FINAL REPORT

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THE EFFECT OF DIAGRAMMATIC SIGNING AT HIGH SPEED INTERCHANGES

by

Frank D. Shepard
Highway Research Engineer

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agency.)

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SUMMARY

Improvements in highway guide signing at interchange areas are needed to reduce driver confusion and the accidents that result from it. One possible means of improving traffic operations within interchange areas is through the use of diagrammatic signs that give a graphic representation of the highway or interchange ahead. This study consisted of a laboratory investigation of the effect of diagrammatic signs at three interstate interchanges, and a field study of one of these.

The results of the study revealed several considerations which should be of benefit in the design and evaluation of diagrammatic signing. First, through the use of a laboratory procedure utilizing motion picture segments to simulate actual roadway conditions, diagrammatic signs, rather than the existing conventional signs, were recommended for the three sites studied. The field study, however, indicated that the new diagrammatic sign observed in the field did not significantly reduce the number of erratic maneuvers.

Although there were certain limitations placed on this study resulting from an abbreviated field phase, the study does propagate an awareness of the many variables which could influence results found from either laboratory or field studies.

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INTRODUCTION

Interstate interchanges, especially in urban surroundings, are apt to create driver confusion and uncertainty as a result of their close spacing and the multiplicity of communications needed for the complex task of driving in high speed traffic.

From the information developed in 1968 by the House of Representatives' Committee on Highway Safety Design and Operations: Freeway Design and Related Geometrics, it became apparent that improvements in highway guide signs at interchange areas was a primary concern and that a major effort was needed to accomplish them. One possible means advanced for improving traffic operations within interchange areas was the use of graphic or diagrammatic signs that give a graphic representation of the highway or interchange ahead. Consequently, there has been much research on the installation and evaluation of diagrammatic signs in field studies, along with instrumented vehicle and laboratory studies.

Laboratory and field studies representing many different research methodologies have been used to study diagrammatic guide signs for various interchange configurations and highway conditions, but very little has been done in the way of assessing the reliability of laboratory procedures by comparing their findings with those of field observations. A correlation of laboratory studies and field experiences could aid the development of design standards for diagrammatic signs.

PURPOSE AND SCOPE

The purpose of this study was to determine the effects of diagrammatic signs at high speed interchanges. The experimentation attempted to measure erratic driver behavior as a function of various diagrammatic and conventional signing schemes in both field and laboratory studies. An attempt was made to correlate the laboratory findings with those from the field.

The scope of the project was limited to a study of three major interchanges. Although laboratory studies were conducted for the three selected interchanges, a diagrammatic sign was erected at only one interchange.

SITE SELECTION AND SIGNING SCHEMES

The three sites selected for study were high volume, accident prone interstate interchanges with unusual geometric characteristics. They are described below.

Site A. Junction of I-95, Southbound, and I-85 in Petersburg, Virginia

The site A interchange was chosen because it presented an opportunity to observe diagrammatic signs for an interstate split. Interstate 85 originates here and bears to the right; Interstate 95, a through route, continues to the left. This site is unique as it represents an interstate split where both highways go south through North Carolina, South Carolina, and Georgia, with I-95 terminating in Miami, Florida, and I-85 continuing through Atlanta, Georgia, into Alabama.

The existing condition is characterized by numerous ground-mounts, as shown in Figure 1, depicting messages that confuse out-of-state motorists following I-95 through Virginia. At first glance, the unfamiliar motorist is likely to visualize I-95 south as being an off-ramp leading to a toll station from the turnpike. It was believed that a diagrammatic sign could more clearly map out the interchange.

Both laboratory and field studies were conducted for this site.

Site B. Junction of I-95, Northbound, and I-495 in Northern Virginia

The site B interchange, shown in Figure 2, was chosen as it is especially confusing to the motorist because it carries high traffic speeds and volumes, has multiple lanes with two drop lanes, and requires two major decisions within a very short time period. Diagrammatic signs possess the capability of relating this geometric condition to the motorist, and are, therefore, thought to be a possible solution to the problem.

Only laboratory studies were conducted for this interchange.

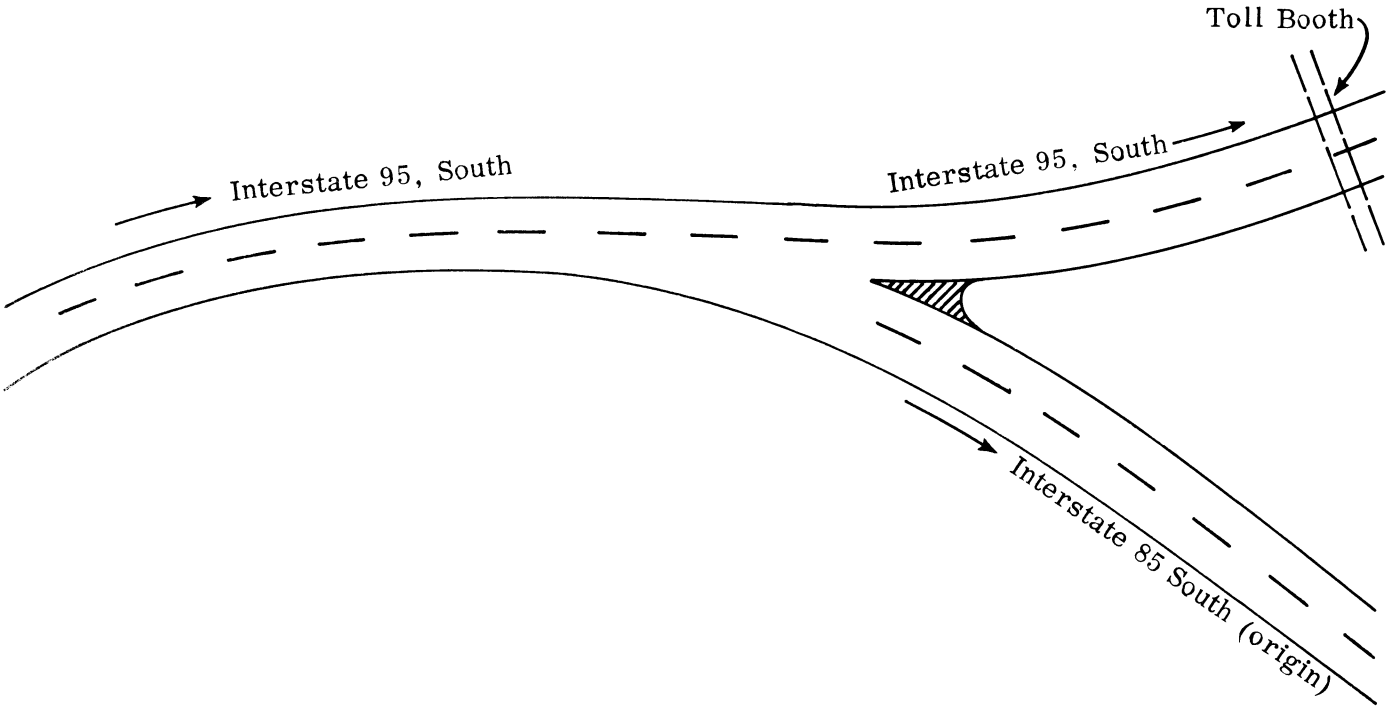


Figure 1. Site A, junction of Interstate 95, Southbound, and Interstate 85 in Petersburg, Virginia.

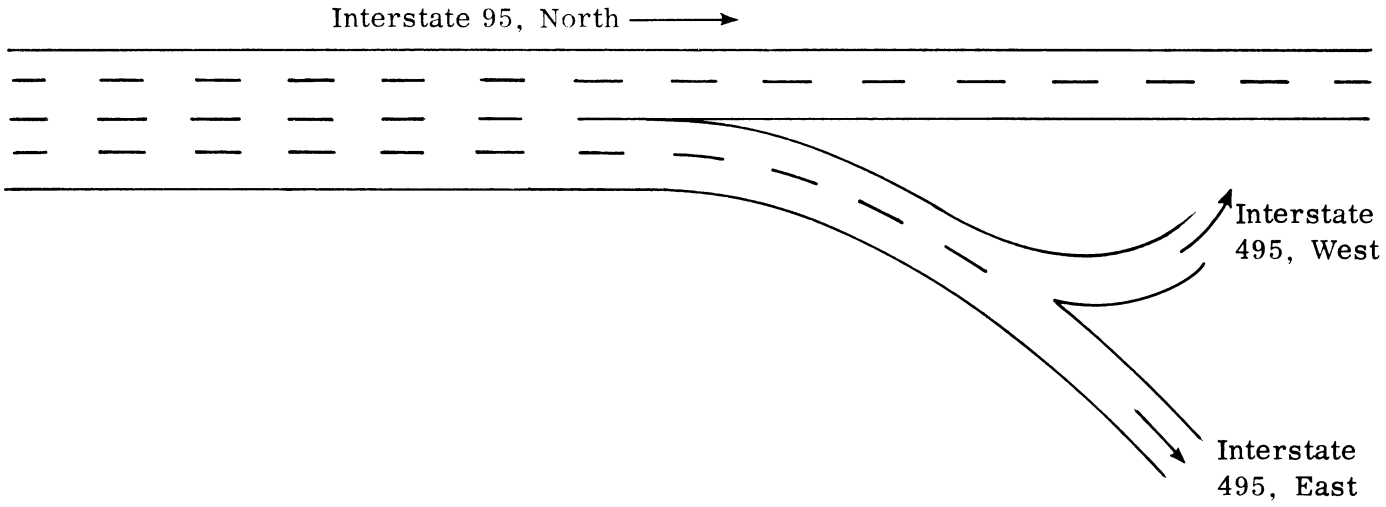


Figure 2. Site B, junction of Interstate 95, Northbound, and Interstate 495 in Northern Virginia.

