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16. Abstract The Texas Department of Transportation (TxDOT) operates thousands of traffic signals along state highways in the state of Texas. The operation of these signals is the responsibility of the TxDOT districts in which they are located. This local operation serves Texas motorists well, but it has also resulted in differences in practice across the state. TxDOT research project 0-5629 developed the <i>Traffic Signal Operations Handbook</i> to (1) provide a uniform basis for signal operation throughout the state and (2) identify cost-effective procedures for maintaining safe and efficient signal operation. This report documents the development and conduct of a two-year series of workshops to share information with TxDOT engineers and technicians regarding the cost-effective design and operation of signalized intersections. Information in the <i>Handbook</i> was used as the basis for the workshop. The workshop was one day in length and was offered at six venues in Texas. Workshop topics include basic signal controller timing, coordination timing, signal phasing, rail preemption, detection design, and diamond interchange timing. The workshop participants applied the <i>Handbook</i> guidelines in several examples using a spreadsheet program called the Texas Signal Coordination Optimizer (TSCO).			
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**TRAFFIC SIGNAL OPERATIONS HANDBOOK WORKSHOP SERIES:
FINAL REPORT**

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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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TABLE OF CONTENTS

LIST OF TABLES	viii
INTRODUCTION	1
BACKGROUND	1
WORKSHOPS	1
Overview	1
Workshop Format	2
Workshop Venues	3
Workshop Evaluation	4
SUMMARY	5
REFERENCES	6

LIST OF TABLES

Table 1. Workshop Agenda.	3
Table 2. Workshop Venues and Attendance.....	3
Table 3. Participant Evaluation of Workshop Content.	4

TRAFFIC SIGNAL OPERATIONS HANDBOOK WORKSHOP SERIES: FINAL REPORT

INTRODUCTION

This report describes the activities undertaken to conduct a workshop series on implementing the guidance contained in the *Traffic Signal Operations Handbook*. The activities undertaken included developing the workshop training materials, identifying the workshop venue, scheduling the workshop, conducting the workshop, and administering the course evaluation form. The next section of this report describes the research background that underlies the workshop information content. The section that follows describes the workshop objectives, content, venues, and participant evaluations. The final section summarizes the participants' perceived usefulness of the workshop based on their reported comments, and the instructors' insights into the participants' challenges in the design and maintenance of signals.

BACKGROUND

A *Traffic Signal Operations Handbook* was developed in TxDOT Project 0-5629 to document the best practices for operating traffic signals in Texas (1). The *Handbook* contains a discussion of concepts related to signal timing, procedures for developing timing plans, and guidelines on when and how to use specific procedures and settings. An Excel®-based spreadsheet program called Texas Signal Coordination Optimizer (TSCO) was also developed to assist with the numerous calculations required to implement the procedures (2).

A series of workshops was conducted around the state to train TxDOT engineers and technicians in the use of the *Handbook* and TSCO. The pilot workshop was conducted in Austin on January 26, 2010. Five more workshops followed, with the last one occurring in Lubbock on July 20, 2011.

WORKSHOPS

This section provides an overview of the workshop and a review of highlights from its six presentations. The first subsection to follow provides an overview of the workshop. It is followed by a review of the workshop learning objectives. Then, the workshop format and schedule are outlined. Finally, the participant evaluations are summarized in the last subsection.

Overview

The objectives of this implementation project are to inform engineers and technicians about the availability of guidance in the *Handbook* and the TSCO spreadsheet tool, and to demonstrate the use of these tools. The workshop material focuses on the guideline portions of the *Handbook*, covering one topic at a time. The workshop instructors were James A. Bonneson and Michael P. Pratt.

A total of six workshops were offered. This report describes the activities undertaken to develop and present the workshops. Specifically, the following three activities were successfully completed:

- Develop workshop training materials (i.e., visual aids, handouts, example problems, software, etc.) that impart to workshop participants the information needed to effectively operate traffic signals.
- Develop an *Instructor Guide* that contains the following information:
 - Instructor's notes (workshop overview and guidance on preparing for and presenting the workshop).
 - Workshop lesson slides (key message and points to be covered for every slide).
 - Solutions to example problems.
 - List of references and source documents.
- Conduct six one-day workshops at different TxDOT districts.

Workshop Format

The workshop content was tailored to facilitate participant learning. The visual aids were primarily in the form of a PowerPoint® presentation. This presentation included numerous photographs, illustrations, and example applications. The visual aids were supplemented with printed materials that included a course notes workbook (that included a print copy of the visual aids) and a copy of the *Handbook*. The computations associated with the operation of a signal were automated using the TSCO spreadsheet, of which a copy was provided to each workshop participant.

Because the *Handbook* covers a diverse set of topics related to signal operations, the workshop was divided into lessons covering the following six topic areas:

- Signal controller timing.
- Signal coordination timing.
- Signal phasing and operation.
- Advanced signal timing settings.
- Detection design and operation.
- Diamond interchange operations.

