were typical drivers motivated by a desire to simplify their driving task.

These two groups can be contrasted with the group responding to the AAA survey. This group, possibly because it was contacted within a few months after the Beltway was opened, identified more specific problems than any other group. They also offered numerous suggestions for improvements. The AAA group represented on the whole the opposite end of the spectrum from the REACT group in that most of the respondents appeared to be sophisticated motor vehicle users who were aware of problems and the need for their solution.

The project was mutually aided by each of the three sources of information. Findings in each group supported information gathered in the others and together they
generated in the researchers a feeling for the freeway signing needs and wants of motorists.

Simply expressed, the freeway driver who is not familiar with the route is seeking guides that will orient him to fixed points which he recognizes. Losing this contact may cause erratic actions or an incorrect turnoff. Interesting data (beyond the scope of this study) on driver behavior as an effect of signing could be obtained from comparisons of freeway drivers in areas with which they are familiar and areas with which they are not.

As was noted previously, some of the data collected in the three studies were identical. This information is summarized in the following paragraphs, after which findings unique to each study are presented.

Percent Reporting Problems

Fifty-two percent of the BPR group reported difficulty in using the Beltway. This compares with 43 percent of the AAA group who reported problems. The higher percentage in BPR could be a result of six months' additional driving experience in which to identify problems on the Beltway. In both cases, this is a large proportion to respond YES to the question, "Do you have any problems in driving the Beltway?"

In the case of the REACT group, these were preselected and only persons who had problems were contacted.

In response to a question about whether the problem was leaving or entering the Beltway, 73 percent of the REACT group indicated it was leaving, 12 percent entering and 15 percent both. In the AAA survey, these figures were 50 percent off, 37 percent on and 13 percent both. The relatively small size of the REACT sample could have had an effect on these percentages but they still reveal that the most serious area of concern was how to leave the freeway.

The BPR group was not asked to classify the location of their problem.

Division of Responses by Jurisdiction

A review of census information shows that the population in the Washington, D.C., Standard Metropolitan Statistical Area is distributed among the three jurisdictions as shown in Table 3. Also shown are the percentages of responses from each jurisdiction in the three surveys which were made.

Because of long-range plans to move BPR into Virginia, there is some bias in the response from this group to Virginia. However, the AAA response is slightly heavier in Maryland when compared to the SMSA population. The REACT group's base radio station is located in Maryland and thus it is logical that these returns would have a strong bias toward this state. However, the relative number of REACT responses was so small that overall it can be stated that the total of all samples was representative of the population outside of the District of Columbia. The small return from D.C. was expected based on the limited usefulness of the Beltway to central city residents.

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>SMSA</th>
<th>BPR</th>
<th>REACT</th>
<th>AAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryland</td>
<td>35</td>
<td>36</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>Virginia</td>
<td>27</td>
<td>46</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>D.C.</td>
<td>38</td>
<td>16</td>
<td>20</td>
<td>12</td>
</tr>
</tbody>
</table>

Excluding D.C.

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>SMSA</th>
<th>BPR</th>
<th>REACT</th>
<th>AAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryland</td>
<td>57</td>
<td>43</td>
<td>88</td>
<td>63</td>
</tr>
<tr>
<td>Virginia</td>
<td>43</td>
<td>57</td>
<td>12</td>
<td>37</td>
</tr>
</tbody>
</table>

Frequency of Use

A comparison of Beltway usage between the BPR groups and the AAA groups shows that while daily trips are approximately equal (14% vs 19%), there are only half as many in the BPR group who classify their usage at less than once a month. On the other hand, twice as many in the BPR group use the Beltway several times each week as did the AAA group. The REACT sample was too small to be meaningful in this comparison.
Trip Purpose

The predominant trip purpose among all three study groups was social-recreation, with percentages ranging from 62 to 69. Work was the second highest with 24 percent in two cases and 19 percent in the REACT group. This latter figure compares with the 1955 Transportation Study which showed work accounting for 41 percent of the automobile trips in the Washington area.

Route Selection

A question which was asked of all three groups was the means used to select the route used on their first trip on the Beltway. Among the BPR respondents 38 percent reported using a map. This compares with 47 percent in the REACT group and 56 percent in the AAA survey.

The number asking for information varied widely ranging from 9 percent for the BPR group, to 20 percent for the AAA survey to 37 percent for the REACT respondents. The other items within each group are not comparable due to variation in tabulation but it is interesting to note that when specifically suggested as an alternative, 26 percent of the BPR group chose "Followed Signs" as their means of route selection.

AAA Questionnaire

The most significant benefit from the AAA questionnaire was obtained from question 10, which asked for comments. Eighty-four percent of the 520 responses contained comments about some aspect of the Beltway. These ranged from brief comments to detailed six-page handwritten critiques. Constructive comments far outnumbered those that could be classed as "sour grapes." In analyzing the comments, only those which pertained to the signing were selected and catalogued under the following headings:

1. "Signs are poor; not enough advance warning."
2. "Signs are confusing."
3. "________ (a specific location) is not included on the signs."
4. "The names of distant cities are misleading; more local names should be used."
5. "The names of local places are meaningless to the stranger."
6. "Incomplete interchanges should be marked."
7. "When interchanges with important routes are omitted, signs should indicate alternate routes."
8. "There is need for specific distinctions between interchanges with two exit points and those with only one."
9. "Roads with similar names cause confusion."
10. "More trailblazers are needed to direct motorists to the Beltway."
11. "Exits which are 'poorly' designed need special signing."

The locations mentioned most often by motorists were compared to the locations that were inadequate in regard to the principles described earlier. In every case there was a violation of principles and the motorists' comments confirmed this. The specific problems thus described were most helpful in formulating the concepts and criteria set forth later.

Cues Used by Motorists

Question 10 on the AAA survey also asked drivers to state cues they sought when driving. A relatively small number responded with a specific answer but these disclosed some interesting relationships.

The cue most mentioned was "Exit Number" with a total of 15. Route name was second with 11 mentions, and then route number and place names, with 8 and 7 mentions, respectively.

Eight persons found cardinal directions to be useful cues but six wanted to use clockwise and counterclockwise on the Beltway. Four suggested a stylized map on the approach to the Beltway might be helpful. On the other hand, 13 commented that cardinal
directions on a directionless loop were confusing. (Virginia uses the cardinal direction on its Beltway signing; Maryland does not.)

