

1. Report No. FHWA/TX-01/1794-3		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle UPDATING EDUCATIONAL MATERIALS ON TRAFFIC CONTROL DEVICES				15. Report Date September 2000	
				6. Performing Organization Code	
7. Author(s) Angelia H. Parham, Garry L. Ford, and S. Renee Hulett				8. Performing Organization Report No. Report 1794-3	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135				10. Work Unit No. (TR AIS)	
				11. Contract or Grant No. Project No. 0-1794	
12. Sponsoring Agency Name and Address Texas Department of Transportation Construction Division Research and Technology Transfer Section P. O. Box 5080 Austin, Texas 78763-5080				13. Type of Report and Period Covered Research: September 1998-August 1999	
				14. Sponsoring Agency Code	
15. Supplementary Notes Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration. Research Project Title: Driver Education Program for Traffic Control Devices					
16. Abstract This report documents the third-year activities of a three-year research project. Project 0-1794 was initiated to build upon the recommendations of TxDOT Project 0-1261 by identifying teenage driver and adult safety instructor needs and developing targeted educational products and programs. The first and second years of the project focused on identifying problems associated with teenage driver comprehension of traffic control devices, identifying critical behavior issues for teenage drivers and for older drivers, and serving as part of the technical working group focusing on improving the driver education curriculum in the state of Texas. During the project's third year, researchers conducted additional survey assessments of older drivers to evaluate traffic control devices that are problematic for older drivers. Surveys of TxDOT traffic safety specialists in all 25 TxDOT districts were also conducted to determine the type of activities conducted by the traffic safety specialists and the types of educational materials that would be most beneficial to them. These survey results, along with survey results from the first and second year of the project, were used to suggest changes for the updated Texas driver education curriculum and to make suggested changes to the new edition of the <i>Texas Drivers Handbook</i> . This information was also used to develop new educational materials focusing on traffic control devices. These materials include: 1) an Internet web site focusing on traffic control devices, which will function as a part of TxDOT's web site, and 2) a spiral-bound notebook that will be distributed to teenage drivers, which includes graphics and information on problematic traffic control devices.					
17. Key Words Traffic Control Devices, Driver Education, Teenage Driver, Older Driver, Driver Comprehension, <i>Texas Drivers Handbook</i> , MUTCD, Driver Behavior Characteristics			18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161		
19. Security Classif.(of this report) Unclassified		20. Security Classif.(of this page) Unclassified		21. No. of Pages 70	22. Price

UPDATING EDUCATIONAL MATERIALS ON TRAFFIC CONTROL DEVICES

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Report 1794-3
Project Number 0-1794
Research Project Title: Driver Education Program for Traffic Control Devices

Sponsored by the
Texas Department of Transportation
In Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

September 2000

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ACKNOWLEDGMENTS

The research reported herein was performed by the Texas Transportation Institute as part of a project entitled Driver Education Program for Traffic Control Devices sponsored by the Texas Department of Transportation (TxDOT) in cooperation with the U.S. Department of Transportation, Federal Highway Administration (FHWA). The authors thank Mr. Rick Collins, P.E., Mr. Greg Brinkmeyer, P.E., and Ms. Karen Gibson of the Texas Department of Transportation Traffic Operations Division for their suggestions and insight into the research activities.

The authors wish to thank Nada Trout for her assistance in developing and administering older driver surveys and to acknowledge the drivers who participated in the survey evaluations.

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CHAPTER 1

INTRODUCTION

BACKGROUND

This report summarizes the third-year activities of TxDOT Project 0-1794. Project 0-1794 was initiated to build upon the recommendations of Project 0-1261 by identifying teenage driver and safety instructor needs to develop targeted educational products and programs (1,2). The original objectives of the project were to:

- identify which traffic control devices have the potential of being misunderstood,
- identify the driver audience(s) that should be emphasized in the educational effort,
- identify target media efforts to educate drivers on traffic control devices, and
- develop and implement these projects.

A secondary focus was added to the project to identify driver behavior issues that are considered critical to reducing traffic crashes and improving traffic safety and to emphasize these issues in educational materials. The project met these goals and objectives through a series of tasks over a 36-month period.

During Phase I of this project, the researchers identified perceptions and problems associated with traffic control devices through surveys of teenage drivers, driver education instructors, and law enforcement personnel. The researchers used the results of these evaluations to develop recommendations for improving teenage driver understanding of traffic control devices. This information is documented in *Report 1794-1: Recommendations to Improve Driver Education on Traffic Control Devices (1)*.

During Phase II of the study, the researchers identified critical driver behavior issues for teenage drivers and older drivers, as presented in *Report 1794-2: Driver Behavior Characteristics of Teenage Drivers and Older Drivers (2)*. The recommendations from Phases I and II were used to suggest additions and changes to the Texas Education Association (TEA) curriculum for teenage drivers. Researchers also made recommendations for changes and additions to the *Texas Drivers Handbook (3)* chapter on signals, signs, and markings; the recommendations were provided to TxDOT in the form of a technical memorandum.

During Phase III, researchers conducted a one-on-one survey with older drivers to further identify older driver behavior issues and perceptions of traffic control devices. Telephone interviews were also conducted with the traffic safety specialists in all 25 TxDOT districts: Researchers used the interviews to find out the types of materials and information that would be most helpful to them.

The findings from Phases I, II, and III were combined to develop educational products as directed by TxDOT. These products included Internet web pages to be accessed through TxDOT's web site and a spiral-bound notebook to be distributed to teenage drivers. These products are discussed in more detail in the following chapters.

CHAPTER 2

OLDER DRIVER SURVEYS

The purpose of the older driver surveys was to assess older driver understanding of traffic control devices and to identify the devices that are misunderstood by drivers 65 years and older. Although numerous general comprehension studies have found devices to be commonly misunderstood, only a small number of older drivers participated in these studies. For this reason, devices needed to be further tested with older drivers. To accomplish these objectives, a total of 200 subjects were surveyed in four Texas cities. This chapter includes survey development, administration, and results.

SURVEY SAMPLE

Researchers used demographic sample of the Texas driving population for participant selection. Demographics included age, gender, and education level. According to statistics obtained from the Texas Department of Public Safety, females comprise approximately 52 percent of the 65 and older population, and males comprise the other 48 percent (4). This equates to 26 females and 24 males for a total of 50 subjects at each study location. The 1990 United States Census indicates the distribution of the Texas driving population education as follows (5):

- 28 percent have no high school diploma,
- 26 percent have a high school diploma,
- 23 percent have some college, and
- 23 percent have a college degree.

Categories for different age levels were not established because of the difficulty and time constraints of matching such small portions of the older population to specific age criteria; the only age requirement was that drivers were 65 or older. Table 1 lists the demographic sample obtained at each study location based on cross-referencing the gender and education level of the Texas population. Some adjustments were made for round-off when applying the education level distribution statistics.

Table 1. Participant Demographics by Study Location.

Education Level	Females	Males	Total
No high school diploma	7	7	14
High school diploma	7	7	14
Some college	6	5	11
College degree	6	5	11
Total	26	24	50

SURVEY INSTRUMENT

Researchers developed the survey instrument after choosing traffic control devices for inclusion in the survey. A preliminary survey instrument was developed and pilot tested in Bryan, Texas; this section includes a description of the survey development and pilot study.

Selection of Traffic Control Devices

Selection criteria were developed to find the most appropriate devices to include in the survey. Selection of devices for survey inclusion was based on:

- findings of low comprehension levels in past studies,
- possible consequences associated with misunderstanding the device,
- inclusion in the *Texas Drivers Handbook* (3) and older driver education courses, and
- frequency of use on Texas roadways.

Low comprehension levels in past studies and possible consequences of misunderstanding a device were weighted heavier in the selection process than the other two factors. The studies used to determine the traffic control devices with the lowest comprehension levels include general traffic control device comprehension studies and other prominent studies focusing on more specific areas. The studies used in the selection criteria include the following:

- 1987 Federal Highway Administration Nationwide Study (6,7,8);
- 1978 - 1995 Texas Transportation Institute Studies in Texas (9, 10, 11, 12, 13,14);
- 1999 Driver Education Study in Texas (1);
- 1998 Teenage Driver Study in Texas (15);
- Federal Highway Administration Older Driver Study in New England (16);

- 1997 Left-Turn Signal Study in Michigan, Pennsylvania, Texas, and Washington (17);
- 1996 Warning Sign Study in Kansas (18);
- 1991 Work Zone Studies in Texas (19, 20); and
- 1988 Railroad-Grade Crossing Study in Tennessee (21).

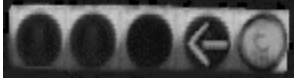
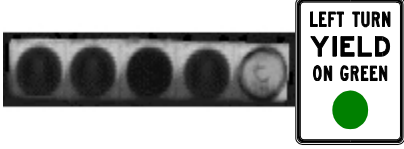




The traffic control devices were then ranked by the possible consequences of misunderstanding a device, including: pedestrian collision, head-on collision, head-on/side collision, side collision, object collision, and loss of vehicle control. Researchers considered pedestrian collisions, head-on collisions, head-on/side collisions, and loss of vehicle control the most life-threatening, and they were included in the survey. Consequences involving side collisions and object collisions were not selected because of the less serious consequences of misunderstanding the device.