Site C. Junction of I-264, Westbound, and I-64 in Chesapeake, Virginia

The site C interchange, shown in Figure 3, includes two overhead mounted conventional signs preparing motorists for a major interstate split and a parallel major arterial road. The unusual geometric condition results from an arterial split immediately following a hidden interstate split. The limited sign distance prior to the interstate split warrants use of a diagrammatic sign to depict the geometrics to the motorist. Another traffic problem that could be eliminated at this interchange is that of a short weaving distance between a nearby off ramp and the aforementioned interchange. Again, only laboratory studies were conducted for this interchange.

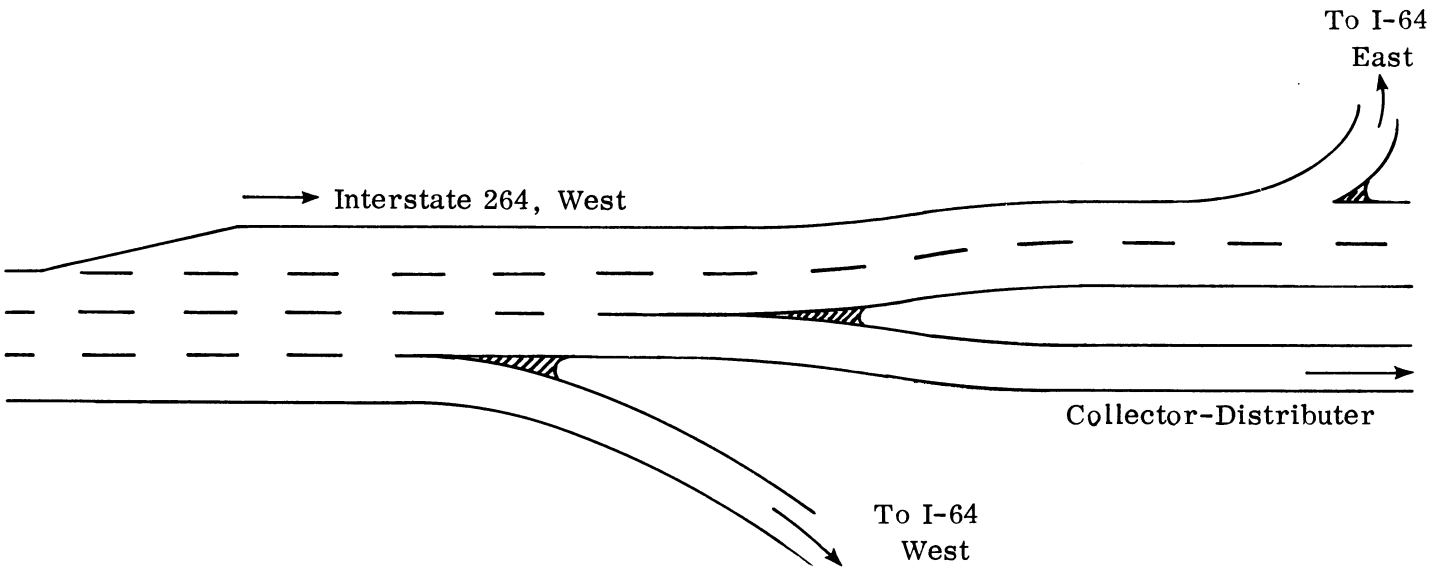


Figure 3. Site C, junction of Interstate 264, Westbound, and Interstate 64 in Chesapeake, Virginia.

PROCEDURE

The laboratory phase of the study was conducted and reported at the West Virginia University Human Factors Laboratory by Dr. L. Ellis King and Dr. R. W. Plummer; the field phase was conducted and reported by the author in Virginia.

Laboratory Phase

The laboratory portion of the study was conducted under controlled conditions on 20 subjects, ranging in age from 19 to 54 years. The driving experience of the subjects varied from zero years (non-driver) to twenty years.

Stimulus Material

After being given specific instructions, test subjects were shown a motion picture of the actual roadway with the various exit options available. The subjects were also presented with the appropriate conventional or diagrammatic sign through the use of a tachistoscope slide projector. When the movie film automatically stopped, the highway sign was shown by the tachistoscope for a four-second interval.

Subject Reaction Evaluation

Upon completion of instructions and a practice session, each subject was given a destination and the experiment began. Both reaction time and lane choice were recorded for each slide depicting a sign until a series was completed for a single interchange. Then, a second destination was given and the next series began. The average reaction time and percentage correct responses were compared for each sign observed.

See the Appendix for details concerning the experimental laboratory procedure.

Field Phase

The field phase consisted of a before - after study with conventional signs being observed under the before conditions and diagrammatic signs under the after conditions. As noted previously, only the I-85--I-95 interstate split in Petersburg, Virginia, was included in the field study.

To determine the effects of diagrammatic signs on driver behavior, the "comparative erratic maneuver" method of analysis was used. The study area was divided into zones as indicated in Figure 4, and erratic vehicle movements were recorded for each zone. Time-lapse photography was used for data collection within Zone II since vehicle maneuvering in this area was rather complicated because of a number of possible maneuvers. A commercially available 8 mm camera was used at an exposure rate of two frames per second,

