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16. Abstract

This research effort explored the knowledge level of a sample of Texas drivers with regard to traffic control devices. Driver licensing stations in five urban and five small city areas were used as survey sites. The survey questionnaire consisted of an album of 27 traffic situations involving control devices. These situations were chosen from a preliminary survey of driver instructors, driver education programs, and the Texas Department of Highways and Public Transportation. The following eleven devices are seriously misunderstood: crossing signs, the slippery when wet symbol sign, the curve vs. turn symbol sign, the pavement width transition symbol sign, the double turn symbol sign, the climbing lane ahead sign, yield to traffic in center lane sign, the double yellow line, the solid white line, protected turn traffic signal indications, and the flashing intersection control beacon.

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PUBLIC UNDERSTANDING OF TRAFFIC CONTROL DEVICES IN TEXAS

by

Rodger J. Koppa
and
Patricia K. Guseman

Research Report 232-1F

Research Study Number 2-18-78-232
Public Understanding of Traffic Control Devices

Sponsored by

The Texas State Department of Highways
And Public Transportation

in cooperation with the

U.S. Department of Transportation
Federal Highway Administration

TEXAS TRANSPORTATION INSTITUTE
Texas A&M University
College Station, Texas

November 1978

Summary of Findings

The intent of this research effort, "Public Understanding of Traffic Control Devices in Texas" was to explore the knowledge level of drivers. A survey approach was undertaken, whereby Texas Department of Public Safety licensing offices were utilized as survey sites in five large urban areas and five matching small cities. In the aggregate, the ten sites evidenced population characteristics highly similar to the Texas population. Thus, the driver sample was representative of the driving public in the State with regard to primary population parameters.

Driver education and defensive driving instructors, State Department of Highways and Public Transportation staff, and previous studies provided the bases for decision-making with regard to the inclusion of 27 traffic control devices in the final survey. The following eleven devices represent those that were the most seriously misunderstood which also pointed to misperceptions that were potentially hazardous:

1. Crossing Signs: Advance vs. at-Crossing symbol sign
2. Slippery When Wet symbol sign
3. Curve vs. Turn symbol sign
4. Pavement Width Transition symbol sign
5. Double Turn symbol sign
6. Climbing Lane Ahead
7. Yield to Traffic in Center Lane
8. Double Yellow Line (nature of prohibition)
9. Solid White Line (not discriminated from dashed)
10. Protected Turn Traffic Signals (green and amber arrows)
11. Flashing intersection control beacon.

As the primary transportation system, the motor vehicle on the public roadway becomes even more overcrowded and technically sophisticated, traffic control devices must be more effectively interpreted by the driving public without elimination or modification of existing traffic control devices, training of motor vehicle operators provides the most appropriate alternative. The Texas Transportation Institute has recommended a study of informational countermeasures for the misunderstandings of traffic control devices found in this research project, based on further analysis of study data and in consultation with education and training specialists in highway safety in Texas.

Implementation Statement

To be effective, traffic control devices must be clearly understood by the driving public. A lack of familiarity or misperceptions regarding the meanings of traffic signs, markings, signals, and delineators precipitates hazardous situations and hinders traffic movement.

The survey findings presented in this report are designated to facilitate implementation of informational programs, including dissemination through:

- Public service announcements
- Driver education and defensive driving courses
- Driver licensing stations
- Vehicle registration
- Roadsign "advertisements"

Specific information approaches will be assessed in conjunction with the Office of Traffic Safety. However, these informational and educational efforts need to be geared to specific population segments, those evidencing the highest misperceptions on the Texas Driver Knowledge Scale: (1) those with low driving exposure; (2) the young and the elderly drivers; (3) female drivers; and (4) ethnic minorities with language and other barriers to understanding traffic control devices.

Other options which warrant consideration, but which may not be feasibily implemented in the near future, include deletion and/or alternation of particularly problematic devices.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

ACKNOWLEDGEMENTS

This project was originally conceived by Mr. John H. Gerling of the Texas State Department of Highways and Public Transportation and his associates. Mr. Gerling, the Technical Monitor, and others in SDHPT are gratefully acknowledged for their interest in and support of this research throughout its period of performance.

The study could not have been accomplished without the cooperation of the Texas Department of Public Safety, especially Chief Joe E. Milner and Captain J. E. McElroy, Traffic Law Enforcement. The interest and cooperation of the Drivers License Division Captains, Supervisors, and personnel in all the cities we visited made the field research a very pleasant experience.

The cooperation of the Texas Safety Association and the Texas Education Agency is also gratefully acknowledged.

Our thanks also to Shell Oil Company for providing a generous supply of Shell Answer Books for distribution to respondents.

ABSTRACT

This research effort explored the knowledge level of a sample of Texas drivers with regard to traffic control devices. Driver licensing stations in five urban and five small city areas were used as survey sites. The survey questionnaire consisted of an album of 27 traffic situations involving control devices. These situations were chosen from a preliminary survey of driver instructors, driver education programs, and the Texas Department of Highways and Public Transportation. The following eleven devices are seriously misunderstood: crossing signs, the slippery when wet symbol sign, the curve vs. turn symbol sign, the pavement width transition symbol sign, the double turn symbol sign, the climbing lane ahead sign, yield to traffic in center lane sign, the double yellow line, the solid white line, protected turn traffic signal indications, and the flashing intersection control beacon.

Key Words:

Traffic Control Devices, Signs, Signals, Markings, Safety, Survey

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I. Statement of the Problem

1.1 Background

Traffic control devices have reached a high level of uniformity and specificity in this decade. In 1971, the national Manual on Uniform Traffic Control Devices for Streets and Highways (1) provided a sound basis for standardization of signs, markings, and delineators. On a statewide scale, the Texas State Department of Highways and Public Transportation (DHT) in 1973 provided a Texas Manual on Uniform Traffic Control Devices for Streets and Highways (2). The traffic control devices outlined in these two volumes, as well as in published revisions, provides for a rigorous set of meanings regarding specific signs, markings, and delineators that must be communicated to the driving public in order to be effective. Thus, a serious problem to motor vehicle operators is presented when these individuals misunderstand or are unfamiliar with the meanings of traffic control devices.

While traffic control engineers have reached a high level of sophistication and uniformity in the utilization of control devices, motorists often have not been cognizant of these improvements. In Texas for example, any driver over 40 years of age has been exposed to four major alterations in the delineation of the center line of a two-way highway. Originally, the center line was solid black, highlighted by white on dark surfaces. With time, the center line became a continuous white stripe. Later, the line became dashed, and finally was delineated in yellow.

When traffic engineers employ traffic control signs or pavement markings which must communicate meanings to motor vehicle operators by symbols, shapes, color, etc., a potential problem arises if these drivers are not knowledgeable

of the intended usage of the control devices. Signs, markings, and delineators must be completely understood before they become an effective means of controlling traffic and travel behavior.

Many motorists may be driving in a dynamic system in which they only half-understand some fundamental inputs they must have to operate efficiently and safely. All unknowing, they may be contributing to traffic turbulence, intrusions into the right-of-way of others, and to the accident toll in Texas. If the signs, markings, or delineators used in the State cannot be made immediately and intuitively obvious to drivers, then information dissemination procedures will be needed to remedy the situation.

Pavement markings portray a wide variety of meanings; such markings are used for channelization, lane usage, crosswalks, edge lines, continuous left turns, median island markings, and stop lines. Within these broad cases, more specific meanings are communicated, based on the color, width, continuous character, and shape of the pavement markings. For example, the broken line pavement marking is used for permissive lane changes while the single solid white line at acceleration/deceleration ramps on freeways is to discourage lane changing. On two-lane highways, a solid yellow line placed in one lane denotes no passing from that lane as long as the solid line appears. Where there are two solid yellow lines, there can be no passing from either direction; however, a singular broken yellow line permits pass maneuvers from either direction. The width of the lines denotes increased danger or adds greater visibility. These descriptions, while readily understood and carefully applied by the traffic engineer, may not be familiar to the public-at-large.

The Highway Research Board of the National Research Council has provided a study dealing with the Development of Information Requirements and Transmission Techniques for Highway Users (3). This volume describes drivers' information needs. However, the emphasis is on the creation of improved fixed highway signing and markings with little treatment of the gap between current usage of traffic control devices and the existing knowledge levels of the public.

Many studies have concentrated on the driving public's misunderstanding of individual traffic control devices such as no-pass zone markings (4), diagrammatic signs (5, 6, 7), and route diversion signing (8). Further, the Texas Transportation Institute (TTI) has recently completed a national study of human factors requirements for driver information displays (9).

1.2 Objectives

Long range objectives of this research were:

Objective 1.

To establish a method for determining traffic control devices which are misunderstood or unfamiliar to the driving public in Texas.

Objective 2.

To determine the proportion of drivers who would violate specific traffic control devices based on reported action.

Objective 3.

To segment the driving public (a) by critical factors reflecting misunderstanding of traffic control devices and (b) by background characteristics of individuals, such as rural-urban residence, age, language barriers, education levels, and driving exposure.

Objective 4.

To provide preliminary identification of strategies for information dissemination regarding less recognized traffic control devices. Dissemination procedures will be selected from a series of possible educational programs, media, and information distribution centers.

Objective 5.

To isolate out those information strategies that would most benefit specific population segments.

Objective 6.

To provide a series of recommendations for assisting the State Department of Highways and Public Transportation in facilitating Texas drivers to gain a fuller knowledge of traffic control devices and for diminishing undue

accidents based on a lack of driver information. These recommendations will provide assistance to the State Department of Highways and Public Transportation staff in the implementation of information dissemination strategies.

Objectives 1-4 were realized in the phase of research being reported on. This research effort took place during the period September 1977 and August 1978.

Objectives 4, 5, and 6 will be addressed in a succeeding countermeasure development project which has been proposed by TTI in conjunction with the Office of Traffic Safety.

II. Methodology

The basic strategy adopted for this study involved:

(1) Identification of misunderstood traffic control devices for inclusion in the project. The approach decided upon was a special survey of traffic safety and education professionals including driver education instructors, Defensive Driving instructors, and State Department of Highways and Public Transportation engineers.

(2) Development of a questionnaire suitable for administration in the field. The Texas Department of Public Safety was approached for permission to administer the questionnaire to drivers seeking license renewal. The DPS very kindly put their facilities and personnel at TTI's disposal for the administration of the questionnaire.

(3) Identification of suitable cities and towns throughout the State of Texas which would provide a valid cross-section of Texas drivers, and which had DPS driver license stations suitable for questionnaire administration.

(4) Field pilot testing of a prototype questionnaire in the Bryan-College Station area, with subsequent revision of procedures, format, and items as needed to insure an acceptable data yield from the full study.

(5) Administration of the final questionnaire throughout Texas.

Each of these steps in the progress of this study will be described and discussed in the following paragraphs of this section.

2.1 Survey of Safety Education Professionals

As the first part of this study, a questionnaire was developed to ascertain comments about misunderstanding of signs, markings, and signals or indicators.

The selected target population consisted of driver education and National Safety Council Defensive Driving Course professionals. The Texas Education Agency recommended 26 outstanding driver education professionals and the Texas Safety Association recommended 30 of its outstanding instructors. Questionnaires were mailed to these personnel with a request for their cooperation. The DDC instructors returned 17 questionnaires (57 percent return rate) and driver educators returned 14 (54 percent return rate). The characteristics of the respondent groups is shown in Table 2-1. The composition of the groups and their response rate bears out the agencies' recommendations of outstanding professionals.

Table 2-2 shows the number of comments that were made by each group to specific inquiries. The numbers in parentheses indicate the total number of comments for the underscored communications system. In many cases responses dealt not only with misunderstanding or confusion with respect to the traffic control device, but also addressed inconsistent application of the device, and attitudes of the driving public, as these professionals see them.

Table 2-1. Questionnaire Respondents' Data

Position Held	Defensive Driving	Driver Education
Instructor	8	5
Supervising instructor	0	4
Supervisor/director	0	5
Coordinator/supervisor	4	0
Director/manager	5	0
	17	14

No. Years in Position	Defensive Driving	Driver Education
Range	1 yr. to 25 yrs.	5 yrs. to 18 yrs.
Mean	7.9 yrs.	9.8 yrs.
Primary Job		
Yes	9	12
No	8	2
No. Contacts/Month with Students		
Less than 10	1	0
10 to 20	3	1
20 to 30	2	1
Over 30	11	12

Table 2-2. Number of Comments by Groups to Respective Communication Systems and Specifics

	Defensive Driving	Driver Education
SIGNS	(30)	(29)
. Regulatory	12	10
. Warning	10	10
. Guide	8	9
MARKINGS	(45)	(58)
. Center lines-pavement	9	5
. Lane lines-pavement	9	7
. No passing-pavement	3	9
. Other markings-pavement	6	9
. Words & symbols-pavement	4	6
. Curb markings	4	4
. Object/obstruction	2	7
. Delineators-location	4	6
. Delineators-colors	3	4
. Colored pavement	1	1
SIGNALS	(40)	(35)
. Traffic Control Signals-colors	4	3
. Traffic Control Signals-meaning/arrows	10	10
. Traffic Control Signals-arrangement of heads	3	3
. Traffic Control Signals-meaning of flashing	6	5
. Pedestrian-location	3	2

(continued)

(Table 2-2. continued)

. Pedestrian-indication	5	2
. Beacons-location	1	1
. Beacons colors/indication	1	0
. Railroad crossings	7	9
BARRICADES/CHANNELIZING DEVICES	(10)	(7)
. Barricades	4	3
. Vertical panel	1	0
. Barrels/drums	2	3
. Cones	3	1
MISCELLANEOUS	(6)	(7)
. Advisory signs	0	1
. Detour signs	1	1
. School zones	0	2
. Yield-access/exit	2	0
. Others	3	3

Regulatory signs are an area of real misunderstanding because 70 percent of the respondents commented in this area. The DDC instructors indicated that prohibition signs and yield signs are most misunderstood or most frequently violated. No U-turn, no left turn and no right turn are the regulatory signs that are most disregarded. Yield signs entering and exiting freeways present a real problem, because applicability to ramp exit vs. service road traffic is inconsistent. The right turn on red regulatory signs and mandatory turn lanes present problems in that advance warnings are not always provided, or given too late. The driver educators (DE) support the consensus of the Defensive Driving Course instructors on the yield and prohibition signs. However, DEs indicate that speed control signs are either ignored or misunderstood, i.e., slow traffic keep right (What is slow?), speed limits of maximum and minimum (What's the purpose?), and exceeding speed limits in special zones and on the open roads. On turn lanes, DEs raised a question with multiple lanes where the one lane is a mandatory turn and the other is a permissive turn or through traffic.

For warning signs, 65 percent commented on various misunderstandings. Merging traffic, lane drops, and divided opposing lanes present communications problems to the motoring public. Sharp curves and 90° turns are not readily discriminated. The slippery when wet and winding road signs are confusing. The advanced warning and crossing zone for pedestrian and school signs are frequently interpreted as the same sign. The advisory speed on curve warning signs is too small.

Guide signs were commented on by 55 percent of the respondents. Comments were made that highway designation should be posted shortly after a route changes direction and at city limit signs. Inconsistency in next

town or next exit signing (suggest either highway route marker or street name be used, but not interchangeably). Some guide signs have too much information for a single sign — the information should be divided into two signs. Some guide signs give insufficient advance notice which introduces the hazard of last minute lane changes.

The broad area of markings has received more comments than the other areas. On center line pavement markings, 45 percent of the respondents had specific comments. Both color and continuous or broken stripes are not always understood, i.e., all white lines are not interpreted as used in one-way lanes. Solid stripes are disregarded as restrictive crossing areas. Such questions arise as: "Do double solid center lines prohibit left turns into driveways or entrance to businesses?" "Does the slightly raised median painted yellow have the same meaning as the double solid yellow?" "On the continuous left turn lane, where is the center line?"

Other lane pavement markings also drew considerable comments, i.e., 52 percent. Solid white stripes for acceleration and deceleration lanes on freeways are disregarded. The width of lines has little or no meaning. Pavement markings at gore areas are misunderstood. Stop lines and cross-walks are confused as to their purpose. The purpose of or need for the edge lines is not appreciated.

The no passing pavement markings were commented on by 39 percent of the group. Some states use the long-pass concept while others use the short-pass concept which creates dangerous situations. Does the center line and a no passing stripe mean the same as the double solid yellow lines? Passing should not be permitted immediately preceding merging

areas, lane drops, or divided highway areas. When no passing stripes become extremely long on uphill grade, provision should be made for climbing lanes for slow moving traffic. A no passing stripe should be used on the approach to every bridge.

Other pavement markings stimulated remarks from 48 percent of the respondents; however, some of these are repeats of the former three. Stop lines at intersections are inconsistently used or extremely faded. Continuous left turn lanes and esplanades are used in a like manner which causes numerous violations at esplanade turns or interferes with through lane traffic. Island and median markings are confused as to their meaning. Markings used to channelize traffic are not understood, or advance warnings are inadequate. Special zone markings, i.e., school, hospital, pedestrians, etc., are ignored by motorists.

Words and symbols used in pavement markings drew comments from 32 percent of those responding. The railroad crossing is too close to the actual railroad without adequate warning. Letters are too close together, do not have sufficient height of letters, or are faded so they cannot be readily recognized. Stop ahead or turn lane arrows are too close to the intersection, without advance warning thus are disregarded or violated. Pedestrian crosswalks should have some distinguishing markings different from the stop lines.

Curb markings apparently are relatively effective inasmuch as only 25 percent commented on this means of communication. No parking, loading zone, or customer parking vary from state to state. Red no parking, fireplug, and fire lanes should be similarly marked. Markings are frequently too faded to be recognized.

Object or obstruction markings were mentioned by 29 percent of the respondents. Obstruction markers are too close to the road and get run over too frequently. Bridge markers are confused with dead-end street markers. Culvert markings and changes in road alignment are not observed as potential hazards. Motorists do not know the difference between vertically and horizontally placed object markers.

Location of delineators or reflectors was noted by 32 percent. Motorists fail to recognize significance of spacing of delineators at curves. Wrong-way reflectors on freeways should be used consistently. Sometimes delineators are very close to the edge of the roadway while on other occasions they are a considerable distance from the edge.

Color of delineators or reflectors is apparently understood better by motorists since only 23 percent commented on this area. The purpose for white and single amber delineators is not clear to motorists. The red, white, and yellow reflectors on the pavement for wrong way, same direction travel, and opposite direction travel are not associated by motorists with the same color scheme for pavement markings.

Colored pavement comments were only 6 percent. A different colored pavement for the improved shoulders was thought to be better than the edge lines.

General traffic signals are fairly well understood by the motor public; however, two areas exist where understanding is lacking, i.e., the meaning of arrows and railroad crossings. The color of traffic control signals was mentioned by 23 percent of the respondents. Flashing and continuously illuminated lights denoting full stops, yielding, and hazardous warning are

confused by some drivers. Travel lanes control by red X's and green +'s can be misunderstood.

The meaning of arrows in traffic control signals is the most misunderstood signal — 63 percent commented in this area. DE's indicate that the novice drivers stop when a red light is on for through traffic and the student is asked to turn on a protected arrow. The turn on arrow and protected turns present similar problems to other drivers as well, i.e., such questions as: "Is the turn on arrow only a protected turn?" "Can a turn be made on green if oncoming traffic is cleared and the arrow is not on?" are asked. When the green light is on for through traffic and the green arrow is on for turning, the motorist does not trust oncoming traffic to stop unless stopped after traffic for green light has started moving and oncoming remains stopped. Amber colored arrows present like problems — "Can the turn be made?"

The arrangement of signal heads does not present serious problems because only 19 percent made comments in this area. The location of traffic signals seems to be a greater problem than the arrangement of the heads. The head arrangement is more critical to colored blind drivers than others. Whatever the arrangement, the red light should be larger than the others to give a greater distance to recognize or see it.

The meaning of flashing traffic control signals was commented upon by 36 percent of the respondents. Flashing red lights are interpreted as rolling stops or yield rather than full stops. Intersections with flashing lights leave the driver wondering what control is provided for oncoming and intersecting traffic lanes. Who has the right-of-way in the amber or

red flashing light when driver does not know what color the other lanes have? The flashing lights at railroad tracks, without gates, present problems of stopping, waiting or going.

The location of pedestrian signals does not present a serious misunderstanding — only 16 percent commented on this factor. The signal sometimes is not placed in the same relative position at all crosswalks, i.e., the signal should be placed in relative alignment with the crosswalk.

The indications of pedestrian signals present a somewhat greater problem, for 23 percent commented in this area. Particular misunderstanding of the flashing indication after the WALK phase was mentioned in various ways.

The location of beacons and their colors and indication drew very minor comments, 6 and 3 percent respectively. Red or yellow beacons, either continuously on or flashing, create motorists concern because of the uncertainty of what oncoming traffic and intersecting traffic signals might be indicating. Road hazard beacons are not observed due to a lack of alertness or excessive speed, thus they are violated.

Railroad crossings signals are misunderstood or disobeyed by motorists since 52 percent of the respondents commented in this area. The crossbuck RR crossing and flashing lights may tend to invite beating the train or not heeding the warning. Better markings are required on rural roads and malfunctioning signals need to be repaired. The present system is inadequate and needs to be improved with gates plus flashing lights or flashing lights need to be placed on mast arms or span wires. The swinging signals and red lights are too small at railroad crossings.

Barricades were the subject of 23 percent of the group's comments. The road construction, men working, closed roads, and dead end drew comments about disregarding them or driving through them. Suggestions were offered to use stable barrels or drums rather than the saw horse type. The flashing amber lights do not provide enough light during darkness.

Barrels or drums used as barricades and channelizing devices drew remarks from 16 percent of the respondents. The attenuation aspect of absorbing impact was listed as a benefit; however, complaints were concerned about not locating them to protect all hazards and the fading color which decreases visibility.

Cones and vertical panels received comments from 13 and 3 percent of the respondents respectively. The major complaint about cones for channelizing or as barricades is that motorists can disregard them, drive over them, or remove them without any consequences, i.e., damage to the vehicle cited for moving devices, or disposing of them from the site. The temporary use of cones presents a problem in that motorists are not looking for them or expecting them. Vertical panels are somewhat similar, but to a far less degree.

With regard to miscellaneous traffic control devices, even though 42 percent of the groups commented in this area, there was not a significant indication of anything specific but simply a repeat of items mentioned above.

2.2 Development of Survey Instrument

Although the driver educators and the DDC instructors had as many or more comments directed at adequacy per se of the present array of traffic control devices available to the Texas traffic engineer, than were directed toward how well drivers understood these devices, the major focus of the project, was, of course, driver understanding. Given that the devices identified in the Texas Uniform Manual were going to be used as specified, what problems might be encountered?

Based on the survey responses with respect to driver comprehension, plus inputs from the literature and from the State Department of Highways and Public Transportation collected by our Contract Monitor on the same form used for the survey, a basic "shopping list" of 42 different devices, markings, signs, or indications was made up. These items were ordered with regard to priority of inclusion in the final questionnaire to be administered in the field. The prioritization was done in the course of several meetings between the project staff and the Contract Monitor, and was accomplished on the basis of (1) Severity of consequences of erroneous interpretation and (2) Number of sources mentioning the problem in the preliminary Literature Survey and questionnaire. Sources are listed at the end of Table 2-3 and keyed to individual TCD's in that Table.