Survey of Requests for Road Directions by Radio

Approximately 25 percent, or 85 returns were received from the mailed questionnaires. However, this total included 19 returned as non-deliverable and 17 from people who could not recall the problem they had or who were REACT members who called in to help motorists without radios who were in difficulty. The latter group did not recall the specific incident in enough detail to report on it. Thus, there were 49 usable responses, about 15 percent of the sample.

This survey was able to contact both strangers and local residents. Several comments were common to both groups, such as: (a) partial interchanges cause a problem; (b) maps do not show interchanges clearly; (c) when exit numbers are used, they should be repeated on each sign in a sequence; (d) travel speeds are too high for the road; and (e) there is not enough advance warning. Although not specifically stated, there was noticeable feeling of anxiety among many of those who responded to the questionnaire.

Beltways, like many urban freeways, have relatively short average interchange spacing compared with rural freeways. Thus, several people spoke of the lack of advance warning and the need for an advance sign two miles from the exit ("Like on the New Jersey Turnpike"). This is impossible on the Beltway in many places. Also, there were complaints of high speeds and lack of time to make decisions. A rural freeway driver is conditioned to a fairly long interval between interchanges, giving him time to recover from decision-making processes concerning the previous interchange. On an urban freeway, these decisions must be made as often as every 60 seconds and in some places on the Beltway within 45 seconds. For a driver who does not use the Beltway frequently and is not thoroughly familiar with its interchanges, this appears to be a decision-making rate approaching his capacity under the existing system of signing. This system does not provide a continuum of information, but rather individual pieces which must be processed for each interchange.

Other Comments

There were numerous other comments among the 33 persons reporting difficulty on the Beltway. In addition, several suggestions were made for such things as rest areas with maps, pictorial signs of the Beltway, additional roadway lighting, telephones, and more overhead signs. As in the AAA survey, the responses were generally constructive and indicated appreciation of the Beltway as a useful new road.

Questionnaire and Interview Study in BPR

Response to the questionnaire portion of the BPR survey was excellent. Within two weeks, 337 responses had been returned. Approximately 25 percent of the respondents made written comments about many aspects of the Beltway even though comments were not specifically requested. A total of 75 comments were received on signing, and 65 on other aspects ranging from speeding through design features to maps. In the latter group, 13 comments were received dealing with some aspect of speed such as slow traffic keep right, minimum speeds, or that speed is too high for the traffic. Another 38 comments dealt with various design features of the road, with lane drops, both at pavement width transitions and at interchanges, being mentioned most often. Inconsistency of interchange types and driver inability to identify the type being approached were mentioned in 8 of the 38 comments on design features. Several respondents suggested the need for improved maps and urged that exit numbers be shown on all maps.

Of the 75 comments directed specifically to signing, approximately one-third dealt with problems at specific locations. All dealt with the same locations mentioned in the AAA survey, but each location was only mentioned a few times since comments were not specifically requested. No new locations were mentioned. Another 40 percent of the comments on signing were directed to the messages used. Again, depending on the
point of view, comments on place names suggested that strangers needed more distant points; area residents needed more local names; and a third group felt that there were too many local names. Among those who use exit numbers, there were several suggestions for consistent and complete placement of such numbers if they are to be used.

Cardinal directions was the subject of about 12 percent of the comments on signing. Some said, "Do not use on a beltway." Others said they should be used, and a few suggested clockwise and counterclockwise in place of cardinal directions.

The remainder of those who commented (about 12%) summarized their feelings in the phrase, "Not enough advance warning." The phrase is most puzzling because it tells nothing of the real problem. However, a better idea of what was meant was obtained in the personal interviews which are described next.

The Personal Interviews

Approximately 10 percent of those who returned a questionnaire were requested to have a personal interview. The researchers were permitted to use a desk in the BPR offices and over a two-week period contacted 33 persons for a 20-minute personal interview. The interview was unstructured and each person was encouraged to describe the problems he or she had while driving on the Beltway. Often in describing their problems, general suggestions were made after which the interviewer tried to obtain specific comments on the portion of the sign message which was most helpful, the understanding of cardinal directions and preferences in regard to sign location.

In selecting interviewees, a larger percentage of women were included than actually responded to the questionnaire. Maryland residents had fewer comments than Virginia residents, and thus fewer of the former were included in the sample. The characteristics of the sample are as follows:

<table>
<thead>
<tr>
<th>Total Interviewed</th>
<th>33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>23 (70%)</td>
</tr>
<tr>
<td>Women</td>
<td>10 (30%)</td>
</tr>
<tr>
<td>Maryland Residents</td>
<td>9</td>
</tr>
<tr>
<td>D. C. Residents</td>
<td>3</td>
</tr>
<tr>
<td>Virginia Residents</td>
<td>21</td>
</tr>
</tbody>
</table>

Interview Responses—Face-to-face discussion with actual Beltway users was a most useful adjunct to the study. Some of the categorical phrases which had been seen only in written form began to take shape, and a feeling for some of the more basic problems on the Beltway was developed as interviews progressed.

Phrases such as "Not enough advanced warning," and "Speeds are too high" are the only way that the layman can describe his feelings of insecurity as he drives a portion of the Beltway with which he has little or no familiarity. In short, it becomes obvious that the close average spacing between interchanges on an urban freeway creates a need for driver decisions at a much faster rate (as often as every 45 seconds in some places) than required on other limited access highways.

Because of this need to make a continuing series of decisions at a rapid rate, those drivers who are on an unfamiliar section of a freeway are looking for aids to their orientation. They want the kind of orientation they get when they have a two-mile advance warning of an interchange, plus a distance to the next interchange—almost like a map unfolding in front of them as they drive; something which they can relate to a map if they are using one.

In contrast to this desire, we find that present Beltway signing is like a series of insulated cells, with no message continuity. Thus, a driver has no way to prepare for decisions several miles in advance but must pass through several closely spaced interchanges, each of which has to be processed on an "Is this the one I want?" basis. It is understandable that drivers desire unenforceable low speed limits or ask for "more advance warning."

On the basis of interviewee desire for more orientation, as well as the number of written responses with the same implication, study recommendations will urge expanded application of signing to provide the desired orientation.
Other more specific information was also obtained from the interviews. One example of this was the way in which drivers combined the cardinal direction and place name. Even though there is a distinction in letter style and size, many people did not recognize this distinction, and would read the message "Rt. 7 EAST—Falls Church" as "Rt. 7—East Falls Church." Because there is an East Falls Church, not reached by using Rt. 7, the sign creates immediate confusion in the minds of some motorists. The use of words like "to" and "and" was suggested to separate cardinal direction and a place name.