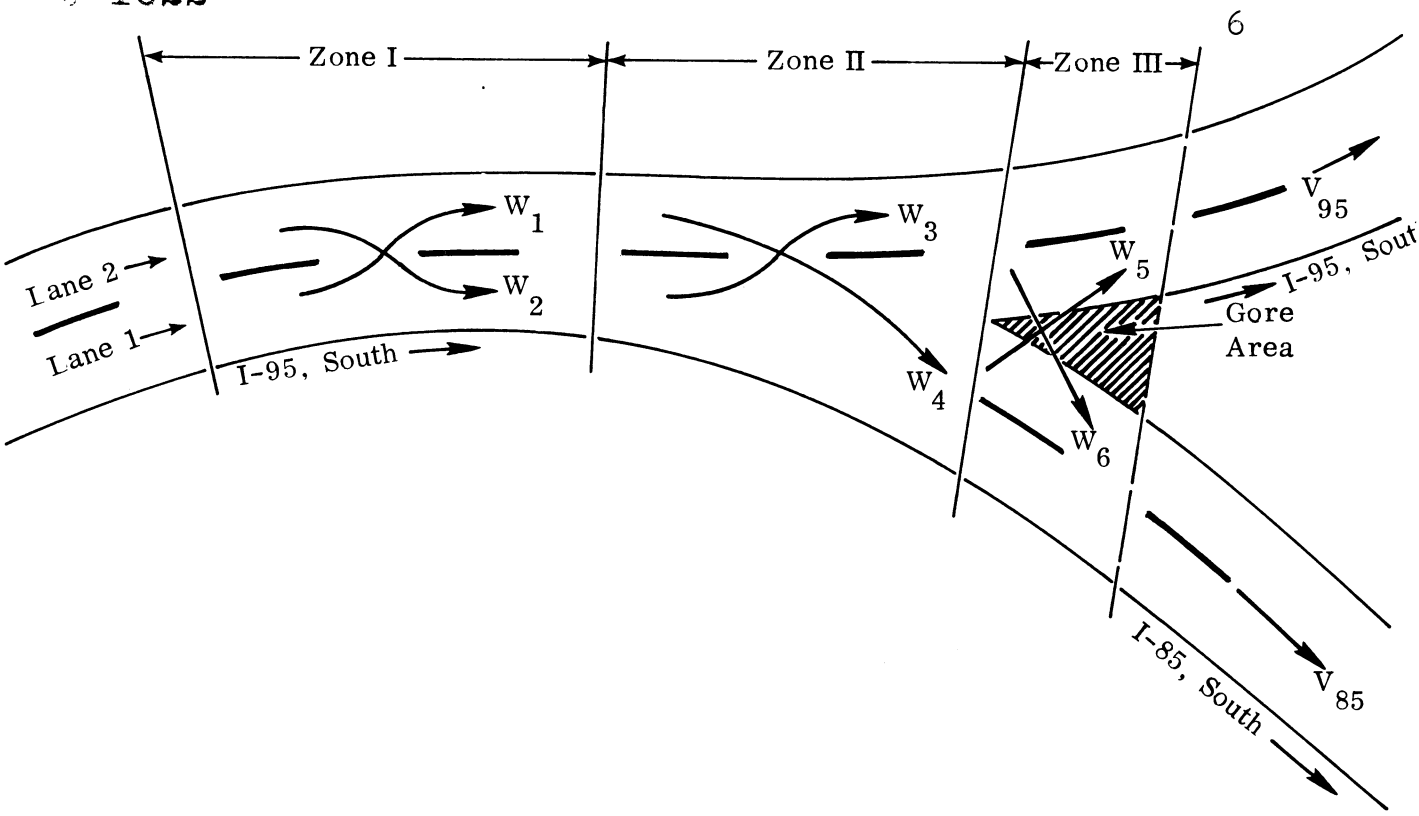


Figure 4. Zone and weave designations.

which permitted 30 minutes of continuous data for each roll of film. Data for zones I and III were collected manually by observers stationed in the median area. The majority of erratic maneuver data involved vehicle weaving within zones I, II and III, however, these data were supplemented by counts of vehicles stopping in the gore area.

Volume and erratic maneuver data were recorded for 56 hours for the before condition and 56 hours for the after condition. Observations were made between the hours of 9:00 a.m., and 6:00 p.m. on weekdays between July 25, 1973, and August 24, 1973. The diagrammatic sign was erected in place of the existing sign on August 7, 1973.

Figure 5 depicts both the existing signs for the before condition and the diagrammatic sign for the after condition. The 10 ft. x 35 ft. sign utilizes 13.3" route name lettering and 36" shields.

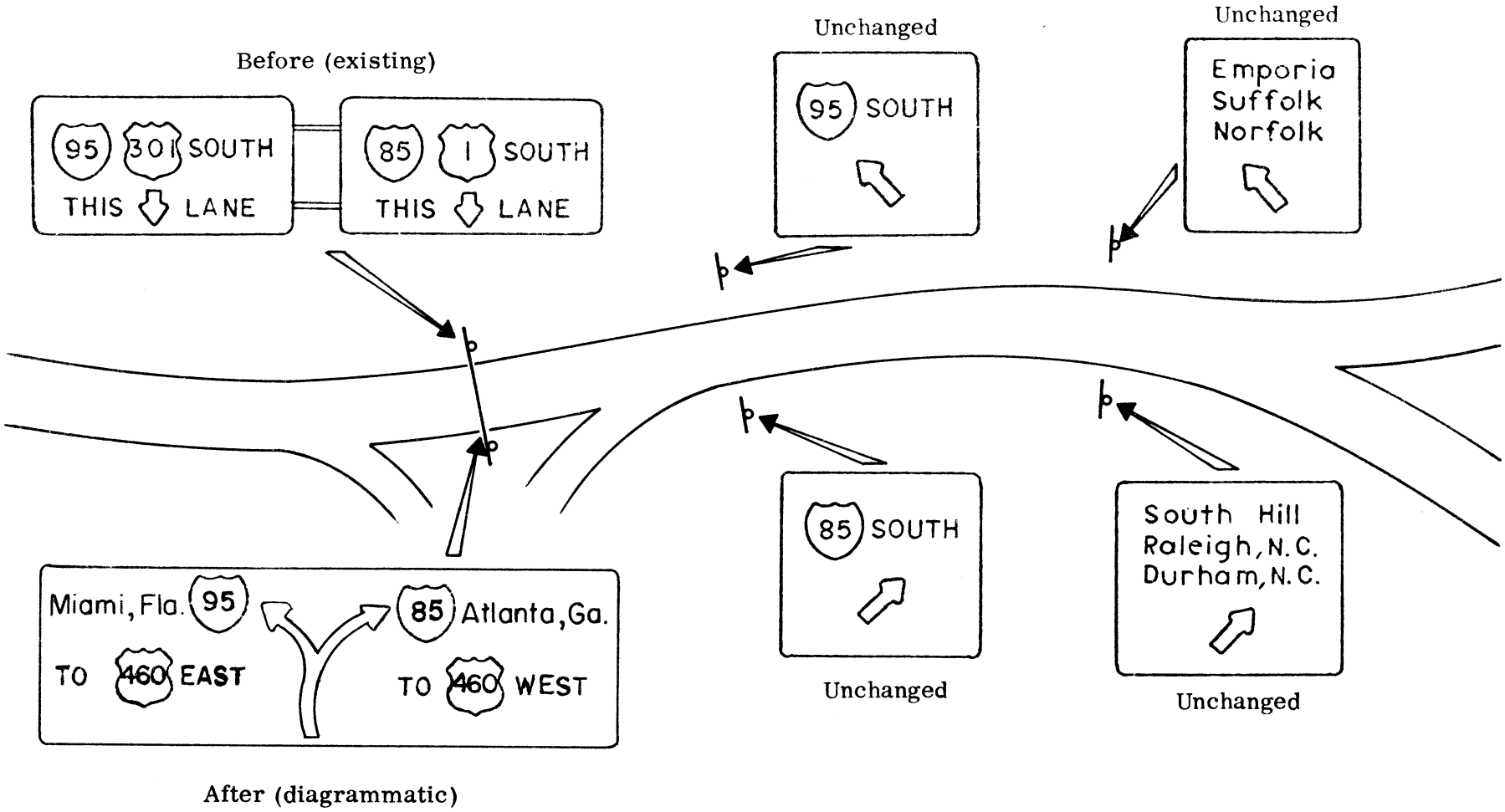


Figure 5. Signs for "before" and "after" conditions.

RESULTS

Laboratory Phase

The results of the laboratory phase are shown in Tables 1 and 2. Table 1 gives the average reaction times for the 20 subjects and Table 2 gives the percentages of correct responses. The reaction time data were subjected to a statistical analysis of variance, the results of which are shown in Tables 3 through 5. The percentage of correct response data do not lend themselves to an analysis of variance, since these data are discrete rather than continuous.

TABLE 1

SUMMARY OF AVERAGE REACTION TIME VALUES (SECONDS)

Sign Series*	Sign Location				
	Site A - I-85—I-95				
	1	2	3		
Existing	3.435	2.968	2.166		
DS-1	2.346	1.926	1.827		
DS-2	2.329	1.619	1.822		
DS-3	2.724	2.146	1.986		
	Site B - I-95—I-495				
	1	2	3	4	5
Existing	2.490	2.629	2.885	2.311	1.591
DS-1	3.515	2.170	2.580	2.396	1.556
DS-2	3.140	2.501	2.452	1.994	1.751
	Site C - I-264—I-64				
	1	2			
Existing	3.223	2.725			
DS-1	2.470	1.783			
DS-2	2.878	2.575			
DS-3	3.132	2.628			

*For description of sign series, see Figures 7, 9, 10, and 12.