Items were included in the questionnaire until the questionnaire reached a size that could be administered in 20 minutes or less -- the maximum time that could be spared by the average drivers license renewal applicant, based on past experience in undertaking studies in driver license stations. The final list of items is given in Table 2-3.

Table 2-3

Final Items Considered For Questionnaire in Stations

Item	TMUTCD	Source	Disposition
GUIDE SIGNS			
1. Exit Direction Sign	F2-1	2,7	Included
2. Mile Post Marker Sign	E18-1	6	Dropped
3. 3-digit (Loop) Designator	M1-6L	6*	Dropped
4. Diagrammatic Guide Sign	1-D(2)-7	2,5	Dropped
WARNING SIGNS			
5. Lane Drop (right)	W4-2R	2,3,6	Included
6. Divided Highway Ahead	W6-1	5,6*	Included
7. Divided Highway Ends	W6-2	5,6*	Dropped
8. School Crossing (Advance and at location)	S1-1 S2-1	5	Included
9. Merging Traffic (from right)	W4-1	3	Included
10. Lane Ends - Merge Left	W4-3L	5,6	Dropped (see 5)
11. Pavement Ends	W8-3	6*	Included
12. Railroad Advance Sign and Crossbuck	W10-1 W10-2A	5,6*	Included
13. Slippery When Wet	W8-5	5,6*	Included
14. Soft Shoulder	W8-4	6*	Included
15. Curve vs. Turn Ahead	W1-2L or R W1-1L or R	6	Included
16. Traffic Divides (Double Arrow)	W12-1	6*	Dropped
REGULATORY SIGNS			
17. Double Turn	R3-8L	5,6	Included
18. Keep Right (Symbol)	R4-7	3,5,6	Included
19. No Turns Across Double Yellow Line	R4-11	6	Dropped, but Double Yellow Line included (see Markings)

Table 2-3 (continued)

Item	TMUTCD	Source	Disposition
20. One Way	R6-1L or R	5,6	Included
21. Right Turn Prohibited (Symbol)	R3-1	5,6	Included
22. Slower Traffic Keep Right	R4-3	3	Dropped
23. Yield	R1-2	5	Dropped
24. Do Not Cross Double Yellow Line to Pass	R4-9	6	Included
25. Yield to Traffic in Center Lane	R4-6B	3	Included
26. Climbing Lane Ahead	R4-6A	6*	Included
TRAFFIC SIGNALS			
Protected Left Turn:	Part III-B	2,3,4,5, 6,7	Included
27. . Green Arrow + Through Traffic Red			
28. . Amber Arrow + Through Traffic Red			Included
29. Right Turn on Red	III-B-4	3,5,6	Dropped
30. Don't Walk (Flashing)	III-G-4	5	Included
31. Amber Flashing Beacon	III-H-2	4,5,6,7	Included
PAVEMENT MARKINGS			
32. Crosswalk	II-B-17	1,4,5,6	Included
33. Dashed vs. Solid Lines	II-B-1	6	Dropped
34. Solid White Line	II-B-5	1,4,5,6	Included
35. Double Solid White Line	II-B-5	1,4,5,6	Dropped
36. Turn Bay Diagonal Stripes	II-B-14	3	Dropped
37. Yellow Solid Line (divided highway)	II-B-8	6,7	Dropped
38. Two-way Left Turn Channelization	II-B-15	4,5,6	Dropped
OTHER DEVICES			
Barricade Striping			
39. . Directionality	V-C-4	4,6*	Included
40. . Colors			Dropped
41. Delineator Arrays	II-C-1ff	2,5,6	Dropped
42. Delineator Colors	II-C-Iff	2,5,6	Dropped

Table 2-3 (continued)

Sources

1. Gordon, D. A. "Studies of the Road Marking Code" (13)
2. TTI "Diagnostic Field Studies" (Report 606-4) (14)
3. SDHPT - Contract Monitor
4. SDHPT - letter with collected information with respect to Survey Questions
5. Defensive Driving Instructors
6. Driver Education Instructors * = over 10% of DE students miss this item
7. Huchingson, R. D., Dudek, C. L., et al. (9)

From the very first inception of the study, it was decided to present drivers with operational situations in which their answers would be determined by their perception of relevant traffic control devices. Various methods of presenting such situations were considered. Group presentations were precluded by the facilities in which project interviewers would be working -- DPS driver license stations. Any presentation had to be (a) individualized, (b) reasonably quiet so as not to disturb the station's operation, (c) quick -- 20 minutes or less, and (d) suitable for private answer of the questions, both to eliminate bias from other interviewees or from spectators and to insure the personal privacy of the driver. For reasons of cost, complexity, as well as the criteria listed above, preliminary ideas of using films or slides were discarded in favor of a multiple-choice questionnaire format in an album or booklet of color photographs of the traffic control device situations of interest.

Each traffic control device misunderstanding thus was formulated into a short multiple-choice problem. Members of the project staff and the Contract Monitor obtained photographs of suitable situations in the Bryan-College Station, Austin, and Corpus Christi areas, and a final selection of photographs with accompanying problem was made.

The questionnaire was structured around an imaginary trip through "Anytown, Texas," a mythical city (Figure 2-1). The driver was to "take a trip" through the album of photographs, answering questions as he went. Figure 2-2 represents the instructions the driver followed.

The design of the questionnaire booklet itself was guided by three basic ideas: a) ease in making the booklets, b) ease of administration, and c)

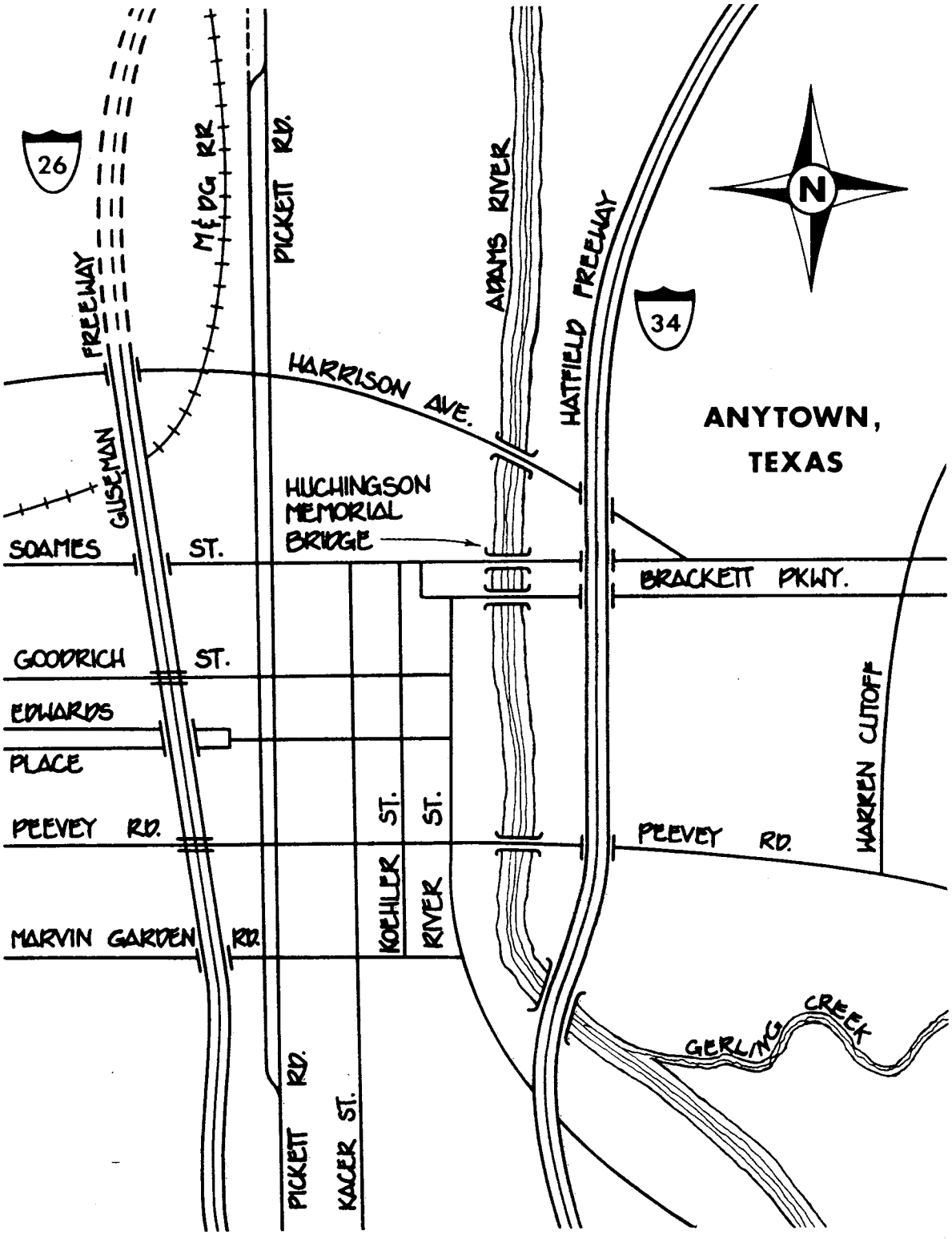


Figure 2-1 "Anytown" Texas

TEXAS A&M UNIVERSITY

TEXAS TRANSPORTATION INSTITUTE

COLLEGE STATION TEXAS 77843

Human Factors Program

This is a research study conducted for the State Department of Highways and Public Transportation--your Highway Department--by Texas A&M University's Transportation Institute. We will be asking you some questions in the form of a short 15 minute game we'd like you to play. The DPS is not connected with this study, and your answers to our game will in no way affect your driver's license or driving record. We're not even going to ask you your name. OK so far?

You are going to make an imaginary trip through a small Texas city and into the countryside. When you start, you will be on a highway called the Hatfield Freeway. You are going to get off this freeway, and drive through this town that you have never seen before. Then you will wind up on another freeway to take you out of town. As you go, you are going to see different situations on the highways, streets, and roads of this area. The trip is made by going through this booklet of photographs, and answering the questions which appear on each page as you turn to it. You record your answers by punching holes through the booklet--just like voting. At the end of the booklet are some questions about you that we would like for statistical purposes.

In return for your help in this study, we have an envelope of very interesting "Answer Books" from the Shell Oil Company for you, plus some information on the questions we ask you in this trip booklet.

As you open to the first page, you find yourself on the Hatfield Freeway, northbound near Anytown, Texas. Have a good trip, and feel free to ask any questions about the study after you finish the booklet. Now do you have any questions about how we are going to do this?

TURN TO NEXT PAGE

Figure 2-2 Instructions

ease of grading the answer sheets. The latter two requirements were met by the decision to use a modified version of the booklets typically found in voting booths. An example of the test booklet is shown in reduced form in Appendix 1.

The actual size of the booklet was 12 1/8" x 18 1/2". Each booklet was composed of nine pages of test items, two cover pages of the same material, and two sheets of acetate on the front and back for added protection from dirt and moisture. The booklet directions were on the front cover page. There was a hole beside each response choice of the twenty-seven items and the nine test pages increased incrementally in width so that the holes from preceding pages do not interfere with holes on other pages. This also facilitated easy turning of the pages. Compressing the twenty-seven items to nine pages made the booklet appear reasonable in length to the participants.

Participants responded by punching the hole(s) by their answer(s) with the stylus provided for this purpose. Their answers were recorded on a response sheet which rested on a thin layer (¼") of cork directly after the ninth page of test items or the tenth page of the booklet. The participants were asked to press with the stylus until they felt the cork "give". This proved to be more than adequate direction as most people enthusiastically punched their stylus completely through the cork, back cover, and acetate as well. Needless to say, the responses on the answer sheet were easily discernable in most cases.

The material chosen to make up the pages of the booklet was #2 weight Bristol Board as it is stiff enough to facilitate easy turning of the pages but not too stiff to make binding and punching the necessary holes difficult.

3" x 5" color prints of highway signs and traffic situations were glued into the bound booklets above the items each picture illustrated.

The items in each booklet were individually typed. However, if large numbers of booklets are required (at least 50) then it would probably be more efficient and economical for a printing firm to make up the booklets. The only tasks alloted to a printing facility in this case were cutting the paper, punching the holes, binding the booklets, and printing the answer sheets from a master given to them.

A master copy booklet was made of translucent paper so that each item could be exactly placed in every booklet. This was critical for two related reasons. First, it was important to circumvent inadvertant interference of the holes beside the response choices from item to item, page to page. Second, the holes were punched after the typing was completed on all booklets. Therefore, the items had to be placed with consistant precision in every booklet. Except for a few minor exceptions, this technique worked with notable success. However, because this system did have its share of errors in spite of all the time and tedium expended to position the items with precision, another technique, in retrospect, might have been better utilized.

The response sheet is shown on the last page of Appendix 1. The necessary demographic data were placed around the areas where the holes were punched. To help line up the response sheets with holes of the twenty-seven items, four holes were punched along the top of both the booklets and the response sheets. The loose binding made this technique essential, and it resulted in greatly reduced time to insert a new response sheet in preparation for a new subject. The loose-style plastic binding was necessary so that the booklets would remain flat when opened on any page.

The entire booklet was placed on a slanted platform (top elevated 18°) for easier reading. The booklets were fitted into position via four studs at the top of the platform. A small ledge down at the base was a convenient pencil prop as well as additional support for the booklets, and a small hole in the upper right corner held the stylus which was attached to the board via a lightweight chain. Nylon string would probably be better instead of the chain as the chains often became tangled during the frequent packing and unpacking of the equipment at the various test sites. This platform is shown in Figure 2-4 (shown on page 34).

2.3 Sample Designation

Two different stages of the sampling process were employed, one to delimit five large urban areas and five matching rural sites and a second phase to delineate the number of respondents required for each of the ten sites. Texas population characteristics, based on 1970 census enumerations are presented in Table 2-4. Because no one city contains population characteristics identical to the composite state population, five large urban areas were selected which, in the aggregate, retained characteristics indicative of the state as a whole in regard to age distribution, ethnicity, and socioeconomic status. Following delineation of these five urban sites, an attempt was made to select five small cities which matched individual large cities as closely as possible. These small sites also were selected in close proximity to their urban counterparts as shown in Figure 2-3. Each study site contains at least one drivers license station, which served as the location for the surveys to be undertaken.

Potential sampling error is reduced by having increased homogeneity within clusters being sampled. While the cities chosen are each very diverse in terms of population characteristics, they are considerably more homogeneous than is the state as a whole. The primary goal of the city choices was to select unique areas which, when aggregated or summed, provided a representative portrayal of the Texas driving public. To this point, emphasis has been on the choice of survey sites. Once these "clusters" of the population were selected, the next step was to ascertain the number of respondents needed within each cluster or site. Such a sampling approach is referred to as probability proportionate to size (PPS) sampling. With this approach, the number of drivers surveyed per city is dependent on city size.

Table 2-4

1970 Population Characteristics at Ten Study Sites: Five Large Urban Areas and Five Matching Rural Sites*

	Texas	Dallas	*Sherman*	San Antonio	*Uvalde*	El Paso	*Pecos*	Amarillo	*Borger*	Pasadena	*Port Arthur*
Total Population	-	844,401	*29,079*	654,153	*10,764*	322,261	*12,682*	127,010	*14,195*	89,316	*57,380*
Population < 18	35.72	34.09	*31.50*	38.37	*38.6*	41.13	*42.9*	31.02	*32.5*	38.70	*34.60*
Population ≥ 65	8.86	7.85	*11.80*	8.33	*11.1*	6.02	*6.0*	8.48	*9.7*	3.40	*10.60*
Dependency Ratio	80.45	72.24	*76.35*	87.63	*98.6*	89.21	*95.71*	77.02	*73.1*	72.71	*82.48*
Percent Black	12.47	24.90	*9.80*	7.60	*0.76*	2.30	*3.91*	7.70	*4.11*	-	*40.04*
Percent Mexican-American	18.40	8.04	*2.20*	52.18	*54.64*	58.12	*49.05*	6.58	*3.14*	7.70	*6.60*
Median Family Income	$8,490	$10,019	*$8,883*	$7,734	*$5,853*	$7,963	*$7,471*	$8,928	*$8,901*	$7,841	*$11,058*
Percent of Families Below Poverty Level	14.6	10.1	*8.2*	17.5	*28.0*	16.8	*17.9*	9.3	*9.6*	4.8	*15.0*
Median Education Level	11.6	12.2	*12.2*	10.8	*9.6*	12.1	*11.0*	12.2	*9.6*	12.1	*10.4*
Percent White Collar Workers	48.5	56.17	*48.2*	50.80	*42.8*	52.57	*39.5*	53.58	*42.8*	49.7	*34.0*

* Matched rural sites are in italics.

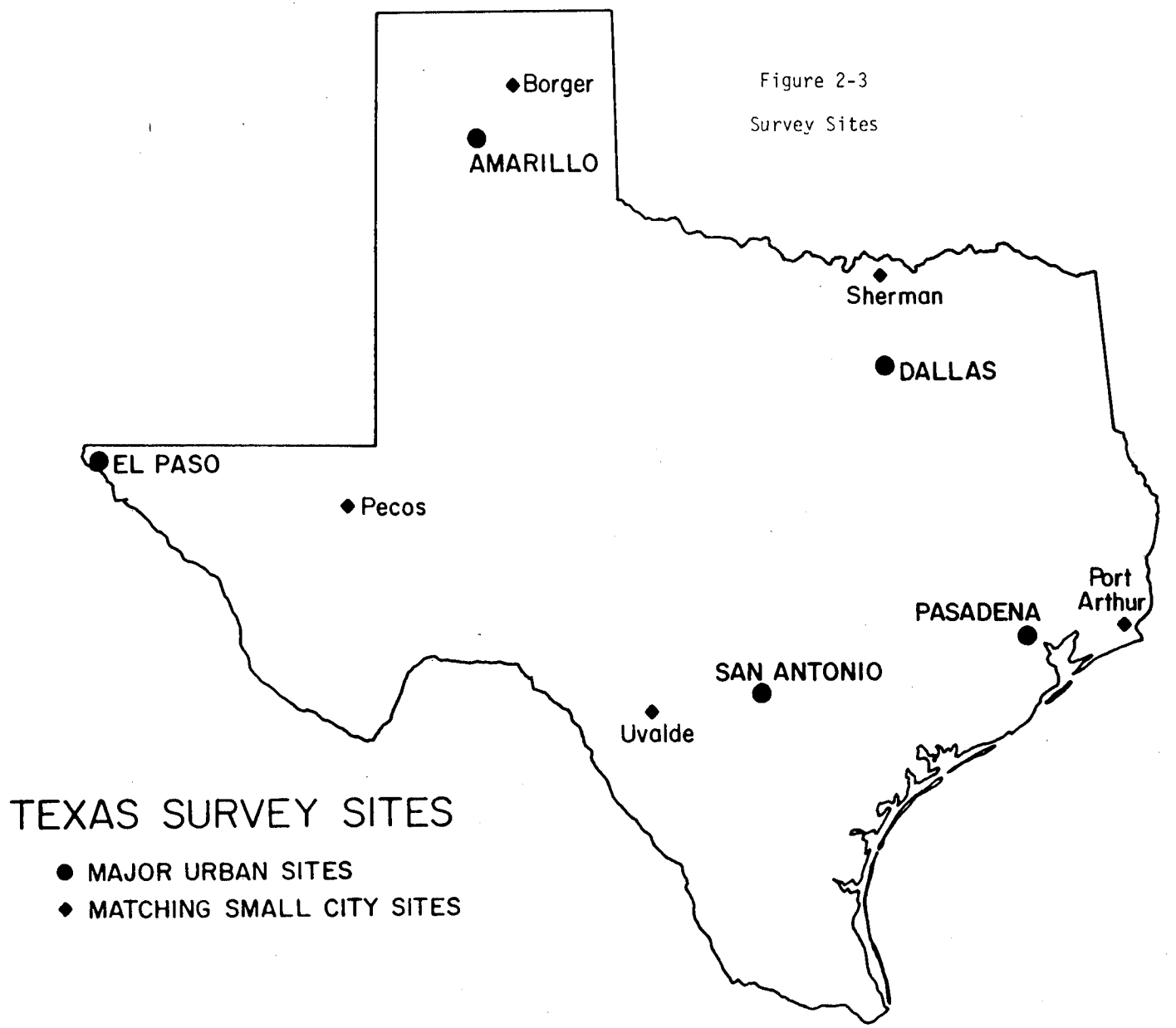


Figure 2-3

Survey Sites

At the outset of the study, several survey sample sizes were evaluated and confidence levels determined for each.[1] With 400 as the desired sample size, the standard error is .024 if 250 respond correctly to any one survey item. Thus, the confidence interval in this one case is .095144.

Because of the wide variations in population sizes for the five urban areas and five matching small-city sites, a completely derived sample proportionate to city population size would require over 100 respondents in Dallas and less than 2 subjects in Uvalde, based on an overall sample size of 400. Thus, a modified proportionate sampling scheme was undertaken, whereby at least 50 respondents were obtained in large urban sites and a minimum of 17 drivers were surveyed in small city locations. On the allotted survey days at each site, a larger number of respondents was obtained where time permitted and where large numbers of drivers were entering the drivers license station.

1 Confidence intervals represent the degree of assurance that responses to any one survey item would be repeated again, or replicated, with ensuing studies using the same item or items.

2.4 Administration in Driver Licensing Stations

Upon arriving at a given Driver License Station, the experimental field team first made contact with the DPS person in charge. This person then introduced the team to the other DPS personnel, explained the situation to their personnel, and requested their cooperation. The DPS person in charge also directed the team where to set up their equipment. The primary rule of the experimenters was total cooperation with DPS personnel. Typically, the study was set up in the waiting area near the writing ledges and/or the desks provided by the DPS for persons taking the written exam for a driver's license.

In addition to the five booklet platforms and six booklets, the equipment taken from one DPS station to another consisted of three folding card tables, an art easel, a poster board "advertising" the study, several boxes of complimentary packets of Shell Answer Books plus the answers to the test booklets, and a large carrying case for response sheets, experimenter folders, pencils, etc. The complimentary packets were given to participants when they completed the response sheet and to all the DPS Station personnel. The DPS station personnel generously provided the team with chairs for the card tables.

The card tables accommodated three platforms easily, or four in a pinch. In the small stations, three books were usually sufficient. If a rush of people occurred, however, five booklets were put into use using writing ledges or desks provided by the DPS. The larger stations required the constant use of all five booklets with even the spare booklet utilized upon occasion.

A poster designed to draw the attention of prospective subjects was displayed on an easel and positioned as conspicuously as possible without being obstrusive. Figure 2-4 depicts a typical setup in a station.

The experimenters approached people who were finished with their DPS business, or had an extended wait before it could be completed, or were waiting for a friend or spouse to complete his or her business. It was found to be most helpful for the DPS person in charge to tell his personnel to send people over to the experimental station when their business with the DPS was completed or when they had a wait. In early visits there was a significant decrease in the volunteer rate if the experimenters solicited prospective participants without their being asked by the DPS personnel.