Discussion of Selected Traffic Control Devices

A total of 11 traffic control devices were chosen for the pilot test. These devices consisted of six traffic signal indications, three warning signs, one school sign, and one pavement marking.





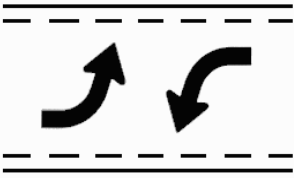
Table 2 lists the traffic control signals included in the pilot and final surveys. Horizontal displays were used for all traffic signal indications because that is the primary signal head configuration used in Texas (22). Although numerous left-turn display combinations exist, some of the most commonly used displays were chosen for the survey to assess older drivers' basic knowledge of left-turn displays. Two of the signal indications also included an associated regulatory sign because these often accompany traffic signals and are commonly misunderstood. Researchers included both flashing red and flashing yellow intersection beacons due to the seriousness of misunderstanding these indications.

Table 2. Traffic Control Signals Included in the Pilot and Final Surveys.

Device	Traffic Control Signal Indication	Pilot Survey	Final Survey
	Circular Green and Green Arrow	✓	✓
	Circular Green with LEFT TURN YIELD ON GREEN Light (R10-12)	✓	
	Circular Red and Green Arrow	✓	✓
	Circular Red and Green Arrow with PROTECTED LEFT ON GREEN ARROW (R10-9)	✓	✓
	Flashing Red Intersection Beacon	✓	✓
	Flashing Yellow Intersection Beacon	✓	✓

The signs and markings assessed in the pilot and final surveys are listed in [Table 3](#). Three warning signs met the selection criteria and were chosen for inclusion in the survey: the Turn (W1-1R), Divided Highway Ends (W6-2), and Slow Down on Wet Road (W8-5) signs. Warning signs serve to warn traffic of existing or potentially hazardous conditions on or adjacent to a highway or street ([23](#)).

Table 3. Signs and Markings Included in the Pilot and Final Survey.

Device	Sign Name or Marking Type	TMUTCD Sign Designation	Pilot Survey	Final Survey
	Turn	W1-1R	✓	
	Divided Highway Ends	W6-2	✓	✓
	Slow Down on Wet Road	W8-5	✓	✓
	School Advance	S1-1	✓	✓
	Two-Way Left Turn Lane Pavement Markings	-	✓	✓

School signs play an important role in ensuring the safety of small children, who are not as versed in traffic operations as adult drivers. The School Advance sign (S1-1) was included because of its low comprehension levels in past studies and the threat to child safety if misunderstood.

Pavement markings constantly convey warnings or other information to the driver (23). Misunderstanding two-way left-turn markings poses a threat to drivers who are unaware of possible oncoming left-turning vehicles, especially on high-speed roadways. These markings were also included in the survey.

Survey Instrument Development

The survey instrument is an important tool for gathering information to describe, compare, or explain knowledge, attitudes, or behavior (24). Researchers considered the following criteria when developing the survey instrument (1, 22):

- ease of developing, reproducing, and administering the survey instrument;
- cost of reproducing and administering the survey instrument;
- reliability and validity of the survey instrument;
- time required for participants to complete the survey; and
- ease of data reduction.

Open-ended questions were chosen for the survey because of their advantages over multiple-choice questions. Past studies have shown that the correct response rates for multiple-choice questions are usually significantly higher than open-ended questions because some participants may guess or deduce the correct responses from the possible multiple-choice answers (18). For this reason, the survey instrument for this study consisted exclusively of open-ended comprehension questions. This choice allowed for various responses and helped to pinpoint why a device with a low comprehension level is misunderstood.

One-on-one interviews were chosen for the survey type. This style of survey allows the following controls during the course of the interview:

- interviewer may play a key role in enhancing subject participation;
- interviewer may answer questions that a subject may need answered;
- interviewer may provide clarifications when the subject does not understand the question; and
- interviewer may probe, which is a technique to obtain more information when a response is unclear or incomplete.

Additionally, observations of human nature indicate that older participants are more likely to participate if they just have to talk and are not required to write.

Preliminary Survey Instrument

Researchers developed 11 multi-part comprehension questions and large flash cards with a color graphical representation for each device.

Questions were written in conventional language that followed a conversational tone to make the interview understandable and comfortable for the participant (25). Each graphical representation of a device was accompanied by questions that addressed the subject's interpretation of the device, other questions about the device in particular, and why the subjects provided their answers. For example, the following questions were asked about the Slow Down on Wet Road sign:

- When you see this sign on the road, what does it mean to you?
- What driving actions would you take, if any?
- Why do you think this?

In addition to the comprehension questions, surveys asked several demographic questions for analysis purposes. Demographic questions included age, education level, total number of years the participant has been driving, miles driven per year, and participation in any driver education courses in the past few years. Researchers also recorded both the gender and ethnicity of the participants. Researchers designed the survey instrument to take no more than 20 minutes in order to encourage participation and to cut down on data collection time. Questions were also ordered to reduce bias effects. The research team conducted a pilot test to assess the survey instrument after developing the preliminary survey instrument.

Pilot Study

A pilot study was conducted with seven participants at a senior activity center in Bryan, Texas. The purposes of the pilot study were to (26):

- assess the administration procedures,
- determine the length of time needed to interview each participant,
- assess the format of the survey based on how it flowed and upon participant reaction, and
- identify any deficiencies in the questions.

The pilot survey proved very helpful in identifying modifications that needed to be made to the survey instrument.

From an administrative viewpoint, the one-on-one survey accompanied by flash cards worked well. Most of the surveys took about 15 minutes to complete; researchers found that this was too long for the participants because many of them seemed to get restless toward the end.

Several changes were made to the traffic control signal questions, but no changes were made to the questions for either of the flashing intersection beacons. Many of the participants noted the abundance of traffic signal questions in the survey and thought they were shown the same signal indication again and again. For this reason and others, changes were made to the traffic signal questions so that participants would not feel like they were answering the same question repeatedly. For time considerations, the circular green indication with the LEFT TURN YIELD ON GREEN LIGHT sign was dropped from the survey. All of the participants understood that they must yield the right-of-way because they did not have a protected left turn. The results for the circular red and green arrow indication, with and without the PROTECTED LEFT ON GREEN ARROW sign, yielded similar results. To reduce redundancy, researchers decided that half of the participants in the final survey would answer questions about the signal indication with no sign, and the other half would answer questions with the sign. This division provided an opportunity to statistically compare the results of the two graphical representations.

Only one sign was dropped from the final survey, and the two-way left-turn lane marking questions remained. Minor modifications were made to these questions: some questions were modified to reduce confusion; some probe questions were omitted to reduce redundancy, and some questions remained the same. The main objective of the Turn sign was to determine if drivers realize they must slow down to 30 miles per hour or less on sharp turns in the roadway. All of the participants indicated they would go slow at speeds of about 20 to 25 miles per hour or they would go the speed posted on a supplemental advisory plate. There seemed to be no confusion about this sign, so it was dropped from the survey for time considerations.

[Appendix A](#) contains the final survey instrument format and [Appendix B](#) shows the flashcards used in the survey to illustrate all of the traffic control devices.

SURVEY ADMINISTRATION

Researchers developed a survey administration plan to determine the geographic areas of interest, the target sample size, and the target survey groups based on representation of the driving public in Texas. To reduce the effects of standard error, a total of 200 subjects over the age of 65 were surveyed, including 50 subjects from each of four Texas cities: El Paso, Fort Worth, Houston, and San Antonio. These cities are major metropolitan areas that use all of the devices in the survey and are representative of the overall Texas population. El Paso and San Antonio were specifically chosen to ensure the inclusion of the large Hispanic population in Texas.

Researchers made contact with various senior citizen activity centers and veteran/military organizations prior to arriving in each city. Appointments were set up so that surveys could be conducted at times when large numbers of senior citizens participated in meetings, lunches, and various activities such as bridge, bingo, and dances. Two tables were set up away from each other at each activity center so that two people participating in the survey at one time would not be influenced one another. To qualify for participation, potential participants were asked if they were over the age of 65 and if they possessed a valid Texas driver’s license. Visual proof of licensure was not required. All volunteers meeting these qualifications were interviewed, and all participation remained anonymous.

SURVEY RESULTS

Nine traffic control devices were included in the final survey. This section presents a summary of the results from the survey and the characteristics of the 200 older drivers sampled.

Sample Characteristics

The demographic and driving characteristics of each study participant were recorded as a part of the survey, as shown in Tables 4 and 5. The gender and education level of all the participants closely matched the general Texas population characteristics.

Table 4. Demographic Characteristics of Survey Participants.