TABLE 2

SUMMARY OF PERCENTAGES OF CORRECT RESPONSES

Sign Series	Sign Location				
	Site A - I-85--I-95				
	1	2	3		
Existing	100	55	95		
DS-1	15	10	0		
DS-2	75	90	95		
DS-3	95	90	100		
	Site B - I-95--I-495				
	1	2	3	4	5
Existing	95	90	55	65	100
DS-1	95	95	0	25	90
DS-2	95	100	85	90	95
	Site C - I-264--I-64				
	1	2			
Existing	100	75			
DS-1	90	95			
DS-2	70	75			
DS-3	95	100			

TABLE 3

COMPARISON OF REACTION TIME OF FOUR DIFFERENT SIGN SERIES FOR SITE A

Source	df	MS	F
Signs (location 1)	3	5.306	4.772*
Residual	75	1.112	
Signs (location 2)	3	6.565	10.240*
Residual	75	0.641	
Signs (location 3)	3	0.522	1.031
Residual	75	0.506	

*Significant value, $p < .05$

TABLE 4

COMPARISON OF REACTION TIME OF THREE DIFFERENT SIGN SERIES FOR SITE B

Source	df	MS	F
Signs (location 1)	2	5.374	4.144*
Residual	57	1.297	
Signs (location 2)	2	1.125	1.148
Residual	57	0.793	
Signs (location 3)	2	0.990	1.309
Residual	57	0.756	
Signs (location 4)	2	0.895	1.069
Residual	57	0.837	
Signs (location 5)	2	0.216	0.892
Residual	57	0.242	

*Significant value, $p < .05$

TABLE 5

COMPARISON OF REACTION TIME OF FOUR DIFFERENT SIGN SERIES FOR SITE C

Source	df	MS	F
Signs (location 1)	3	2.273	2.149
Residual	76	1.058	
Signs (location 2)	3	3.779	4.998*
Residual	76	.756	

*Significant value, $p < .05$

Site A

The interchange at the junction of I-85 and I-95 was tested at three locations as shown in Figure 6. Four sign series, as shown in Figure 7, were tested for each location. The four series consisted of the existing signing and three diagrammatic signing schemes, referred to as existing, DS-1, DS-2, and DS-3. For each location, the reaction time was greater for the existing signing than for the diagrammatic schemes. At sign locations #1 and #2 the lowest reaction times were recorded for DS-2, while DS-2 and DS-1 gave equal reaction times at location #3. The analysis of variance shown in Table 3 indicated that the differences between the existing and the diagrammatic schemes were significant for sign locations #1 and #2, but not statistically significant for sign location #3. The reaction time differences for sign location #3 could occur due to chance.

The existing signing gave a high percentage of correct responses at sign locations #1 and #3, but did not perform as well at location #2. DS-3 performed relatively well at all three locations, while DS-1 performed poorly at all three locations. At location #3, DS-1 received no correct responses. The percentage of correct responses for DS-2 at location #1 is somewhat lower than for DS-3, equal to DS-3 at location #2, and slightly lower at location #3.

Site B

Five signing locations were tested for the junction of I-95 and I-495 as shown in Figure 8. Figures 9 and 10 show the existing signing along with two diagrammatic signing schemes tested at each location. The analysis of variance as shown in Table 4 indicated that the differences in reaction time were statistically significant only at location #1, where the existing gives the lowest reaction time.

Considering the percentage of correct responses for each location, all three schemes performed equally well at location #1. The existing gave 100% correct responses at location #5, while DS-1 received no correct responses at location #3. DS-2 performed relatively well at all five locations.

Site C

The site C interchange as shown in Figure 11 was tested for four signing schemes at two locations. The sign series shown in Figure 12 consisted of the existing signing and three diagrammatic

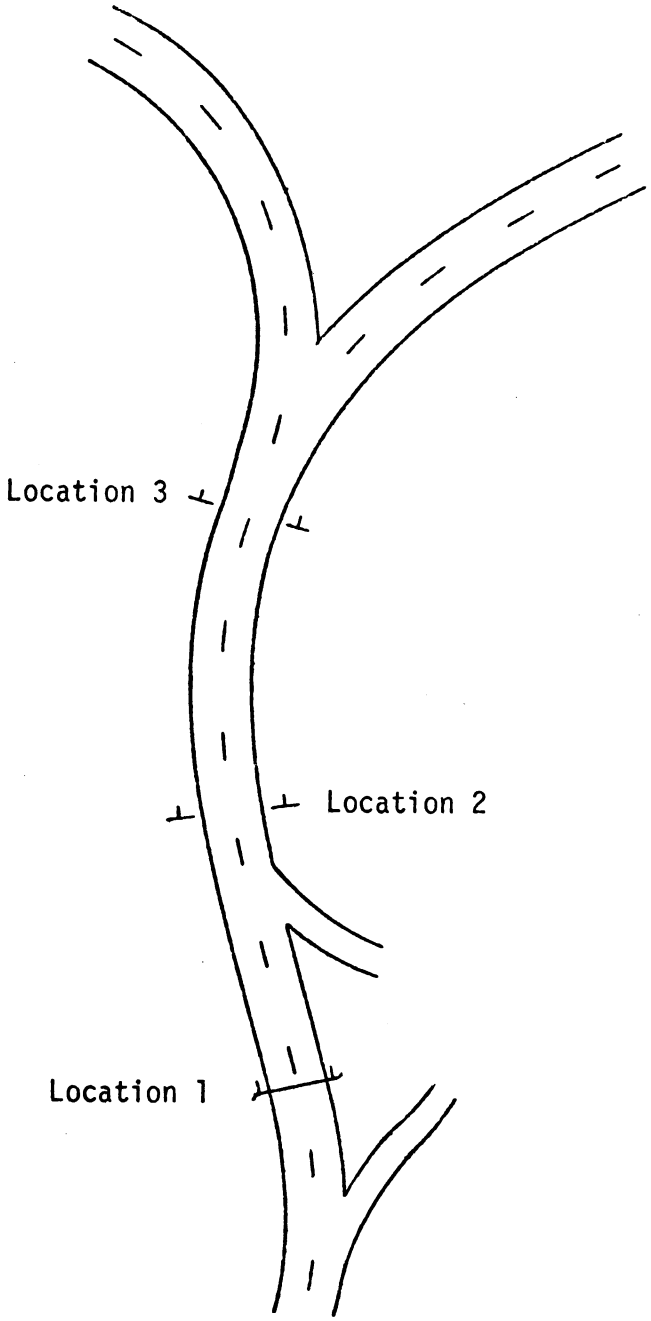


Figure 6. Site A- junction of Interstate 95 and Interstate 85.

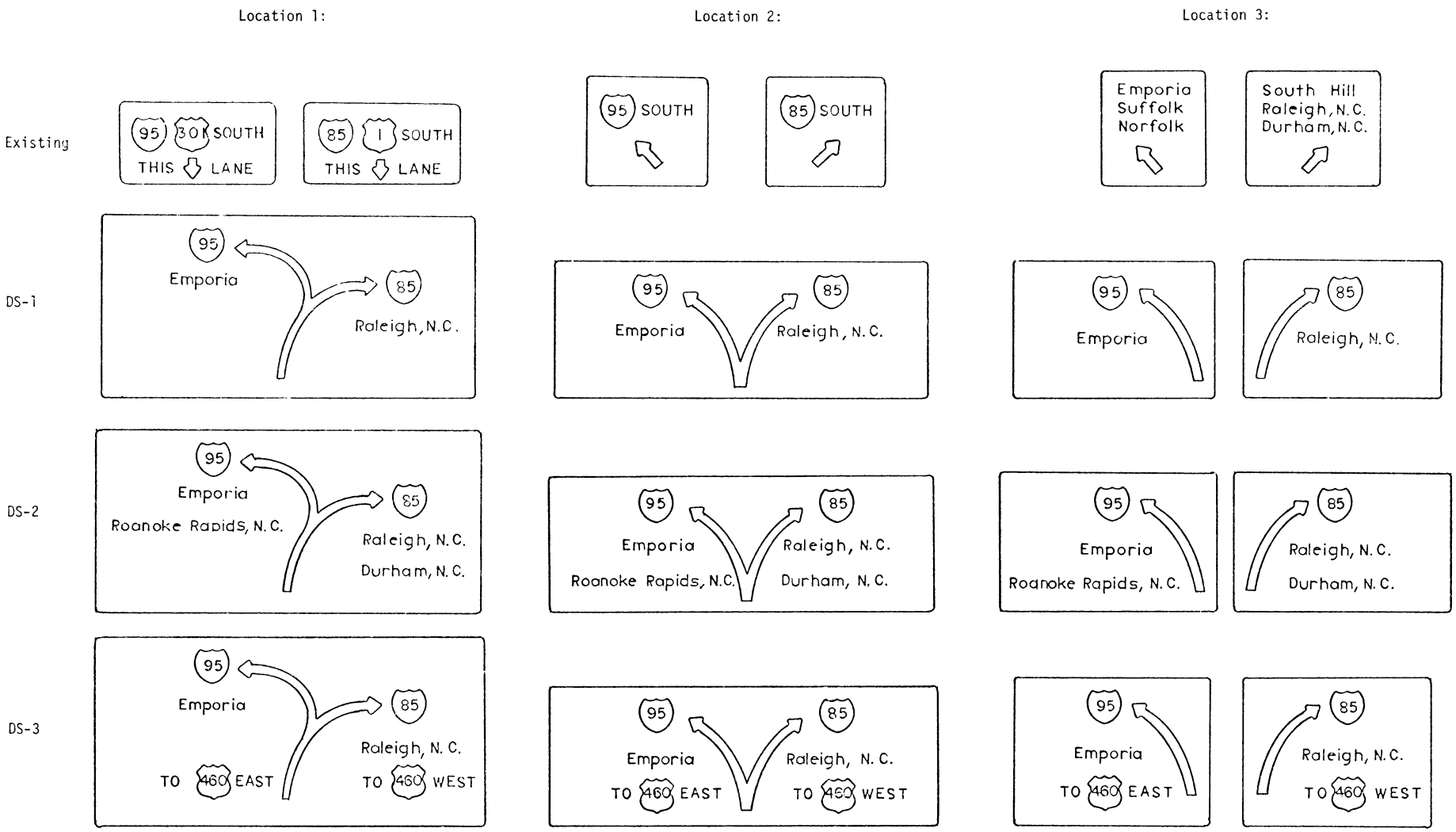


Figure 7. Signs tested for Site A.