After a brief explanation of the study which emphasized sponsorship of the Texas Department of Highways and Public Transportation and assured people that their participation would be anonymous, they were then asked to participate. If they declined, they were thanked politely, and another person was solicited. There was no attempt made to persuade resistant people. If they accepted, they were directed to a vacant booklet station. An acceptance log and a refusal log were provided in the experimenter's folder (shown in Figures 2-5 and 2-6). On these logs the experimenters unobtrusively recorded every person solicited. Besides acceptance or refusal, she noted down race, sex, age range (Y, M, O), and any other relevant information about the subject that might be helpful in the analysis or in tracking the characteristics of the sample being collected.

When a person accepted and was directed to a vacant booklet station, the second experimenter explained the booklet in more detail, asked the person to read the instruction page, and encouraged questions regarding the

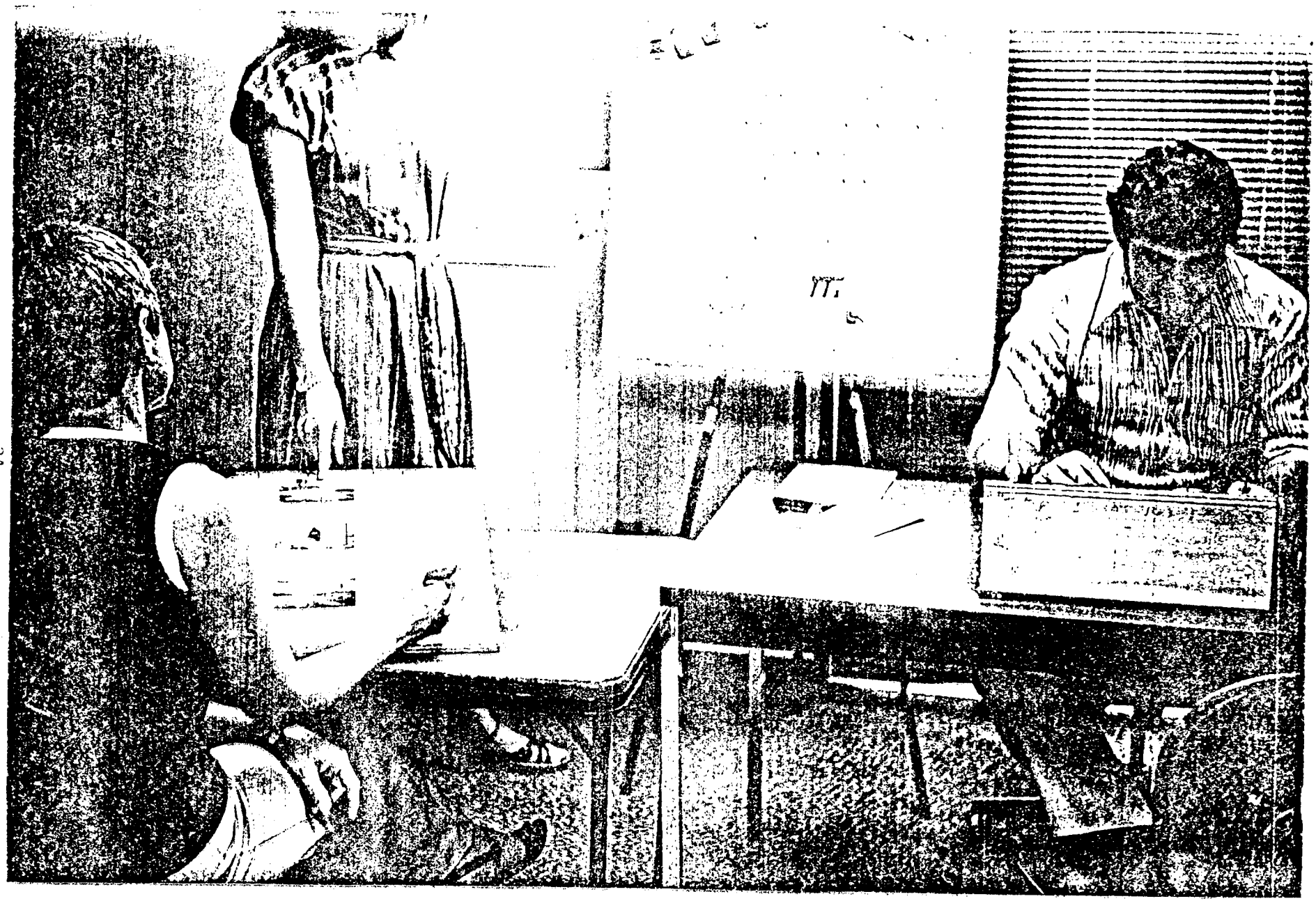


Figure 2-4

booklet format. Both experimenters endeavored to reduce any anxiety that the study was a "test" that would affect the participant's driving record. In addition, the role of this experimenter was to monitor the progress of participants, ensure that all test items and demographic data were answered, answer questions when possible, hand out the complimentary packets when a subject finished, and insert a new answer sheet.

The two experimenters' roles were interchanged by the two team members whenever a change was needed in order to maintain their air of interest. When the response quota was surpassed by a few extra participants, the experimenters closed down, packed up, and thanked all the DPS personnel for their help and cooperation.

Name of Survey Assistant:

Study Site:

Figure 2-5.

Refusal Log for Survey

Reasons for Refusal	Sex	Age	Ethnicity	Comments
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	
	M F	Y M O	A B M O	

M=Male
F=Female

Y=Young
M=Mid-Age
O=Older

A=Anglo
B=Black
M=Mex-Am
O=Other

Name of Survey Assistant:

Study Site:

Figure 2-6.

Comments Log for Special Problems
Regarding Survey Respondents

Code No.	Comments regarding Survey Respondents

III. Analysis of Diagnostic Evaluation

All data sheets were encoded and transferred to punched cards according to a format developed earlier. These data were then analyzed by the Statistical Analysis System (SAS) which is part of the software library of the Texas A&M University Data Processing Center. The actual card images are provided in Appendix 3 for all 422 respondents. Most of the analytic work on this project was accomplished in support of the respondent characteristics study reported on in Chapter 4.

An explanation of the analytic methods used, assumptions, and levels of confidence will be found in Appendix 3.

Only two statistics will be reported here/for each item:

(1) Percent correct responses of total number of responses to a given item (drivers could and did choose several answers to an item)

(2) Mean number responses ($\bar{x}$) for <u>each correct answer</u> given by

$$\bar{x} = \frac{\Sigma(1's)}{N}$$

Where N = the number of drivers responding to the question and

(1's) = the sum of the correct answers with the incorrect responses coded as 0.

3.1 Roadway Signs

Commonly used warning, regulatory, and guide signs provided the largest proportion of roadway communication devices included in the diagnostic survey.

Guide Signs

Exit Direction Sign. The perceived distance to the approaching freeway exit was assessed, as shown in Figure 3-1. The five-category range of responses elicited 40 and 43 percent respectively of the responses correctly identifying the two possibilities for approximate distance to the exit turn off.

(a) Percent correct = 40
Mean ($\bar{x}$) = 0.41

(b) Percent correct = 43
Mean ($\bar{x}$) = 0.44

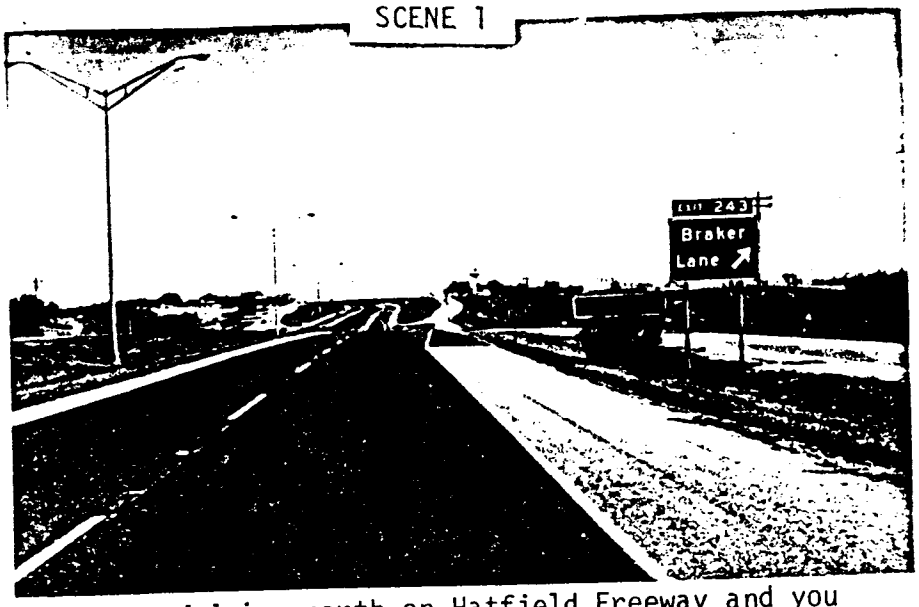
Warning Signs

Two-way traffic symbol sign. The warning sign depicting two-way traffic was correctly interpreted by 96 percent of the study participants (Figure 3-2). There was no alternative consistently considered as an accurate response by the remaining seven percent, so that no informational strategies are necessary for this sign if it is displayed at all appropriate sites.

Percent correct = 93
Mean ($\bar{x}$) = 0.96

Pavement Width Transition Sign. Sixty-five percent accurately interpreted the warning denoting the right lane was ending. However, 21 percent responded that the sign referenced a single lane of traffic ahead while 7 percent were unsure of the appropriate response. The primary alternative response chosen

Figure 3-1



You are driving north on Hatfield Freeway and you are approaching the city of Anytown, Texas. You plan to drive through this city. You need to exit at Braker Lane. Along the freeway, you see Scene 1. How far ahead would you expect the exit to be? *Punch one or more of the following:*

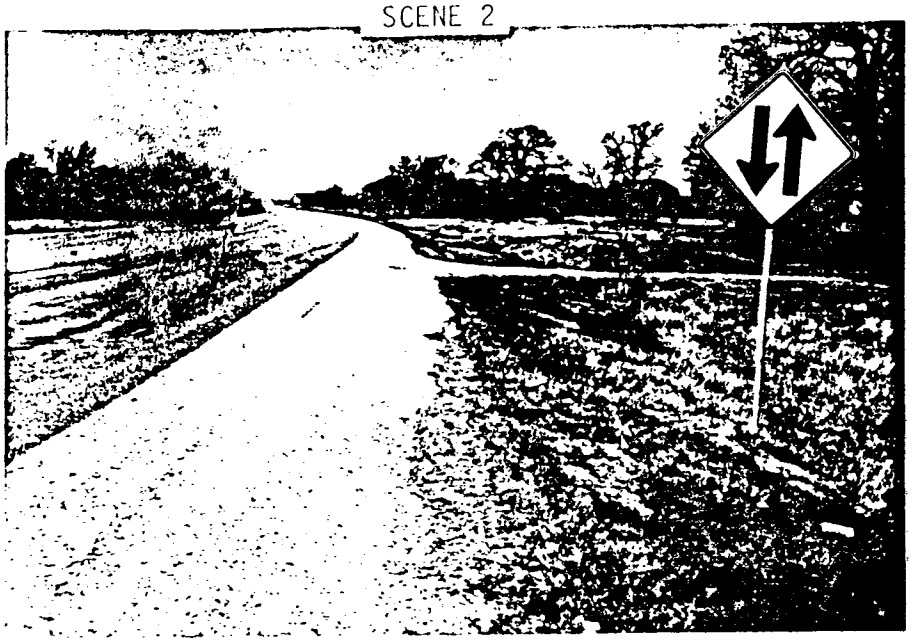
		N
(a)	(•)____About a quarter of a mile ahead *	172
(b)	(•)____About 500 feet ahead *	185
	(•)____About 50 feet ahead	50
	(•)____Right by the sign	14
	(•)____Not sure	9
		430

Be sure and punch your answer to the Right of the red line in holes provided.

*Correct Response

Figure 3-2

SCENE 2



After you have taken the exit ramp and are on the service road, you see this sign (Scene 2). What does the sign mean? *Punch one or more of the following:*

(•)	The service road is a two-way roadway*	400
(•)	The service road is a one-way roadway	11
(•)	No passing zone	13
(•)	"U" turns permitted in this zone	2
(•)	Not sure	3
		429

*Correct response.

is appropriate in the scene depicted in the survey, so that misinterpretation in this case would have no detrimental consequences.

Percent correct = 61

Mean ($\bar{x}$) = 0.65

School Crossing Symbol Signs: Advance and On-Site. Thirty-nine percent of the answers denoted the correct response to the school crossing symbol, as shown in Figure 3-4. The most common misconception was evidenced in the identification of both signs as advance warning symbols, which has a hazardous set of consequences if misinterpreted in actual driving situations.

Percent correct = 39

Mean ($\bar{x}$) = 0.47

Merge Symbol Sign. The merge symbol was accurately perceived by 79 percent, with the most common incorrect response depicting the merging of a major roadway to the right with the highway (see Figure 3-5). Some hazard exists if the right lane yielding to merging traffic.

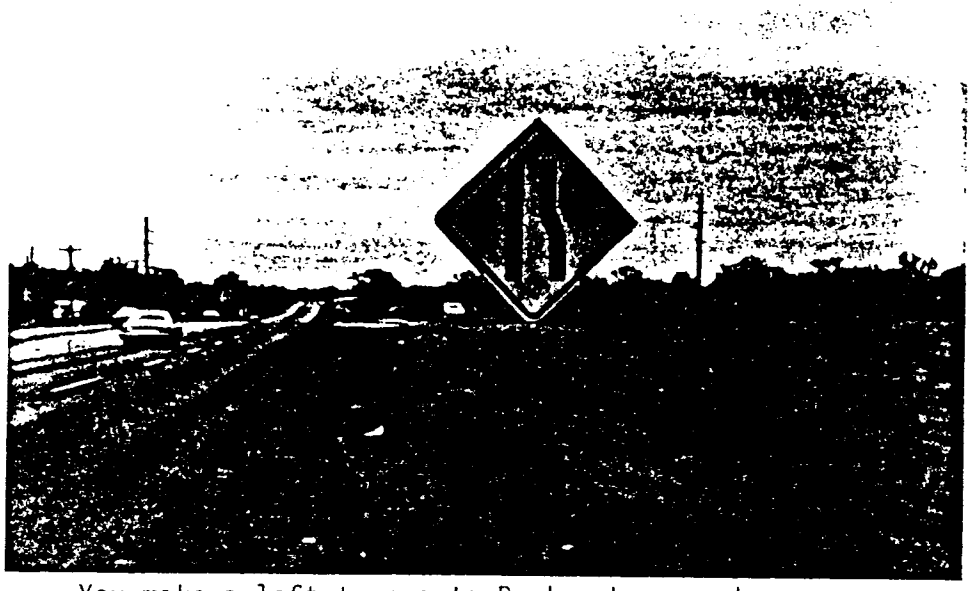
Percent correct = 79

Mean ($\bar{x}$) = 0.87

Pavement Ends Sign. Driver expectation of this sign as a warning for the highway to end was evident in over one out of eight cases. However, 84 percent correctly depicted the sign as pointing to a change to gravel or earth pavement from the existing hard surface facility. The coefficient of kurtosis denotes a normally peaked response distribution, with some negative skewness of the response pattern (Figure 3-6).

Figure 3-3

Scene 5

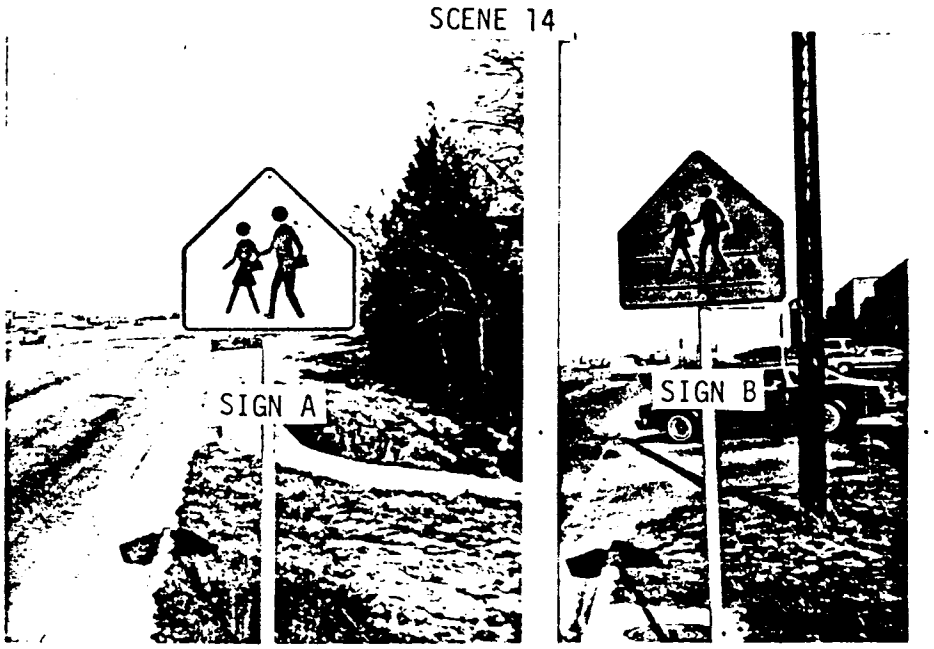


You make a left turn onto Braker Lane and are now driving on a undivided street. You see this sign (Scene 5) ahead. What does the sign mean? *Punch one or more of the following:*

(•)____	Sharp left turn, then right turn ahead	41
(•)____	Right Lane ends ahead*	269
(•)____	One-lane traffic ahead	86
(•)____	Narrow bridge ahead	13
(•)____	Not sure	29
		438

*Correct Response

Figure 3-4

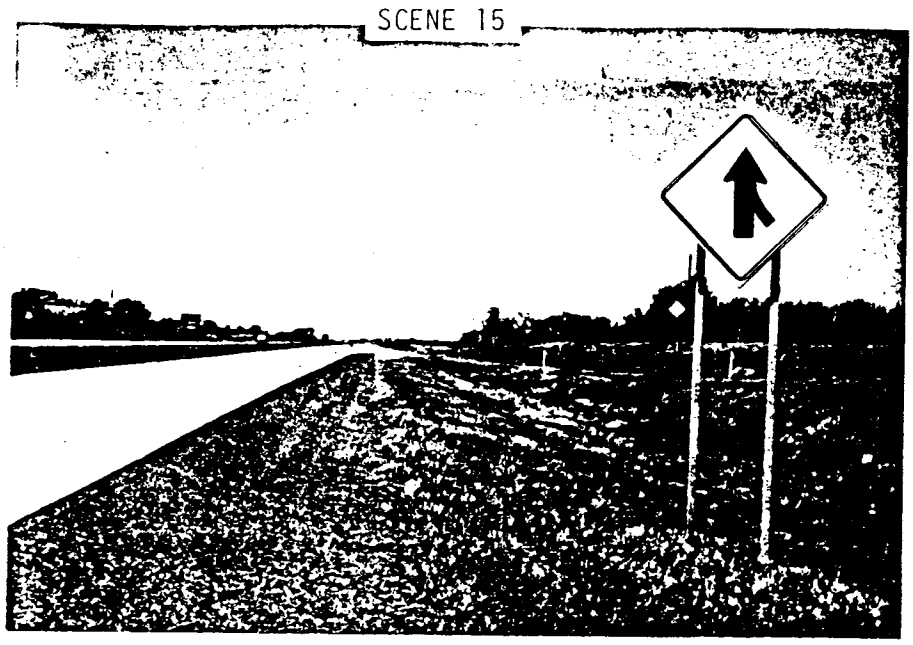


You are driving down Edwards Place and you see two more signs (Scene 14). First you see Sign A; then you see Sign B. What do the signs mean? *Punch one or more of the following:*

(•)	____Both signs mean an advance warning of school children crossing some distance ahead.	163
(•)	____Sign A is an advance warning of children crossing. Sign B is just before the crossing itself.*	190
(•)	____I agree with above statements, but the pedestrians are adults instead of children.	73
(•)	____The signs mean a school is ahead near the street (need not be a crossing)	53
(•)	____Not sure.	9
		488

*Correct response.

Figure 3-5



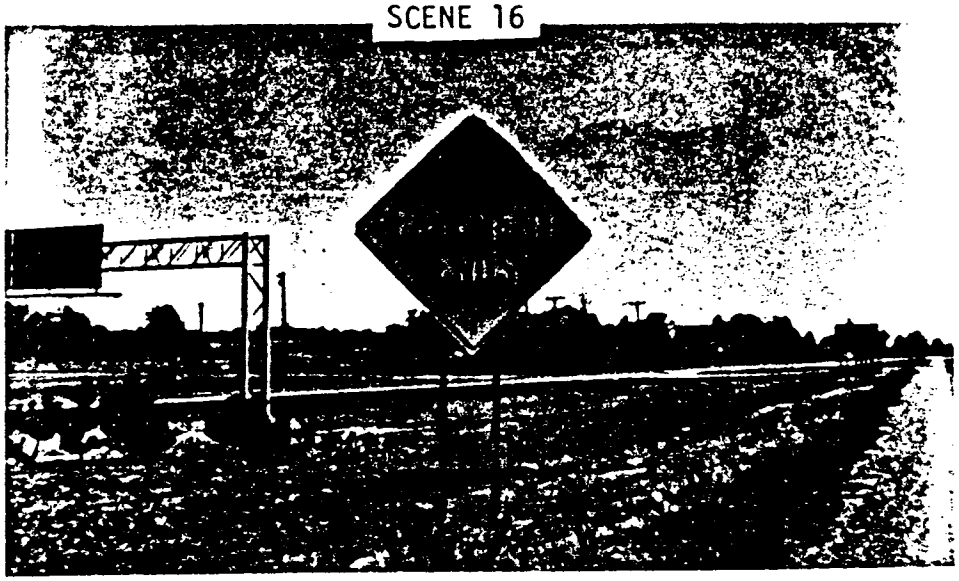
You are now headed north on Guseman Freeway. You see a sign on the right shoulder (Scene 15). What does it mean? *Punch one or more of the following:*

(•) ____	Pavement width narrows ahead.	8
(•) ____	A major roadway to the right is merging with the highway.	53
(•) ____	A smaller roadway to the right is merging with the highway.	350
(•) ____	Right lane yields to merging traffic.	29
(•) ____	Not sure	0
		440

*Correct response.

Figure 3-6

SCENE 16



After driving a while on Guseman Freeway you see the sign shown in (Scene 16). What does this sign mean? *Punch one or more of the following:*

(•) ____	Highway ends ahead. Be prepared to exit.	52
(•) ____	Dead end ahead. Make a "U" turn.	2
(•) ____	Highway changes from a hard surface to gravel or earth.*	358
(•) ____	Roadway closed. Traffic must detour to the shoulder or off the highway to another road.	10
(•) ____	Not sure.	6
		428

Percent correct = 84

Mean ($\bar{x}$) = 0.87

Railroad Advance Warning Sign and Railroad Crossbuck Sign. Figure 3-7 shows two signs depicting an impending railroad crossing. Of the 504 responses of 422 subjects, 252 or 50 percent accurately identified Sign A as the advance crossing sign. Further, 131 or 26 percent recognized Sign B as erected at the crossing only.