There was another, smaller group who used the phrase "not enough advance warning" to criticize the location of overhead "gore" signs. To these people a gore sign which is actually mounted in the gore provides final information too late in comparison to a gore sign which is over the road several hundred feet in advance of the exit ramp nose.

Another desire was for uniform marking of the gore with a sign such as the presently used EXIT sign. Both written and verbal comments indicated that some drivers use this sign as a definite indication of exit nose location. However, present practice is to omit this sign in certain situations, particularly where there is an overhead sign in advance of the gore.

One of the problems dealt with in the interviews was the kind of information drivers use in deciding what exit to use. As was found in the California study, drivers want a mix of information which varies not only on an individual basis but with the same driver in different situations.

Drivers generally use signs to only a limited degree when in familiar surroundings; but, as travel extends to the metropolitan area, they rely primarily on route names and/or place names. Women seem to prefer place names over all other information. Men will use either place names or route names, whichever is convenient. In neither case is much attention given to cardinal directions. Women, in particular, claimed little compass orientation.

Knowledge and use of route numbers were more limited than for either place names or route names, particularly for state route numbers. However, Interstate system numbers and major US route numbers were fairly well known, particularly those routes within the interviewees' states. It appears then that the Interstate Highway System is generating an awareness of a number of freeway routes.

A few of those interviewed suggested that symbol signs would be helpful; others said identifying every road crossing, whether there was an interchange or not, would aid in area orientation.

Field Observations of Driver Actions

A total of 453 unusual actions were observed in 95 man-hours at the 12 interchanges studied. This can be considered a minimum number of observed actions because there were locations where even two men could not observe the whole interchange and it was possible to miss one action while another was being observed. The types of actions observed and the number recorded by location on the Beltway or local road are shown in Table 4. The number at each interchange is also shown in the table. Note that there is considerable variation from one location to the next.

The pattern observed indicates that the technique of field observations can be used to obtain a relative measure of signing effectiveness. By relating the number of usual maneuvers to the volume of traffic entering the interchange, a problem approach quickly stands out from the others. Useful information was obtained from observation periods as short as two hours. The success of this approach strongly suggests the need for further research in depth to explore these relationships.

The percentages of a single approach related to all the other approaches taken as a group are plotted in Figure 7. A definite break appears above 0.2 percent. Thus, it is safe to assume for the data collected in this study that 0.2 percent of the drivers using any approach will have problems requiring an unusual action. However, when the percentage exceeds this level, the signing should be studied in depth to see which principles are being violated. In the case of the approaches which are above 0.2 per-
TABLE 4
TYPES OF UNUSUAL DRIVERS' ACTIONS OBSERVED IN FIELD

<table>
<thead>
<tr>
<th>Type of Action Observed</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On Beltway</td>
</tr>
<tr>
<td>Swerved, weaved, or hesitated to enter an off ramp</td>
<td>68</td>
</tr>
<tr>
<td>Stopped and backed up</td>
<td>37</td>
</tr>
<tr>
<td>Stopped and cut across gore</td>
<td>—</td>
</tr>
<tr>
<td>Stopped, read map, then proceeded</td>
<td>38</td>
</tr>
<tr>
<td>U-turned—at a cross street on local road</td>
<td>—</td>
</tr>
<tr>
<td>— across median</td>
<td>5</td>
</tr>
<tr>
<td>— using interchange</td>
<td>7</td>
</tr>
<tr>
<td>Crossed a divider between ramps</td>
<td>2</td>
</tr>
<tr>
<td>Continued all the way through a collector road</td>
<td>13</td>
</tr>
<tr>
<td>Totals</td>
<td>170</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interchange Number</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>17</td>
<td>8</td>
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<td>22</td>
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<tr>
<td>31</td>
<td>6</td>
</tr>
<tr>
<td>38</td>
<td>0</td>
</tr>
</tbody>
</table>

The previous tabulations show that, although there are some differences among the three questionnaire surveys conducted, data trends were all in the same direction. Thus, it was felt that the information acquired from each was valid and the impressions from each were merged to develop the conclusions in this report.

MEETING OF EXPERTS

One of the unique phases of this study was a seminar of prominent traffic authorities to study and critique the information which had been collected. The meeting was held December 13 and 14, 1965, in Washington, D.C. Those participating were: C. S. Carmean, Traffic Engineer, Iowa State Highway Commission; M. J. Hartigan, Assistant District Engineer, Illinois Division of Highways; C. J. Keese, Executive Officer, Texas Transportation Institute, Texas A and M University; J. O. Morton, Commissioner, New Hampshire Department of Public Works and Highways; A. R. Pepper, Traffic Engineer, Colorado Department of Highways; and J. E. Wilson, Traffic Engineer, California Division of Highways.

The plan of the meeting was to provide the six experts with an overview of the facility under study and then draw from them points of agreement and disagreement as to the criteria which should govern freeway signing in general and beltway routes in particular. Therefore, the first item on the agenda was a clockwise tour of the entire Beltway including several interchanges of varying types. In place of a prepared commentary, the group preferred to use commonly available road maps. Destinations were selected which they then tried to reach mentally by following the signing. The commentator then explained points which were in question.

After the tour, the group split into two subgroups. One group dealt with "on-route" signing of a beltway route. The other group considered signing approaching a beltway on any crossroad which interchanged with it.
The group then reconvened, discussed the conclusions reached separately and unanimously set forth the following summary statements:

1. Guide signing should lead the driver along a route, or series of routes, in such a way that it confirms and supplements trip planning based on other information, such as road maps.

2. As a corollary to signing which confirms and supplements trip planning, maps should be prepared which are as accurate as possible, particularly where interchange detail is shown. A map which shows interchange ramps that do not exist, or route names that disagree with the signing, can create impossible decision-making situations. Roadside rest areas on both beltway and radial routes can be used to display official large scale state maps; these can give the motorist an overview of both the highway system he is on, and the one which he is approaching.

3. There are two distinct classes of guide signing required by the motorist—orientation guide signs and interchange guide signs. Orientation signing should not be included in the interchange sequence and should be differentiated both by its lateral and linear position with respect to the traveled lanes. As used here, orientation refers to signing which helps the motorist locate himself, gives him a target destination at
which to aim, or confirms a decision just made. The elements of the orientation sign-
ing series would not be new but would consist of present mileage, confirmatory route
marker, through lane and interchange sequence signs. However, recognizing orienta-
tion and interchange signing as two distinct classes permits achievement of more con-
sistent design and installation.