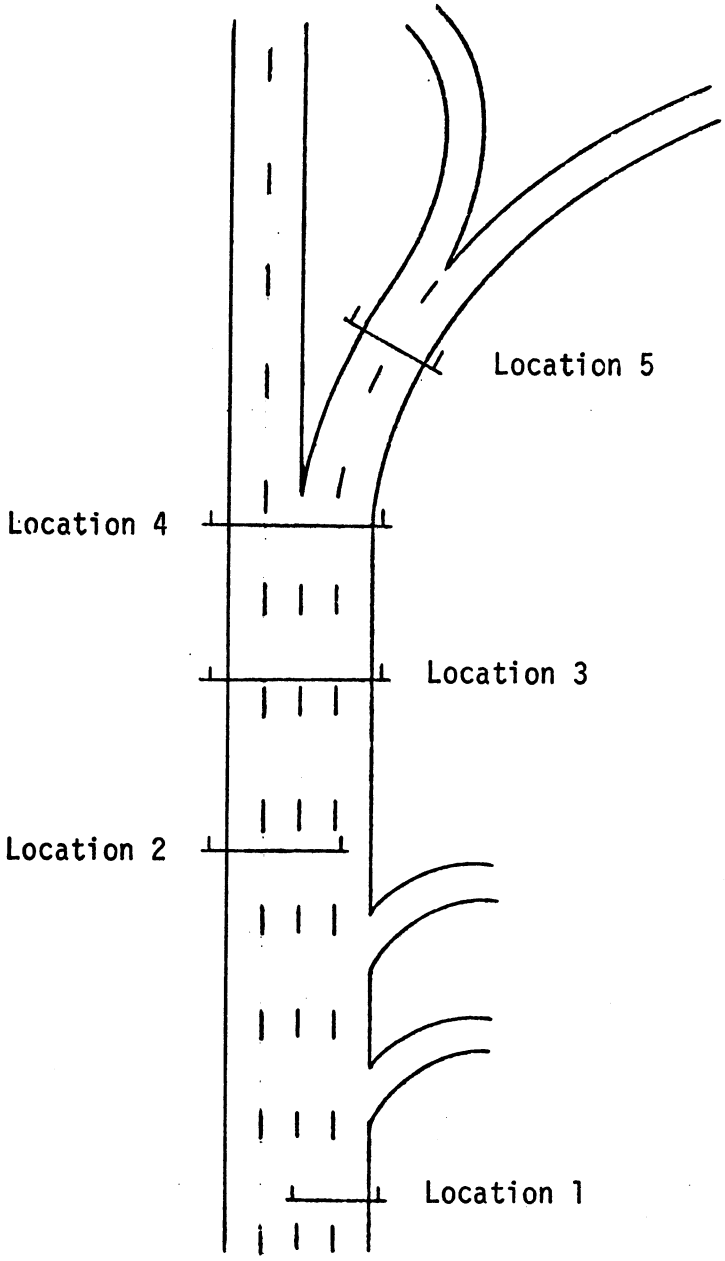
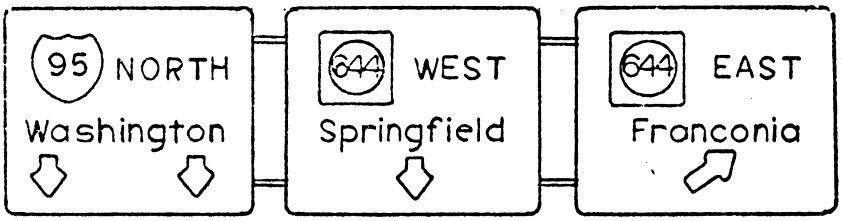
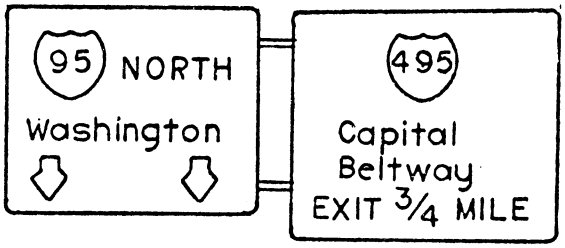


Figure 8. Site B- Interstate 95 junction with Interstate 495.

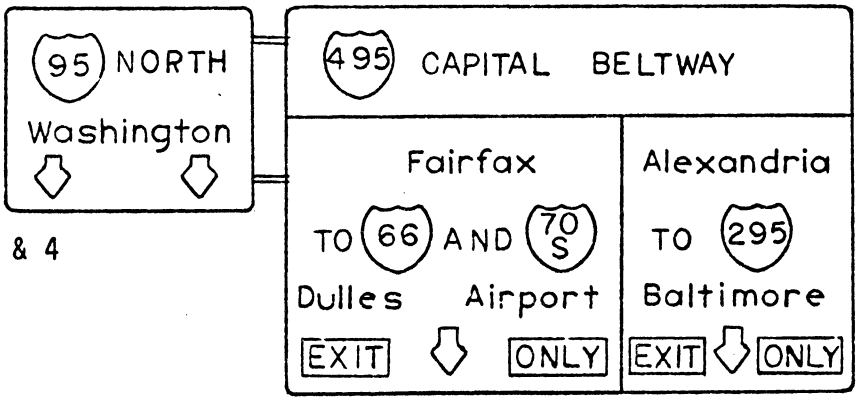
Location 1



Location 2



Locations 3 & 4



Location 5

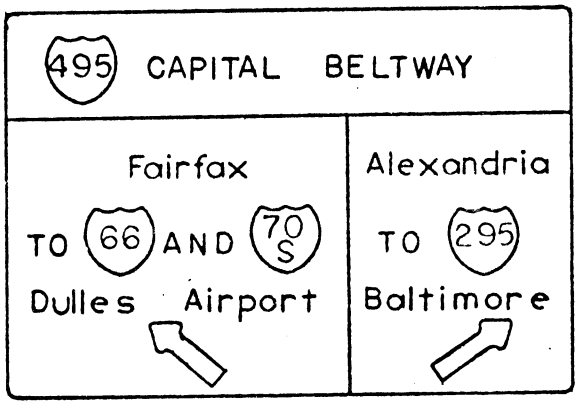
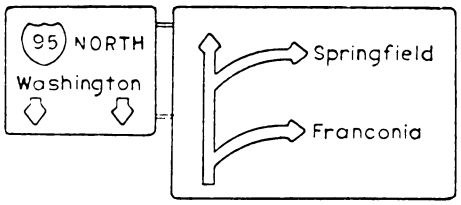


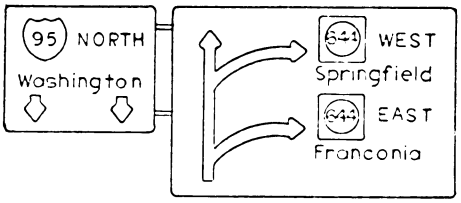
Figure 9. Existing signs tested for Site B.

