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16. Abstract Highway safety is an ongoing concern for the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. To assist in achieving this goal, TxDOT research project 0-4703 developed the <i>Roadway Safety Design Workbook</i> for engineers responsible for highway geometric design. This <i>Workbook</i> describes quantitative safety relationships for specific design components known to be correlated with crash frequency. As part of TxDOT Project 0-4703, a series of workshops were developed to share safety information with TxDOT roadway designers. Information in the <i>Workbook</i> was used as the basis for the workshops. The workshops addressed rural highways, urban streets, and freeways. They included a mixture of classroom discussion and hands-on training activities for the participants. The participants indicated that the information presented in the workshops will be beneficial as they make decisions about highway safety improvements.			
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HIGHWAY SAFETY DESIGN WORKSHOPS

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NOTICE

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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- Mr. Wade Odell, Research Engineer (TxDOT, Research and Technology Implementation Office).

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HIGHWAY SAFETY DESIGN WORKSHOPS

OVERVIEW

This report provides a review of workshops presented as part of TxDOT Implementation Project 5-4703: Workshops on Incorporating Safety into the Highway Design Process. These workshops are being conducted to present roadway designers at TxDOT with the latest findings from research conducted in TxDOT Project 0-4703, Incorporating Safety into the Highway Design Process. The review focuses on workshop content, attendance, and participation evaluation.

BACKGROUND

As part of TxDOT Project 0-4703, quantitative safety information was gathered from a variety of different sources and then synthesized into safety information specific to the state of Texas. This information is summarized in the *Roadway Safety Design Synthesis (1)*. To make this information readily accessible to highway design personnel, a safety analysis procedure was developed based on the procedure used by Harwood et al. (2). This procedure is presented in the *Roadway Safety Design Workbook (Workbook) (3)* and automated in the Texas Roadway Safety Design (TRSD) software. Materials for a workshop series were also developed for the project. The purpose of these materials is to inform TxDOT highway designers about the *Workbook* and software. The materials developed in Project 0-4703 were used in the workshops offered for this implementation project. These workshops addressed the following facility types:

- rural two-lane highways,
- urban/suburban arterials, and
- rural multilane highways and freeways.

WORKSHOP SERIES

The objective of this implementation project is to improve roadway safety by providing designers with a procedure for quantitatively assessing the safety of roadway segments and intersections as may be influenced by their design elements or traffic control devices. This procedure is documented in the *Roadway Safety Design Workbook (3)*. Both the workshop content and the *Workbook* were written for use by engineers and technicians.

A multi-year workshop series was established for this implementation project. The workshops offered in any given year focused on one facility type. The workshops offered in the first year focused on rural two-lane highways. The workshops in the second year focused on urban/suburban arterial streets. The workshops in the third year focused on rural multilane highways and freeways. This part of the report describes the content of each of the three facility-based workshops offered during this project. It also summarizes the location, date, and topic of each workshop as well as the findings from the participant evaluation.

Rural Two-Lane Highway Workshop

This section provides an overview of the rural two-lane highway workshop. It also provides a review of highlights from its presentation at several locations in Texas. The first subsection to follow provides an overview of the workshop format. The second subsection identifies the workshop venues. The third subsection provides a summary of the participant evaluations.

Workshop Format

The workshops consisted of approximately seven hours of instruction that included a presentation, a demonstration of the TRSD software, and seven interactive participant exercises. The visual aids used in each workshop consisted primarily of 177 PowerPoint® slides. The purpose of the exercises was to help the participants gauge their understanding of the course content. During the project, some slides were added to the presentation or dropped from the presentation, and the exercises were revised in response to comments received from the workshop participants.

The workshop agenda is provided in Table 1. The agenda consists of six sessions that comprehensively describe safety issues on rural two-lane highways. The first four sessions are presented in the morning portion of the workshop. The first three of these sessions discuss the role of safety in the design process, working with crash data, and an overview of the safety analysis process that is used in TRSD. The fourth session describes the procedure for evaluating the safety of a rural two-lane highway segment. It contains exercises to allow participants to use the TRSD software.