Demographic Group (50 participants in each city)		El Paso	Fort Worth	Houston	San Antonio	Total	
						Total	%
Gender	Female	26	26	26	26	104	52.0
	Male	24	24	24	24	96	48.0
Education	No high school diploma	14	13	14	14	55	27.5
	High school diploma	14	15	14	14	57	28.5
	Some college	11	11	11	11	44	22.0
	College degree	11	11	11	11	44	22.0
Age	65 to 69	11	13	12	10	46	23.0
	70 to 74	14	9	15	16	54	27.0
	75 to 79	14	16	16	15	61	30.5
	80 to 84	8	7	7	6	28	14.0
	85 and older	3	5	0	3	11	5.5

The driving characteristics of the survey participants are shown in [Table 5](#). The survey participants had been driving for an average of 53 years, and approximately one-third of them currently drive less than 4,999 miles per year. About 14 percent continue to drive over 15,000 miles per year, which is the approximate average for the general driving population of all ages. Additionally, 45 percent of the participants have taken some type of driver education course in the past few years. Many participants indicated that they take the 55 Alive class offered by the American Association of Retired Persons (AARP) every three years to receive insurance reductions. Others take defensive driving courses to avoid traffic violation fines or for insurance reductions. Nineteen percent of the participants who have not taken a driver education course in recent years indicated they would be interested in taking a class. The 30 percent who indicated they would not be interested in taking a driver education course for older drivers cited the following reasons:

- no need for it,
- no need for it because they currently drive very little,
- no time to take a class, and
- they still drive just fine.

Table 5. Driving Characteristics of Survey Participants.

Demographic Group (50 participants in each city)		El Paso	Fort Worth	Houston	San Antonio	Total	
						Total	%
Average Number of Years Driving		53	56	51	54	53	N/A
Miles Driven per Year	Less than 4,999	22	18	9	17	66	33.0
	5,000 to 9,999	10	13	13	15	51	25.5
	10,000 to 14,999	14	13	12	13	52	26.0
	More than 15,000	3	4	15	5	27	13.5
Driver Education Taken within the Past Few Years	AARP (55 Alive)	18	12	9	6	45	22.5
	Defensive Driving	10	3	10	7	30	15.0
	AARP & Defensive Driving	2	3	1	3	9	4.5
	Other	1	1	3	0	5	2.5
No Driver Education Taken Recently	No Desire to Take an Older Driver Course	9	17	12	22	60	30.0
	Desire to Take an Older Driver Course	8	12	7	10	37	18.5
	No Indication Either Way	1	1	6	2	10	5.0

Overall Survey Findings

The 85 percent comprehension criterion was used because it is a typical threshold for comprehension studies and is also commonly used in traffic engineering design (12, 26). All traffic control device aspects with comprehension levels of 85 percent or slightly lower than 85 percent, but not statistically different, were considered to be adequately understood by the older driving population. All comprehension levels falling below this level indicated device aspects that are not well understood by the older driving population.

Table 6 lists the devices understood by 85 percent or more of the study participants and lists the comprehension level for each device. Older drivers seem to have a clear understanding of which direction of traffic is allowed to go for each of the three signal indications presented in the survey. They also understand the basic meaning of what their initial reaction should be at both flashing yellow and red intersection beacons; the crossroad traffic actions are discussed later. Older drivers seem to understand the basic concept of the traffic control signals included in the survey, but a discussion of the device aspects that were misunderstood will show there are other aspects of traffic control signals that are misunderstood. Overall, older drivers did not have a good understanding of the signs in this study. They did possess adequate understanding of some sign aspects such as the driving actions associated with the Slow Down on Wet Road sign and the driving actions and sign location of the School Advance sign. However, there was confusion about the other sign aspects. Finally, older drivers understood all aspects of two-way left turn lane markings.

Table 6. Devices Understood by 85 Percent or More of Study Participants.

Item	Comprehension Percentages				
	El Paso	Fort Worth	Houston	San Antonio	Total
(50 participants in each city)					
<i>Signals</i>					
Green Ball & Green Arrow-Direction of Travel	98	98	100	96	98
Red Ball & Green Arrow-Direction of Travel	76*	84*	88	76*	81*
Red Ball & Green Arrow (With PROTECTED LEFT ON GREEN ARROW Sign)-Direction of Travel	96	88	88	84*	89
Flashing Yellow Control Beacon- Meaning	80*	82*	80*	80*	81*
Flashing Red Control Beacon- Meaning	94	96	96	98	96
Flashing Red Control Beacon- Crossroad Movement	78*	88	78*	82*	82*
<i>Signs</i>					
Slow Down on Wet Road- Driving Actions	91	95	98	96	95
School Advance- Driving Actions	86	96	100	96	96
School Advance- Sign Location	88	72*	70	82	79*
<i>Markings</i>					
Two-Way Left-Turn Lane- Meaning	90	94	100	100	96
Two-Way Left-Turn Lane- Awareness of Oncoming Vehicles	100	96	92	98	96
Two-Way Left-Turn Lane- No Passing	85	92	88	90	89

* Based on a confidence interval test, comprehension level was not statistically different than 85 percent at α equal 0.05.

Table 7 lists the devices understood by less than 85 percent of the study participants. Subjects did not understand who has the right-of-way at left-turn signals for any of the three traffic control signal displays used in the survey. They also did not understand what driving action vehicles on the crossroad should be taking when they approach a flashing yellow intersection beacon. All aspects of the Divided Highway Ends sign were not understood, and the meaning of the Slow Down on Wet Road sign and School Advance sign were not understood. These results are discussed in more detail in the following sections that contain analysis by device type.

Table 7. Devices Understood by Less Than 85 Percent of Study Participants.

Item (50 Participants in each city)	Comprehension Percentages				
	El Paso	Fort Worth	Houston	San Antonio	Total
<i>Signals</i>					
Green Ball & Green Arrow- Right-of-Way	66	82*	80*	80*	77
Red Ball & Green Arrow- Right-of-Way	44	75*	79*	44	60
Red Ball & Green Arrow (With PROTECTED LEFT ON GREEN ARROW Sign)- Right-of-Way	84*	80*	64	76*	76
Flashing Yellow Control Beacon- Crossroad Movement	27	33	32	34	32
<i>Signs</i>					
Divided Highway Ends- Meaning	32	44	46	42	41
Divided Highway Ends- Arrow Meaning	73*	65	68	83*	73
Slow Down on Wet Road- Meaning	50	66	56	62	59
School Advance Meaning	40	18	24	40	31

* Based on a confidence interval test, comprehension level was not statistically different than 85 percent at α equal 0.05.




Traffic Control Signals

The traffic control signals investigated in this study included three types of left-turn displays and the flashing yellow and flashing red intersection beacons. For all of the left-turn display configurations, participants were asked what direction of traffic was allowed to go to see if they understood the basic meaning of the display. They were also asked who would be at fault, and why, if they were to turn left and get into an accident with an oncoming vehicle to establish if they understood the right-of-way assignments. Participants were asked what they would do if they approached either the yellow or red flashing intersection beacons to determine if they understood the meaning of the device. To determine whether they understood how the crossroad traffic operates, they were asked whether or not the crossroad traffic had to stop and why. Overall, older drivers understood the general meaning of all of these devices but failed to correctly identify who has the right-of-way at left-turn displays and how the crossroad traffic behaves at flashing intersection beacons.

Table 8 shows the correct response percentage rates and other common incorrect responses for left-turn traffic signal display questions. A correct response comprehension level of 98 percent for the circular green and green arrow indicates a clear understanding that left-turning vehicles are allowed to go when this indication is displayed. Although comprehension levels for the circular red and green arrow displays with and without the PROTECTED LEFT

ON GREEN ARROW sign were 81 and 89, respectively, older drivers understood that left-turning vehicles are permitted to travel through the intersection when shown these displays. Common misinterpretations of these displays included: the straight movement on the other side may go, I have to stop or wait, nobody is allowed to go, and not sure.

Table 8. Responses to Left-Turn Traffic Signal Display Questions.

Device	Device Aspect	Correct Responses (%)**	Other Common Responses (%)
 Circular Green and Green Arrow	Direction of Travel	98	
	Right-of-Way	77	I have to wait/watch for oncoming traffic (8) They have right-of-way (6)
 Circular Red and Green Arrow	Direction of Travel	81*	Straight movement on other side may go (6) I have to stop/wait (5) Nobody (3) Not sure (3)
	Right-of-Way	60	I have a red light (18) Not sure (6) They have right-of-way (5) I have to wait (4)
 Circular Red and Green Arrow with PROTECTED LEFT ON GREEN ARROW Sign (R10-9)	Direction of Travel	89	Not sure (5) Nobody (3)
	Right-of-Way	76	I have a red light (8) I have to wait (5) Not sure (4) They have right-of-way (3)



* Based on a confidence interval test, comprehension level was not statistically different than 85 percent at α equal 0.05.

The comprehension level for all three displays indicates that older drivers do not adequately understand who has the right-of-way when these indications are shown. The circular green and green arrow display had a correct comprehension level of 77, while the circular red and green arrow displays, with and without the regulatory sign, had correct comprehension levels of 60 and 76, respectively. Common misinterpretations for all three displays included that they have to wait or watch for oncoming traffic before turning left or that the oncoming traffic has the right-of-way. A large number of participants indicated they would be at fault in an accident with an oncoming vehicle because of the circular red light shown in the display. The circular red display shown in conjunction with the green arrow is most likely confusing to older drivers because red lights have always meant to stop. Many participants also mentioned that the display was confusing because of the circular red on the left-hand side of the signal, whereas they felt the green arrow should be placed in that location because they thought it was more logical for indicating a left-turn maneuver.