(a) Percent correct = 50

Mean ($\bar{x}$) = 0.62

(b) Percent correct = 26

Mean ($\bar{x}$) = 0.32

Slippery When Wet Symbol Sign. (Figure 3-8) three-fourths of those responding to this survey item accurately suggested that the sign referred to curves in the road. This misperception is potentially hazardous, as were other incorrect responses, in that the driver would be unprepared for possible sliding in wet conditions.

Percent correct = 77

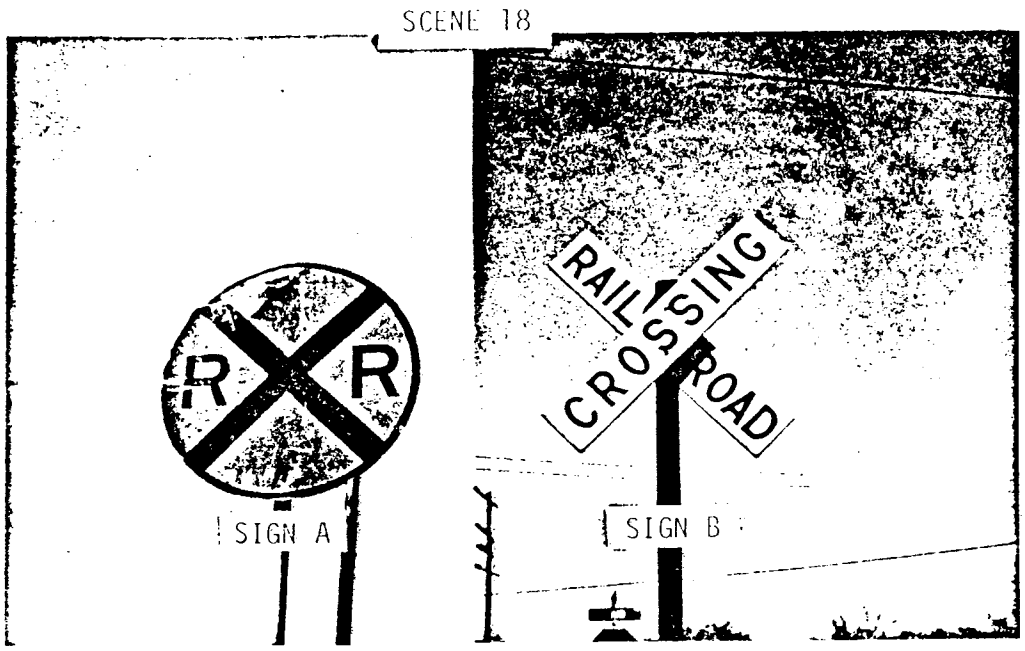
Mean ($\bar{x}$) = 0.77

Soft Shoulder Sign. There were no particular difficulties in interpreting this sign (Figure 3-9), although it is interesting that of the 49 who missed it, 30 or 7 percent of the total thought that soft spots would be encountered on the pavement. This might have some consequences such as some drivers slowing or at least turbulence in a traffic stream.

Percent correct = 88

Mean ($\bar{x}$) = 0.91

Figure 3-7



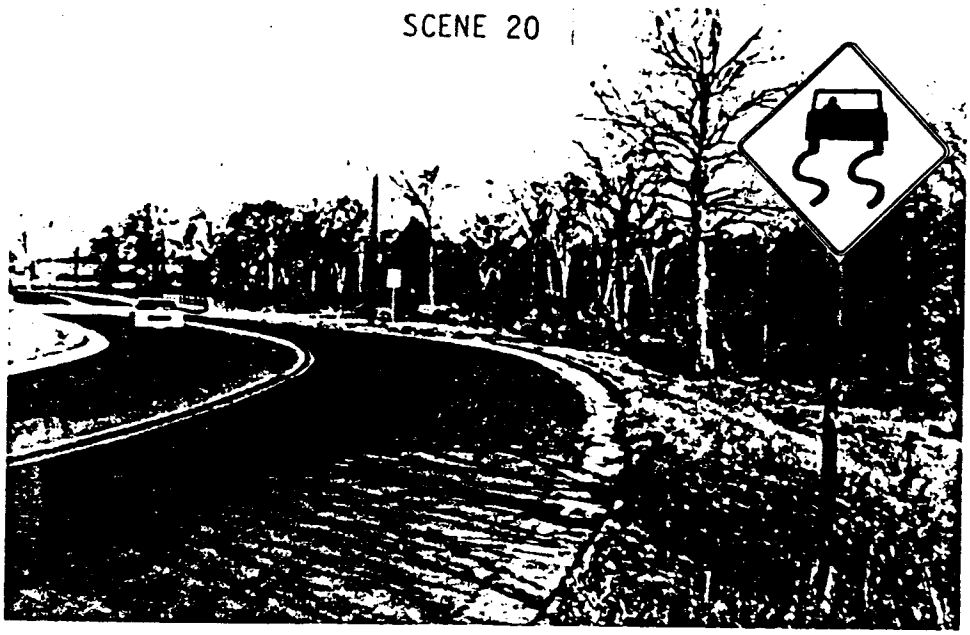
You have detoured off Guseman Freeway and you are now traveling east on Harrison Avenue. You see two signs (Scene 18). Do the signs mean exactly the same thing or is there a difference? *Punch one or more of the following:*

(a)	(•)	Sign A will come before Sign B. Sign A is an advance warning sign.*	252
	(•)	Sign B will come before Sign A. Sign B is an advance warning sign.	11
	(•)	Either Sign A or Sign B may come first.	97
(b)	(•)	Sign B is used only at the railroad track.*	131
	(•)	Not sure.	13
			504

*Correct response.

Figure 3-8

SCENE 20



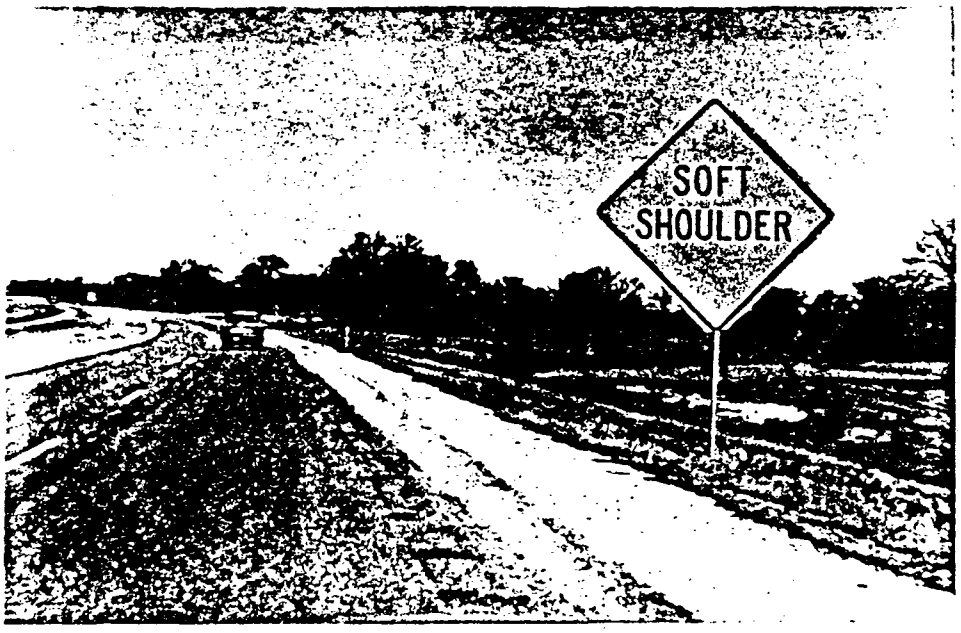
As you drive north on Route 43 out of the city limits, you see a sign (Scene 20). What do you think it means? *Punch one or more of the following:*

(•)_____	Beware of drunk drivers. Taverns in area	2
(•)_____	The raodway winds or curves several times	88
(•)_____	The roadway may be slippery when wet*	313
(•)_____	Icy bridge ahead	7
(•)_____	Not sure	9
		419

*Correct Response

Figure 3-9

SCENE 21



Another sign on Route 43 is as shown in (Scene 21). What does this sign mean? *Punch one or more of the following:*

(•)____	Beware of soft spots in the pavement	30
(•)____	Avoid tiring while driving long distances	2
(•)____	Pavement becomes unstable under extreme summer heat	12
(•)____	Beware of the condition of the pavement to the right of the highway *	369
(•)____	Not sure	5
		418

*Correct Response

Left Curve and Left Turn Signs. Signs A and B in Figure 3-10 were recognized as left curve and left turn signs, respectively, by 80 percent of those participating in the study. Twenty percent, on the other hand, inappropriately labeled the two signs as identical. This form of misperception raises a potential hazard unless accompanied by a speed limit sign.

Percent correct = 79

Mean ($\bar{x}$) = 0.80

Divided Highway Symbol Sign and Keep Right Symbol Sign. Fifty-one percent suggested that the two signs shown in Figure 3-11 were equivalent. Although there may be overlapping usage, the divided highway symbol is used on approaches to roadway barriers separating opposing traffic, whereas the keep right symbol is placed at obstructions of various types. The differences in meaning and locational configuration are slight and the severity of misinterpretation is low.

Percent correct = 51

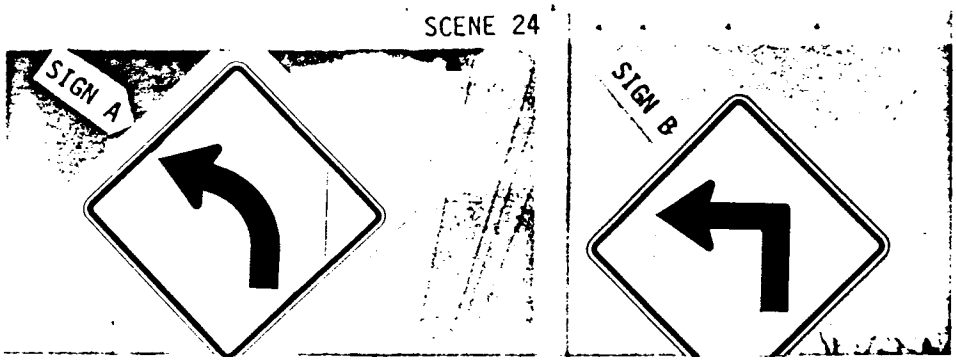
Mean ($\bar{x}$) = 0.52

Pavement Width Transition Signs: Left/Right Lane Ends. The scene in Figure 3-12 was correctly identified by 60 percent as representing two signs with disparate meanings, one depicting the converse of the other. Of the 157 respondents who inappropriately answered that the signs had the same meaning, many could have recognized that the left and right lane ending symbol was different. Nevertheless, drivers must be prepared for merging in the appropriate lane, otherwise, a potentially hazardous situation arises.

Percent correct = 60

Mean ($\bar{x}$) = 0.61

Figure 3-10



You see some more signs as you drive on Route 43. For each of the following pairs of signs, you decide if there is a difference in meaning between Sign A and Sign B.

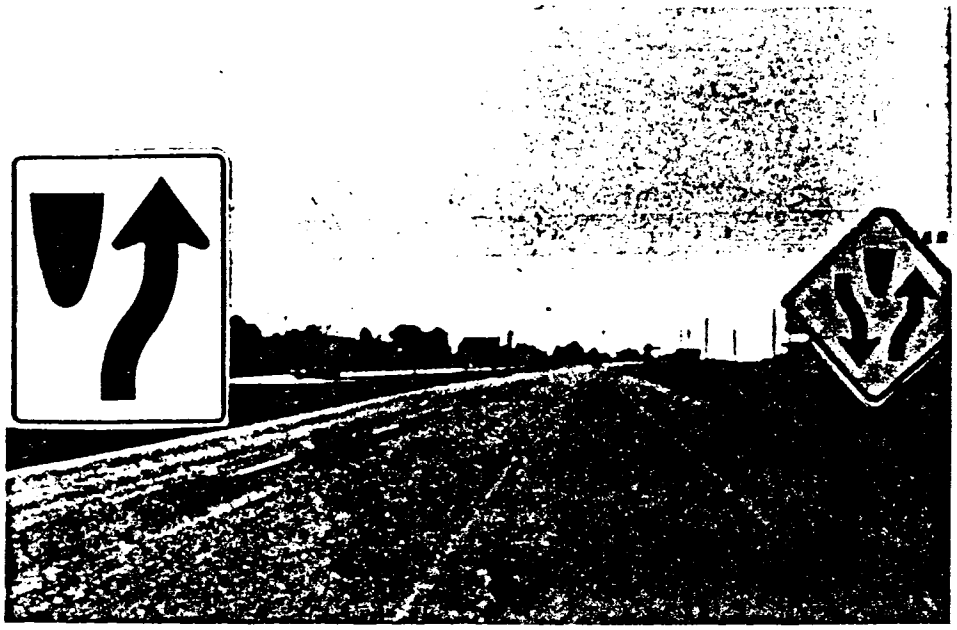
Here is the first pair of signs. (Scene 24). Do the signs mean the same thing to you?

(•)_____Yes	82
(•)_____No *	326
(•)_____Not sure	4
	412

* Correct Response

Figure 3-11

SCENE 25



Here is the second pair of signs (Scene 25).
Do they mean the same thing?

(•)_____	Yes	193
(•)_____	No *	210
(•)_____	Not sure	7
		410

*-Correct Response

Figure 3-12

SCENE 26

Here is the third pair of signs (Scene 26).
Do they mean the same thing?

(•)_____	Yes	157
(•)_____	No*	246
(•)_____	Not sure	7
		410

*-Correct Response

Regulatory Signs

Double Turn Sign. Of the participants responding to this item, 66 percent correctly identified the sign. Twenty-eight percent suggested that only the left lane could be used for turning. This misconception causes a queuing delay.

The second portion of the question asked regarding the double turn sign pointed to 79 percent as realizing that drivers who are in the left lanes must turn left. On the other hand, 20 percent of the participants indicated that a driver in the left turn lane also had the choice of continuing forward through the intersection (see Figure 3-13). This error in actual driving behavior could result in serious accidents and interference with the traffic stream.

I. Percent correct = 66
Mean ($\bar{x}$) = 0.71

II. Percent correct = 79
Mean ($\bar{x}$) = 0.80

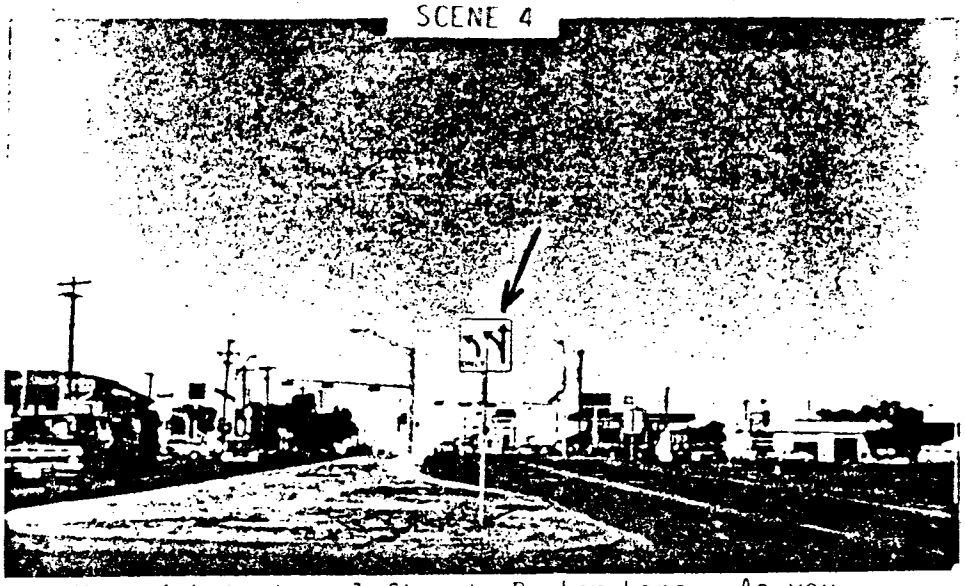
Keep Right Symbol Sign. This sign, used at the ends of medians and other obstructions, was correctly defined by 74 percent of the respondents (see Figure 3-14). Seventy-four felt that the sign referred to an obstacle to bypass and then undivided highway would return ahead. Actually, this latter response could be accurate in many situations and no problems exist because of this form of misunderstanding.

Percent correct = 74
Mean ($\bar{x}$) = 0.74

One-Way Sign. Eighty-one percent correctly identified the meaning of the one-way sign in Figure 3-15. While no other credible alternative state-

Figure 5-13

SCENE 4



You wish to turn left onto Braker Lane. As you approach the intersection, you see this sign (Scene 4) in the center median area. Which lane should you get into? *Punch one or more of the following:*

I.	(●) ____Only in the left lane	127
	(●) ____Only in the middle lane	20
	(●) ____May be in either lane*	295
	(●) ____Not sure	2
		444

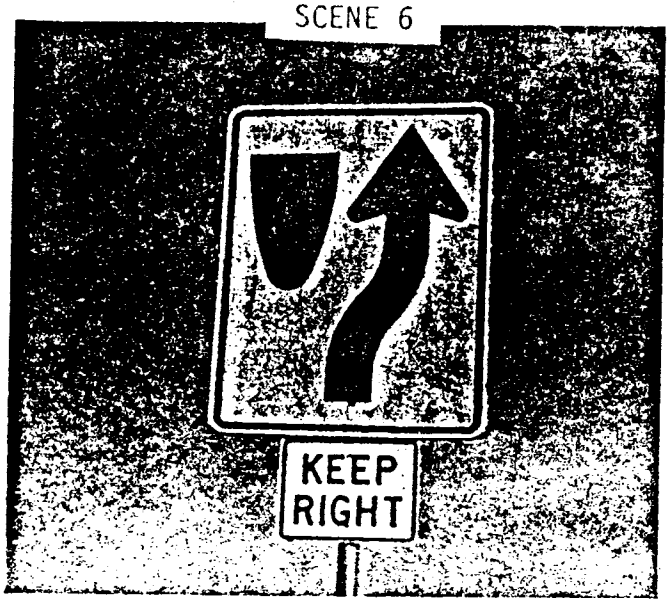
In Scene 4, if you were in the left lane, do you have a choice between turning left or continuing through the intersection? *Punch one or more of the following:*

II.	(●) ____Yes, I can do either	68
	(●) ____No, I must turn left*	267
	(●) ____Not sure	3
		338

*Correct Response

Figure 3-14

SCENE 6



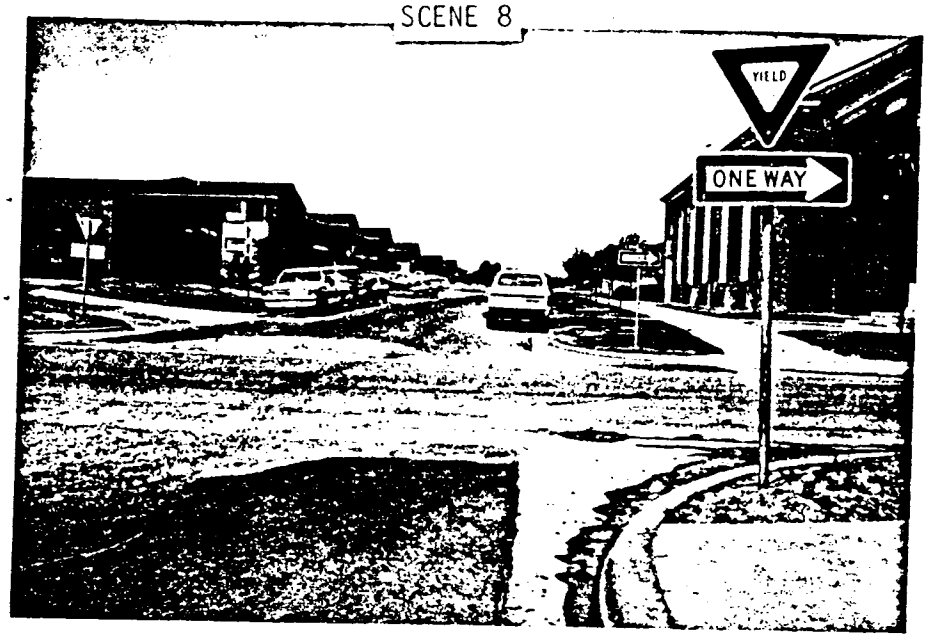
As you drive along Braker Lane, you soon see another sign (Scene 6). What does it mean? *Punch one or more of the following:*

(•)____	Roadway is blocked; drive on the right shoulder	21
(•)____	Sharp right turn ahead	8
(•)____	Divided roadway with center median ahead;* Keep right	318
(•)____	There is an obstacle (like a bridge support) in the center median. Keep right. Undivided highway returns ahead.	74
(•)____	Not sure	8
		429

* Correct Response

Figure 3-15

SCENE 8



You are now approaching another intersection. (Scene 8). What does this sign tell you? *Punch one or more of the following:*

(•)_____	I must turn right at the intersection	51
(•)_____	No right turn	15
(•)_____	Road ends ahead	4
(•)_____	No left turn *	352
(•)_____	Not sure	12
		434

* Correct Response

ments were presented to the respondents, those with misconceptions would not seriously impact on an actual driving situation.

Percent correct = 81

Mean ($\bar{x}$) = 0.85

No Right Turn Symbol Sign. As with the sign shown in Figure 3-15, the no right turn symbol was clearly understood. Ninety-one percent accurately identified this traffic control device. However, it appears that 9 percent do not yet understand the meaning of the red circle/slash. Informational guides should be improved for this symbol. In addition, Figure 3-16 was envisioned by seven respondents as suggesting that traffic on the street was all heading right; these few participants--less than two percent of the sample--represent potentially hazardous drivers.

Percent correct = 91

Mean ($\bar{x}$) = 0.93

Climbing Lane Ahead Sign. Seventy-three percent recognized the climbing lane ahead sign (shown in Figure 3-17). Further, 81 percent of the participants in occupations requiring driving, primarily transport equipment operatives such as truck drivers, understood the meaning of the sign. However, it has been suggested by transport equipment operatives--those most dependent on the use of this climbing lane--that such lanes are insufficient for effective use in many instances (see Woods, et al., 1970:25). Twenty percent misconstrued the sign to depict an impending steep hill, but no additional lane. Misperception, other than by the transport equipment operative, will not be hazardous.