DS-1

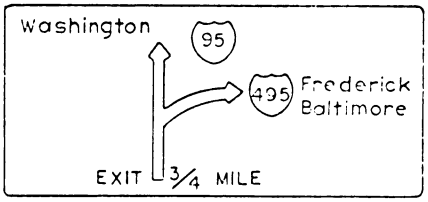
DS-2

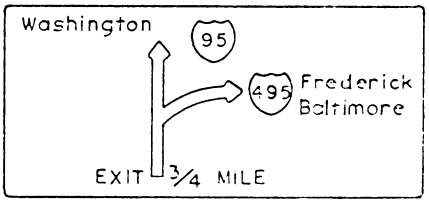
Location 1



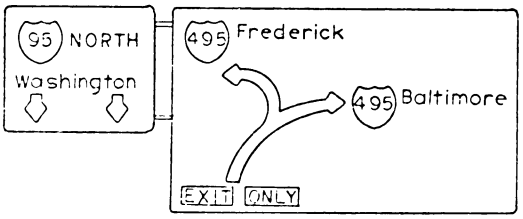


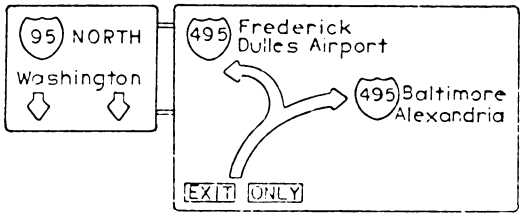
Location 2



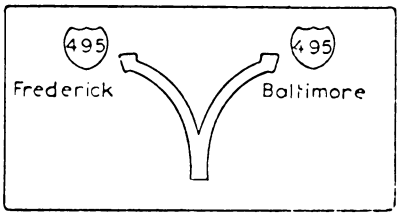


Locations 3 & 4





Location 5



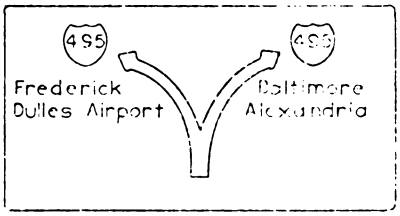


Figure 10. Diagrammatic signs tested for Site B.

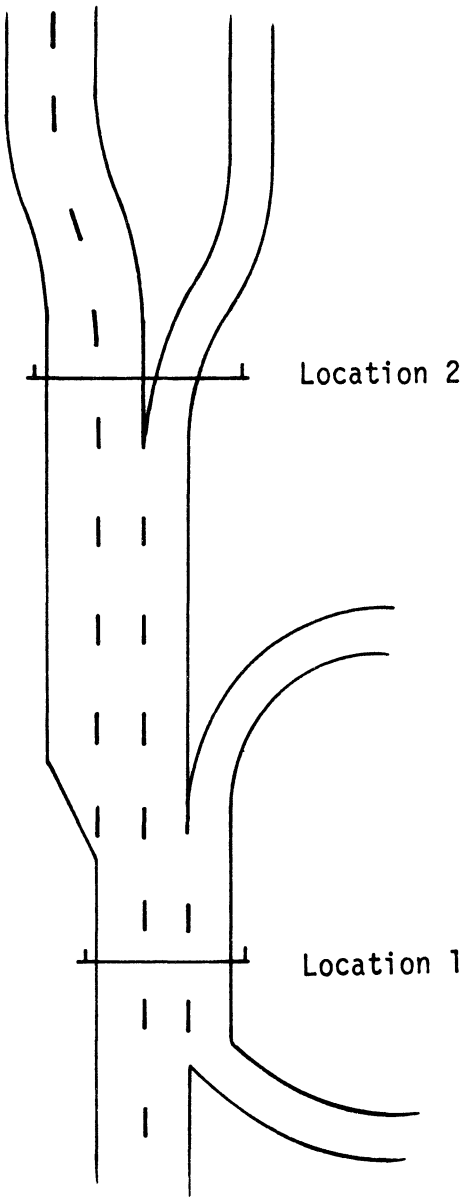


Figure 11. Site C- Interstate 264 junction with Interstate 64.

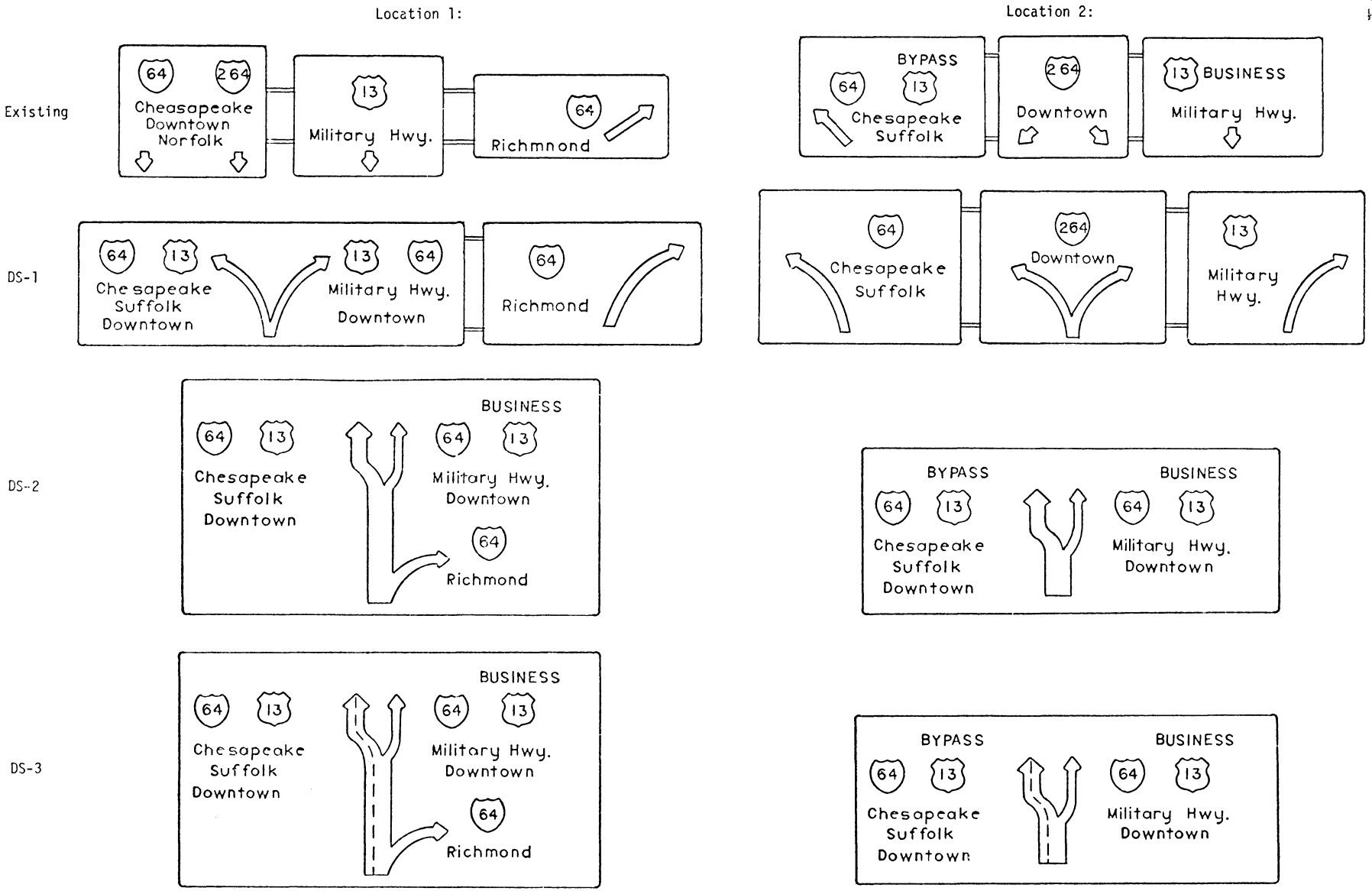


Figure 12. Signs tested for Site C.

signing schemes. For both locations, the reaction time for DS-1 was lower than for the existing, DS-2, and DS-3. However, the analysis of variance shown in Table 5 verifies a statistically significant differenct only for sign location #2.

At location #1 the greatest percentage of correct responses was recorded for existing and DS-3. At location #2, DS-1 and DS-3 gave the greatest percentage of correct responses. DS-2 was considerably lower than the other three series at location #1, and equal to existing at location #2.

Discussion of Results

Although not within the purpose and scope of this study, there are various points concerning the laboratory procedure utilized in this study and the data concerning diagrammatic signing which should be noted.

In a study by Dr. Gretchen S. Kolsrud entitled "Diagrammatic Guide Signing for Use on Controlled Access Highways", Volume III, Part 3 (Synthesis and Conclusions), all relevant research on laboratory studies of diagrammatic guide signs is reviewed. Of the six studies described, three utilized slide presentations of roadway scenes while one used the UCLA Sign Tester and another a driving simulator. The last study included in this group involved the viewing of a movie on which highway signs were projected. This last mentioned study was a part of a much larger one on the general topic of highway guide signs that included only one diagrammatic sign.

The laboratory procedure used in the present study also used a movie taken of the actual roadway with experimental diagrammatic signs inserted on them with a tachistoscope. However, the laboratory phase used here went much further. It included the existing conventional signs along with three different diagrammatic designs for three locations at one interchange; the existing signing along with three separate diagrammatic designs for two locations at a second interchange; and the existing signs in addition to two diagrammatic designs for each of five locations at a third interchange.