Further analysis of the circular red and green arrow displays with and without the PROTECTED LEFT ON GREEN ARROW sign were conducted. The analysis indicated that there is no statistically significant difference between the two indications with respect to the basic sign meaning, but that there is a statistically significant difference between older drivers' understanding of right-of-way for these signal indications. Based on the comprehension levels, this implies the display with the sign is better understood by older drivers than when no sign is present (31).

Table 9 lists the correct response percentages and other common incorrect responses for the survey questions pertaining to flashing intersection beacons. The meaning of the flashing yellow intersection beacon was understood by 81 percent of respondents, which was not shown to be significantly different from the 85 percent criterion. The most common incorrect response was that drivers must stop. Although older drivers understood they must slow down and proceed with caution at a flashing yellow intersection beacon, the device as a whole was not adequately understood because of the lack of understanding of the crossroad movement. Drivers clearly understood the meaning of the initial driver response to the flashing red intersection beacon with a comprehension level of 96 percent.

Table 9. Responses to Flashing Intersection Beacon Questions.

Device	Device Aspect	Desired Responses (%)**	Other Common Responses (%)
 Flashing Yellow Intersection Beacon	Meaning	81*	Stop (9) Stop & look both ways (4)
	Crossroad movement	32	Depends on their light (18) Crossroad does not stop because they have a yellow light (11) Not sure (9) Crossroad stops because they have a yellow light (6) Crossroad does not stop because they have right-of-way (6)
 Flashing Red Intersection Beacon	Meaning	96	
	Crossroad movement	82*	Not sure (11) Green light (2)

* Based on a confidence interval test, comprehension level was not statistically different than 85 percent at α equal 0.05.

** Desired response rates were based on how closely the response matched the Texas MUTCD definition.

Older drivers poorly understood how the crossroad traffic behaves at comprehension levels of 32 and 82 percent for the flashing yellow and red beacons, respectively. For both beacons, approximately 18 percent responded that the crossroad movement depended on the light showing, indicating that respondents were not sure which light the crossroad traffic had, or what behavior they should follow. When shown the flashing yellow intersection beacon, responses included: the crossroad did not stop because they also had a yellow light; crossroad traffic stopped because they also had a yellow light; they have the right-of-way; or they were not sure.

Although the 82 percent desired response rate for the crossroad movement for the flashing red intersection beacon met the 85 percent criterion, many partially correct responses were considered to be desired responses. Sometimes flashing red beacons are installed on all intersection approaches, creating an all-way stop. Usually, such applications are accompanied by STOP signs (R1-1) and supplemental 4-WAY (R1-3) or ALL WAY (R1-4) signs. Participants who responded that crossroad drivers stop because they have a red light, everybody stops, 4-way stop, or depends on their light were included because this could be true depending on the intersection in question. Since a flashcard was shown, participants may not have been fully able to put the device into context. However, the lack of understanding of the crossroad movement of the yellow intersection beacon and the 36 percent who assumed there was an all-way stop indicate that confusion exists between when a flashing red beacon is used in conjunction with a yellow or red beacon. This poses a serious danger to drivers when the crossroad traffic has a

yellow intersection beacon and drivers believe they will stop, when in fact they are not required to stop.

Signs



The survey included two warning signs (Divided Highway Ends and Slow Down on Wet Road) and one school sign (School Advance). For all three signs, participants were first asked to give the meaning of the sign in order to determine if older drivers understand the basic sign concept. They were then asked additional questions for each sign. For the Divided Highway Ends sign, subjects were asked what the arrows on the sign mean to possibly establish reasons for sign misunderstanding. Participants were asked what driving actions they would take upon seeing the Slow Down on Wet Road sign to find out if drivers know they should slow down and be prepared to drive in wet weather conditions. They were also asked about the driving actions of the School Advance sign to see if they are aware they should be watching for children. Furthermore, subjects were asked where School Advance signs may be located to find out if drivers associate these signs exclusively with school areas. There were mixed levels of comprehension for these device aspects.

Table 10 contains the correct response percentages and common incorrect answers for the two warning signs. A comprehension level of 41 percent for the meaning of the Divided Highway sign indicates a very poor understanding of the device. Participants frequently responded that the sign meant curve, island, or narrowing road. Further analysis of the arrow meaning showed that only 73 percent of the subjects responded correctly. The increased comprehension level of the arrow meaning compared to the meaning of the sign implies that a fair amount of subjects actually understand the sign although they gave incorrect answers for the sign meaning. However, the comprehension rate is not high enough to indicate adequate comprehension of the sign. Other common responses to the meaning of the sign arrows included curve and other vague notions. The wide variety of incorrect responses did not help to determine why older drivers misunderstand the sign.

Participants correctly responded to the meaning of the Slow Down on Wet Road sign at a comprehension level of 59 percent, showing that it is not clearly understood. The most common incorrect response was that it meant curvy road, and a small percentage of respondents indicated it meant drunk drivers. Although the basic meaning of the sign was not well understood, subjects correctly identified the appropriate driving actions associated with the sign at a 95 percent correct response rate. However, these results are not entirely conclusive because of the difficulty with interpreting answers. Most responded that they should slow down, which is also associated with curvy roads and other incorrect responses. It was difficult to tell if participants knew to be prepared for possible skidding due to water on the road; although 59 percent correctly identified

the sign meaning, only about 12 percent mentioned possible skidding and appropriate braking and steering maneuvers associated with such conditions.


Table 10. Responses to Warning Sign Questions.

Device	Device Aspect	Desired Responses (%)**	Other Common Responses (%)
 Divided Highway Ends (W6-2)	Meaning	41	Curve (15) Not sure (12) Island (8) Narrowing road (4)
	Arrow meaning	73	Curve (4) Slow down (4) Stay in your lane (3)
 Slow Down on Wet Road (W8-5)	Meaning	59	Curvy road (13) Not sure (10) Drunk driver (5)
	Driving actions	95	

** Desired response rates were based on how closely the response matched the Texas MUTCD definition.

Older drivers did not completely understand all aspects of the School Advance sign, as shown in [Table 11](#). Only 31 percent of respondents correctly identified the meaning of the sign, and almost all incorrect responses mentioned that the sign meant crossing and that the crossing was for either school children or pedestrians. A total of 96 percent correctly responded to the driving actions they would take upon seeing the sign. The majority of desired responses included some notion of slowing down but did not mention anything about watching for children. Approximately 79 percent realized these signs are located prior to schools, but many responded that they may also be located in other high pedestrian locations such as hospitals, shopping centers, and churches. The responses to all device aspects indicate a lack of knowledge about constantly watching for children in a school area regardless of whether or not a school crossing is located shortly after the School Advance sign.

Table 11. Responses to School Advance Sign Questions

Device	Device Aspect	Desired Responses (%)**	Other Common Responses (%)
 School Advance (S1-1)	Meaning	31	School crossing (25) Children crossing (15) Pedestrians crossing (14) Crosswalk or crossing (10)
	Driving actions	96	None (2)
	Sign location	79	School crossings (5) Crosswalks (2)

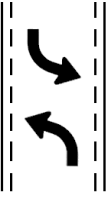
** Desired response rates were based on how closely the response matched the Texas MUTCD definition.

Markings

Researchers asked several questions about two-way left-turn lane markings, including what the lane was used for and if passing was allowed. To determine whether or not drivers are aware that oncoming vehicles may be turning from the opposite direction, subjects were asked who would have the right-of-way if more than one vehicle was present in this lane. [Table 12](#) lists participant responses to these questions.

Older drivers possess an adequate understanding of two-way left-turn markings based on their responses to all aspects. A total of 96 and 89 percent correctly responded to the usage and passing questions, respectively. The actual comprehension level for the awareness of oncoming vehicles in the turn lane could not be ascertained because the responses could not easily be interpreted for awareness. The comprehension level was determined to be 96 percent because only 4 percent of the responses could definitely be considered incorrect: these participants indicated that another vehicle should not be present or that the presence of another vehicle did not matter because they were not in each other's way. The ambiguousness of responses is most likely attributed to the poor wording of the question.

Table 12. Responses to Two-Way Left-Turn Lane Marking Questions.

Device	Device Aspect	Desired Responses (%)**	Other Common Responses (%)
 Two-Way Left-Turn Lane Markings	Usage	96	Not sure (3) Used by emergency vehicles (1)
	Passing	89	Passing is allowed (10) Might be able to pass (1)
	Awareness of oncoming vehicles	96*	Not sure (22) Awareness could not be determined based on answer (9) Does not matter-not in each other's way (2) Should not be another vehicle (2)

* Actual comprehension level could not be determined based on the responses.

** Desired response rates were based on how closely the response matched the Texas MUTCD definition.

DISCUSSION OF RESULTS

The misunderstanding of traffic control signals poses serious danger to older drivers and others on the roadway. A lack of understanding of the right-of-way assignments at left-turn signal displays may cause older drivers to wait unnecessarily for gaps in oncoming traffic, possibly resulting in rear-end collisions caused by other drivers who do not perceive the older driver's hesitation. This misunderstanding could also lead to frustration and road rage of drivers waiting in the left-turn queue behind older drivers. Further, the poor comprehension of crossroad traffic activity at flashing beacon controlled intersections may lead to numerous types of serious collisions, especially at high speed intersections.