4. For a route forming a closed loop and carrying its own route number, mileage
signs should show route numbers and names of major intersecting radial routes rather
than off-route place names. On a beltway the place names which can be used on the
mileage sign fall into two classes—those of major cities some distance from the area
which the beltway encircles and those of relatively small and unknown satellite com-

Specific criteria for signing freeways in particular, but which are equally applicable
to all road systems, were discussed throughout the meeting. The following statements
present in summary form the points on which there was unanimous agreement:

1. The information presented on a sign can be ranked in the following order of im-
portance: (a) Route Number, (b) Route Name, (c) Cardinal Direction, and (d) Place
Names. Rather than "permit" the use of all categories, only the first one or two items
should be standard. Additional items of information should be added only if the desired
alternative is not clear, in which case, an item would be added until it was. The same
classes of information should be provided to motorists on all routes regardless of
route classification. If standard items are limited to route name and number, it would
be expected that greater use would be made of supplemental guide signs in the inter-
change signing sequence.

2. At no time should the driver face more than two choices at a decision point.
These choices may be between two route numbers, two route names, two cardinal di-
rections, right or left, or two place names, but for each item of information presented
for one choice, there should be a comparable item for the alternative. If true com-
parability is not possible, the clearest alternatives should be selected.

3. A cardinal direction should be used only in situations where it represents true
direction. On a beltway or at locations where the direction would cause confusion, it
should be dropped and another item of information used to give directional orientation
if required.

4. A sign bearing an important place name either along the route or at the route
terminal should be used at the gore rather than "Thru Traffic." On a beltway, the
place name would be replaced by the number and/or name of the route.

5. There is need for a consistent distinction between interchanges with one and two
exits. Steps to achieve this are: (a) On interchange sequence signs, show two distances
for two exits. For example:

River Road
East—$1\frac{1}{4}$
West—$1\frac{1}{2}$
(b) On advance signs change EXIT to ONE EXIT and EXITS to TWO EXITS; (c) On interchange signing, do not show cardinal directions when there is a single exit; (d) if exit numbers are used, supplement them with a letter designating cardinal direction for each ramp where there are two exits. If there are more than two exits or two exits with the same cardinal direction letter, use other letters such as A, B and C instead of N, E, W, S.

6. Arrows can be useful in guiding motorists. Down arrows should be used only for lane assignment. Upward sloping arrows are used for ramps which are not extensions of the through lanes. Where the ramp makes a severe turn, the slope of the arrow should be exaggerated to show this.

7. More extensive overhead illuminated signing should be required on urban freeways and approaches to achieve better assignment of traffic to lanes.

8. Locating substantial signs and their supports in the gore creates unnecessary hazards. All signs, except possibly an EXIT sign on a break-away post, should therefore be located in advance of the gore.

9. Sequence signs should identify the next three interchanges, including route number, route name, exit number, if used, and mileage to the nearest quarter mile.

10. Mileage signs should be permitted to carry three lines of information.

11. A trailblazer symbol combining the standard route shield and the word "beltway" would be useful both on and off the route.

The group believed that present signing of freeway routes, with refinements such as greater use of the interchange sequence sign, would provide adequate information. In fact, it was the consensus of the group that if a motorist becomes confused with only a few elements of information, the addition of more signing elements would only confuse him further.

The present standards with modifications discussed previously can be applied to beltway routes with a minimum of difficulties. The most crucial problem, however, and the one for which the group did not have an answer, is how to sign a radial route which interchanges with a beltway route. (The reverse problem of signing from the beltway route to a radial or linear route can be handled with present standards as modified.)

Motorists approaching a beltway route on a radial can be classified logically as (a) those whose destination is the central city; (b) those whose destination is some distance beyond the beltway and who are outbound from the central city, or who wish to bypass the central city; and (c) those whose destination is around the periphery of the central city in the area served by the beltway. Each of these groups is seeking a different kind of information but it is extremely difficult to include it all in an interchange signing sequence. However, on the basis of what is presently known, elements which can be excluded have not as yet been identified.

The panel spent a portion of its time discussing the pros and cons of symbolism on highway signs both for directional orientation at an interchange and on trailblazers leading to various facilities. There was agreement that there are known instances where interchange symbol signs have been effective. However, there was a reluctance to state at this time that symbols would resolve some of the difficulties discussed previously. The panel strongly supports additional research on the use of symbols at interchanges.

In contrast to the lack of enthusiasm for symbols at this time, there was strong support for unique trailblazer symbols for the Interstate system. Trailblazers could be used to lead people to the system and could then be used on the system to alert people to unique elements of the system such as a beltway.

CONCLUSIONS

The merging of the data collected in this study with the work done previously in California and the opinions of the experts has led to three basic concepts for signing beltways in particular but which have application to freeway signing generally. From these concepts, it is possible to establish rather specific criteria for the use, location and message of each of the eleven elements which make up a complete freeway signing
package. Some of the most significant of these are given at the end of the discussion of the concepts.

Signing Concepts

Concept 1—Provide orientation through the consistent application of a series of sign elements which will provide sequential and confirmatory information for the motorist.

The evidence gathered for this report points strongly toward the need for an element within the framework of freeway signing which will keep the motorist consistently informed as to what lies ahead. The individual interchange approach to signing does not suffice in areas where interchanges are closely spaced and the decision-making rate is correspondingly rapid.

On a rural freeway, the motorist usually has several miles between interchanges to determine the appropriate exit. In contrast, on an urban freeway it is not infrequent to find interchanges are passing by quicker than decisions can be made. Drivers who must rely on signing for directions are generally unable to gage their position with any precision. When interviewed about their needs in these situations, they consistently ask for "more advance notice."

A word which better describes this motorist need is orientation. It has been used before in highway signing work, but not in the sense that it represents a package of information which is used consistently at every interchange and which answers the following questions:

1. Where am I now in relation to the interchange I am seeking, and what is its configuration?
2. If this is not the interchange I want, where are the through lanes at this interchange?
3. If this is the interchange I wanted, did I take the right road when I turned?

What kind of signing is required to provide orientation? Actually, all the elements of an orientation series of guide signs exist now, but the pieces have not been related to each other to form a consistent pattern. The key element is the interchange sequence sign (Fig. 8) which provides distances to the next three interchanges in such a way that the motorist knows at a glance his progress toward a desired interchange.

The other elements of the package are the mileage sign showing distances to major points, the route confirmation marker, and the through lane sign used at the gore of some interchanges. Outside of the interchange areas, orientation would be fostered by a consistent policy of naming road crossings, prominent topographical and geographical elements, and political boundaries.