Percent correct = 73

Mean ($\bar{x}$) = 0.77

Figure 3-16

SCENE 9

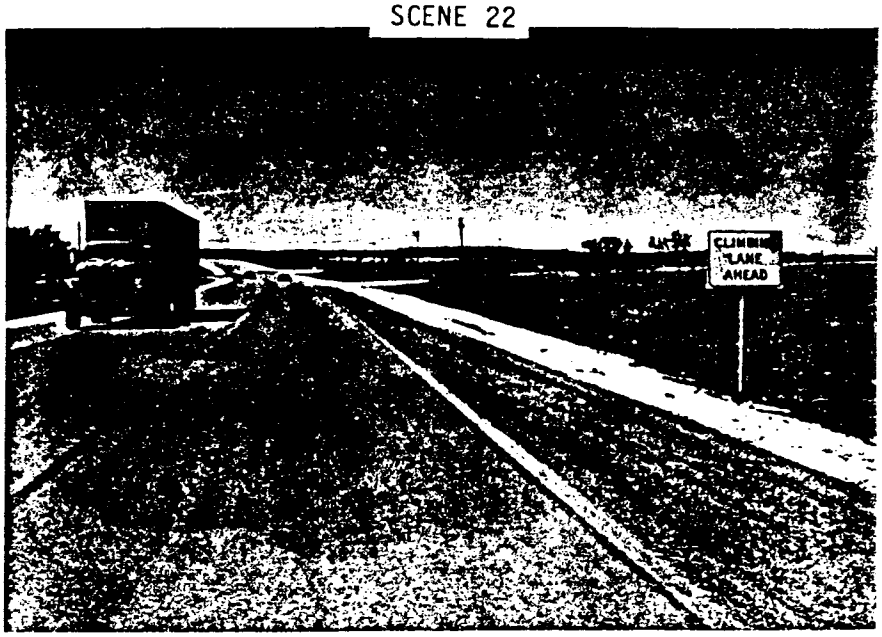
You drive on and at the next intersection you see another sign. (Scene 9) What does this sign mean? *Punch one or more of the following:*

(•) ____	You must turn right on this street	3
(•) ____	No right turn any time onto this street*	380
(•) ____	Traffic on this street is all headed right	7
(•) ____	No right turn on red (Wait for green traffic light)	13
(•) ____	Not sure	8
		416

*Correct response

Figure 3-17

SCENE 22



You are beginning to go up a hill when you see another sign (Scene 22). What does the sign mean?
Punch one or more of the following:

(•)____	Steep hill ahead. Trucks shift into low gear	34
(•)____	Slow traffic should move into an additional lane on the right*	314
(•)____	Look out for traffic entering from a merging lane ahead	17
(•)____	Roadway ahead winds back and forth (switch backs)	2
(•)____	Not sure	13
		430

*Correct Response

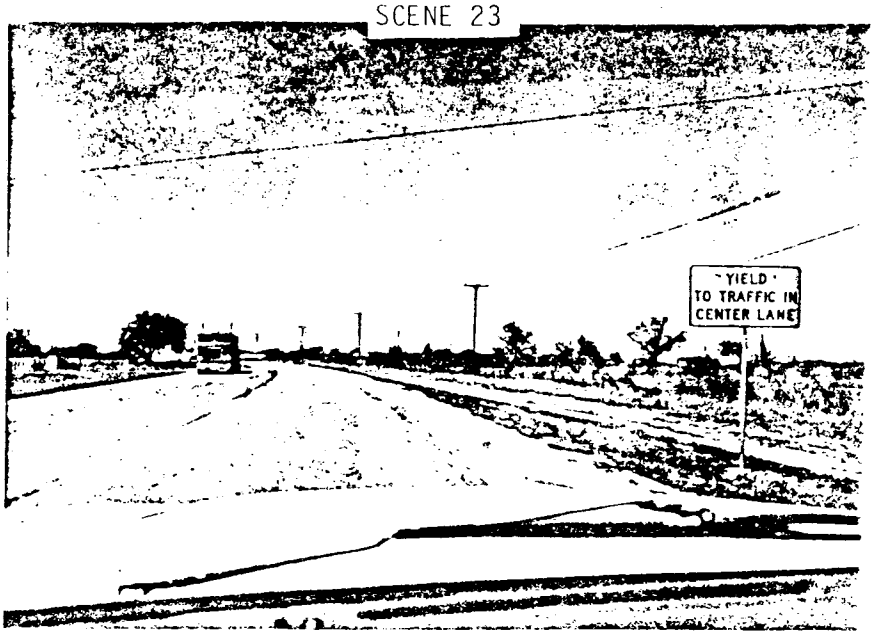
Yield to Traffic in Center Lane Sign. This regulatory device, as shown in Figure 3-18, was the least understood sign included in the survey. With 37 percent correctly identifying the sign, 31 percent defined this visual communication as meaning that right lane traffic must yield to left lane traffic when the road narrowed. Another one-fourth of the sample suggested the sign depicted traffic merging into the driver's lane from a climbing lane and 36 respondents declared no knowledge of the sign. While educational procedures would prove effective, it is also possible that the sign presents a confusing visual communication to drivers.

Percent correct = 37

Mean ($\bar{x}$) = 0.39

Figure 3-18

SCENE 23



As you pass over the top of the hill and start down, the no-passing stripe ends; but you see another sign (Scene 23). What does it mean? *Punch one or more of the following:*

(•)	Roadway narrows ahead. Right lane traffic must yield to left lane traffic	135
(•)	Look out for traffic merging into your lane from a climbing lane	104
(•)	If you should try to pass and cross over into the middle lane with an oncoming vehicle in it, you do not have the right of way*	161
(•)	Not sure	36
		436

* Correct Response

3.2 Markings

Markings have definite functions that either supplement other devices or are used singly for traffic control purposes. Such markings convey warnings or information to drivers without diverting vision from the roadway. There are problems with the markings, however, such as poor visibility in heavy traffic or bad weather and deterioration on road surfaces. Further, the markings--communicating primarily as symbols--may not be adequately understood by the public.

Double Yellow Line. Based on the answers to the scene shown in Figure 3-19, 76 percent correctly identified the solid double yellow line markings. Fourteen percent suggested that the markings and sign conveyed an inability to cross the double yellow lines for any purpose, such as turning into a driveway. Slightly less than 10 percent suggested that these centerline markings depicted no passing in the driver's own lane.

Percent correct = 76

Mean ($\bar{x}$) = 0.83

Pedestrian Crosswalk. Figure 3-20 represents the scene and concomitant responses to pedestrian crosswalk markings. The first correct answer--the warning to wait if pedestrians were crossing--was identified in 44 percent of the total number of responses. In addition, 43 percent accurately identified the second correct answer--to avoid crossing the white lines while waiting at a red light. It is interesting to note, however, that only 23 percent correctly responded to both meanings conveyed in Figure 3-20.

Figure 3-19

SCENE 3

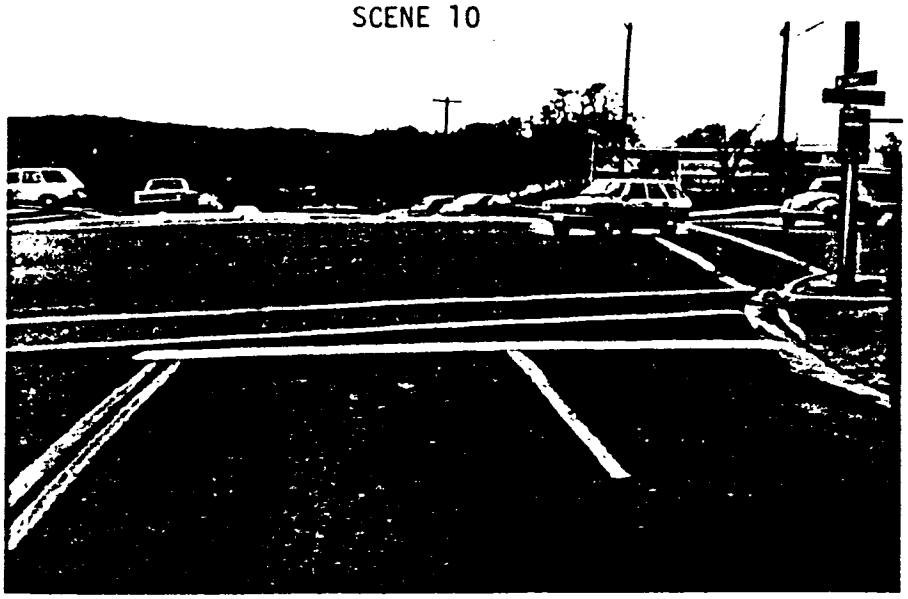
You notice a double solid yellow line down the center of the road and a sign on the right shoulder (Scene 3). What do the lines and sign tell you? *Punch one or more of the following:*

(•)	Do not pass the vehicle in your lane	43
(•)	Do not cross over the centerline to pass a vehicle*	348
(•)	Look out for oncoming traffic if you pass	2
(•)	Do not cross the centerline for any reason (such as turning into a driveway)	66
(•)	Not sure	0
		459

*Correct response.

Figure 3-20

SCENE 10



As you approach the next intersection, you see two lines extending across the pavement in front of your car. (Scene 10) What do they mean? *Punch one or more of the following:*

(•)	____If pedestrians are crossing, you must wait*	228
(•)	____If pedestrians are crossing, they must wait	11
(•)	____If your traffic light is green, you must still stop, look, and then continue	41
(•)	____Do not cross the lines while waiting at a red light*	218
(•)	____Not sure	14
		512

*Correct response.

Problematic situations potentially exist among those drivers suggesting that pedestrians should wait if crossing and for those respondents who believed that, even though the light is green, they should stop, look for pedestrians, and then continue. Motor vehicle laws for pedestrians right-of-way in crosswalks state somewhat ambiguously (20):

> "...when traffic-control signals are not in place or not in operation the driver...shall yield the right-of-way...to so yield, to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling, or when the pedestrian is approaching so closely as to be in danger ...

Together these two respondent-sets comprised 10 percent of the sample response.

(a) Percent Correct = 44
Mean ($\bar{x}$) = 0.55

(b) Percent Correct = 43
Mean ($\bar{x}$) = 0.53

Solid White Line. The situation depicted in Figure 3-21 was accurately identified by 35 percent of the total sample in that the driver in Lane A was restricted in crossing the solid white line into the left turn lane, but not prohibited from crossing the stripe altogether. In actual driving situations traffic turbulence could be created if the meaning of this marking was not understood, so that information dissemination appears necessary in this case.

Percent correct = 35
Mean ($\bar{x}$) = 0.39

Figure 3-21

SCENE 12

You enter the left turn lane and notice a solid white line on your right (Scene 12). What does the white line tell you? *Punch one or more of the following:*

(•) ___	The line is a divider line marking lanes. Drivers may cross it if they want.*	165
(•) ___	If you are in Lane A you cannot cross the line into the left turn lane.	99
(•) ___	If you are in the left turn lane you cannot cross the line into Lane A.	173
(•) ___	Not sure.	28
		465

*Correct response.

3.3 Traffic Signals

Five traffic signal indications were assayed in the survey. The roadway signals included three forms of power operated traffic devices, encompassing traffic control signals and beacons, as well as pedestrian crossing signals. Thus, the signals in the survey incorporated those used for vehicular and pedestrian traffic. While signals are of utmost value in providing for the orderly movement of traffic and for reducing the frequency of certain types of accidents, they represent devices that must be clearly understood by the public to be effective.

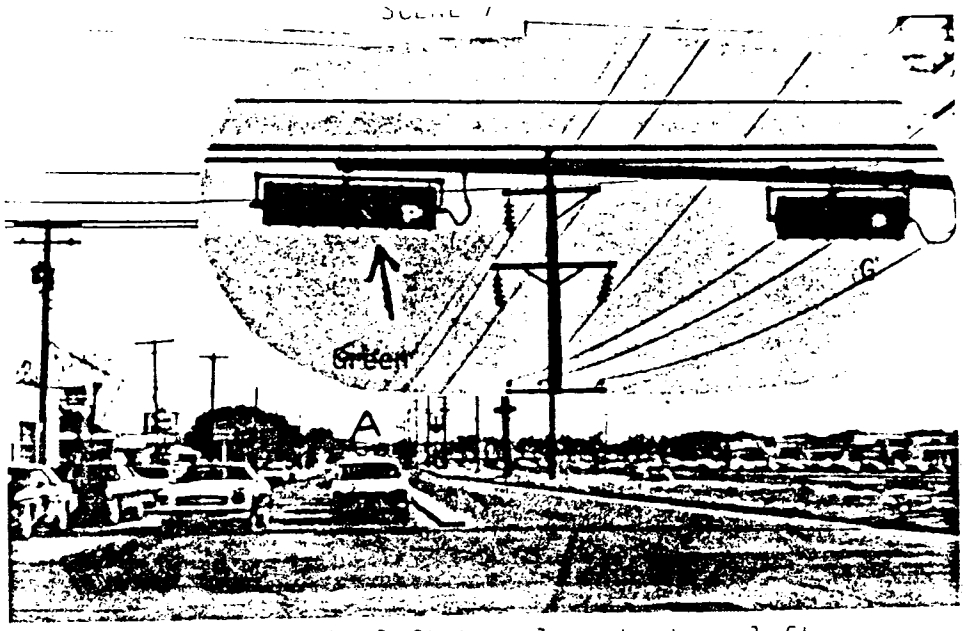
Left-turn Arrow. Of the survey responses to the left-turn arrow item (Figure 3-22), 76 percent of the responses were correct. However, 60 responses out of 426 suggested the green left-turn arrow inferred a wait until opposing traffic crosses the intersection, then the driver may turn left. Educational techniques are necessary for this form of misunderstanding, to inform drivers that the left-turn arrow provides a protected turn.

Percent correct = 76

Mean ($\bar{x}$) = 0.78

Red Light with Green Left-Turn Arrow. Seventy-seven percent of all respondents and 68 percent of all responses identified the green left-turn arrow when the red light signalled forward-moving traffic to stop (Figure 3-23). As with the aforementioned left-turn arrow item, almost 30 percent did not realize that the green left-turn arrow points to a protected turn. Again, the need for information provision in this area of signalization is evident.

Figure 3-22



You move into the left turn lane to turn left. (Scene 7). Notice that traffic is waiting in the opposing lane (headed your way). You see the green arrow. What should you do? *Punch one or more of the following:*

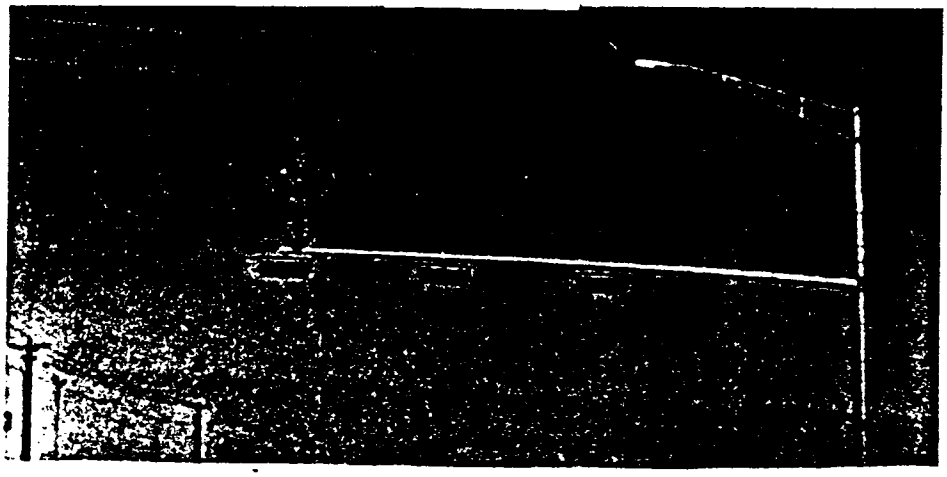
(•)	Wait until the opposing traffic crosses the intersection, then turn left	60
(•)	Wait until "CAR A" turns left, then turn left	38
(•)	Turn left immediately. Opposing traffic is stopped *	322
(•)	Not sure	6
		426

*Correct Response

Figure 3-23

Green

SCENE 11



After attending to some business on Puckett Road, you decide to take Guseman Freeway **northbound.** The best entrance is Edwards Place, so you get into the left land at Puckett and Edwards (Scene 11). What do the traffic lights tell you? *Punch one or more of the following:*

(•) ____	Wait until the red light turns green	39
(•) ____	You can turn left on green arrow even with the red light on*	315
(•) ____	You can turn left on green arrow, but must yield to cross-traffic from the right	40
(•) ____	You can turn left on green arrow, but must yield to oncoming traffic	57
(•) ____	Not sure	12
		463

*Correct response.

Percent correct = 68

Mean ($\bar{x}$) = 0.77

Pedestrian "Con't Walk" Signal. Only 42 percent of all responses indicated a correct understanding of the flashing "Don't Walk" signal; the majority, while familiar with the pedestrian signal, were overly cautious (Figure 3-24). These individuals suggested the need to return to the curb or wait in the center median area at the on-set of the flashing signal. However, the pictures did not depict a center median. As the misunderstandings present no apparent hazard, the low proportion correctly identifying the flashing "Don't Walk" for pedestrians represents no critical problem.

Percent correct = 42

Mean ($\bar{x}$) = 0.46

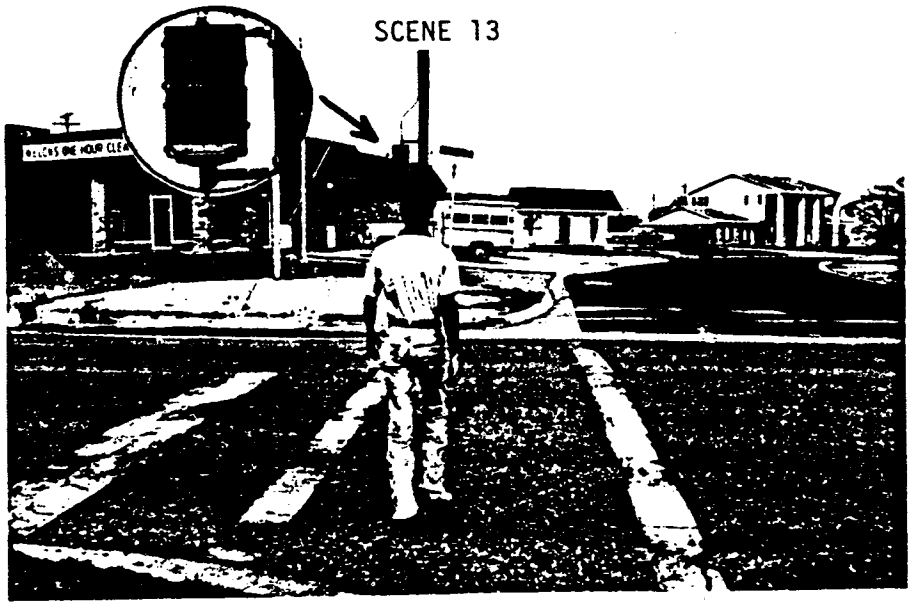
Amber left-turn arrow. Not used as commonly as the green left-turn arrow, the amber left-turn signal represents a serious problem in driver understanding. Only 22 percent of the responses correctly identified this control device, as depicted in Figure 3-25. The two alternatives to the correct response of "turn quickly" did not represent hazards, both indicating the need to wait before turning left. Nevertheless, there is a need to increase the public's awareness of this lesser known amber left-turn signal.

Percent correct = 45

Mean ($\bar{x}$) = 0.46

Flashing Amber Beacon. At the intersection depicted in Figure 3-26, the flashing amber beacon was correctly assessed by slightly over half of the respondents. Considerable doubt existed among the remaining drivers in the study sample as to whether they must stop or proceed with caution. As the

Figure 3-24



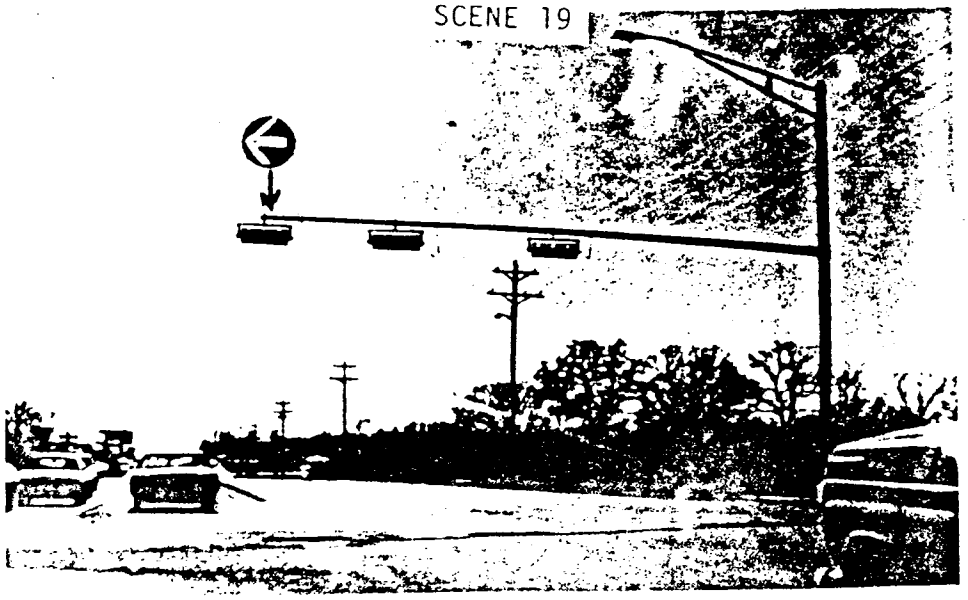
At an intersection you see a pedestrian traffic light (Scene 13). A pedestrian has started crossing the street when the light starts flashing "Don't Walk." What should he do? *Punch one or more of the following:*

(•) ___	Continue crossing quickly; the light will not likely turn red until he reaches the curb*	187
(•) ___	Go back to the curb and wait for a green light	177
(•) ___	Wait in the center median area for a "Walk" light	60
(•) ___	Stop walking	7
(•) ___	Not sure	11
		442

*Correct response.

Figure 3-25

Amber



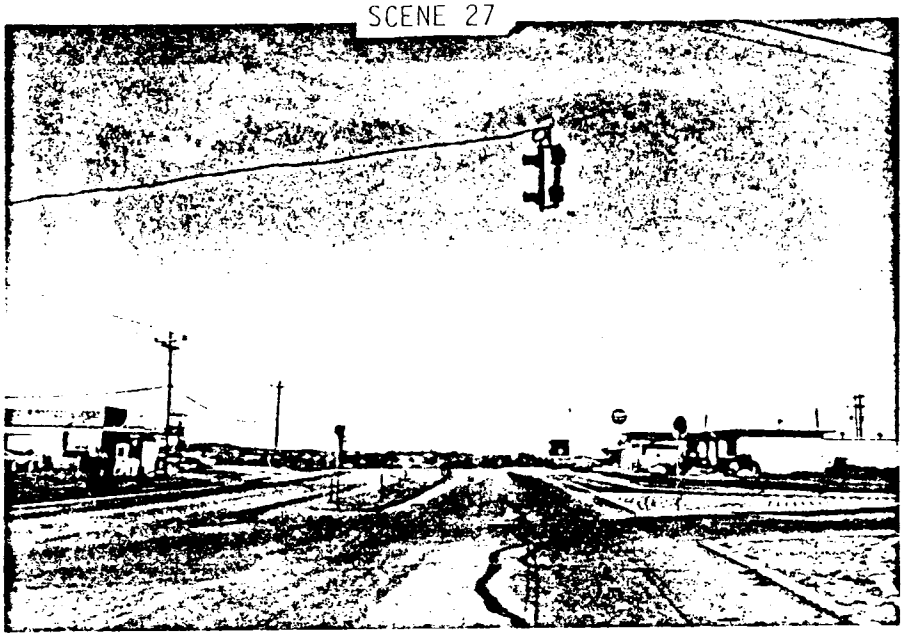
You continue on Harrison to Route 43, which is your alternate route north. You are in the left turn lane preparing to turn onto Route 43. The traffic lights are as shown in (Scene 19). What do you think these lights mean? *Punch one or more of the following:*

(•)____	Turn left quickly. You still have the right of way.	94
(•)____	Wait. The turn light will be red before you could turn. *	187
(•)____	Wait. The turn light will change to green next and you will be able to turn left.	119
(•)____	Not sure	19
		419

*Correct Response

Figure 3-26

SCENE 27



You reach an intersection (Scene 27) which has a flashing amber beacon on it. What is the correct meaning? *Punch one or more of the following:*

(o) ___	The road which crosses your highway also has an amber flashing beacon. Both of you have right of way, but be alert.	74
(o) ___	The other road has a red flashing beacon. You have the right of way.*	236
(o) ___	The other road could have either a red or amber flashing beacon.	116
(o) ___	Not sure.	14
		440

*Correct response.

amber flashing beacon is a frequently used device, driver improvement in understanding the purpose of this signal is necessary.