The three signs included in the survey were poorly understood. Those who misunderstood the Divided Highway Ends sign face potential danger if they do not realize they should be watching for oncoming vehicles. The low comprehension level of the Slow Down on Wet Road sign may lead to the loss of vehicle control for those who do not anticipate wet road conditions. Additionally, the low understanding level of all aspects of the School Advance sign poses a great risk to older drivers and possible collisions with small children.

Two-way left turn lanes were the best understood device on the survey, with no confusion about any of the device aspects. Older drivers possess an adequate understanding of these markings.

The demographic characteristics provide some insight into older Texas drivers because the sample was representative of the Texas population. The survey results indicate that older drivers need increased awareness of traffic control devices.

CHAPTER 3

UPDATING THE TEXAS DRIVER EDUCATION CURRICULUM

INTRODUCTION

In October 1998, the Texas Education Agency initiated a project to update the driver education curriculum in Texas. The project was funded by a Federal Highway Safety Grant awarded to TEA by TxDOT. The goal of the project was to develop a user-friendly, comprehensive teaching guide that would enable teachers to provide a program of instruction that will prepare their students to meet the challenges of the current driving environment. Since there were no provisions or funding to adopt new driver education textbooks in 2001, the revised curriculum was intended to be the primary teaching guide for all driver education instructors in Texas. The curriculum revision project was planned for completion by September 1999, and distribution and teacher training were scheduled to begin in September 2000.

ADVISORY COMMITTEE

The Driver Education Curriculum Advisory Committee was established to ensure that information pertaining to the revision of the state driver education curriculum was a collaborative process with regard to the needs of all instructors, public and private schools, service centers, parent taught driver education, and colleges and universities. The committee members included representatives from the following organizations: Operation Lifesaver, Education Service Center, TEA, Texas Health Department, Texas Driver Training and Traffic Safety Education Agency, Texas Alcohol and Beverage Commission, TxDOT, Texas Transportation Institute (TTI), Texas Department of Public Safety, and various driver education and traffic safety schools. TTI's primary role was to address education needs related to traffic engineering, including traffic control devices.

CURRICULUM RECOMMENDATIONS

During Phase I of this study (*1*), researchers developed recommended descriptions of problematic devices for inclusion in the driver education curriculum. These recommendations were implemented in the revised curriculum as Fact Sheets in Module 1—Texas Driver Responsibilities: Knowing Texas Traffic Laws. Fact Sheets are intended to assist the driver education instructor in a particular section of the revised curriculum. TTI also reviewed all the modules in the curriculum related to traffic control devices and traffic engineering issues.

CHAPTER 4

TRAFFIC SAFETY SPECIALIST SURVEYS

Researchers conducted telephone surveys with TxDOT traffic safety specialists in all 25 TxDOT districts to determine the type of activities conducted by the traffic safety specialists and the types of education materials that would be most beneficial to them.

Tables 13 through 18 summarize the survey responses. The responses indicate that Traffic safety specialists are involved in a wide variety of activities and serve a wide variety of audiences. However, results for the six survey questions are briefly summarized as follows:

- most traffic safety specialist activities focus on some aspect of traffic safety;
- most presentations are to schools and civic groups;
- requested materials focus on seat belt use, child safety seat use, bicycle safety, traffic safety, drinking and driving;
- the most desired educational items are promotional items with a message that people can keep;
- target audiences vary widely, including age groups from elementary school students to older drivers; and
- suggestions for materials that would be helpful included seat belt use, driving while intoxicated (DWI), aggressive driving, alcohol use, child safety, red-light running, laws and requirements, and various items related to traffic control devices.

The traffic survey specialist survey responses were considered in the development of educational materials for this project.

Table 13. Summary of Question 1 Responses: Traffic Safety Specialist Survey.

Question	Categories and Number of Responses	Specific Answers and Number of Responses
1. What types of activities are you involved in as a traffic safety specialist?	General Activities 9	Everything 7 Safety coordinator 1 Plans 1
	Traffic Safety & Alcohol Campaigns 10	Teenagers & alcohol, underage drinking 3 Alcohol 2 Safe & Sober 2 DWI 2 MADD (zero tolerance/ MIPs) 1
	Traffic Safety & Occupant Protection Campaigns 14	Seat belt 3 Buckle up 3 Child passenger safety 2 Occupant protection 2 Car seats 2 Car seat checks and inspections 2
	Other Traffic Safety Campaigns 11	Bicycle safety 5 Pedestrian safety 1 Teenage education 1 Driver inattention 1 Aggressive driving 1 Fatigue 1 Speeding 1
	Yearly/Seasonal Safety Campaigns 18	Spring break 6 Project Graduation 5 Project Celebration 3 Lights on for Life 2 Quarterly campaigns 1 Holiday 1
	Fairs & Local Festivals 18	Health fairs 7 3-D month 2 House fairs 1 Safety fairs 1 Jalapeno Festival 1 July 4 th Family Fun Fest 1 Red Ribbon Week 1 Booths at rodeo 1 Auto shows 1 Kids' Day Saturday 1 State Fair 1
	Miscellaneous Activities 5	Law enforcement activities 2 Hospitals 1 Public transportation 1 Roll-over simulations 1
	Media 2	Radio talk shows 1 Newspaper/ magazine interviews 1
	Grants & Contracts 5	Traffic safety 3 Waves (mini-grants) 1 Contract to local office 1

Table 14. Summary of Question 2 Responses: Traffic Safety Specialist Survey.

Question	Categories and Number of Responses	Specific Answers and Number of Responses
2. Are you asked to give presentations?	Yes 2	Did not indicate 17 All the time 2 Seldom 1 Sometimes 1
	No 4	Used to, but doesn't anymore due to lack of materials 1 Has a list of safety advocates to do presentations 1
If so, to what groups and about what subjects?	All Age Groups 1	All age groups 1
	Schools in General 17	Bicycle safety 4 Did not indicate subject 3 Everything 1 Dummy costumes 1 Head Start (monthly) 1 Pedestrian safety 1 General traffic safety 1 Operation Lifesaver 1 Seat belts 1 Driver education 1 DWI 1 Audience: school bus drivers 1
	Elementary Schools 13	Seat belts 4 Bicycle safety 4 Pedestrian Safety 3 School bus safety 1 Did not indicate subject 1
	Middle Schools 3	Drinking and driving (zero tolerance) 1 Underage drinking 1 Seat belts 1
	High Schools 9	Underage drinking, MIPs 2 Drinking & driving 2 Zero tolerance 2 DWI 1 Seat belts 1 Traffic safety 1
	Junior Colleges and Universities 6	Drinking & driving 3 Traffic safety 1 0.08 alcohol level law 1 DWI 1
	Driver Education 4	Did not indicate subject 2 Attitude surveys 1 Buckle Up pledges 1
	Boys and Girls Clubs 2	Did not indicate subject 1 Seat belt safety 1

Table 14. Summary of Question 2 Responses: Traffic Safety Specialist Survey (continued).

Question	Categories and Number of Responses	Specific Answers and Number of Responses
If so, what groups and about what subjects?	Civic Groups or Adult Clubs/Drivers 11	Seat belts 4 Did not indicate subject 3 DWI 2 Car seats 1 Attitude surveys 1
	Hospitals 2	Did not indicate subject 1 Air bags 1
	Businesses 3	Alcohol 1 Seat Belts 1 Operation Lifesaver 1
	Miscellaneous or General Public 7	Police departments 2 General public- roll-over simulations, railroad crossings 1 Safety meetings 1 Churches (day care centers) 1 Parents groups 1 Parks & recreation-seat belt safety 1

Table 15. Summary of Question 3 Responses: Traffic Safety Specialist Survey.

Question	Categories and Number of Responses	Specific Answers and Number of Responses
3. Do you receive requests for materials related to traffic safety? If so, what subject areas are requested most often?	Child Safety 5	Did not indicate 1 General public 1 Schools 1 Parents groups 1 Health fairs 1
	Child Safety Seats 13	Did not indicate 2 Everyone/variety 2 Schools 2 Elementary schools 2 General public 1 Day cares 1 Hospitals 1 Pre-natal classes 1 Law enforcement 1
	Seat Belt Use 23	Schools 6 Elementary schools 4 High schools 2 Universities 2 Everyone/variety 2 General public 1 Day cares 1 Safety coalitions 1 Cities & counties 1 Hospitals 1 Law enforcement 1 Did not indicate 1
	Bicycle Safety 9	Schools 2 Elementary schools 1 Universities 1 Parent groups 1 Individuals 1 Bicycle associations 1 Health fairs 1 Cities & counties 1
	Pedestrian Safety 1	Elementary schools 1
	Traffic Safety & Laws 8	High schools 3 Did not indicate 2 Everyone/variety 1 Universities 1 Adults 1

Table 15. Summary of Question 3 Responses: Traffic Safety Specialist Survey (continued).

Question	Categories and Number of Responses	Specific Answers and Number of Responses
	Speed 1	Did not indicate 1
	Underage Drinking 1	Did not indicate 1
	Alcohol, Drinking, & Driving 19	Everyone/variety 3 High schools 3 Universities 3 Schools 2 Middle schools 2 General public 1 Safety coalitions 1 DWI schools 1 Defensive driving 1 MADD 1 Cities & counties 1
	DWI 12	High schools 3 Did not indicate 1 Schools 1 Universities 1 Adults 1 Safety coalitions 1 Defensive driving 1 Driver education 1 MADD 1 Fairs/festivals 1
	Aggressive Driving 1	Everyone/variety 1
	Road Rage 1	Road rage 1 Everyone/variety 1
	Air Bags 1	General public 1
	General Requests from Various Types of Organizations 8	Everything 2 Elementary schools 2 Schools 1 High schools 1

Table 16. Summary of Question 4 Responses: Traffic Safety Specialist Survey.