Figure 8. Typical interchange sequence sign showing use of exit numbers.
On freeways with close interchange spacings, one or more of these three signs (mileage, route confirmation, through lane) are often omitted because of lack of space between interchanges. However, there is no prescribed pattern which should be followed in deciding which to omit and which to include. Thus, the first concept is to provide an orientation guide sign series which is consistently applied to each interchange on a freeway and which creates a common thread running through all interchanges, and to further identify intermediate points which will help a motorist to locate himself along his route.

Concept 2—Establish route numbers and route names as the primary elements of interchange guide signs and reserve the use of place names for selected locations where they give the motorist directional orientation which could not be otherwise provided.

As has been found in previous studies, the data gathered on guide sign messages indicate that a motorist operates on a mixture of route name, route number, and place name information, depending on his location in relation to his most traveled routes. However, it also appears that, when required to do so, he can do a reasonably good job of finding his way by using road names and route numbers. Either one may be used, but road names are generally more familiar than state route numbers to the motorist who is reasonably familiar with his surroundings, while strangers to an area find that route numbers are most useful. Some US route numbers and the Interstate System routes appear to have fairly widespread recognition among all classes of motorists.

Place names, particularly in an urban area, are useful to many motorists, but cannot begin to depict all the places that may be reached from a particular interchange. The data collected from the motorists contacted for this study indicate that place names never really satisfy anyone. A name which is suitable for one person does not suit the next. It is soon learned that there is no "right" name. Furthermore, names of numerous local communities often create confusion for the stranger who is seeking only route numbers.

It appears that the situation in signing urban freeways is much the same as that for the city street system. It has long been recognized as unfeasible to indicate at each cross street along a particular route all the streets in each direction from the intersections. The motorist must, therefore, at least learn the street name he is seeking. Likewise, when using a freeway, he should be seeking a particular road from which his destination may be reached. This tailoring of route selection to individual needs is often required because the interchange selected by the authorities for a particular place may only serve to confuse a person seeking a destination which is best reached by using a street in the next municipality.

This concept envisions a gradual elimination of most place names from freeway signing. Some of the routes intersected along a freeway will lead to major places some distance away, and the use of a place name serves to give quickly recognizable directional information for all classes of motorists. These places may be either the terminals of the route or major places on the route. In the area served by the freeway there may also be places which are best reached from a particular interchange. These, too, could be included on the guide signing, provided they are readily identifiable, and also give useful directional orientation.

If public policy decrees that place names be provided for every interchange, supplemental place name signs with appropriate exit information could be used rather than repeating a name several times on the primary guide signing.

In time, it is reasonable to expect that a freeway will become so oriented as part of the street system of an area that the portion of the public which now relies on place names should be able to make effective use of it without reference to place names, being guided only by street names and route numbers. Thus, place names should be a supplement to the basic sign message, and not an inherent part of it. The decision to use place names should be a conscious one, coming only after careful analysis of the functions they can perform in the specific situation being considered.

Concept 3—At the interchange of a radial route with a beltway, limit signing destinations to route intersections, regional areas and identifiable physical features on the beltway route, and exclude destination names except as a supplemental guide not normally repeated in the interchange signing sequence.
As the experts indicated, the question of how to direct motorists around a roadway forming a closed loop is probably the most difficult one to answer. None of the information-gathering techniques used provided a definitive answer, but some insight into an approach to the problem was developed.

The personal interviews conducted at BPR indicated that among residents of the Washington metropolitan area there is a fairly widespread awareness of route numbers or names (if not numbered) of the major radial routes. In most cases, these routes are Interstate or US numbered routes. It thus would appear feasible to sign the radial route at its junction with a closed loop (beltway) by using destinations that are in fact beltway junctions with major radial routes intersecting either half of the loop. Route

![Diagram of roads and signs](image)

Figure 9. A suggestion for completely symbolized interchange guide signs on the approach to a beltway. The arrow on the advance guide sign points to the interchange being approached and indicates the approach is from inside the loop. The exit numbers at the top of the gore sign indicate the first complete interchanges in each direction from the entrance. Field testing is required to test driver reactions and understanding.
numbers should be readily understandable to the stranger and recognizable to the metropolitan area resident.

The alternative to using major routes as destinations is to use place names as is presently done. The problems created by using place names as primary destinations are many but all relate basically to the fact that places of equal importance are usually not located at well-spaced intervals around the circumference of the beltway, nor are there usually off-route points of equal importance to give directional pull. However, as supplemental information during the interim period discussed under Concept 2, a few selected place names could give guidance to area residents on the shortest distance around the loop to their destination. Again, eventually, the relation of the loop to the area should become known well enough to eliminate place names.

Having decided to use junctions of major routes as the principal means of giving directional information, the next question is "What relationship should the selected junctions have to the point of entrance?" Again, there is no easy answer, but an arbitrary rule has been developed based on the Capital Beltway which may have application at other locations. For motorists approaching the Beltway from outside (inbound toward D.C.), junctions approximately 90 to 150 degrees from the point of entrance would be selected as destinations. In the opposite direction (outbound from D.C.), junctions no more than 90 degrees from the point of entrance would be selected.

When a radial route, with a single route number like the Capital Beltway, is bisected by a linear freeway route with the same route number throughout, the beltway should not be signed as a bypass for this through freeway; rather, in accordance with the guidelines given previously, other junctions should be selected as destinations.

Unlike the Capital Beltway, a radial route interchange involving more than one route number on the beltway is comparatively simple to sign, because directional differentiation is achieved through use of these different route numbers.

![Interchange Sequence Sign]

Figure 10. Typical locations of interchange sequence sign based on interchange design.
At one point in the study, an effort was made to incorporate the exit number scheme on the Beltway into radial junction signing. This would give directional information, and answer the question, "Which way is shortest for interchanges approximately 180 degrees from the entrance point?" None of these ideas could be successfully spelled out in words, but symbols appear to be an avenue which merits further exploration. Figure 9 is an example of how a symbol used on an advance sign could be split to show segments of the loop best reached by each of two interchange ramps. The amount of information which could be placed on such signs and assimilated by the driver requires study beyond the scope of the present project. This study then has come to the point where, as a matter of concept, the most practical means to sign the interchange of a radial route with a beltway is to select the junctions of a few principal radials, regional areas, or well-known physical features as destinations, using place names only as secondary, interim information.

Figure 11. Typical exit direction signs.
Selected Signing Criteria

Based on the concepts just described and the information acquired in this study, a number of specific signing criteria can be identified. The most important of these are listed below. Note that many have application to linear freeways as well as beltways.