The last two sessions are presented in the afternoon portion of the workshop. Session 5 describes the procedures for evaluating the safety of intersections along a rural two-lane highway. It also contains exercises to allow participants to use the TRSD software. Session 6 continues the exercises in Sessions 4 and 5 to show participants how to evaluate the safety of a road section that is comprised of segments and intersections. During this session, the participants are informed about the safety evaluation procedure and how it can help make decisions about the safety benefits of road design alternatives.

Workshop Venues

A total of three rural two-lane highway workshops were conducted. Table 2 summarizes the locations, dates, and attendance numbers for each workshop. These locations were selected by the project director. All workshops were held at TxDOT district training facilities. Additionally, participants could join the workshop via TxDOT's video teleconferencing (VTC) system. Between the on-site participants and those participating via VTC, TxDOT personnel from 24 of TxDOT's 25 districts were able to attend these workshops.

Table 1. Rural Two-Lane Highway Workshop Agenda.

Session	Description
1. Highway Safety and Geometric Design	A basic overview of the role of safety in highway design, including what is meant by “safety,” how to quantify safety, how to use safety as part of an analysis of alternatives, and where safety fits into the design process.
2. Working with Crash Data	An overview of what databases are available and the challenges of working with crash data, such as variability, accuracy, precision, and how to determine the effect of design changes on safety by using crash data.
3. Overview of Safety Evaluation	This session presents the safety evaluation process, the basic models, the procedures, and the TRSD software.
4. Procedure for Rural Two-Lane Highway Segments	This session presents the material on two-lane highway segments, including the base model and accident modification factors. Two exercises are included at the end of the session for hands-on training.
5. Procedure for Rural Intersections	This session presents the material for rural intersections. There are two parts to this session: two-way stop controlled intersections and signalized intersections. Each part includes the base model and accident modification factors for each type of intersection. Four exercises are included in this session, two in each part.
6. Highway Section Exercise and Alternatives Analysis	This session is an extension of Sessions 4 and 5. It includes two exercises. The first exercise analyzes an entire roadway section and intersections, showing how the pieces fit together. The second exercise adds an alternative treatment to consider to show how the safety analysis can be used in decision-making.

Table 2. Rural Two-Lane Highway Workshop Venues and Attendance.

Number of Participants by Workshop Location and Date ¹			
Lubbock	San Antonio	Odessa	Total
12/13/2006	1/9/2007	2/8/2007	
32	48	57	137

Note:

1- Includes attendance via video-teleconference.

Workshop Evaluation

Participants were given evaluation forms near the end of each workshop and asked to comment on the course content and format. The evaluation form contained four questions about the course content and four questions about the participant’s general observations about the strengths and weaknesses of the course format. Due to a printer’s error, no evaluation forms were available for the Odessa workshop.

The first four questions inquired about course content and called for a response using a scale of 1 to 5. A “1” was used to indicate “Yes” in response to the question. A “5” was used to indicate “No.” Values of “2,” “3,” and “4” were used to indicate a response somewhere between “Yes” and

“No” (e.g., “Maybe”). Each question was posed such that a “Yes” response indicated a high degree of satisfaction. The responses to the first four questions are summarized in Table 3.

Table 3. Participant Evaluation of Rural Two-Lane Highway Workshop.

Question	Average Participant Response by Workshop Location ¹			
	Lubbock	San Antonio	Odessa ²	Average
1. Did the course meet your expectations?	1.7	1.8	N/A	1.8
2. Was the material presented at the correct level of difficulty?	1.8	1.6	N/A	1.7
3. Was the topic of highway safety design covered adequately?	1.9	1.8	N/A	1.8
4. Was the TRSD software easy to use?	1.4	1.2	N/A	1.3
Average:	1.7	1.6	N/A	1.6

Notes:

- 1- Scores of 1 to 5 were possible. A “1” indicates “Yes” in response to the question. A “5” indicates “No” and values of 2, 3, and 4 indicate somewhere between “Yes” and “No” (e.g., “Maybe”).
- 2- No evaluations were available for the Odessa workshop.

The values in each cell of Table 3 represent an average of all the responses received from the course participants at the designated location for a common question. With a couple of exceptions, the average response ranged from 1.4 to 1.8 for each location and question. Values in this range indicate a high level of satisfaction with the workshop content. There were a few participants who thought the material was too difficult, but on the whole the participants indicated that the material was appropriate. There was some problem with the VTC equipment in Laredo during the San Antonio workshop that drew some unfavorable comments, and several participants indicated that they did not like the general format of VTC for this workshop. The average response values listed in the final column of Table 3 indicate a generally high level of satisfaction with the workshop content.