Question	Categories and Number of Responses	Specific Answers and Number of Responses
<p>4. What types of materials would be most helpful to you? (Brochures, videos, handouts, presentations, etc.)</p>	<p>Brochures (easy to read, all levels) 8 Videos 4 Little of everything 4 Presentations (and handout) 2 More quantity (never enough to do the job) 1 Handouts 1 1. Need to aim at younger drivers to get their attention in a pointed way 1</p>	<p><i>Promotional Item Ideas</i></p> <p>Pencils 8 Key chains 8 Pens 6 Something people can keep/use with a message on it 5 Bookmarks for kids and older drivers 2 T-shirts 2 Rulers 2 Book covers 1 Notepads 1 Calculators 1 Stress balls 1 Bumper stickers (with vinyl cling that can be taken off) 1 Window decals 1 Posters for school (something eye-catching and graphic) 1 Calendars 1 Mouse pads 1 Phone cards (could put a safety message that plays before you make a call) 1 Coloring books 1</p>
<p>Current materials that work well</p>	<p>Texan Activity Book (Pre-K – 5th grade) 1</p>	
<p>Current materials that do not work well</p>	<p>Brochures end up in the trash 1 Brochures are only picked up when they cover a current hot topic 1</p>	

Table 16. Summary of Question 4 Responses: Traffic Safety Specialist Survey (continued).

Question	Categories and Number of Responses	Specific Answers and Number of Responses
Suggestions	English and Spanish	3
	Specific Materials	1
	No Gimmicks	1
	Accurate Data (specific to area) that the people can relate to	1
	Inexpensive, yet effective	1
	Materials should be tried out on a test market	1
	Brochures need to be more colorful (eye catching)	1
	Material needs to get right to the point and not include too much text	1
	Statewide materials need to be real generic so that they apply to all regions	1
	Target the low income more	1

Table 17. Summary of Question 5 Responses: Traffic Safety Specialist Survey.

Question	Categories and Number of Responses	Specific Answers and Number of Responses	
5. Would it be helpful to have materials targeted to different age groups?	Age groups that should be targeted	Older drivers	8
		University students	6
		General adult drivers	5
		Elementary school children	5
		Teenage drivers	5
		High schools students	4
		Pre-drivers	3
		Breakdown of younger children	2
		Middle schools students	2
		All age groups	1
	Age 21 & under	1	
	High school and above	1	
	Age groups that request materials the most	Elementary children	3
New/teenage drivers		2	
All levels of school		1	
Age groups that do not request materials	Older drivers	7	
	General drivers	1	

Table 18. Summary of Question 6 Responses: Traffic Safety Specialist Survey.

Question	Categories and Number of Responses	Specific Answers and Number of Responses
<p>6. Do you have any other suggestions for other materials that may be helpful to you?</p>	<p>Some topics need more coverage</p>	<p>Seat belt use (layman’s terms, consequences of not wearing a seat belt) 5 DWI 3 Aggressive driving (i.e., 1-pg. DPS brochure) 3 Alcohol (and how many drinks it takes to reach 0.08) 2 Child safety (more than just the coloring book, especially for parents to read) 2 Red-light running 2 Laws & requirements (updates on new laws, list fines) 2 Seat belt laws 1 Car seats 1 Bike helmet laws 1 Pedestrian safety 1 Traffic control devices (especially signals, signs, and pavement markings) 1 Flip guide for signs (Flash cards) 1 Meaning of TxDOT equipment 1 Speed 1 Speed limit brochures 1 Road rage 1 Safe driving tips 1 Cell phones 1 Auto license renewal (ALR) 1 Updated statistics (i.e., fact sheet) for state and district on crashes (and causes, speed) 2 Fact sheet in general (useful for presentations) 1</p>
<p>Other suggested ideas:</p> <ul style="list-style-type: none"> • Traffic control device messages such as Read Your Road, General Tips Traffic Signs (exiting, navigating the road, hazards) • Generic nationwide media campaign- need some type of acronym for traffic safety that everybody knows- too many differences between each state right now; “Save a Life” as part of the campaign (i.e.- use a black ribbon symbol to flash across the TV every time somebody dies in a traffic accident) • Interactive hands-on activities (for example, some kind of game or worksheet where a teenager or college student could go through and see how intoxicated they are after so many drinks and what the effects may be) • Model pick-up truck with figurines of children to put in the back- would be helpful for demonstrations on riding in the back of pick-ups; could simulate accidents to show what happens to the riders in the back • Get teenagers and college students to pledge seat belt use and no drinking and driving during spring break 		

CHAPTER 5

EDUCATIONAL MATERIALS

INTERNET WEBSITE

The Internet is becoming a primary source of information exchange in today's society. Internet websites developed by American Automobile Association (AAA) Foundation for Traffic Safety (27), National Highway Traffic Safety Administration (28), and the Insurance Institute for Highway Safety (29) are providing drivers with traffic safety and driver information. Also, in a previous survey (2), teenage drivers indicated that the Internet is an effective means to inform teenagers of important driver information. However, through a keyword search on Internet search engines, researchers found limited sites devoted to the education and meaning of traffic control devices. Based on these findings and upon TxDOT's request, a website was developed to focus on the understanding of traffic control devices.

The Traffic Control Devices Website was developed in coordination with TTI, TxDOT, and TxDOT's Traffic Safety Section. The website is designed to become a part of TxDOT's new Traffic Safety website, and it will provide information on traffic control devices and educational material resources. The website's contents are described on the following pages.

Traffic Control Devices

The importance of traffic control devices with regard to understanding and highway safety is presented on the "home" page. Direct links to the Shapes, Colors, Signs, Signals, and Markings sections are provided on the top, left side bar, and center of the page (see Figure 1). The descriptions of the traffic control devices presented on the site are based on TxDOT Research Project 0-1261 (30), TxDOT Project 0-1794 (1, 2), The MUTCD (23), and the *Texas Drivers Handbook* (3).

The site includes information regarding signs, signals, and pavement markings that were most misunderstood or difficult to understand as determined through surveys of teenage drivers, driver education instructors, older drivers, and law enforcement personnel.

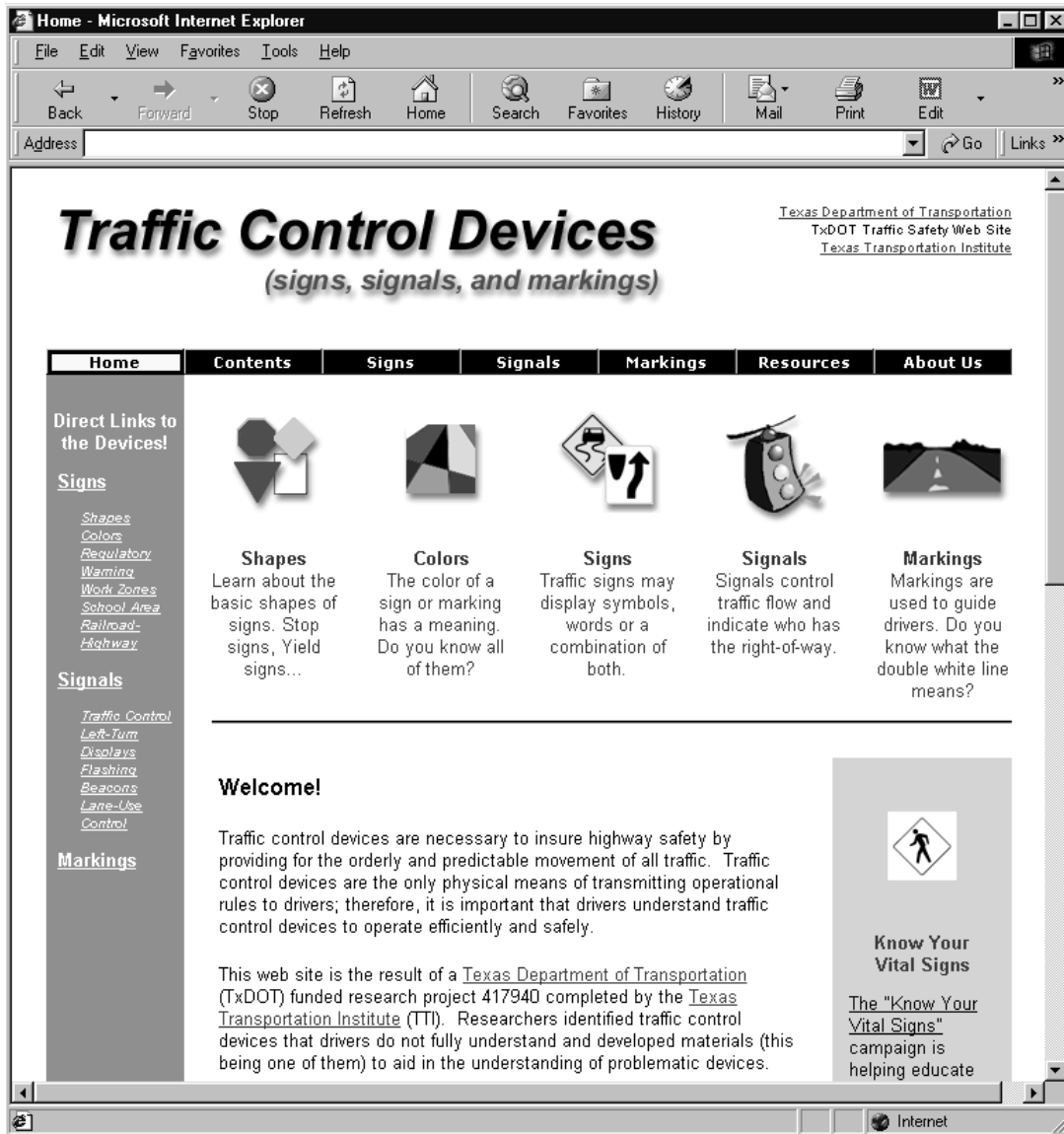


Figure 1. Traffic Control Devices Website Home Page.