1. The interchange sequence sign should be a standard element in beltway signing.
2. The location of the sequence sign should be just beyond the last exit ramp of an interchange, as shown in Figure 10.
3. The gore sign should always be mounted overhead and illuminated on a structure 200 to 300 feet in advance of the exit ramp nose.
4. At a two-exit interchange, it is desirable to mount the second gore sign overhead.
5. The exit direction sign would become a standard signing element and always carry the message "Right (or Left) Lane." It would be mounted about 2,000 feet in advance of the gore sign. If there is more than one exit at the interchange, information for each exit would be included on the sign as shown in Figure 11.
6. Articles and prepositions should be added to guide signs to increase their legibility (see Fig. 14).
7. The advance guide sign would be used only at "Major" (as defined by AASHO) interchanges and then only when it can be located no closer than 800 to 1,000 feet in advance of the exit direction sign. When the distance from the gore is less than one mile, an overhead structure should be mandatory.
8. Every gore should be marked with an EXIT or RAMP sign to identify the point of departure of the ramp from the main roadway lanes.

An in-depth analysis such as that undertaken for the larger project on which this paper is based could specify criteria for each of the 11 elements of freeway signing. These 11 elements are as follows:

Orientation Sign Series
- Interchange Sequence Sign
- Through Lane Sign
- Confirmatory Route Marker
- Mileage Sign
- Trailblazers

Interchange Guide Series
- Gore Sign
- Exit Direction Sign
- Advance Guide Sign
- Supplemental Guide Sign
- Exit Sign
- Destination Sign

ACKNOWLEDGMENTS

This paper is based on a research project conducted for the U.S. Bureau of Public Roads by Alan M. Voorhees and Associates. The report for the project, entitled "Freeway Signing—Concepts and Criteria," is broader but in order to present a paper of manageable proportions, it was decided to limit this presentation to beltway signing. The authors wish to express their appreciation to the U.S. Bureau of Public Roads for permitting this paper to be prepared and presented to the Highway Research Board.

REFERENCES


**Discussion**

T. DARCY SULLIVAN, Assistant Director, Traffic Engineering Division, Traffic Institute, Northwestern University—During the last several years as the Interstate Highway System has begun to take form, there has been a growing recognition of the importance of its signing. The "Interstate Sign Manual" published in 1961 sets forth the basic philosophy and techniques for the signing of the Interstate System. However, I am sure that anyone who has ever attempted to design the signing for a freeway facility in or around an urban area has recognized the limitations of the "Interstate Sign Manual" and the problems encountered in attempting to follow its techniques. The paper which we have just heard has identified many of the problems commonly encountered and done so in a quantitative manner. I am sure that the conclusions reached will not only have an immediate and direct benefit for the motorist driving in and around the Washington, D.C., area but will also be of significant value at such time as the much-needed revision to the urban section of the "Interstate Sign Manual" is undertaken.

It seems to me that many of the difficulties cited and concepts developed in the report have equal application to non-circumferential routes. For instance, the problem of close interchange spacing certainly is not unique to a beltway. The Capital Beltway with 37 interchanges over its 66-mile length has an average spacing of just under 2 miles. The freeway system serving the Chicago metropolitan area includes 124 interchanges on 105 miles of roadway. This average interchange spacing (approximately 0.8 of a mile) is probably not unusual for an urban area where an attempt is made to provide access to most or all of the streets comprising the arterial system. In such a case, interchange spacings of 1 mile or even ½ mile are not unusual and the ultimate may very well be the section of Chicago's Kennedy Expressway adjacent to the Loop where motorists face 7 decision points within 1 mile.

The existence of a multiplicity of communities around an urban center obviously has a distinct impact on the signing of any type of freeway route. Again, drawing from the Chicago metropolitan area with which I am most familiar, there are approximately 123 suburban communities in the metropolitan area.

While not an identical problem, a third similarity between a non-circumferential route and a beltway arises when a primarily east-west road such as I-94 traverses a metropolitan area and travels for some distance in a north-south direction. This in effect creates a route which has no direction which can be signed without causing confusion to the motorist. If it is signed as "I-94 EAST" or "I-94 WEST" the local motorist who knows its true geographical direction is likely to be confused. On the other hand, if it is signed "I-94 NORTH" or "I-94 SOUTH" the long-distance interstate motorist may be misled.
If we can accept that the problems of signing a beltway and almost any other urban freeway route are similar in many ways, then it also follows that many of the concepts developed for signing a beltway would also apply equally to other freeway facilities. Let us then review the signing concepts developed in the report and check their applicability to urban freeway routes in general.

Concept 1—Provide orientation through the consistent application of a series of sign elements which will provide sequential and confirmatory information for the motorist.

The sign elements which might be included in such a series are the interchange sequence sign, the mileage sign showing distances to major points, the route confirmation marker, and the through lane sign used at the gore of some interchanges. As is indicated in the report, on freeways with close interchange spacings, one or more of these signs are often omitted because of lack of spacing between interchanges. While there is no nationally prescribed pattern which should be followed in deciding which sign to omit and which to include, most departments having the responsibility for signing of freeway routes have established local patterns. In the Chicago area, for instance, the mandatory use of the through traffic sign at all interchanges has been discontinued on the assumption that the through lanes will be to the left unless otherwise indicated. The space thus made available can then be used for additional advance warning for other interchanges. In addition to providing the added advance warning desired by so many motorists, the combination of signs located on an overhead sign structure becomes a modified form of the interchange sequence sign.

As a further aid to motorists' orientation the Illinois Division of Highways has installed a series of numbered signs on each light pole along the Stevenson Expressway. The numbers of these signs are tied to the Chicago block numbering system. While the signs were installed to meet the specific problems created by a diagonal route superimposed on a grid arterial system, they also provide a means of continuous orientation for the urban motorist similar to that provided by the mileage markers in a rural area.

The combination of these signs thus fulfills the first concept, which is to provide an orientation guide sign series which is consistently applied to each interchange on a freeway and which creates a common thread running through all interchanges, and further, to identify intermediate points which will help a motorist locate himself along his route.

Concept 2—Establish route numbers and route names as the primary elements of interchange guide signs and reserve the use of place names for selected locations where they give the motorist directional orientation which could not be otherwise provided.

In the signing of the early freeways in the Chicago metropolitan area, one or two suburban municipalities were selected for use in the signing at each interchange. The communities were selected for their orientation value in guiding the motorist at interchanges. Selection was based on the size of the community, its distance from the expressway, and its direction from the expressway. Over the years, this has proved a major source of confusion for many motorists and a constant headache for the responsible authorities. Community pride and constantly changing populations combined to produce a steady stream of requests for change or addition from both municipal officials and the general public.