The second set of four questions inquired about the participant’s general observations of course strengths and weaknesses. Unlike the first four questions, the second set of four questions was open-ended. The specific questions posed to the participants include:

- What did you like most about the course?
- What did you like least about the course?
- What can we do to improve this workshop?
- Do you have any other comments?

Of the 63 surveys returned, 56 provided responses to some or all the four questions listed above. Forty participants gave positive comments on the TRSD software, referring to it as “very useful” and “user friendly.” Ten participants gave positive feedback on the example problems and on the opportunity to get hands-on experience with TRSD. Some of these participants were the same ones who gave positive comments about the software. Almost all of the participants provided generally positive feedback about the course, its contents, and the presentation of the material.

Urban/Suburban Arterial Workshop

This section provides an overview of the urban/suburban arterial workshop. It also provides a review of highlights from its presentation at several locations in Texas. The first subsection to follow provides an overview of the workshop format. The second subsection identifies the workshop venues. The third subsection provides a summary of the participant evaluations.

Workshop Format

The workshops consisted of approximately seven hours of instruction that included a presentation, a demonstration of the TRSD software, and eight interactive participant exercises. The visual aids used in each workshop consist primarily of 184 PowerPoint slides. The purpose of the exercises was to help the participants gauge their understanding of the course content. During the project, some slides were added to the presentation or dropped from the presentation, and the exercises were revised in response to comments received from the workshop participants.

The workshop agenda is provided in Table 4. It consists of eight sessions that comprehensively describe the safety issues on urban/suburban arterial streets. The first four sessions are presented in the morning portion of the workshop. The first three of these sessions discuss the role of safety in the design process, working with crash data, and an overview of the safety analysis process that is used in TRSD. The fourth session describes the procedure for evaluating the safety of an urban or suburban arterial street.

The last four sessions are presented in the afternoon portion of the workshop. Sessions 5 and 6 describe the procedures for evaluating the safety of intersections along an urban or suburban arterial. They also contain exercises to allow participants to use the TRSD software. Sessions 7 and 8 show participants how to evaluate the safety of a road section that is comprised of segments and intersections. During this session, the participants are informed about the safety evaluation procedure and how it can help make decisions about the safety benefits of road design alternatives.

Workshop Venues

A total of two urban/suburban arterial workshops were conducted. Table 5 summarizes the locations, dates, and attendance numbers for each workshop. These locations were selected by the project director. All workshops were held at TxDOT district training facilities. Additionally, participants could join the workshop via TxDOT's VTC system. Between the on-site participants and those participating via VTC, there were 111 TxDOT personnel in attendance. Collectively, they represented nine TxDOT districts.

Workshop Evaluation

Participants were given evaluation forms near the end of each workshop and asked to comment on the course content and format. The evaluation form contained four questions about the course content and four questions about the participant's general observations about the strengths and weaknesses of the course format.

Table 4. Urban/Suburban Arterial Workshop Agenda.

Session	Description
1. Roadway Safety and Geometric Design	A basic overview of the role of safety in highway design, including what is meant by “safety,” how to quantify safety, how to use safety as part of an analysis of alternatives, and where safety fits into the design process.
2. Working with Crash Data	An overview of what databases are available and the challenges of working with crash data, such as variability, accuracy, precision, and how to determine the effect of design changes on safety by using crash data.
3. Overview of Safety Evaluation	This session presents the safety evaluation process, the basic models, the procedures, and the TRSD software.
4. Procedure for Urban Street Segments	This session presents the safety prediction model and accident modification factors for urban street segments. Two exercises are included at the end of the session for hands-on training.
5. Procedure for Urban Signalized Intersections	This session presents the safety prediction model and accident modification factors for urban signalized intersections. Two exercises are included at the end of the session for hands-on training.
6. Procedure for Urban Unsignalized Intersections	This session presents the safety prediction model and accident modification factors for urban unsignalized intersections. Two exercises are included at the end of the session for hands-on training.
7. Urban Street Section Evaluation	This session is an extension of Sessions 4, 5, and 6. It includes an analysis exercise of an entire roadway section and intersections, showing how the pieces fit together.
8. Alternatives Analysis	This session is an extension of Session 7. It includes an exercise of an alternative treatment evaluation to show how the safety analysis can be used in decision-making.