Signs

The Signs section of the website includes seven subsections. The first two subsections provide information on sign shapes and sign colors. The remaining five subsections cover different types of signs, including: regulatory, warning, construction warning, school area, and railroad-highway grade crossing signs. [Table 19](#) lists the signs described on the website.

Table 19. Website Signs.

Sign Subsection	Shape/Color/Sign Name	Sign Label
Sign Shapes	Octagon	--
	Horizontal rectangle	--
	Equilateral triangle	--
	Pennant	--
	Diamond	--
	Vertical rectangle	--
	Pentagon	--
	Round (circle)	--
Sign Colors	Red	--
	Green	--
	Blue	--
	Yellow	--
	Black	--
	White	--
	Orange	--
	Brown	--
Fluorescent yellow-green	--	
Regulatory Signs	Stop	R1-1
	Stop with Cross Traffic Does Not Stop supplemental sign	R1-1/R1-5B
	Yield	R1-2
	Speed Limit	R2-1
	Center Lane Two-Way Left Turn Only	R3-9b
	Do Not Cross Double White Line	R4-3b
	Keep Right	R4-7
Warning Signs	Turn	W1-1R
	Curve	W1-2R
	Lane Reduction Transition	W4-2R
	Added Lane	W4-3R
	Divided Highway Begins	W6-1
	Divided Highway Ends	W6-2
	Slow Down on Wet Road	W8-5
	Pedestrian Crossing Ahead	W11-2
	Pedestrian Crossing	W11A-2
	Truck Crossing	W11-10
	Advisory Speed Plate	W13-1
	Low Shoulder	W8-9a
	No Passing Zone	W14-3
	Ramp Metered When Flashing	W19-3
Construction Warning Signs	Flagger Ahead	CW20-7a
	Road Work	CW20-1
School Area Signs	School Advance	S1-1
	School Crossing	S2-1
	School Speed Limit	S5-1
Railroad-Highway Grade Crossing Signs	Railroad Advance Warning	W10-1
	Railroad Crossing (Crossbuck)	R15-1

Signals

The Signals section consists of four subsections, including: traffic control signals, left turn traffic control signal displays, flashing intersection beacons, and lane-use control signals. [Table 20](#) lists the signals described on the website.

Table 20. Website Signals.

Signal Subsection	Traffic Control Device
Traffic Control Signals	Steady red light Steady yellow light Steady green light
Left Turn Traffic Control Signal Displays	Cluster signal head, red ball and green arrow indication Horizontal signal head, green ball indication Horizontal signal head, red ball and green arrow indication Horizontal signal head, green ball and green arrow indication Left Turn Yield On Green Ball (R10-12) sign Protected Left On Green Arrow (R10-9) sign Left Turn Signal (R10-10L)
Flashing Intersection Beacons	Flashing Red Intersection Beacon Flashing Yellow Intersection Beacon
Lane-Use Control Signals	Downward Green Arrow Yellow X Red X

Markings

The Markings section describes the color and general meaning of pavement markings. Five specific pavement markings are described in detail. These include:

- broken yellow lines,
- solid double yellow lines,
- solid and double yellow lines,
- broken white lines, and
- double solid white lines.

Resources

In addition to specific traffic control devices, the website provides other resources related to educational materials, traffic safety information, and comprehension research studies. The Resources section provides a list of available educational materials and contact information to obtain the materials. A number of other traffic safety websites are listed and linked in this section. Finally, a comprehensive list of research studies associated with understanding of traffic control devices is included.

NOTEBOOK FOR DRIVER EDUCATION STUDENTS

At TxDOT's request, researchers developed a spiral-bound notebook to be distributed to teenage drivers. The notebook cover and dividers include illustrations and text explaining signs, signals, and pavement markings that were misunderstood or difficult to understand based on surveys conducted during this project. The information is similar to or the same as that included on the website, but it is formatted to attract teenagers' attention. The notebook cover is illustrated in [Figure 2](#).

The inside covers and dividers include sections on sign shapes, sign colors, regulatory signs, warning signs, pavement markings, traffic signals, flashing beacons, school areas, and railroad-highway grade crossings.



Figure 2. Notebook Cover for Spiral-Bound Notebook.

CHAPTER 6

SUMMARY

This report documents the third-year activities of a three-year research project. Project 0-1794 was initiated to build upon the recommendations of TxDOT Project x-1261 by identifying teenage driver and adult safety instructor needs and developing targeted educational products and programs. The first and second years of the project focused on identifying problems associated with teenage driver comprehension of traffic control devices, identifying critical behavior issues for teenage drivers and for older drivers, and serving as part of the technical working group focusing on improving the driver education curriculum in the state of Texas.

During the project's third year, researchers conducted additional survey assessments of older drivers to evaluate traffic control devices that are problematic for older drivers. Surveys of TxDOT traffic safety specialists in all 25 TxDOT districts were also conducted to determine the types of activities conducted by the traffic safety specialists and the types of educational materials that would be most beneficial to them.

These survey results, along with the survey results from the first and second years of the project, were used to make suggested changes to the updated Texas driver education curriculum and to make suggested changes to the new edition of the *Texas Drivers Handbook*.

This information was also used to develop two new educational materials focusing on traffic control devices. These materials include: 1) an Internet website focusing on traffic control devices which will function as a part of TxDOT's website; and 2) a spiral-bound notebook including graphics and information on problematic traffic control devices that will be distributed to teenage drivers.

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APPENDIX A

OLDER DRIVER SURVEY FORM

This appendix contains a copy of the survey instrument that was conducted on a one-on-one basis with 200 older Texas drivers.

SCREENING QUESTIONS

Do you hold a valid Texas driver's license? **Continue only if YES.**

What is your age?

- 65 – 69
- 70 – 74
- 75 – 79
- 80 – 84
- 85+

What is the highest level of education you have completed?

- No high school diploma
- High school diploma
- Some college
- College degree

COMPREHENSION QUESTIONS

1) **When you see this sign on the road, what does it mean to you?**

Probe: What driving actions would you take, if any?

Probe: Where do you think these signs are located?

If answer is vague or "school areas," probe: Exactly where in school areas? On school grounds?

Off school grounds? _____

2) **If you are in the left-turn lane and see this light, what direction of traffic is allowed to go?**

Probe: If you were to turn left and get into an accident with an oncoming vehicle, who would be at fault? _____

Probe: Why do you think that person would be at fault?

3) If you were driving and came up to the flashing yellow light, what would you do?

Do you think the cars on the crossroad have to stop?

Probe: Why do you think this?

4) When you see this sign on the highway, what does it mean to you?

If answer is incorrect, probe: What do you think it means this?

Probe: What do you think the arrows on the sign mean?

5) When you see this sign on the road, what does it mean to you?

If answer is incorrect, probe: Why do you think it means this?

Probe: What driving actions would you take, if any?

6) If you were driving and came up to the flashing red light, what would you do?

Do you think the cars on the crossroad have to stop?

Probe: Why do you think this?

7) What do you think the middle lane is used for in this picture?

If answer is correct, probe: If there is more than 1 vehicle in this lane, who has the right-of-way?

Probe: Would you use this lane for passing? _____

8) If you are in the left-turn lane and see this light, what direction of traffic is allowed to go?

Probe: If you were to turn left and get into an accident with an oncoming vehicle, who would be at fault?

Probe: Why do you think that person would be at fault?

DEMOGRAPHIC/MISCELLANEOUS QUESTIONS

Record gender

- Male
- Female

Record ethnicity

- Caucasian
- African American
- Mexican
- Asian
- Other _____

How many years have you been driving? _____

How many miles do you drive per year?

- 0-4,999
- 5,000-9,999
- 10,000-14,999
- 15,000 or more

Are there any restrictions on your driver's license? If so, what are they?

Have you participated in any type of driver education course in the past year?

- No: Would you consider taking a driver education course designed for older drivers?
 - No
 - Yes
- Yes: What type of course?
 - Defensive Driving
 - AARP Class
 - AAA Class
 - Other _____

APPENDIX B

FLASH CARDS FOR OLDER DRIVER SURVEYS

This appendix contains copies of the flash cards that were used in the one-on-one surveys of 200 older Texas drivers.