On the most recently constructed expressways and when major sign modernization is undertaken on any of the older freeways, the use of suburban place names is being dropped completely. The only place names currently being used are those of distant large cities, bordering states, and the large airports serving the metropolitan area. In the areas where this has been done, there has been only moderate and short-lived public reaction, most of it from the residents of communities whose names have been removed from the sign.

A logical corollary of Concept 2 would be the use of freeway proper names at major interchanges. The justification for this is based on the answer to a fundamental question: Will urban freeway users ever develop a familiarity with "Interstate" numbers? Drivers in most urban areas do not refer to "I" routes when talking nor do they seem to orientate to them when driving. I realize that this is contrary to the U.S. Bureau of Public Roads' policy. This poses a second basic question: Which is the easiest to change, policy or the driving public?
Concept 3 pertains to the interchange of a radial route with a beltway and obviously has no general application to urban freeway routes.

In summary, the lack of realistic national standards for freeway signing in urban areas has led to the development of fifty or more sets of local practices. Some of the concepts developed in the present report appear to have general application to urban freeways and may provide a basis for the development of a national policy. Of primary interest in this regard will be Concepts 1 and 2, which point the way toward a standard sign sequence and stronger criteria to be used in the selection of sign legend.

Once an "Urban" supplement to the "Interstate Sign Manual" has been developed and approved, its use in the modernization of existing freeway signing should be encouraged by the U.S. Bureau of Public Roads, through the approval of matching funds for this purpose.

GENE P. D'IPPOLITO, Ohio Department of Highways—Those who develop sign plans for freeway systems, especially closed loop freeways, will welcome this paper for its practical approach to freeway signing problems. This discussion, due to the nature of the paper, has been based primarily on further implications which may be drawn from the conclusions and recommendations.

The question still to be answered is: "How can the freeway guidance needs of all types of motorists be provided?" This is the ultimate goal in freeway guidance which may not have an answer. Therefore, the needs must be determined and then ranked in importance so that the message conveyed is the most important one to the driver having the greatest need. This, in itself, is an admission that the needs of some will not be provided and that driving errors can be expected. It then can be asked: "What percentage or number of errors can be tolerated? Can these be driving errors resulting in minimum hazard to the driver and surrounding traffic?"

A credit to the paper is that specific elements have been explored resulting in specific recommendations. Too often in the past signing problems and recommended solutions have been in generalities which offered no assistance in most specific applications. Words such as uniformity are quite popular terms but there are no two urban or suburban freeway interchanges that are exactly similar in respect to the signing required. A specific treatment proven successful at one interchange will not be sufficient at another seemingly similar interchange.

The significance of using freeway names is not discussed in the paper. The use of freeway names is generally avoided due to such problems as map identification, insignificance to non-local drivers, sign message space requirements, and de-emphasis of route numbers. Since official route markers, unique in design, have been established for the Interstate System it seems that a driver should not be required to read a name each and every time he is confronted with an Interstate route marker. It is surprising that a recommendation made by the experts was to expand the use of the freeway name to be included as part of a trailblazer symbol. The use of a freeway name to identify it as a closed loop freeway would have no significance unless the terminology was standardized.

A concept of guide sign treatments not often thought of is that any guide sign sequence must tell the driver exactly where he is located. Many other problems are avoided when this information is successfully conveyed to the driver. Much of the paper is devoted to the methods of conveying this information, most of which may well become accepted standards.

Although the Capital Beltway is a completed facility, the freeway system of which it is a part is yet to be completed. Is the existing traffic similar to the type of usage for which the Beltway was designed? Observance of other freeway systems developing during stage construction has shown that usage changes. This also has advantages in that driver familiarity with the freeway system can grow with the growth of the system.
Driver problems and errors are due to numerous contributing factors. Can we accurately determine and isolate those problems caused by signing? What percentage of the traffic can we expect will make errors even under ideal conditions with the best possible sign guidance? Answers to these questions would provide a yardstick to measure comparative quality of sign guidance systems. A freeway, by its design, encourages an attitude of more relaxed driving. Does this attitude act as a handicap to the driver in his response to sign messages? Drivers on a freeway will risk making an unusual maneuver to leave at a certain exit because of the difficulty in returning to that point if the exit is not made. Due to this difficulty in returning, an error is made which would not have been detected if it was an "around the block" type of situation due to a missed turn on a lower type facility. Do the pressures on a driver from the character of the traffic stream also result in errors even though the signs may have been proper?

An interesting phase of the study would have been to analyze each trip specified on the questionnaire returns to see how the sign messages applied to the trip. This analysis would also offer data for testing the concept of using route intersections as destinations at radial route interchanges. Concept 3 in the paper recommends the relative location of the route intersections in respect to the radial route interchange. The inference from this criterion is that inbound drivers use a greater length of the Beltway and outbound drivers use a relatively short length. This is a logical assumption and may have been substantiated by a trip analysis. Can it be assumed that a trip involving a short length of the Beltway is planned better and the driver has better knowledge of the routes? The answer would provide an insight into the needs of outbound drivers vs inbound drivers.

It is gratifying to note that a major conclusion in the paper is the recommended de-emphasis on the use of place names. There is no doubt that the most perplexing problem of freeway signing is the selection of destination names and the pressures for additional or different names. Modern guide signing started with the route number as the primary guidance system. It is unfortunate that those who established freeway sign standards gave such prominence to the size and location of place names on freeway signs. The cycle is being completed with the proposal to set back place names to their secondary role as they properly should be.

The problems caused by incomplete interchanges are normally attributed to the lack of all movements in the interchange. Normally a freeway system is designed based on origin-and-destination studies to provide the maximum service regardless of where sign routes are located. The sign route system should be studied and revised to best correlate with the freeway system and other routes. Route revisions can help alleviate problems due to incomplete interchanges. Changes in street names should also be considered where clarification of freeway signing can be accomplished by so doing.

A logical question that should be asked after review of the paper is: "Does the use of a single number for a closed loop freeway have any merit?" It is understood that many major factors are involved in the assignment of Interstate route numbers; nevertheless major operational problems in traffic guidance deserve consideration. Different routings and numbering systems should be explored to determine the relative merit of each. Allocating the linear route onto the Beltway with different number assignments to sections within the confines of the Beltway offers several distinct advantages. Specific destinations and cardinal directions can be assigned to all segments of the freeway system. A disadvantage of overlapping numbers and the difficult assignment of numbers to all directional segments of the Beltway would arise. Although routing assignments are often difficult to revise due to many other factors, the pursuit of maximum efficiency in a freeway system should not ignore any possibilities to overcome operational problems.