Table 5. Urban/Suburban Arterial Workshop Venues and Attendance.

Number of Participants by Workshop Location and Date ¹		
Houston	Lubbock	Total
9/26/2007	11/15/2007	
53	58	111

Note:

1- Includes attendance via video-teleconference.

The first four questions inquired about course content and called for a response using a scale of 1 to 5. A “1” was used to indicate “Yes” in response to the question. A “5” was used to indicate “No.” Values of “2,” “3,” and “4” were used to indicate a response somewhere between “Yes” and “No” (e.g., “Maybe”). Each question was posed such that a “Yes” response indicated a high degree of satisfaction. The responses to the first four questions are summarized in Table 6.

The values in each cell of Table 6 represent an average of all the responses received from the course participants at the designated location for a common question. The average responses for questions 1, 2, and 3 ranged from 1.7 to 2.0, indicating good satisfaction with the workshop content.

The average response for question 4 ranged from 1.4 to 1.5, indicating a higher level of satisfaction with the TRSD software.

Table 6. Participant Evaluation of Urban/Suburban Arterial Workshop.

Question	Average Participant Response by Workshop Location ¹		
	Houston	Lubbock	Average
1. Did the course meet your expectations?	1.7	2.0	1.9
2. Was the material presented at the correct level of difficulty?	1.7	1.9	1.8
3. Was the topic of highway safety design covered adequately?	1.8	1.9	1.9
4. Was the TRSD software easy to use?	1.4	1.5	1.4
Average:	1.7	1.8	1.7

Note:

1- Scores of 1 to 5 were possible. A “1” indicates “Yes” in response to the question. A “5” indicates “No” and values of 2, 3, and 4 indicate somewhere between “Yes” and “No” (e.g., “Maybe”).

The second set of four questions inquired about the participant’s general observations of course strengths and weaknesses. Unlike the first four questions, the second set of four questions was open-ended. The specific questions posed to the participants include:

- What did you like most about the course?
- What did you like least about the course?
- What can we do to improve this workshop?
- Do you have any other comments?

Of the 99 surveys returned, 89 contained written responses to some or all of the eight questions. Twenty-three participants gave positive comments about the TRSD software. Many participants referred to it as “user-friendly” or “easy to use,” or indicated that it was their favorite part of the workshop. Seven participants indicated desire for more example problems using the software.

Rural Multilane Highway and Freeway Workshop

This section provides an overview of the rural multilane highway and freeway workshop. It also provides a review of highlights from its presentation at several locations in Texas. The first subsection to follow provides an overview of the workshop format. The second subsection identifies the workshop venues. The third subsection provides a summary of the participant evaluations.

Workshop Format

The workshops consisted of approximately seven hours of instruction that included a presentation, a demonstration of the TRSD software, and nine interactive participant exercises. The

visual aids used in each workshop consist primarily of 193 PowerPoint slides. The purpose of these exercises was to help the participants gauge their understanding of the course content.

The workshop agenda is provided in Table 7. It consists of seven sessions that comprehensively describe safety issues on multilane highways and freeways. The first two sessions discuss the role of safety in the design process, working with crash data, and an overview of the safety analysis process that is used in TRSD.

Table 7. Rural Multilane Highway and Freeway Workshop Agenda.

Session	Description
1. Review of Highway Safety Issues	A basic overview of the role of safety in highway design, including what is meant by “safety,” how to quantify safety, how to use safety as part of an analysis of alternatives, and where safety fits into the design process.
2. Overview of Safety Evaluation	This session presents the safety evaluation process, the basic models, the procedures, and the TRSD software.
3. Procedure for Multilane Highway Segments	This session presents the safety prediction model and accident modification factors for rural multilane highway segments. Two exercises are included at the end of the session for hands-on training.
4. Procedure for Freeway Segments	This session presents the safety prediction model and accident modification factors for freeway segments. Two exercises are included at the end of the session for hands-on training.
5. Procedure for Interchange Ramps	This session presents the safety prediction models for interchange ramps. Two exercises are included at the end of the session for hands-on training.
6. Section Evaluation	This session is an extension of Sessions 3, 4, and 5. It includes an analysis exercise of an entire roadway section and shows how the individual segment evaluations are combined.
7. Alternatives Analysis	This session is an extension of Session 6. It describes how safety information is used for design alternatives assessment and decision-making.