Percent correct = 54

Mean ($\bar{x}$) = 0.58

3.4 Barricades

Barricades, as with other channelizing devices, function to direct the motorist at construction and maintenance sites. They are intended to impose an obstacle, real or apparent, in the normal traffic flow. Further, barricades should provide a highly visible barrier to drivers.

Type III Barricade Stripes. Less than half (39 percent) of the respondents correctly identified the barricade in Figure 3-27 as channeling traffic to the left, with the stripes beginning at the upper right side of the panels and sloping downward to the lower left side. The barricades--Types I, II, and III--appear to be poorly understood by the motoring public. Because respondents in this study could have answered correctly with guesswork alone, there is likely to be less understanding evidenced in actual driving situations unless the barricades are complemented by signs with written communication or additional visual aids.

Percent correct = 39

Mean ($\bar{x}$) = 0.40

Figure 3-27

SCENE 17

The road ahead is barricaded as shown in (Scene 17). On which side of the barricade should you drive (if you did not see a sign to guide you)? *Punch your answer:*

(•)	____Left*	162
(•)	____Right	176
(•)	____Either	34
(•)	____Not sure	42
		414

*Correct response.

IV. Characteristics of Respondents and Understanding of Control Devices

With the knowledge that greater misperceptions of specific signs, markings, and traffic signals exist than for other devices included in the study, it is useful to ascertain an overall measure of understanding for individual drivers. Such an indicator was derived as a simple aggregation of the 28 items included in the survey.* A range of 0 to 28 represented the continuum of possible scores for respondents. Three items had two correct answers, so that each correct response was given a 0.5 in these cases, with the remaining 25 items receiving a 1 if accurately answered. The actual range of responses was 17.50, with the lowest score to the Texas Driver Knowledge Scale (TDKS) 8.0 and the highest value 25.5.

The Scale mean was 18.99 pointing to an average of nine traffic control devices that were inaccurately perceived by the driving public represented in the sample. TDKS was slightly skewed to the left, or lower scale scores, with a skewness coefficient of -0.636. The plotted scores pointed to an insignificant flattening of the normal curve, with a platykurtic distribution.

Tests were undertaken of the internal consistency of TDKS by factor analysis, Guttman scaling techniques, and a measure of equivalence of the 28 items included in the testing of device understanding. Generally, the items tended to measure different dimensions of the traffic control system. There was no way to rank or order the items along a hierarchy, with understanding on one item observed before individuals correctly perceived other items.

---

*One of the 27 devices on which respondents were queried had two types of questions attached to it, forming 28 items.

Correlation of responses among items also was fairly low; a correct response regarding one device did not consistently correlate with other responses about the meaning of related devices. Thus, this lack of internal consistency or correlation of responses to the devices occurred not only generally but also for specific, related devices, such as different traffic signals.

For ease of examination, TDKS was divided into four categories, with two categories above and two below the mean as shown in Table 4-1. One standard deviation (3.11 = standard deviation) above the mean (18.99 = mean) on TDKS was used to separate the two categories above the mean, and one standard deviation below the mean was used similarly. Therefore, the scale, which had ranged from 8.0 to 25.5, was merged into the following categories:

Level I (<15.88)	Lowest TDKS
Level II (15.88 - 18.99)	Lower Middle TDKS
Level III (19.00 - 22.10)	Upper Middle TDKS
Level IV (>22.10)	Highest TDKS

4.1 Demographic Characteristics

The Texas drivers participating in the study had dissimilar personal characteristics. Differentiation in traffic control device understanding skills was evidenced by specific population segments in many cases. Salient personal characteristics examined included:

- Age
- Sex
- Socioeconomic ranking
- Ethnicity
- Physical disabilities

Age. With the use of the TDKS scoring procedure, age of the driver had a significant relationship to level of understanding. Older persons -- those aged 55 and older -- had low scores on the overall understanding scale, with 68 percent classified in Level I of TDKS. These individuals had not been exposed to driver education and, on the whole, have no formal driving training. The youngest driving ages (14 - 24) also evidenced lower scores generally than did the 25 to 34 age category, with only 39 percent in this latter category falling into Level I of TDKS.

Previous studies have shown similar results, based on actual driving situations (15, 16). Age thus appears to be a dominant segmental element for describing levels of understanding of traffic control devices. A curvilinear relationship exists between age of drivers and accurate perception of the meanings of traffic signs, markings, and signals.

Sex. Distinctions in TDKS by sex were significant, as depicted in Table 4-2. Forty-eight percent of the female subjects were in the low understanding category whereas only 36 percent of the male respondents fell into Level I. The Driver Knowledge Scale has the capability for measuring only recognition errors, rather than "high risk" driving errors. Controlling for driving exposure, other studies have shown that males evidence a significantly higher traffic conviction rate while both sexes have very similar accident rates (15). Previous studies have demonstrated that females evidence more recognition errors (or lack accurate perceptions of signs, right-of-way, etc.), while males show more risk-taking and alcohol-related driving errors (16, 17, 18).

Table 4-1. Texas Driver Knowledge Scale (TDKS) by Age of Respondents

Level of Understanding	Age of Respondents					
	15-25	25-34	35-44	45-54	55-64	65+
I	51 *(36[a])*	34 *(30)*	26 *(42)*	21 *(48)*	26 *(70)*	7 *(64)*
II	26 *(18)*	25 *(22)*	9 *(15)*	2 *(4)*	4 *(11)*	4 *(36)*
III	49 *(35)*	38 *(33)*	22 *(35)*	17 *(39)*	5 *(14)*	0 *(0)*
IV	15 *(11)*	17 *(15)*	5 *(8)*	4 *(9)*	2 *(5)*	0 *(0)*
Totals	141 *(100)*	114 *(100)*	62 *(100)*	44 *(100)*	37 *(100)*	11 *(100)*

$x^2 = .0041^{*b}$

[a] Percentage with respect to totals in ( ).

[b] The asterisk in this table and those tables which follow denotes that the relationship between the two variables presented is significant at or beyond the .05 level.

Table 4-2. Texas Driver Knowledge Scale (TDKS) by Sex of Respondents

Level of Understanding	Sex of Respondents	
	Male	Female
I	96 *(36)*	68 *(48)*
II	44 *(16)*	26 *(19)*
III	90 *(34)*	41 *(29)*
IV	37 *(14)*	6 *(4)*
Totals	267 *(100)*	141 *(100)*

$x^2 = 0.0063$*

Nevertheless, recognition errors can be reduced among females with appropriate informational aids. Female drivers are evidencing more diverse trip purposes requiring skill in accurately perceiving traffic control devices. Increases in level of understanding of traffic controls among female drivers should facilitate traffic flow and decrease accidents caused by recognition errors.

Socioeconomic Ranking. As shown in Table 4-3, a linear relationship was found for level of understanding by respondents' years of school completed. Those with no college training provided a useful cutting point, with 47 percent falling in Level I.

Occupational ranking also was related to the level of understanding regarding traffic control devices, although the distinctions among occupations were not significant (see Table 4-4). The majority of respondents who were retired, unemployed, or housewives scored in the lowest level of the TDKS categories. Additionally, over 50 percent of the white collar workers in the sales and managerial/administrative categories scored in the lowest level of the scale. The latter finding was unanticipated, and it should be noted that a bifurcation of the scores is evident for white collar workers, who also had highest scores in approximately 15 percent of the cases. Differentiating the population by 12 occupational categories provided an average of only 8 respondents per cell which is not considered a stable sample of the population and could explain the unexpected results above.

Educational level provides a more consistent means of pointing to the relationship between socioeconomic ranking of the driver and level of understanding. Socioeconomic status, like age and sex, provide a basis for seg-

Table 4-3. Texas Driver Knowledge Scale (TDKS) by Years of School Completed by Respondents

Level of Understanding	Years of School Completed						
	9th Grade or Less	10th-11th Grades	High School Graduate	Technical/Business School	Some College	College Graduate	Some Graduate School
I	22 *(63)*	18 *(47)*	57 *(44)*	11 *(42)*	29 *(29)*	17 *(33)*	10 *(36)*
II	6 *(17)*	8 *(21)*	21 *(16)*	5 *(19)*	14 *(14)*	11 *(22)*	5 *(18)*
III	6 *(17)*	10 *(26)*	42 *(33)*	8 *(31)*	43 *(42)*	16 *(31)*	7 *(25)*
IV	1 *(3)*	2 *(5)*	9 *(7)*	2 *(8)*	15 *(15)*	7 *(14)*	6 *(21)*
Totals	35 *(100)*	38 *(100)*	129 *(100)*	26 *(100)*	101 *(100)*	51 *(100)*	28 *(100)*

$x^2 = 0.1151$

Table 4-4. Texas Driver Knowledge Scale (TDKS) by Occupational Ranking

Level of Understanding	Occupational Ranking											
	Professional and Technical Workers	Managers and Administrators	Sales Workers	Clerical and Related Workers	Craftsmen and Foremen	Operatives of Equipment	Laborers	Service Workers	Students	Housewives	Unemployed	Retired
I	20 *(31)*	16 *(50)*	11 *(55)*	10 *(37)*	9 *(28)*	12 *(28)*	7 *(35)*	7 *(29)*	15 *(29)*	26 *(53)*	5 *(46)*	13 *(52)*
II	10 *(15)*	2 *(6)*	1 *(5)*	6 *(22)*	5 *(21)*	9 *(21)*	6 *(30)*	4 *(22)*	10 *(20)*	7 *(14)*	3 *(27)*	6 *(24)*
III	23 *(35)*	11 *(34)*	5 *(25)*	11 *(41)*	13 *(46)*	20 *(46)*	3 *(15)*	6 *(33)*	19 *(37)*	12 *(25)*	2 *(18)*	4 *(16)*
IV	12 *(19)*	3 *(10)*	3 *(15)*	0 *(0)*	4 *(5)*	2 *(5)*	4 *(20)*	1 *(6)*	7 *(14)*	4 *(8)*	1 *(9)*	2 *(8)*
Totals	65 *(100)*	32 *(100)*	20 *(100)*	27 *(100)*	31 *(100)*	43 *(100)*	20 *(100)*	18 *(100)*	51 *(100)*	49 *(100)*	11 *(100)*	25 *(100)*

$x^2 = 0.2095$

menting the driving public for providing further information about, and clarifying the meaning of, commonly used traffic control signals.

Ethnicity. As noted in Table 4-5, 56 percent of the ethnic minority population sampled had TDKS scores in the Level I category, compared to Anglos with 36 percent. Relative to the State average, black respondents were poorly represented in the study, with only 4 percent black. Nineteen percent were Mexican-American, primarily from the San Antonio and El Paso study sites, and 2 percent were classified in a residual ethnic minority category, which included American Indians. Anglos comprised 75 percent of the sample.

While larger proportions of blacks and the residual minorities category accounted for much of the lower scores in TDKS, the large numbers of Mexican-American respondents also explained these lower scores. Out of all respondents, 109 stated that another language was used in their homes, other than English. Seventy-six percent, or 82, listed Spanish as this other language. Nine respondents named German as the language spoken and seven participants listed French, while 10 subjects had various Asian and American Indian dialects used in the home. Nevertheless, the pronounced dependency on Spanish by 82 of the 407 participants responding to the questions regarding language usage points to one possible explanation for the lower TDKS scores among minorities. In 23 percent of the cases, the foreign language was used only occasionally; however, 40 percent professed to speaking a foreign language either most of the time or all of the time, while 38 percent stated part-time use of a language other than English.

No known studies are available for comparison with these findings. The survey situation, with the questionnaire printed in English only, provides

Table 4-5. Texas Driver Knowledge Scale (TDKS) by Ethnicity of Respondents

Level of Understanding	Ethnicity			
	Anglo	Mexican-American	Negro	Other
I	109 *(36)*	39 *(49)*	14 *(82)*	6 *(67)*
II	50 *(16)*	16 *(20)*	2 *(12)*	2 *(22)*
III	110 *(36)*	18 *(23)*	1 *(6)*	1 *(11)*
IV	37 *(12)*	6 *(8)*	0 *(0)*	0 *(0)*
Totals	306 *(100)*	79 *(100)*	17 *(100)*	9 *(100)*

$x^2 = 0.0136$*

a hindrance to the respondent in reading alternate responses to each survey item. Perhaps more important, however, are signs and other means of written communication provided to drivers in Texas who, because of language barriers, are unable to understand these traffic control devices.

Physical disabilities. Survey participants were queried as to personal physical handicaps. However, when responding about the degree to which such disabilities hindered driving, only 14 answered positively. The prime disabling characteristic was old age. Further, when comparing those stating a disabling condition with the remainder of the driver sample, no significant differences were observed in level of understanding of traffic control devices.

4.2 Personal Transportation Characteristics

Driving exposure has been a consistently predictive feature of understanding of traffic signs, markings, signals, and delineators. Included in respondents' record of exposure were:

- Vehicle availability
- Approximation of miles driven yearly
- Number of years driven

Further, vehicle type or the multiplicity of vehicle types driven by the study participant was considered to be a possible means of differentiating skills in understanding traffic control devices.

Vehicle availability. For the vast majority of respondents, 82 percent, a private vehicle was always available to them. Table 4-6 points to a curvilinear relationship between auto availability and accuracy in identifying

Table 4-6. Texas Driver Knowledge Scale (TDKS) and Vehicle Availability

Level of Understanding	Vehicle Availability				
	Vehicle Always Available	Vehicle Available Most of the Time	Vehicle Available Part of the Time	Vehicle Available Only Occasionally	Almost Never Drive a Vehicle
I	133 *(40)*	18 *(35)*	7 *(64)*	1 *(25)*	1 *(20)*
II	56 *(17)*	9 *(18)*	3 *(27)*	0 *(0)*	0 *(0)*
III	102 *(31)*	23 *(45)*	1 *(9)*	2 *(50)*	4 *(80)*
IV	41 *(12)*	1 *(2)*	0 *(0)*	1 *(25)*	0 *(0)*
Totals	334 *(100)*	51 *(100)*	11 *(100)*	4 *(100)*	5 *(100)*

$x^2 = 0.0624$

traffic control devices. The participants with the greatest proportion in Level I of TDKS were those with a vehicle "part of the time". Thus, availability on a periodic basis appeared to provide a basis for the greatest misperceptions of traffic control devices.

Propensity for Driving. An estimation of driving mileage, based on a four-category breakdown of miles driven within the last year, was obtained from respondents. The association between estimated miles on roadways and level of understanding was highly significant, as demonstrated in Table 4-7. Nineteen percent driving 15,000 or more miles per year scored in Level IV of TDKS, and 57 percent in this heavy driving class were in Levels III and IV.

Other researchers have found that the best single predictor of driver performance was mileage, rather than age, sex, or other personal characteristics, so that obtaining driving exposure data is particularly important. One problem with mileage as a predictor is that estimates provided by subjects are often inaccurate. However, one study (19) compared estimated versus actual mileage and found a fairly high correlation ($r = .65$, $N = 505$).

As the survey utilized in Texas provided for a self-report of mileage in one of four broad categories, this variable was considered valid and a basic indicator of driving exposure. Based on the results provided by this study sample, high mileage drivers are more adept at identifying traffic control devices, so that exposure and level of understanding are strongly related.

Length of Driving Experience. Table 4-8 shows the number of years study participants have been driving relative to their scores on the level of understanding scale (TDKS). As with the age variable, a curvilinear relationship was observed, with those driving less than five years and those with 20 or

Table 4-7. Texas Driver Knowledge Scale (TDKS) by Miles Driven Last Year as Recorded by Respondent

Levels of Understanding	Miles Driven in One Year			
	0-4,999	5,000-9,999	10,000-14,999	15,000 or more
I	42 *(56)*	53 *(48)*	33 *(36)*	32 *(25)*
II	16 *(21)*	18 *(16)*	13 *(14)*	22 *(18)*
III	14 *(19)*	32 *(29)*	38 *(41)*	48 *(38)*
IV	3 *(4)*	8 *(7)*	8 *(9)*	24 *(19)*
Totals	75 *(100)*	111 *(100)*	92 *(100)*	126 *(100)*

$x^2 = 0.0001$*

Table 4-8. Texas Driver Knowledge Scale (TDKS) by Length of Driving Experience

Level of Understanding	Length of Driving Experience					
	0-4 Years	5-9 Years	10-14 Years	15-19 Years	20-24 Years	25+ Years
I	30 *(42)*	29 *(32)*	17 *(32)*	11 *(26)*	19 *(54)*	50 *(52)*
II	14 *(20)*	19 *(21)*	12 *(22)*	9 *(22)*	3 *(9)*	12 *(12)*
III	23 *(32)*	31 *(34)*	19 *(35)*	14 *(33)*	11 *(31)*	27 *(28)*
IV	4 *(6)*	12 *(13)*	6 *(11)*	8 *(19)*	2 *(6)*	8 *(8)*
Totals	71 *(100)*	91 *(100)*	54 *(100)*	42 *(100)*	35 *(100)*	97 *(100)*

$x^2 = 0.1127$

more years of driving experience evidencing the lowest scale scores (see Table 4-8). Respondents driving for more than two decades tend to have little formal driver education. Participants driving less than five years, and thus having less driving experience, may not have become as cognizant of traffic control devices as those with longer driving records.

Type of Vehicle. The kind of vehicle driven by respondents pointed to significant differences in level of understanding of traffic control facilities. Because several of the vehicle types contained a small number of respondents, passenger cars and motorcycles were collapsed into one category. Larger vehicles were classified as one category and included pickup trucks, trucks, vans, buses, or campers. Use of two or more vehicle types placed the respondent in the third category. Drivers of passenger cars and those driving a diversity of vehicle types selected accurate responses less often than did those whose mode of transportation was driving larger vehicles. These driver categories contained a large proportion of drivers who reported use of a vehicle for work purposes, primarily as transport equipment operatives.

The traffic control devices on which these participants were tested have been assayed as commonly used visual communication systems. Nevertheless, in examining the Texas Driver Knowledge Scale scores, which were classified into four categories, the proportion of scores falling one standard deviation below the mean are almost four times greater than those falling in the category one standard deviation above the mean score of 18.99. Further, in the analysis of the scores received by various population agents, the most significant differences are observed according to the following breakdowns:

Table 4-9. Texas Driver Knowledge Scale (TDKS) by Type of Vehicle in Predominate Use by Respondents

Level of Understanding	Vehicle Predominately Used by Respondents		
	Passenger Cars and Motorcycles	Pickups, Trucks, Vans, Buses, Campers	Multiple Use of Vehicle Types
I	136 *(43)*	15 *(24)*	12 *(46)*
II	59 *(18)*	6 *(10)*	5 *(19)*
III	92 *(29)*	33 *(53)*	7 *(27)*
IV	33 *(10)*	8 *(13)*	2 *(8)*
Totals	320 *(100)*	62 *(100)*	26 *(100)*

$x^2 = 0.0076$*

(1) estimated miles driven per year (significance > .0001)

(2) ethnic background (significance > .0023)

(3) age of respondents (significance > .0041)

(4) sex of respondents (significance > .0063)

V. Implications of Results

5.1 Conclusions

Table 5-1 summarizes the extent to which the sampled population correctly answered the questionnaire on each of the traffic control devices, and also gives the most commonly made misunderstanding of each device. As can be seen in this table, and in the discussions of the items in Chapter III, some misunderstandings are far more critical than others. In other words, some traffic control devices "fail safe" and others do not.

In the category of warning signs, the confusion many motorists have is between advance signs and signs that pertain to that situation in the immediate vicinity. This confusion exists for both school crossing signs and for railroad crossing signs. The danger is that drivers will perceive the first sign, take appropriate action, but do nothing further for the second sign.

The slippery when wet symbol sign is nationally notorious for misunderstanding, since it seems to mean curve or winding road ahead for a large minority. Both the correct and the incorrect interpretations should lead the driver to slow, but hard or abrupt braking is one of the things the sign is trying to warn against.

Those who confuse turn and curve signs are probably only inconvenienced by excessive slowdown for the curve situation, since drivers tend to underestimate design speed in curves. However, this misunderstanding can cause accidents as well as property damage in some cases.

The confusion between left and right lane drop or pavement width narrows signs can lead to inappropriate merge maneuvers, with resulting turbulence in a traffic stream.

Table 5-1

Outline of Public's Understanding
of 27 Traffic Control Devices

Traffic Control Device	Percent Correct	Most Common Error
I. Roadway Signs		
A. Guide Signs		
Exit direction sign	Two correct responses: 85	50 feet from gore point (12%)
B. Warning Signs		
Two-way traffic symbol	93	No passing zone (3%)
Pavement width transition sign	61	One-lane traffic ahead (20%), which does not indicate a severe error
School crossing symbol signs: advance and on-site	39	Both signs signify advance warning (33%), representing a potentially hazardous situation
Merge symbol sign	79	Major roadway to right is merging with highway (12%)
Pavement ends sign	84	Highway ends (12%)
Railroad advance warning sign and Railroad crossbuck sign	Two correct responses: 76	Either sign may come first (19%), which in some situations could be hazardous
Slippery when wet symbol sign	77	The roadway curves (21%), hazardous in that driver unprepared for wet conditions
Soft shoulder sign	88	Soft spots in pavement (7%)
Left curve and Left turn signs	79	Signs have same meaning (20%)

Table 5-1 (continued)

Traffic Control Device	Percent Correct	Most Common Error
Divided highway symbol sign	51	Signs have same meaning (47%), with no severe consequences of misunderstanding
Pavement width transition signs: left/right lane ends	60	Signs have same meaning (38%), with recognition error presenting hazard
C. Regulatory Signs		
Double turn sign	66	Can turn only in left lane (29%), which is potentially hazardous
Keep right symbol sign	74	Obstacle in the center median (17%)
One-way sign	81	Must turn right at intersection (12%)
No right turn symbol sign	91	No right turn on red light; wait for green traffic light (3%)
Climbing lane ahead sign	73	Steep hill ahead (19%)
Yield to traffic in center lane sign	37	Road narrows ahead (or need to merge with traffic going same direction (31%)
II. Markings		
Double yellow line	76	Do not cross double line for any reason (such as turning into a driveway)(14%)
Pedestrian crosswalk	Two correct responses: 87	If light is green, driver must still stop and look for pedestrians (8%)
Solid white line	35	Crossing solid white line is prohibited (58%), with no severe consequences of misunderstanding except possible traffic flow problems

Table 5-1 (continued)

Traffic Control Device	Percent Correct	Most Common Error
III. Traffic Signals		
Left-turn arrow	76	Wait until opposing traffic crosses intersection, then turn left (14%)
Red light with green left-turn	68	Can turn left on green arrow, but must yield to oncoming traffic (12%)
Pedestrian "Don't Walk" signal (Flashing Mode)	42	Pedestrian must go back to curb and wait for green light if he/she has started crossing the street (40%), shows no hazard
Amber left-turn arrow	45	Wait; the turn light will turn to green next and you will be able to turn left. (28%). with misunderstanding representing potential hazard
Flashing amber beacon	54	The other road could have either a red or amber flashing beacon (26%), with overly cautious misperception no danger
IV. Barricades		
Type III barricade	39	Directional aspect of barricade misinterpreted (42%), represents no danger

In the category of regulatory signs, the double turn sign appears to promote a certain amount of confusion. Some motorists fail to grasp the significance of the double arrow and believe turns can only be made from the left most lane only. Very surprisingly, a sizable minority believe that you can also continue straight through the intersection in either lane!