Figure B-1. School Advance Sign (Survey Question #1).

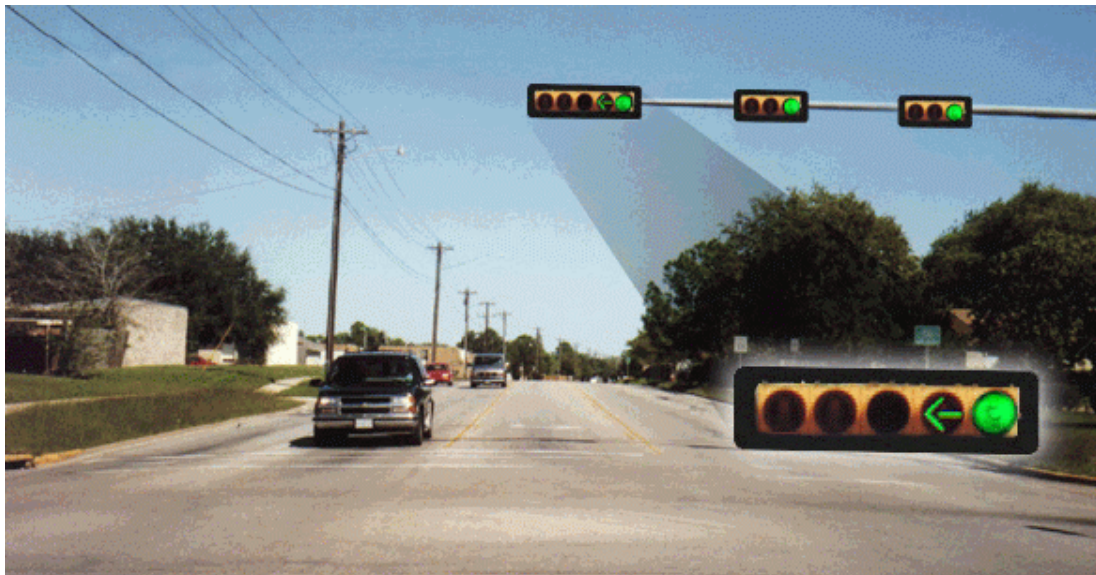


Figure B-2. Circular Green and Green Arrow (Survey Question #2).



Figure B-3. Flashing Yellow Intersection Beacon (Survey Question #3).



Figure B-4. Divided Highway Ends Sign (Survey Question #4).



Figure B-5. Slow Down on Wet Road Sign (Survey Question #5).



Figure B-6. Flashing Red Intersection Beacon (Survey Question #6).

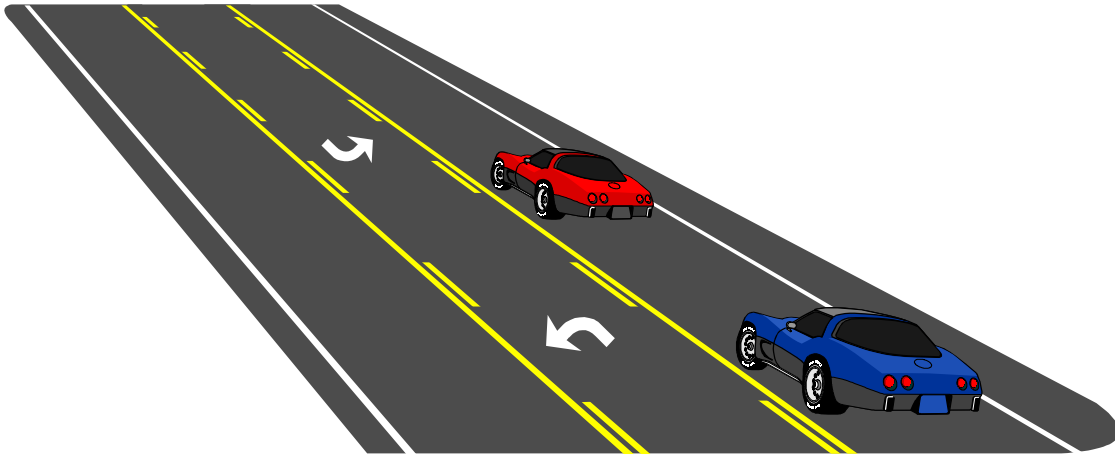


Figure B-7. Two-Way Left-Turn Lane Markings (Survey Question #7).

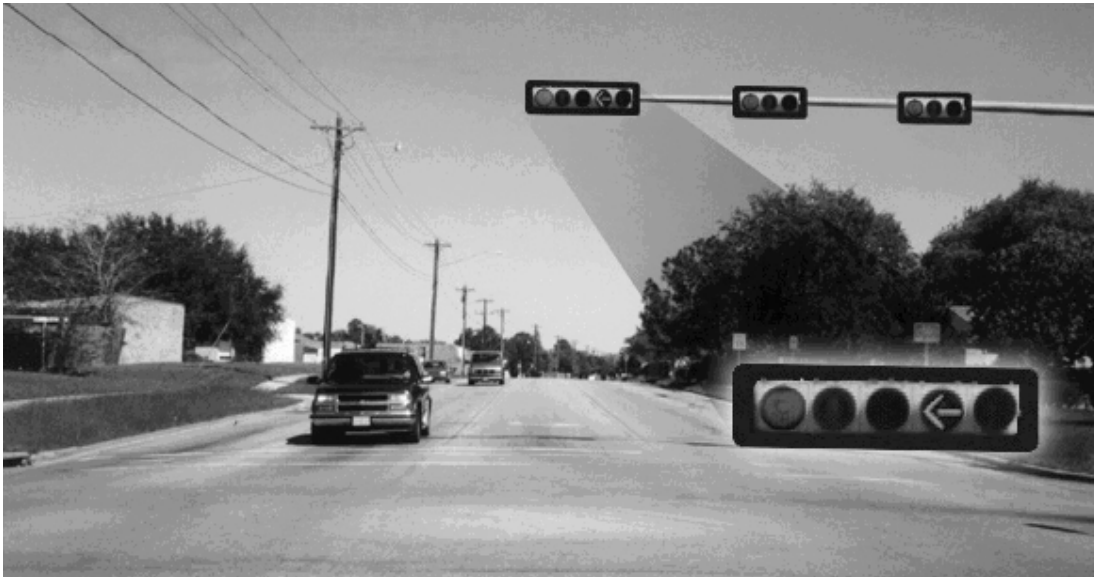
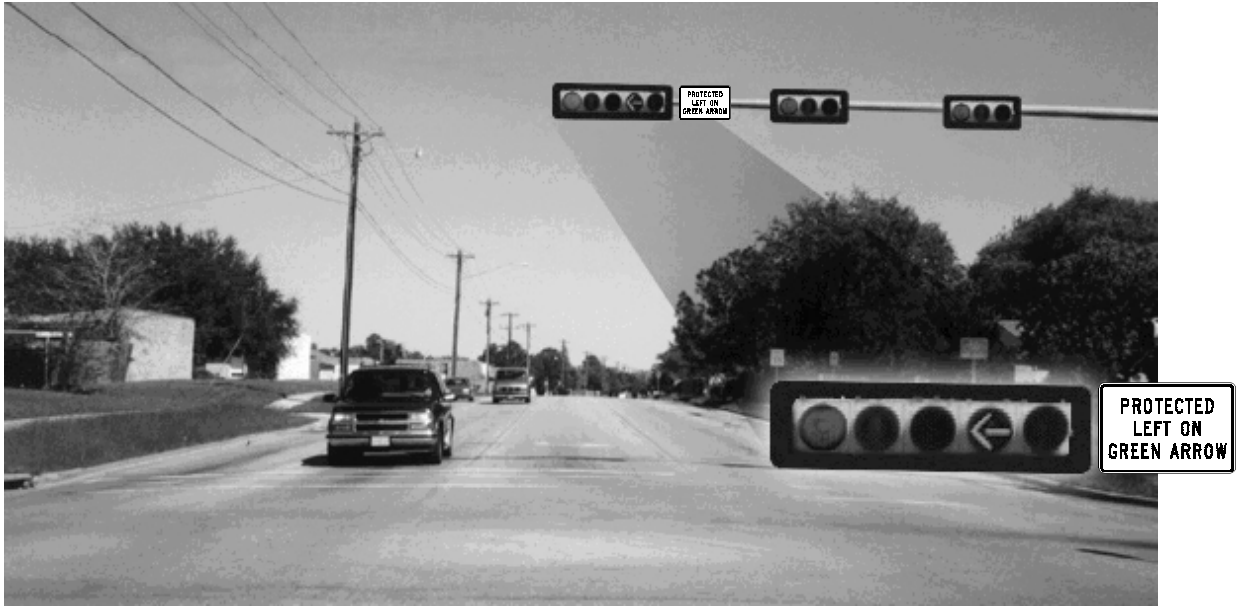


Figure B-8. Circular Red with Green Arrow (Survey Question #8-1 only half of study participants were shown this device)



**Figure B-9. Circular Red with Green Arrow and Protected Left Turn on Green Arrow Sign (Survey Question #8-2).
(only Half of Study Participants were Shown this Device)**