Sessions 3 through 5 are specific to the *Workbook* chapters addressing multilane highways, freeways, and interchange ramps. The sixth session describes the procedure for evaluating the safety of a multilane highway section that is comprised of segments and intersections. The last session describes the use of safety information in the conduct of an alternatives analysis.

Workshop Venues

A total of two rural multilane highway and freeway workshops were conducted. Table 8 summarizes the locations, dates, and attendance numbers for each workshop. These locations were selected by the project director. All workshops were held at TxDOT district training facilities. Additionally, participants could join the workshop via TxDOT’s VTC system. Between the on-site participants and those participating via VTC, there were 178 TxDOT personnel in attendance. Collectively, they represented 18 TxDOT districts.

Table 8. Rural Multilane Highway and Freeway Workshop Venues and Attendance.

Number of Participants by Workshop Location and Date ¹		
Lufkin	Austin	Total
6/23/2009	7/16/2009	
74	104	178

Note:

1- Includes attendance via video-teleconference.

Workshop Evaluation

Participants were given evaluation forms near the end of each workshop and asked to comment on the course content and format. The evaluation form contained four questions about the course content and four questions about the participant’s general observations about the strengths and weaknesses of the course format.

The first four questions inquired about course content and called for a response using a scale of 1 to 5. A “1” was used to indicate “Yes” in response to the question. A “5” was used to indicate “No.” Values of “2,” “3,” and “4” were used to indicate a response somewhere between “Yes” and “No” (e.g., “Maybe”). Each question was posed such that a “Yes” response indicated a high degree of satisfaction. The responses to the first four questions are summarized in Table 9.

Table 9. Participant Evaluation of Rural Multilane Highway and Freeway Workshop.

Question	Average Participant Response by Workshop Location ¹		
	Lufkin	Austin	Average
1. Did the course meet your expectations?	1.7	2.0	1.8
2. Was the material presented at the correct level of difficulty?	1.7	2.0	1.8
3. Was the topic of highway safety design covered adequately?	1.8	1.9	1.9
4. Was the TRSD software easy to use?	1.6	1.7	1.7
Average:	1.7	1.9	1.8

Note:

1- Scores of 1 to 5 were possible. A “1” indicates “Yes” in response to the question. A “5” indicates “No” and values of 2, 3, and 4 indicate somewhere between “Yes” and “No” (e.g., “Maybe”).

The values in each cell of Table 9 represent an average of all the responses received from the course participants at the designated location for a common question. The average responses for questions 1, 2, and 3 ranged from 1.6 to 2.0, indicating good satisfaction with the workshop content. The average response for question 4 ranged from 1.6 to 1.7, indicating a higher level of satisfaction with the TRSD software.

The second four questions inquired about the participant’s general observations of course strengths and weaknesses. Unlike the first four questions, the second set of four questions was open-ended. The specific questions posed to the participants include:

- What did you like most about the course?
- What did you like least about the course?
- What can we do to improve this workshop?
- Do you have any other comments?

Of the 178 surveys returned, 125 contained written responses to some or all of the eight questions. Seventy-four participants gave positive feedback about the TRSD software, indicating that they found it easy to use or the exercises with TRSD were their favorite part of the course. Five people stated that they like having a tool to quantify the safety effects of design decisions.

RECOMMENDATIONS

The high level of satisfaction with the workshop content and the positive tone of the evaluation comments are evidence that the workshop content is informative and its format is organized for effective learning. The participants indicate that the information presented in the workshops will be beneficial as they make decisions about highway safety improvements. Based on these findings, it is recommended that the workshop series continue to be offered by TxDOT. The Instructor's Guide prepared during this project will facilitate this activity.

A few participants suggested additional roadway safety features and geometric elements that they would like to see included in the *Workbook* and TRSD software. The most commonly suggested features and elements are provided in the following list.

- all-way STOP controlled intersections,
- rolled-in vs. milled-in rumble strips,
- transverse rumble strips at intersections,
- passing and no-passing zones (including the super 2 design), and
- vertical curvature.

Hence, it is recommended that TxDOT commission additional research to quantify and document the safety influence of the features and elements in the preceding list.

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