Other misconceptions arise from both sides of a steep hill with a climbing lane. Some drivers think that climbing lane refers to the hill per se, and not to the existence of a special lane; many drivers can make no sense out of the companion sign for the downhill side of a climbing lane, Yield to traffic in center lane. All it means to say is that opposing traffic next to you is operating in a legitimate traffic lane, and is not making a passing maneuver around traffic in the climbing lane--so don't expect them to get out of your way if you are passing! The difficulty of expressing the last thought in a succinct highway sign needs no elaboration.

In the category of traffic control markings, drivers appear to think that double yellow lines are an absolute prohibition against maneuvers over them. This mistake probably affects commercial strip establishments along busy arterials more than anyone else, but some safety implications exist here too, in the form of U-turns at intersections, needless doubling of the block, and the like. As is well-known, the significance of dashed vs. solid white lines is lost to many motorists.

In the category of traffic signals, most errors with respect to protected left turns are conservative; the driver does not know what a protected left turn is, or discounts the protection. This can lead to rear-enders in left turn bays, but is otherwise reasonably fail-safe. Conservative error characterizes amber left turn arrows and "don't walk" flashing indications

as well. The only really serious misunderstanding in the category of traffic signals is the confusion found in almost half the drivers concerning flashing beacons at intersections. Again, rear end collisions can occur if a driver does not appreciate that if he has a flashing amber beacon the cross traffic indication has to be flashing red which requires a stop. The errant driver may decide to stop at the intersection, instead of proceeding with caution. At the very least, this confusion will cause needless delays and hesitant negotiation of such controlled intersections.

The finding of barricade directional coding should come as no surprise to traffic engineers. Directional coding must be supplemented by directional arrows at all times.

Table 5-2 summarizes our interpretation of these findings. There are at least 11 different control devices or indications which require some kind of educational countermeasure to improve the public's comprehension. It is important to note that no less than 5 of these are symbol signs. It should be recalled that the test question pictures deleted the word signs that still accompany many of these symbol signs. Without the word messages, these signs cannot stand on their own. Although in many cases the symbols have been in use for nearly ten years, a sizable number of drivers still "aren't getting the message."

Drivers exhibited different levels of understanding in general along demographic and socio-economic lines. The older drivers and the very young

Table 5-2

Traffic Control Devices that are
Seriously Misunderstood

1. Crossing Signs: Advance vs. at-Crossing symbol sign
2. Slippery When Wet symbol sign
3. Curve vs. Turn symbol sign
4. Pavement Width Transition symbol sign
5. Double Turn symbol sign
6. Climbing Lane Ahead
7. Yield to Traffic in Center Lane
8. Double Yellow Line (nature of prohibition)
9. Solid White Line (not discriminated from dashed)
10. Protected Turn Traffic Signals (green and amber arrows)
11. Flashing intersection control beacon

tended to show less understanding of the devices than the middle-yeared drivers. Number of years of driving experience showed the same relationship. Females tended to score lower than males, and a not surprising linear relationship between years of formal schooling and understanding was demonstrated. The burgeoning white collar worker class tended to polarize high and low on overall understanding, a finding that will require further analysis of the data not within scope of this project. Even though half of the signs and devices shown were nonverbal, the questionnaire was verbal, which may have disadvantaged the spanish language dominant drivers.

Part-time or occasional drivers tended to score lower than drivers who had access to vehicles all or most of the time. There is a very strong association between estimated mileage per year and level of understanding.

With respect to relative significance of these different driver characteristics, experience was most significant, ethnic background was next, age was third, and sex of the driver was fourth. Since the ethnic background factor may have been exaggerated because of the written nature of the questionnaire, the top three factors are exposure or experience in driving, age, and sex.

5.2 Preliminary Countermeasure Suggestions

It seems quite clear from the findings of this study that widespread misconceptions of the meaning of common traffic control devices exist. At least 11 of the 28 different devices or indications tested are sufficiently misunderstood that remedial action should be taken by the State of Texas. Most of the others ought to be included in some way.

Remedial or countermeasure action can take several forms:

(1) Modification of the traffic control device or indication

(2) Elimination of the traffic control device

(3) Training of the driving public

Measures (1) and (2) are severely constrained by the existence of state standards based on national standards which must be taken into account. Non-use of certain devices, even if the Manual on Uniform Traffic Control Devices provides a warrant, is easier than modification of a device or its message. However, nonprovision of device where warranted because of possible misunderstanding exposes the State to adverse legal action if a loss occurs, to say nothing of the implications to the public good.

Modification of traffic control devices may take the form of combining word messages with symbolic arrays or with signals, and in many cases this is routinely prescribed both in the MUTCD and in the Texas Manual. But confusion and information overload can result from this practice. An effective traffic control device presents its message quickly, succinctly, and unequivocably.

As our personal transportation system, the motor vehicle on the public motorway, becomes ever more overcrowded and technically sophisticated, the best way to accomplish this goal of effective traffic control devices is

through training. This includes training of the motoring public now operating on the streets and highways of Texas, and training of those now taking driver education courses. Training, of course, may take the form of public information or campaigns, as well as be formal classroom presentation of material.

Delivery of such training may be through various agencies. Which agency can do the most effective job, or which combination of agencies, depends upon the target group. Driver education is accomplished through school districts and the Texas Education Agency. All drivers pass through driver license stations where a measure of training can be accomplished almost across the board. Some stations distribute a colored poster with many of the traffic control devices that were studied in this project. Special audiences can be reached by Defensive Driving Courses, and by Driver Improvement activities.

Public service announcements and campaigns have been used very extensively in traffic safety, but often with indifferent results. Without careful management, it is possible to imagine misunderstanding becoming worse, or leading to a less conservative interpretation of a traffic control device.

In conclusion, two primary recommendations are summarized below:

- It is recommended that the State Department of Highways and Public Transportation review the eleven problem traffic control items to determine the feasibility of modification or elimination of these traffic control devices.
- It is recommended that an educational program be developed and implemented to improve public understanding of traffic control devices. It would appear that the Office of Traffic Safety in the State Department of Highways and Public Transportation has the capability of implementation. Therefore, based on this study, TTI has initiated a proposal for an educational program to be funded through the Office of Traffic Safety.

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APPENDIX

1. Survey Instrument
2. Answers Provided Respondents
3. Statistical Analysis

1. Survey Instrument

TEXAS A&M UNIVERSITY
TEXAS TRANSPORTATION INSTITUTE
COLLEGE STATION TEXAS 77843

HUMAN FACTORS DIVISION

This is a research study conducted for the State Department of Highways and Public Transportation--your Highway Department--by Texas A&M University's Transportation Institute. We will be asking you some questions in the form of a short 15 minute game we'd like you to play. The DPS is not connected with this study, and your answers to our game will in no way affect your driver's license or driving record. We're not even going to ask you your name. OK so far?

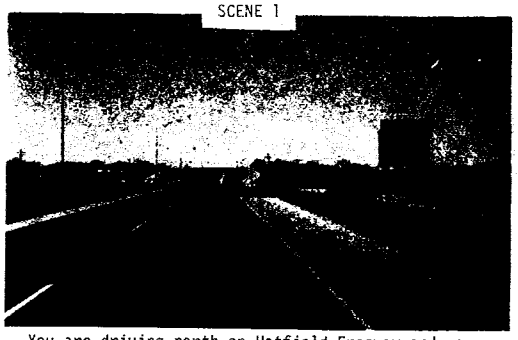
You are going to make an imaginary trip through a small Texas city and into the countryside. When you start, you will be on a highway called the Hatfield Freeway. You are going to get off this freeway, and drive through this town that you have never seen before. Then you will wind up on another freeway to take you out of town. As you go, you are going to see different situations on the highways, streets, and roads of this area. The trip is made by going through this booklet of photographs, and answering the questions which appear on each page as you turn to it. You record your answers by punching holes through the booklet--just like voting. At the end of the booklet are some questions about you that we would like for statistical purposes.

In return for your help in this study, we have an envelope of very interesting "Answer Books" from the Shell Oil Company for you, plus some information on the questions we ask you in this trip booklet.

As you open to the first page, you find yourself on the Hatfield Freeway, northbound near Anytown, Texas. Have a good trip, and feel free to ask any questions about the study after you finish the booklet. Now do you have any questions about how we are going to do this?

TURN TO NEXT PAGE

SCENE 1

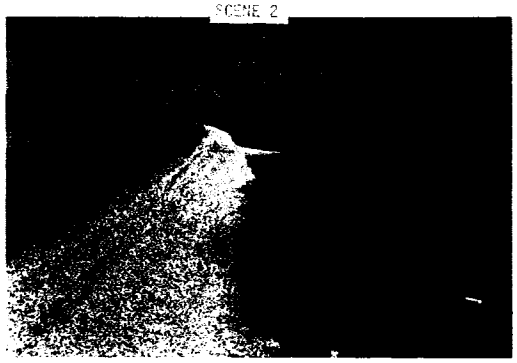


You are driving north on Hatfield Freeway and you are approaching the city of Anytown, Texas. You plan to drive through this city. You need to exit at Braker Lane. Along the freeway, you see Scene 1. How far ahead would you expect the exit to be? *Punch one or more of the following:*

- (●) About a quarter of a mile ahead
- (●) About 500 feet ahead
- (●) About 50 feet ahead
- (●) Right by the sign
- (●) Not sure

Be sure and punch your answer to the Right of the red line in holes provided.

SCENE 2



After you have taken the exit ramp and are on the service road, you see this sign (Scene 2). What does the sign mean? *Punch one or more of the following:*

- (●) The service road is a two-way roadway
- (●) The service road is a one-way roadway
- (●) No passing zone
- (●) "U" turns permitted in this zone
- (●) Not sure

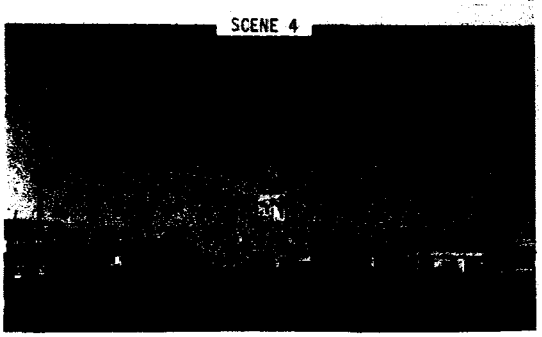
SCENE 3

You notice a double solid yellow line down the center of the road and a sign on the right shoulder (Scene 3). What do the lines and sign tell you? *Punch one or more of the following:*

- (●) Do not pass the vehicle in your lane
- (●) Do not cross over the centerline to pass a vehicle
- (●) Look out for oncoming traffic if you pass
- (●) Do not cross the centerline for any reason (such as turning into a driveway)
- (●) Not sure

TURN TO NEXT PAGE

SCENE 4



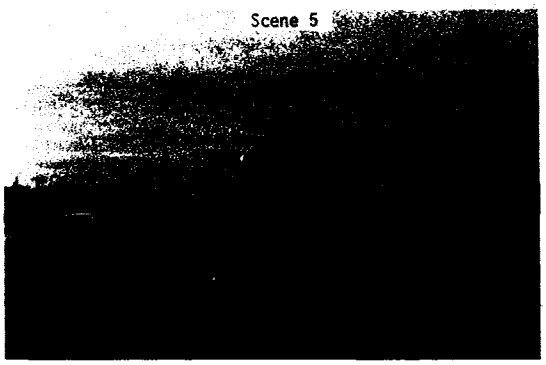
You wish to turn left onto Braker Lane. As you approach the intersection, you see this sign (Scene 4) in the center median area. Which lane should you get into? *Punch one or more of the following:*

(●) Only in the left lane
(●) Only in the middle lane
(●) May be in either lane
(●) Not sure

In Scene 4, if you were in the left lane, do you have a choice between turning ledt or continuing through the intersection? *Punch one or more of the following:*

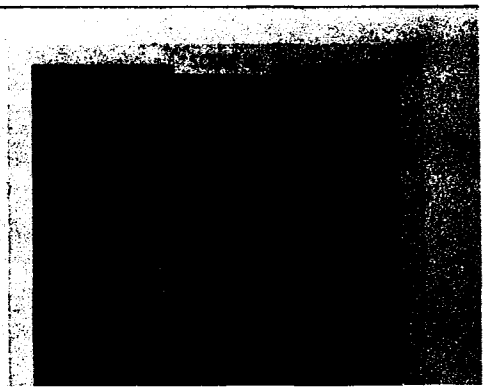
(●) Yes, I can do either
(●) No, I must turn left
(●) Not sure

Scene 5



You make a left turn onto Braker Lane and are now driving on a undivided street. You see this sign (Scene 5) ahead. What does the sign mean? *Punch one or more of the following:*

(●) Sharp left turn, then right turn ahead
(●) Right lane ends ahead
(●) One-lane traffic ahead
(●) Narrow bridge ahead
(●) Not sure

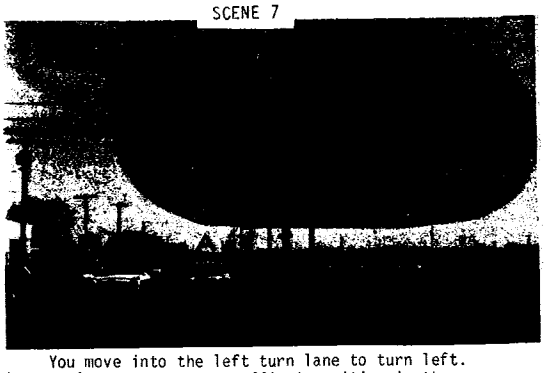


As you drive along Braker Lane, you soon see another sign (Scene 6). What does it mean? *Punch one or more of the following:*

(●) Roadway is blocked; drive on the right shoulder
(●) Sharp right turn ahead
(●) Divided roadway with center median ahead. Keep right
(●) There is an obstacle (like a bridge support) in the center median. Keep right. Undivided highway returns ahead.
(●) Not sure

TURN TO NEXT PAGE

SCENE 7



You move into the left turn lane to turn left. (Scene 7). Notice that traffic is waiting in the opposing lane (headed your way). You see the green arrow. What should you do? *Punch one or more of the following:*

- ( ) Wait until the opposing traffic crosses the intersection, then turn left
- ( ) Wait until "CAR A" turns left, then turn left
- ( ) Turn left immediately. Opposing traffic is stopped
- ( ) Not sure

SCENE 8

You are now approaching another intersection. (Scene 8). What does this sign tell you? *Punch one or more of the following:*

- ( ) I must turn right at the intersection
- ( ) No right turn
- ( ) Road ends ahead
- ( ) No left turn
- ( ) Not sure

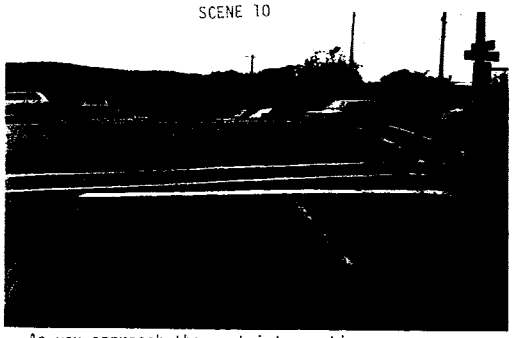
SCENE 9

You drive on and at the next intersection you see another sign. (Scene 9). What does this sign mean? *Punch one or more of the following:*

- ( ) You must turn right on this street
- ( ) No right turn any time onto this street
- ( ) Traffic on this street is all headed right
- ( ) No right turn on red (Wait for green traffic light)
- ( ) Not sure

TURN TO NEXT PAGE

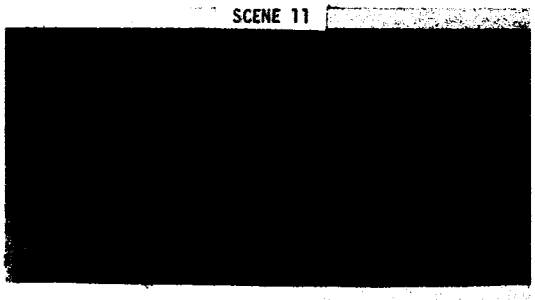
SCENE 10



As you approach the next intersection, you see two lines extending across the pavement in front of your car. (Scene 10). What do they mean? *Punch one or more of the following:*

- (●) If pedestrians are crossing, you must wait
- (●) If pedestrians are crossing, they must wait
- (●) If your traffic light is green, you must still stop, look, and then continue
- (●) Do not cross the lines while waiting at a red light
- (●) Not sure

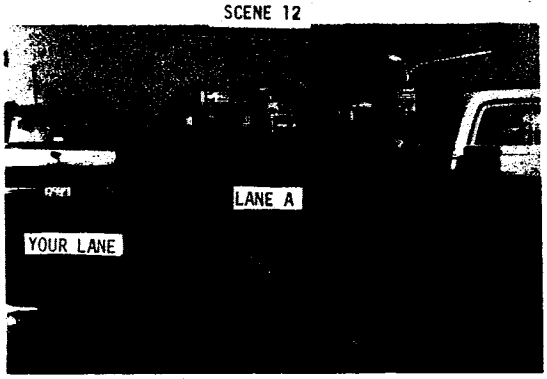
SCENE 11



After attending to some business on Puckett Road, you decide to take Guseman Freeway northbound. The best entrance is Edwards Place, so you get into the left lane at Puckett and Edwards (Scene 11). What do the traffic lights tell you? *Punch one or more of the following:*

- (●) Wait until the red light turns green
- (●) You can turn left on green arrow even with the red light on
- (●) You can turn left on green arrow, but must yield to cross-traffic from the right
- (●) You can turn left on green arrow, but must yield to oncoming traffic
- (●) Not sure

SCENE 12



You enter the left turn lane and notice a solid white line on your right (Scene 12). What does the white line tell you? *Punch one or more of the following:*

- (●) The line is a divider line marking lanes. Drivers may cross it if they want.
- (●) If you are in Lane A you cannot cross the line into the left turn lane
- (●) If you are in the left turn lane you cannot cross the line into Lane A.
- (●) Not sure

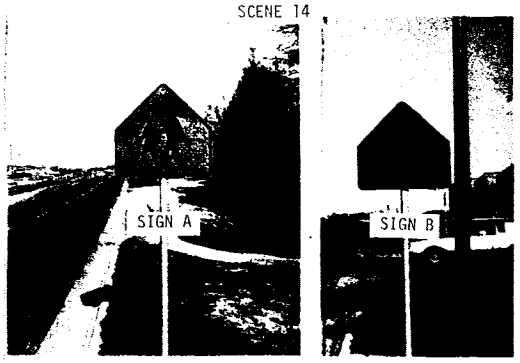
TURN TO NEXT PAGE

SCENE 13

At an intersection you see a pedestrian traffic light (Scene 13). A pedestrian has started crossing the street when the lights start flashing "Don't Walk." What should he do? *Punch one or more of the following:*

(●) Continue crossing quickly; the light will not likely turn red until he reaches the curb
(●) Go back to the curb and wait for a green light
(●) Wait in the center median area for a "Walk" light
(●) Stop wlaking
(●) Not sure

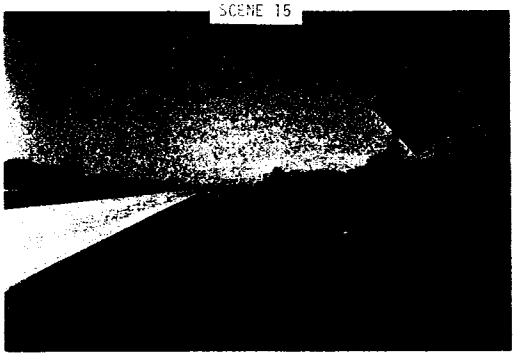
SCENE 14



You are driving down Edwards Place and you see two more signs (Scene 14). First you see Sign A; then you see Sign B. What do the signs mean? *Punch one or more of the following:*

(●) Both signs mean an advance warning of school children crossing some distance ahead
(●) Sign A is an advance warning of children crossing. Sign B is just before the crossing itself.
(●) I agree with above statement, but the pedestrians are adults instead of children
(●) The signs mean a school is ahead near the street (need not be a crossing)
(●) Not sure

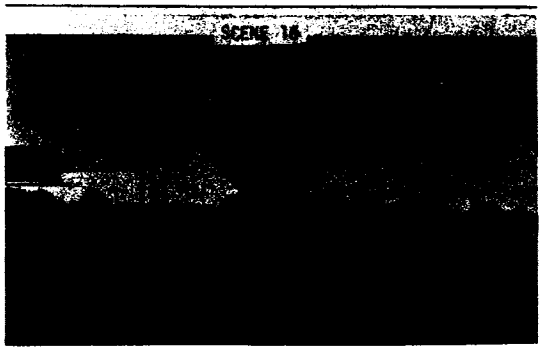
SCENE 15



You are now headed north on Guseman Freeway. You see a sign on the right shoulder (Scene 15). What does it mean? *Punch one or more of the following:*

(●) Pavement width narrows ahead
(●) A major roadway to the right is merging with the highway
(●) A smaller roadway to the right is merging with the highway
(●) Right lane yields to merging traffic
(●) Not sure

TURN TO NEXT PAGE



After driving a while on Guseman Freeway you see the sign shown in (Scene 16). What does the sign mean? *Punch one or more of the following:*

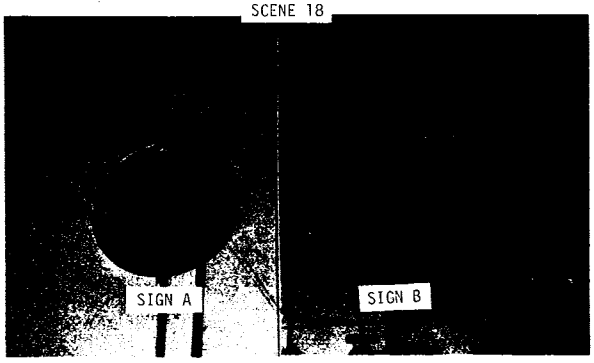
(●) Highway ends ahead. Be prepared to exit
(●) Dead end ahead. Make a "U" turn
(●) Highway changes from a hard surface to gravel or earth
(●) Roadway closed. Traffic must detour to the shoulder or off the highway to another road
(●) Not sure