From data presented in Table 1, which summarizes the average reaction time values, of the 25 comparisons between the conventional signs and the various diagrammatic designs 21 of the diagrammatic designs exhibited lower reaction times (four significantly different) than did the conventional signs. Of the four cases for which the conventional signs had lower reaction times, statistically significant differences were found in two.

Considering the percentage of correct responses, Table 2 shows that for the 25 possible comparisons nine diagrammatic designs gave higher percentages of correct responses than did the

conventional signs, four were equal, and 12 exhibited lower percentages of correct responses. Also, five diagrammatic designs showed extremely low percentages of correct responses, in the zero to 25% range.

Some interesting points emerge from the laboratory study data presented in this report. First, similar diagrammatic designs show large differences in the percentages of correct responses and, secondly, diagrammatic signs were recommended over the existing conventional signing for each of the three sites selected for study.

Summary of Results

The results of the laboratory phase may be briefly summarized as follows:

1. For Site A, diagrammatic series DS-2 gave the lowest reaction time values, with DS-3 a close second. DS-3 showed the best overall performance with regard to the percentage of correct responses.

2. Differences in reaction time values were statistically insignificant at four of the five signing locations of Site B. In general, DS-2 performed best with regard to the percentage of correct responses.

3. At Site C, the reaction time was lowest for DS-1. At location #1 the existing received the highest percentage of correct responses, as did DS-3 at location #2.

Field Phase

The results of the field phase are presented in terms of erratic vehicle maneuvers for the before and after conditions. Table 6 gives a summary of the traffic volumes along with weaves as a function of the actual and adjusted volumes. Since there was a difference in the before and after volumes, the influence of this differential on weaving was investigated by running a regression analysis of weaves-to-volume ratios versus volumes from which an adjustment was made to the increased volume as shown in Table 6.

A statistical analysis was conducted using a hypothesis test under the conditional probability distribution of the weaves, given that a vehicle will weave. Based on this test, in addition to the Chi-square test, no significant differences were found in the before-after erratic maneuver rates at the 90% confidence level for both the observed and adjusted volume rates.

TABLE 6

ERRATIC MANEUVERS AND TRAFFIC VOLUME--SITE A

	Before	After	After Adj.
Total Volume (Avg. ½ hour)	488	572	
Lane 1 Volume (enter zone I - avg. ½ hour)	291	343	
Lane 2 Volume (enter zone I - avg. ½ hour)	197	229	
Total Weaves/total volume - %	6.99	6.59	
Weaves (W_1) in zone I/volume in lane 1 - %	6.53	6.64	
Weaves (W_2) in zone I/volume in lane 2 - %	2.83	2.39	
Total weaves in zone I/total volume - %	5.03	4.90	4.70*
Weaves (W_3) in zone II/volume in lane 1 - %	1.31	1.24	
Weaves (W_4) in zone II/volume in lane 2 - %	1.56	1.39	
Total weaves in zone II/total volume - %	1.42	1.30	1.40*
Weaves (W_5) in zone III (Gore)/volume (V_{85}) - %	0.73	0.56	
Weaves (W_6) in zone III (Gore)/volume (V_{95}) - %	0.41	0.23	
Total weaves in zone III/total volume - %	0.54	0.36	0.47*
Vehicles stopping in gore/total volume	0.05	0.07	

*adjusted for volume increase.

Although the differences were not statistically significant, it is interesting to note that all but one weaving maneuver type was reduced, that being "W_1" in zone I. This increase within zone I might be expected if the diagrammatic sign is effective in conveying to the motorist information needed to negotiate the interchange properly, since this would result in earlier weaving (zone I) rather than within the hazardous area encompassed by zones II and III.

Also, as noted in Table 6, the percentage of vehicles stopping in the gore area was extremely low for both the before and after conditions.

COMPARISON OF LABORATORY AND FIELD PHASE

The only opportunity for comparison of the laboratory results with those found in the field existed at location 1 for the I-85 and I-95 interchange (site A). Although it was felt that insufficient information was available to allow a positive statement concerning the correlation of the laboratory and field phases, there are similarities in the results which warrant consideration. For example, regarding the comparison of the existing signs (existing) with the new diagrammatic sign (DS-3) at location 1, there was very little difference in the percentages of correct responses for the two signs, with 100 percent correct for the existing signs and 95 percent for the diagrammatic sign. There was a significant difference in reaction time, however, the 0.7 second differential is not critical at location 1 since the motorist has ample time for maneuvering in response to a diagrammatic sign that exhibits 95 percent correct responses. Considering the above, very little difference was found in the laboratory study for the two signing concepts, which confirms the conclusion found in the field phase that no significant difference existed between the signs.

DISCUSSION OF RESULTS

This project was initially set up to include three interchanges for both the laboratory and field phase and a correlation of the two phases, however, two of the three interchanges originally selected were deleted for reasons beyond the control of the author. For example, diagrammatic signing had been designed and tentatively approved for the northbound approach to the I-95—I-495 interchange; however, subsequent differences of opinion on the sign messages resulted in cancellation of the proposed diagrammatic signing. Field studies for this interchange formed a major portion of the field phase, therefore, deletion of this interchange resulted in the omission of a principal part of the study.

It is important to note that the laboratory phase was conducted prior to the field phase, therefore, signing changes and deletions after the laboratory phase was completed seriously jeopardized the chances for a valid laboratory-field comparison.

Another point which should be considered concerns the characteristics of site A where certain features unique to this interchange could possibly influence the laboratory results as well as the comparison of the two phases. As noted earlier, the interchange is characterized by an interstate split with the origin of interstate 85 bearing to the right and interstate 95, a through route, continuing to the left. The unique characteristics of the interchange are

that both highways go south through North Carolina, South Carolina, and Georgia, which leads to some confusion concerning which routes one should take. This circumstance was reflected when motorists stopping on the shoulder (before condition) as a result of confusion were questioned about their problem. Almost 50 percent of those stopping indicated that the uncertainty of which route to take was primarily responsible for their erratic actions. It is doubtful that this condition was taken into consideration when conducting the laboratory studies, as test subjects were provided with a destination name which appeared on the sign.

Although the diagrammatic signs were designed to help alleviate motorist confusion associated with the interchange, the percentage of motorists going to either Miami or Atlanta, as shown on the diagrammatic sign, could be small compared to those desiring other destinations which are accessible by either interstate route. If the routes did not run parallel through common states, this uncertainty of route choice would, in most probability, be extremely small.

Because of the above considerations caution should be exercised in deriving any trends for the design of diagrammatic signsbased on the conclusions from the laboratory study and the results pertaining to the diagrammatic sign.

CONCLUSIONS

Observation of the existing conventional signs along with various new diagrammatic designs in both the laboratory and field revealed several considerations which should be of benefit when contemplating new diagrammatic signs and laboratory procedures for design or evaluation:

1. The use of motion picture segments to simulate actual driving through the study area, on which diagrammatic designs were tachistoscopically projected, added a dimension of realism seldom incorporated in laboratory studies.

2. Based on the results of the laboratory study, diagrammatic signs rather than the existing conventional signing were recommended for all three sites studied.

3. The one opportunity existing for a comparison of laboratory and field results revealed similarities for the particular diagrammatic design considered.

4. It is apparent that the new diagrammatic sign observed in the field did not contribute significantly to the reduction of erratic maneuvers. However, because of the unique nature of the interchange studied, i.e., both interstates going south through common states, caution should be exercised in deriving any trends in the design of diagrammatic signs based on the field study.

Although there were certain limitations placed on this study because of the abbreviated field phase, the study does propagate an awareness of the many variables which may influence the results and validity of results found from either the laboratory or field studies and it is, therefore, hoped that the results presented will give a better insight into the use of laboratory procedures for investigating potential signing along with considerations associated with the study of highway and interchange signing.

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BIBLIOGRAPHY

1. Berger, Wallace G., Criteria for the Design and Deployment of Advance Graphic Signs, Serendipity, Inc., Contract No. FH-11 7284, Arlington, Virginia, September 1970.

2. Hanscom, F. R., Diagrammatic Signing at Capital Beltway Exit No. 1, Virginia Highway Research Council, Charlottesville, Virginia, 1971.

3. Kolsrud, Gretchen S., Diagrammatic Guide Signs for Use on Controlled Access Highways, Volume III - Traffic Engineering Evaluation of Diagrammatic Guide Signs, Part 1, 2 and 3; FHWA-RD-73-23, 24 and 26; December 1972.

4. Mast, T. M., and G. S. Kolsrud, Diagrammatic Guide Signs for Use on Controlled Access Highways, Volume I, Recommendations for Diagrammatic Guide Signs; FHWA-RD-73-21; December 1972.