The workshops consisted of approximately eight hours of instruction, which included a presentation and interactive participant example problems. At the beginning of the workshop, the participants were told that the first topic area would be covered in the first lesson, and then additional topics would be covered as time allowed. The presented topic areas were chosen based on participant interest and available time. Questions and discussion were encouraged during the lessons, such that the time needed to present each lesson varied based on the amount of participation that occurred.

The visual aids used in each workshop consist primarily of PowerPoint slides. The workbook also included 12 self-paced example problems for the participants to work on in an

independent manner. The goal of these example problems was to help the participants gauge their level of understanding of the course content.

The agenda for the workshops is provided in Table 1. There are a total of six lessons. The introduction and Lessons 1 and 2 were presented at all workshops, while the remaining lessons varied based on interest and time.

Table 1. Workshop Agenda.

Lesson	Material Covered
Introduction	Background, <i>Handbook</i> organization, and introduction to TSCO.
Lesson 1: Signal Controller Timing	Phase settings, detector settings, and pedestrian settings.
Lesson 2: Signal Coordination Timing	Coordination potential, system settings, and phase splits.
Lesson 3: Signal Phasing and Operation	Left-turn mode and phasing, right-turn phasing, and pedestrian phasing.
Lesson 4: Advanced Signal Timing Settings	Settings for volume-density control, phase sequence, and rail preemption.
Lesson 5: Detection Design and Operation	Layout for loop detection and video detection.
Lesson 6: Diamond Interchange Operations	Phasing and detection for diamond interchanges.

Workshop Venues

A total of six workshops were conducted. Table 2 summarizes the locations, dates, and attendance numbers for each workshop. All workshops were held at TxDOT district training facilities.

Table 2. Workshop Venues and Attendance.

Workshop Venue	Workshop Date	Attendance
Austin (pilot workshop)	1/26/2010	21
Houston	4/20/2010	29
Dallas	7/1/2010	22
Waco	12/1/2010	11
Corpus Christi	3/23/2011	20
Lubbock	7/20/2011	12
Total:		115

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 four questions that inquired about course content were the following:

1. Did the course meet your expectations?
2. Was the material presented at the correct level of difficulty?
3. Will the information provided in the workshop help you determine effective signal settings and/or detection layouts?
4. Did the information provided in the workshop help you understand how to apply the software evaluation tool?

Participants were instructed to respond to each question 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 Workshop Content.

Question	Average Participant Response by Venue						
	Austin (pilot)	Houston	Dallas	Waco	Corpus Christi	Lubbock	Average
1	1.9	1.8	2.1	1.4	1.4	1.3	1.7
2	1.9	1.8	2.0	1.4	1.3	1.5	1.7
3	1.9	1.6	1.8	1.5	1.4	1.5	1.6
4	1.9	1.7	1.9	1.5	1.3	1.4	1.6
Average:	1.9	1.7	1.9	1.4	1.4	1.4	1.7

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:

5. What did you like most about the course?
6. What did you like least about the course?
7. What can we do to improve this workshop?
8. Do you have any other comments?

When the participants were asked what they liked best about the workshop, the most common responses were the TSCO spreadsheet program or the self-paced example problems

using TSCO (36 participants). Some of these participants specifically stated that they appreciated receiving a CD with the TSCO program so they could take it to the office and use it when needed. Three participants stated that the *Handbook* was their favorite part of the workshop. Fifteen participants responded by stating which portion of the workshop was their favorite; of these participants, 10 specified that their favorite topic was rail preemption (covered in Lesson 4).

Forty-one participants expressed concern about the amount of material in the workshop. These participants generally stated that there was a large amount of material and opined that it would take two days to cover everything properly. Some of these participants expressed disappointment that certain lessons that they wanted to cover were not presented. In most of the workshop presentations, time allowed for four of the six lessons to be presented. Three participants also stated that they were hoping to cover issues that were not addressed in any of the lessons. These issues included troubleshooting signal equipment and programming settings in an Eagle controller. One of these three participants explained that he was hoping for an approach that was more “layman” and less “technical.”

SUMMARY

The numeric responses in Table 3 and the positive responses relating to the TSCO spreadsheet program and the self-paced example problems suggest that the participants perceived the workshop to be helpful. The commonly-stated disappointment about lessons not being presented shows that the participants would appreciate opportunities to learn about more topics in a workshop setting. Though a small number of participants stated that some of the material was too technical for their preference, the participants generally seemed to think that the level of difficulty was appropriate and that there was good material provided for both engineers and technicians.

Based on questions and comments provided both in the evaluation forms and during the workshops, the *Handbook* and the TSCO spreadsheet program will be useful for engineers and technicians as they address issues that often arise with signal design and maintenance. The materials will address the lack of guidance, and also reduce the amount of field data needed to achieve effective signal timing. Most of the participants were able to see the practical benefit of the workshop material, and they believe that they could benefit from an even longer workshop that would cover all lessons. However, engineers and technicians will still struggle with equipment maintenance, reliability, and cost issues. These challenges were often topics of conversation during break periods, and they were acknowledged by the participants who expressed interest in learning about troubleshooting equipment or working in the Eagle controller.

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