SCENE 17

The road ahead is barricaded as shown in (Scene 17). On which side of the barricade should you drive (if you did not see a sign to guide you)? *Punch your answer:*

(●) Left
(●) Right
(●) Either
(●) Not sure

SCENE 18

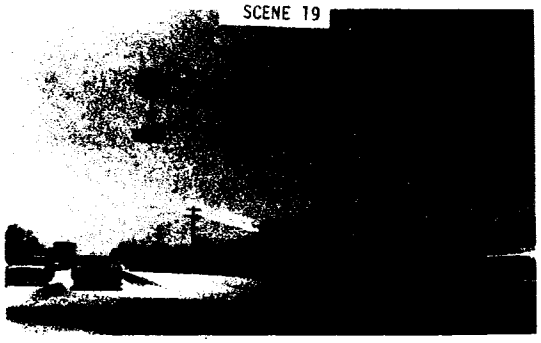


You have detoured off Guseman Freeway and you are now traveling east on Harrison Avenue. You see two signs (Scene 18). Do the signs mean exactly the same thing or is there a difference? *Punch one or more of the following:*

(●) Sign A will come before Sign B. Sign A is an advance warning sign
(●) Sign B will come before Sign A. Sign B is an advance warning sign
(●) Either Sign A or Sign B may come first
(●) Sign B is used only at the railroad track
(●) Not sure

TURN TO NEXT PAGE

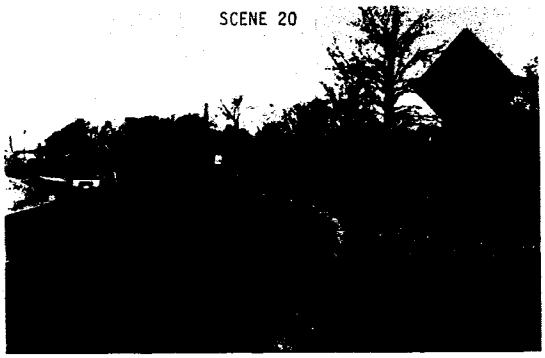
SCENE 19



You continue on Harrison to Route 43, which is your alternate route north. You are in the left turn lane preparing to turn onto Route 43. The traffic lights are as shown in (Scene 19). What do you think these lights mean? *Punch one or more of the following:*

- (●) Turn left quickly. You still have the right of way
- (●) Wait. The turn light will be red before you could turn
- (●) Wait. The turn light will change to green next and you will be able to turn left
- (●) Not sure

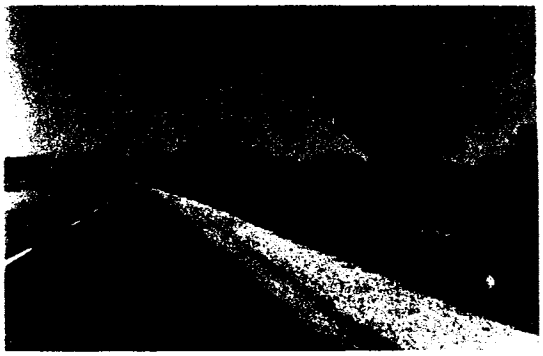
SCENE 20



As you drive north on Route 43 out of the city limits, you see a sign (Scene 20). What do you think it means? *Punch one or more of the following:*

- (●) Beware of drunk drivers. Taverns in area
- (●) The roadway winds or curves several times
- (●) The roadway may be slippery when wet
- (●) Icy bridge ahead
- (●) Not sure

SCENE 21



Another sign on Route 43 is as shown in (Scene 21). What does this sign mean? *Punch one or more of the following:*

- (●) Beware of soft spots in the pavement
- (●) Avoid tiring while driving long distances
- (●) Pavement becomes unstable under extreme summer heat
- (●) Beware of the condition of the pavement to the right of the highway
- (●) Not sure

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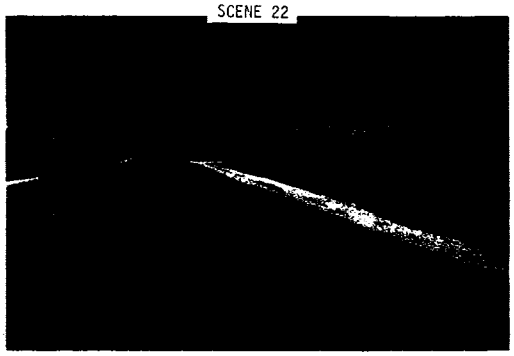
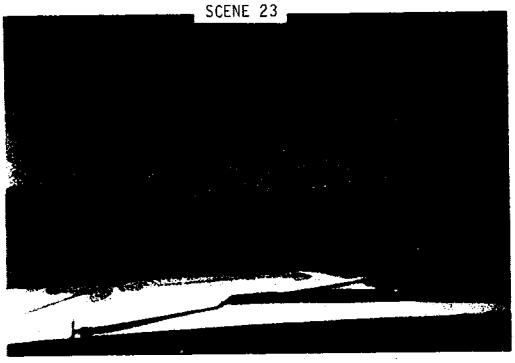
SCENE 22



You are beginning to go up a hill when you see another sign (Scene 22). What does the sign Mean? *Punch one or more of the following:*

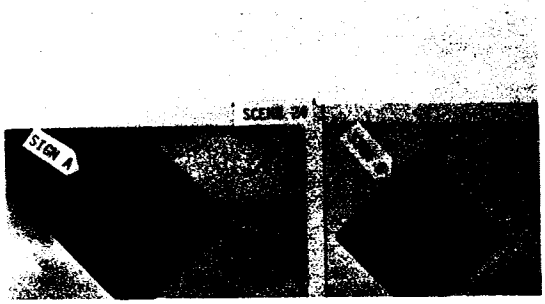
(●) Steep hill ahead. Trucks shift into low gear
(●) Slow traffic should move into an additional lane on the right
(●) Look out for traffic entering from a merging lane ahead
(●) Roadway ahead winds back and forth (switch backs)
(●) Not sure

SCENE 23



As you pass over the top of the hill and start down, the no-passing stripe ends; but you see another sign (Scene 23). What does it mean? *Punch one or more of the following:*

(●) Roadway narrows ahead. Right lane traffic must yield to left lane traffic
(●) Look out for traffic merging into your lane from a climbing lane
(●) If you should try to pass and cross over into the middle lane with an oncoming vehicle in it, you do not have the right of way
(●) Not sure



You see some more signs as you drive on Route 43. For each of the following pairs of signs, you decide if there is a difference in meaning between A and Sign B

Here is the first pair of signs. (Scene 24). Do the signs mean the same thing to you?

(●) Yes
(●) No
(●) Not sure

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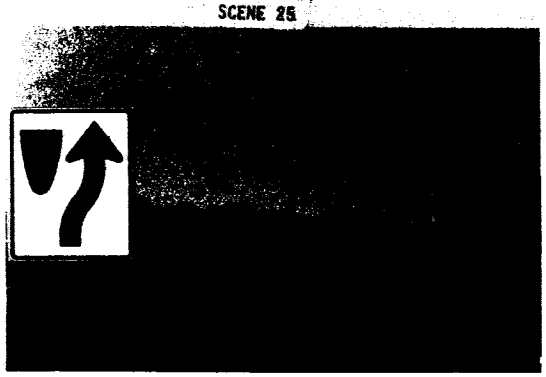
SCENE 25



Here is the second pair of signs (Scene 25).
Do they mean the same thing?

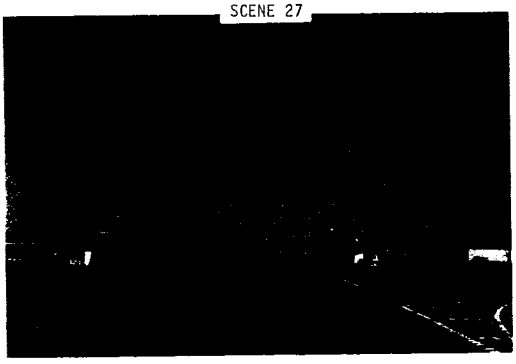
(●) Yes
(●) No
(●) Not sure

SCENE 26

Here is the third pair of signs (Scene 26).
Do they mean the same thing?

(●) Yes
(●) No
(●) Not sure

SCENE 27



You reach an intersection (Scene 27) which has a flashing amber beacon on it. What is the correct meaning? *Punch one or more of the following:*

(●) The road which crosses your highway also has an amber flashing beacon. Both of you have the right of way, but be alert
(●) The other road has a red flashing beacon. You have the right of way
(●) The other road could have either a red or amber flashing beacon
(●) Not sure

TURN TO NEXT PAGE

Hello. Hope you enjoyed your "Trip" through Anytown, Texas and found a few signs that were a surprise to you. Now we need a few facts about you.

203

Please do not write your name! Your name is your business and none of ours.

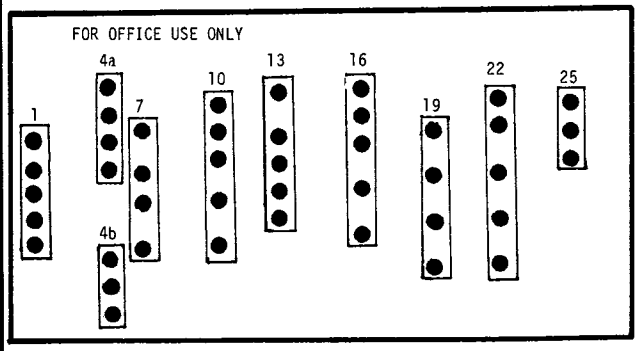
1. What is your sex? ---------- [ ] Male, [ ] Female

2. How old are you? ---------- [ ] 15-24, [ ] 25-34, [ ] 35-44, [ ] 45-54, [ ] 55-64, [ ] 65 Plus

3. How many years have you lived in Texas? --------- _____ years

4. In what city and county are you a resident? ----- _____ (city), _____ (county)

5. What is your current occupation in as specific terms as possible? ---------- _____
(also please state if retired, unemployed, student, or housewife) _____
_____



6. What is the last year of school you completed? ------ [ ] 9th grade or less, [ ] 10th grade or less, [ ] High School Graduate, [ ] Technical/Business School, [ ] Some College, [ ] College Graduate, [ ] Some Graduate School, [ ] Graduate Degree

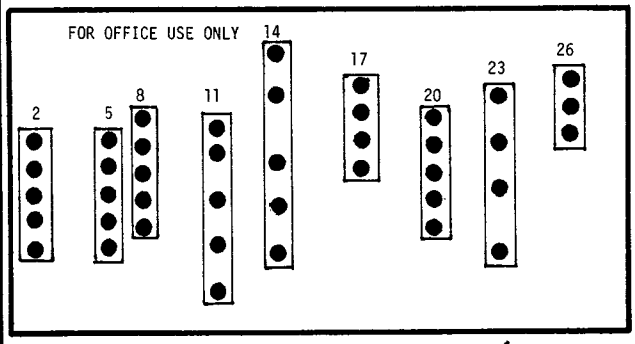
7. Is English the only language spoken in your home? --- [ ] Yes, [ ] No (If "yes", skip to question 10.)

8. If "no", what other language do you speak in your home? ---- [ ] Spanish, [ ] German, [ ] French, [ ] Other _____ (What?)

9. How often is this other language used by you and your household members? --- [ ] Only occasionally, [ ] Most of the time, [ ] Part of the time, [ ] All the time

10. Is there anything about you that makes it difficult to drive a car? -------- [ ] Yes, [ ] No
(If your answer to 10 was "no", skip to question 12.)

11. Which of the following gives you the most difficulty? -------- [ ] Old age, [ ] Paralysis, [ ] Arthritis/joint disease, [ ] Loss of limb(s), [ ] Heart condition, [ ] Vision problems, [ ] Hearing loss, [ ] Mental or nervous condition, [ ] Breathing problems, [ ] Other _____
(Can you tell us what it is?)

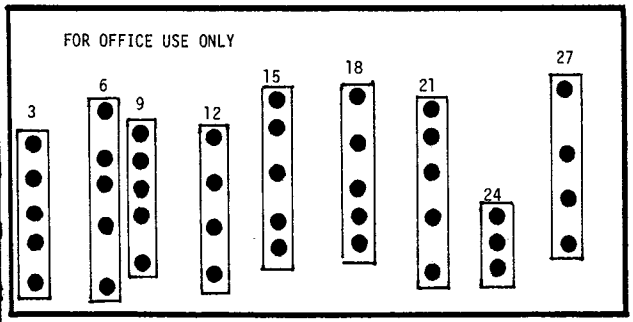


12. What kind of vehicle do you drive most of the time? --------- [ ] Passenger car, [ ] Pickup, [ ] Truck, [ ] Motorcycle, [ ] Bus, Van, or Camper, [ ] Other

13. How often do you have a vehicle available? ---------- [ ] Always, [ ] Most of the time, [ ] Part of the time, [ ] Occasionally, [ ] Almost never

14. How many miles do you drive a year? (best guess) ---------- [ ] 0-4,999 miles, [ ] 5,000-9,999 miles, [ ] 10,000-14,999 miles, [ ] 15,000 miles or more

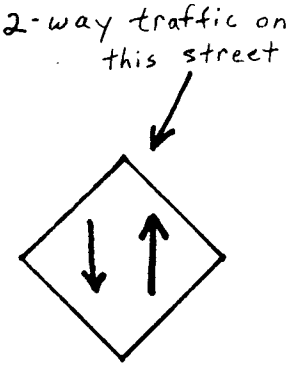
15. How many years have you been driving? ---------- _____ years



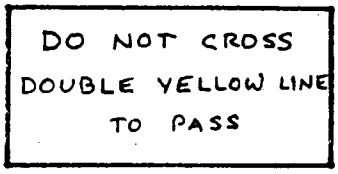
2. Answers Provided Respondents

①

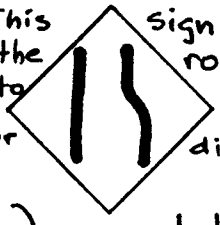
A sign like this will be at least 500 ft from the exit

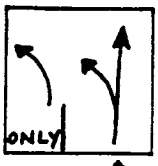


THIS means "no passing" for traffic in either direction BUT you <u>can</u> cross over to turn into a drive or shopping area.



This sign warns you that the road ahead is going to drop a lane in your direction of travel

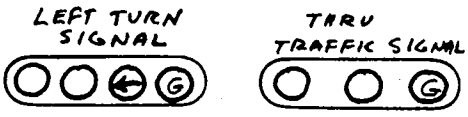




If you are in this lane you <u>must</u> turn left.

If you are in this lane, you may go straight <u>or</u> turn left. BE SURE TO STAY IN YOUR LANE!

This means that there is a median or a traffic island or some obstacle ahead and you will need to keep right.

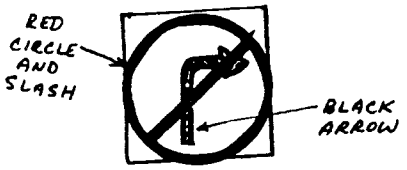


GREEN ARROW GREEN LIGHTS

This tells you opposing traffic has a red light and you have right of way for a left turn. This is the "protected" left turn.

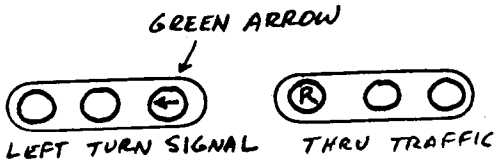
(2)

If you see this at an intersection it tells you traffic will cross from left to right only and you may not turn left. (If you do it will spoil your whole day!)

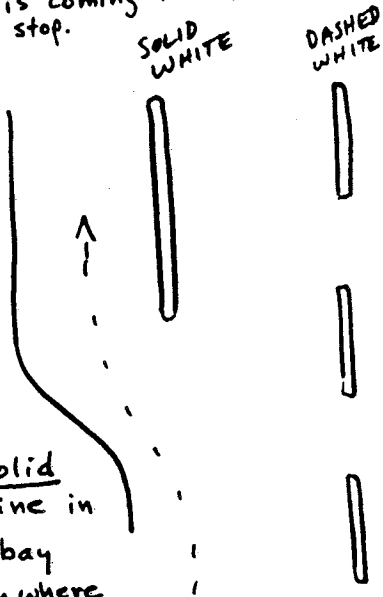


Don't turn right!

Use these as stop lines if a sign or signal makes you stop. If there are pedestrians in your lane you must stop. If they are in the other lane they must stop. Otherwise drive through intersection carefully.

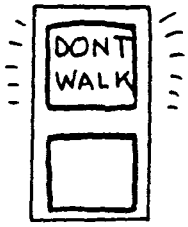


THIS is another case of the "protected left turn": Through traffic in your direction is stopped, but you can turn left. the amber arrow says your protected turn is coming to an end. Better stop.



The solid white line in a turn bay (or anywhere else) is like a fence. You should not cross it.

(3)



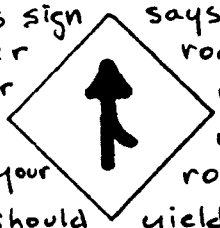
A flashing DONT WALK means that if you have already started across the street, you have time to make it across. BUT DONT WASTE TIME!

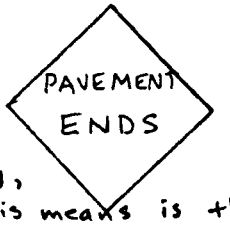
this sign warns you that school kids are going to cross ahead of you (150 or more feet)

This sign shows a walkway. THIS is where the kids will cross (but watch out all around the school area)

The PEDESTRIAN CROSSING SIGN looks like the school sign but it's a 

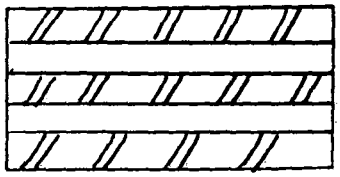
This sign says a smaller roadway to your right will merge with your roadway They should yield to you, but don't bet on it.





Strictly speaking, all this means is that your roadway surface is going to change from hard pavement to something softer— like gravel or dirt. But there's probably a detour in your future!

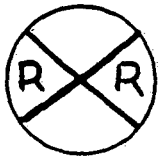
DRIVE ON THIS SIDE



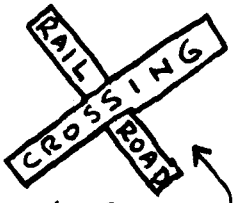
STAY OUT OF HERE

The barricade stripes point down in the direction you are to go. Look for directional arrows and cones to make sure which way to go.

ADVANCE SIGN

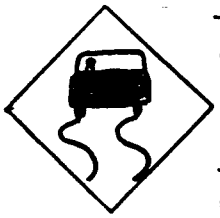


CROSS BUCK



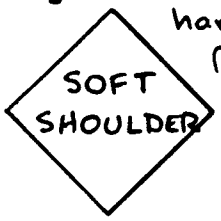
This tells you to get ready for this The crossbuck is at the crossing

(4)



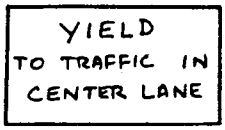
When you see this sign it tells you the pavement will be slippery if it is raining or the surface is wet. Watch yourself.

this sign lets you know that you can't use the side of the road as a traffic lane even if it were legal - it's not hard pavement (there's probably a drop-off too)

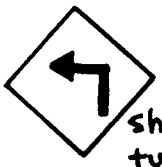


An extra lane will be added at your right for slower traffic to use to climb up the hill thats coming up. GOOD NEWS if <u>you're</u> slower traffic.

You will see this on the down lane of a hill with a climbing lane. It tells you that traffic coming up the hill is NOT passing slow traffic but will stay in the center lane. If <u>you</u> pass someone don't plan on center lane traffic to get over. they are in their legal lane of travel. You are not.



Curve ahead

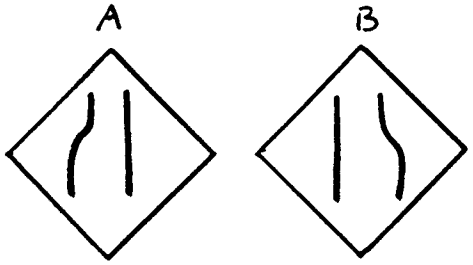


Sharp 90° turn ahead

this you know already (p. 1)

This means that you are about to go onto a divided highway

(5)

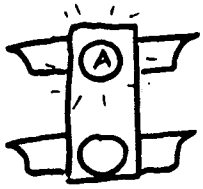


These 2 signs look like mirror twins but the sign on the left (A) says that the roadway is going to drop a left lane

(B) says that the roadway is going to drop a right lane.

Prepare to get over (merge) if you are in the lane that is going to drop out.

This is a flashing amber traffic signal



Cross traffic will <u>always</u> have a <u>red</u> flashing signal. You have the right of way but move through the intersection cautiously.

Flashing beacons may be 4-way red or as above.

Please consult your <u>Texas Driving Handbook</u> or the <u>Manual on Uniform Traffic Control Devices</u> for the legal interpretation of these signs and signals.

3. Statistical Analysis

Appendix 3

Statistical Analysis

1. Responses to Questionnaire Items

Confidence Interval:

For a percentage of 50 percent for a response for any item on the questionnaire, the confidence interval associated with a sample size of 422 that repeated samples of that size of the Texas population would yield within ± 5 percent of 50 is given by

$$(1)\quad \sqrt{N} = \frac{Z\,s}{e}$$

Where N = sample size

Z = confidence limit in standard score form

S = estimator of standard deviation, for proportions equal to P (outcome of interest)

e = allowable error.

Rearranging terms:

$$(2)\quad Z = \frac{\sqrt{N}\ e}{S}$$

and in the present case,

$$Z = \frac{\sqrt{422}\ \ 0.05}{0.5} = 2.054.$$

Reference to a tabled normal distribution yields a confidence interval of 0.9798 that a second sample of 422 Texans would divide on the particular item between 45 and 55 per cent.

Inspection of equation (2) will reveal that items that are responded to in percentages less than 50 per cent will yield even greater confidence intervals. If greater precision is required (e.g., 1 per cent) with the same level of confidence, the sample size would have to be (from equation 1).

$$(3) \quad N = \frac{Z^2 S^2}{e^2}$$

$$= \frac{2.054 \times 0.5^2}{0.01}$$

$$= 10{,}547$$

Reduction of Data

The response distributions for each item were found to be of various shapes, thus purely enumerative statistics are reported herein:

(a) percent correct responses for each item:

$$\%R = \frac{\text{No. responses to correct answer}}{\text{No. responses to all answers}} \times 100$$

(b) Mean number selecting each correct answer

$$\bar{x} = \frac{\Sigma (1's)}{N}$$

Where N = number of 1's and 0's since each respondent's answer's to an item were so coded from his sheet

Multiplying the $\bar{x}$ by 100 gives an estimate of the percentage of the population sampled by this study which would answer the item correctly.