5. Roberts, A. W., Diagrammatic Sign Study, Phase I Report, Bureau of Safety and Traffic, Division of Research and Evaluation, New Jersey Department of Transportation, May 1970.

6. Shepard, Frank D., Evaluation of Certain Signing on the Capital Beltway, Virginia Highway Research Council, Charlottesville, Virginia, January 23, 1969.

7. Wyoming State Highway Department, Traffic Engineering Department, Evaluation of Diagrammatic Signing, 1970.

APPENDIX

LABORATORY PROCEDURE

In designing the experimental procedure for this study, the Information Processing Concept of the human operator was employed. This model has provided the fundamentals to much of our present understanding of the factors determining speed and accuracy of human performance. Since statistical evaluation of this laboratory investigation depended on the measures of reaction time and accuracy, it was deemed appropriate to apply this proven concept.

The experimental set-up is shown in Figure A-1. The subject was seated at the enclosed desk directly in front of the projection screen. A panel containing three response buttons was positioned on the desk. The subject pressed the appropriate button in order to record his response. Since the laboratory was darkened during the test period, a tensor lamp was provided to light the panel.

Each subject was seated at the desk and given the following instructions:

> The purpose of this test is to compare and determine the effectiveness of different classes of highway signs and observe which types of signs are easier for you to comprehend.
>
> The experiment consists of (1) a film taken from within a vehicle while being driven on different segments of various interstate freeways, and (2) a series of slides displaying various highway signs.
>
> The film and the slides will be projected upon the screen located directly in front of you.
>
> Your task is to reach a given destination by observing the film and following the information presented on the traffic signs.
>
> The film will stop automatically at certain points and a highway traffic sign will be flashed upon the screen above the film for only a short period of time. -- "Watch the screen for an example." -- Knowing your desired destination, you must respond to this slide displaying the traffic sign by pressing the proper button on your desk.
>
> The response box located on your desk contains three buttons which are marked with left, straight and right pointing arrows.

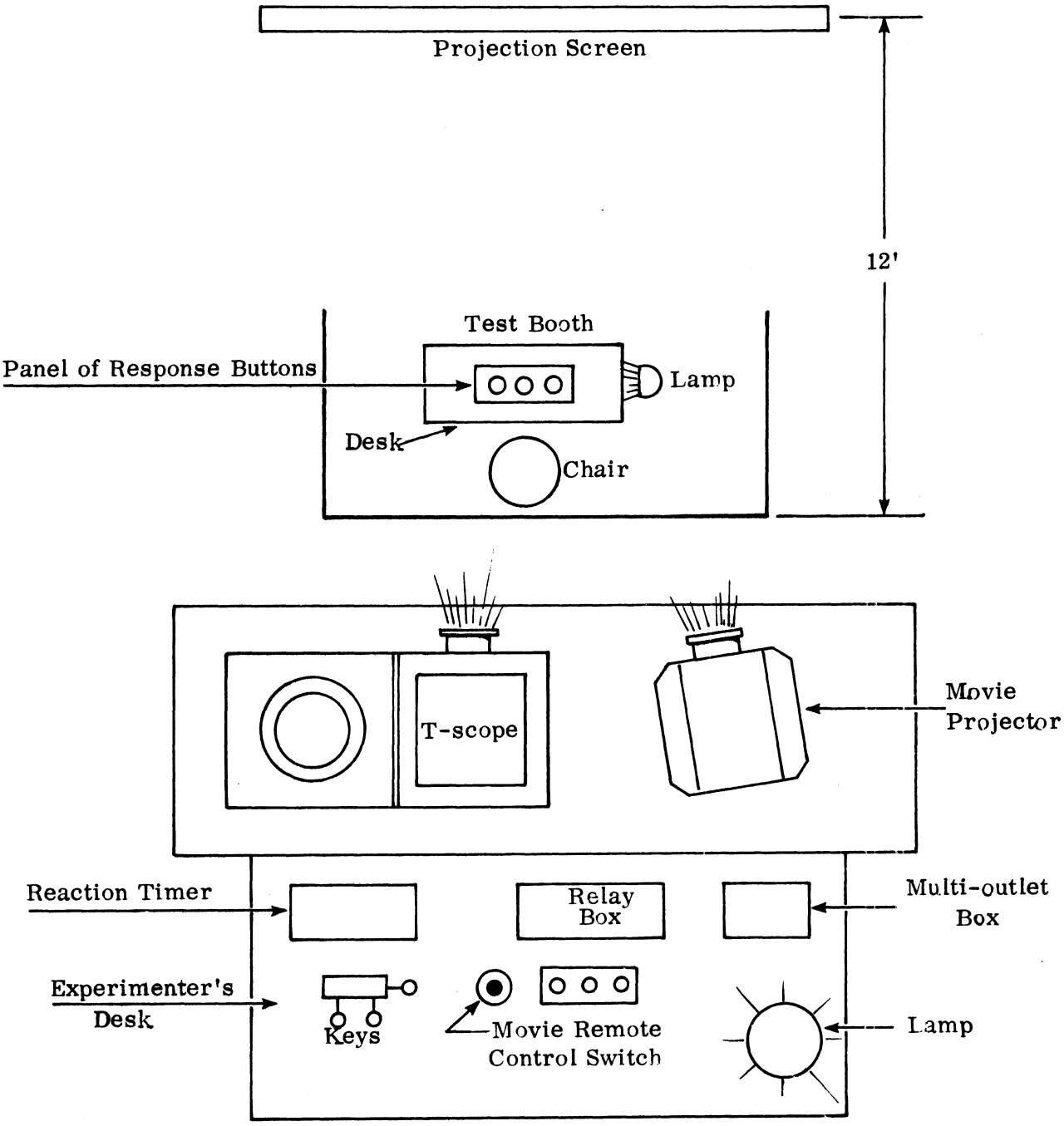

Figure A-1. Laboratory study setup.

As you watch the film, pay particular attention to the lane in which the vehicle is traveling. That lane corresponds to the middle button which is marked by a straight ahead arrow. If the combination of the film and the traffic sign indicate that the vehicle is proceeding in the correct lane to reach the desired destination, press the middle button. However, if the vehicle needs to move to the right lane to reach the desired location, press the right button. On the other hand, if the vehicle should move to the left lane, press the left one. -- Example: For this situation (flash the sign), the <u>right</u> button should be pressed if <u>Raleigh, N. C.</u>, is our destination.

Do you have any questions? Please respond as quickly as possible, but try to be accurate in making your response.

One more item, please keep your response hand on the desk except when a response is required.

The following segment is a practice session, so please respond by pressing the proper button and bear in mind that the lane in which the vehicle is traveling corresponds to the middle button on your desk.

----------(Practice Session)---------- Do you have any questions?

The actual study will now begin. -- Your first destination is ****.

After completion of the instructions and practice session, the experimenter answered any questions and made certain that the subject was aware of the nature of his task. The first destination was then given to the subject and the actual experiment began.

The experimenter started the movie projector by remote control and the film was projected upon the screen. As the vehicle in the film approached the guide signs on the freeway, the film automatically stopped while the vehicle was still a considerable distance away from the signs. Immediately after the film stopped the test sign was flashed on the screen and the reaction timer started simultaneously. The sign remained

on the screen for an exposure duration of four seconds. During this time the subject made his lane choice decision and recorded it by pressing one of the three response buttons. Pressing a button also stopped the reaction timer. The researcher recorded both reaction time and lane choice.

The experimenter then reset the reaction timer, indexed the slide projector, and started the film again for the next presentation. This procedure was repeated until the first series of slides for a single interchange was completed. At that time a second destination was given to the subject and the next series began.

A total of 35 slides (not including the practice session) was viewed by each subject. The series of slides was presented in random order. Only the experimenter and the subject were present in the room during the period of the test. The experimenter was positioned to observe both the film and the slides while the study was being conducted. The complete test took approximately one hour, and at the end of the experiment the subject was asked to fill in the personal information at the top of his data sheet, as shown in Figure A-2.

Date_____ Name_____ Age_____ Sex_____
Driving experience in U.S._____
How long have you had your driver's license?_____
Have you had any driver's education classes?_____
Have you frequently driven on the freeway?_____
Driving experience abroad_____ if so, where_____

	←	↑	→	Reaction time (Sec.)
Site B				
Ser. 2				
Site A				
Ser. 4				
Site C				
Ser. 2				
Site A				
Ser. 2				
Site B				
Ser. 4				
Site B				
Ser. 1				
Site C				
Ser. 3				
Site A				
Ser. 3				
Site C				
Ser. 1				
Site B				
Ser. 3				
Site A				
Ser. 1				

Exposure Time (Sec.)_____

Figure A-2. Sample data sheet.