The present paper makes a significant contribution toward the improvement of guidance concepts on a closed loop freeway and also linear freeways. It also opens avenues for needed additional research work.
SLADE HULBERT, Institute of Transportation and Traffic Engineering, University of California, Los Angeles—Perhaps the most important aspect of this report is the conclusion that two independent research techniques resulted in determining the same highway locations that were causing difficulties for motorists. Locations where the directional signing was found to be in violation of certain basic principles were also those locations where trouble was actually occurring. Thus, perhaps for the first time in this important field of work, evidence is presented confirming the validity of basic principles that were set forth in earlier work.

A second major contribution of this work is the conclusion that beltways as a category of highway facility require a different set of signing principles from straight-through routes. It is important to bear in mind that the suggested changes in signing are merely suggested changes and have not been made; therefore, they could not be evaluated. It is to be hoped that not only will these changes be made, but that some measurements will be taken of the effectiveness of these changes.

The authors present some concepts that seem to be at variance with the goal of uniformity. For example, the authors state that directional signs should contain the most appropriate information for the particular situation. Implicit in this statement is the fact that the most appropriate information may differ from location to location, and would be therefore at variance with the concept of uniformity. It is important here to understand that the appropriate information need not and should not be at variance with the basic principles of freeway signing. The authors' conclusions suggest to me a concept of uniformity of principles rather than a more narrowly defined, rigid concept of uniformity.

The study has clearly described the potential value of field observations. This successful attempt to quantify field observations represents a notable contribution in itself. Traffic engineers have always used such observations in their work, but research use and documented evidence of such observations are, unfortunately, rare.

An important statement is made that the freeway system offers no easy source for the lost driver to obtain information. In this respect, the reports of the use of two-way radios is noteworthy. Fifty confused drivers a month reporting over two-way radios must represent a very large portion of those drivers whose vehicles are equipped with two-way radios and who were driving in the study area at the time.

For the first time, the suggestion of a "normal" proportion of motorists experiencing difficulty, or what could be called a normal confusion level, is set forth and a value suggested of 0.2 percent. The potential merit of using a "confusion index" as a method for rating interchanges or exit designs is presented in this report but may tend to be overlooked. I hope it is not. It was interesting to note that a higher percentage of drivers reported having problems leaving the system than in entering it, which is exactly opposite of the trend discovered in the study performed in Los Angeles.

It is important to note that, in one of the surveys, strangers were not interviewed and that the researchers acknowledged the important potential differences in response. It is to be hoped that future research will also make this distinction.

An important discussion is presented of "decision rate." Decisions every 60 seconds, and in some cases every 45 seconds, are suggested for urban freeways, and these high rates are contrasted with much lower rates for rural freeways. The implications for traffic safety are obvious for both extremely high decision rates and extremely low rates. Designers of interchanges also utilize this concept to some degree, but there is need for joint consideration of the total decision rate as influenced by other factors inside and outside the vehicle. Such a total rate, if available, could be a major highway design parameter. But the point made by this study is that it is not the driver's decision rate per se, but that rate relative to his degree of orientation or his "feeling of confidence about where he is relative to where he is going" that is important, not only for his well-being but for the safety and efficiency of the highway facility. I don't think this point can be overstressed or that anyone can fail to agree with it. However, the average driver seems only to be aware of the end result of inadequate orientation, and his statements characteristically are, "there is not enough warning," "speeds are too high," or "I got lost." Herein lies a message from this report extremely relevant to the engineering profession; namely, the user does not know
the true reason for his discomfort and therefore brings political and other pressure to bear for "more signing" or "more advance notice." If his clamor is acceded to, the situation may actually be worsened.

At least one example of "negative reasoning" is included in this paper. This human factor is perhaps the most subtle problem faced by the signing designer. The omission of information can, in certain contexts, be extremely misleading and must be taken into account insofar as possible. Perhaps exposure of proposed signing to drivers completely naive about freeway design and the locale is the only way to cope with this problem. Once a person knows the "lay of the land" he cannot react as though he does not; nor can he imagine all the ways in which a naive person will react.

It is encouraging that this study not only identifies and quantifies certain aspects of signing design that need improvements, but also provides some clearly stated suggestions for making improvements. From this starting point, additional research or trial installations can be implemented.

STEPHEN G. PETERSEN and DAVID W. SCHOPPERT, Closure—It is gratifying to have three discussers support the findings of a research study to the extent that Messrs. Sullivan, Hulbert and D'Ippolito have in this instance. A few additional remarks are nevertheless warranted.

Sullivan makes the point that the findings of the study can be extended beyond beltways to linear freeway routes with little or no modification. The authors are pleased to hear this for they made similar recommendations to the U.S. Bureau of Public Roads in the larger report on which this paper was based. The facilities Mr. Sullivan mentions would be excellent candidates to test some of the concepts set forth in the paper.

Hulbert has emphasized some of the major points in the paper and stated them even more succinctly than the authors. His restatement of the inability of drivers to tell the engineer exactly what is wrong with signing is particularly good. The engineer, after hearing numerous ill-defined complaints, shrugs his shoulders and mumbles something about "poor driver training." In fact, the problem may be quite subtle and need concentrated study not only by the engineer but by human factors oriented specialists as well. We must take more pains to see behind the driver's often quoted but unsophisticated complaints to determine his real problems.

Because his everyday duties involve freeway signing, the authors are particularly pleased with the support of the conclusions and recommendations provided by D'Ippolito. The general questions he raises are logical extensions of the work started in California in 1958 and pushed forward in this study. They illustrate that there is much more to be done.

In response to D'Ippolito's more specific questions about the Capital Beltway, it appears that as future facilities are completed it might carry less "stranger" traffic as a percentage of the total traffic than it does now, since the Beltway presently serves as the terminus of linear routes which will eventually go through the District of Columbia.

Another question dealt with the analysis of outbound vs inbound trips. Not enough trips to and from points some distance removed from the Beltway were obtained to validate the decision to choose points beyond the 90-degree points for inbound trips and less than 90 degrees for outbound trips. These selections were instead based on a logical deduction that a driver starting at the center would be most likely to take a radial oriented somewhat in the direction of his eventual destination, whereas one inbound may be seeking points farther around the loop.

The authors firmly believe that many of the findings in this study, if applied to present-day freeway signing, would add significantly to the driver's ability to navigate these high-speed roads. It is hoped that there will soon be opportunities to prove this through a program of controlled installations sponsored by the U.S. Bureau of Public Roads.