



*Improving the Quality of Life
by Enhancing Mobility*

University Transportation Center for Mobility

DOT Grant No. DTRT06-G-0044

Creating the Next Generation of Transportation Professionals

Final Report

Melisa D. Finley and Debbie Jasek

Performing Organization

University Transportation Center for Mobility™
Texas Transportation Institute
The Texas A&M University System
College Station, TX

Sponsoring Agency

Department of Transportation
Research and Innovative Technology Administration
Washington, DC



**UTCM Project #11-00-62
November 2011**

Technical Report Documentation Page

1. Project No. UTCM 11-00-62		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Creating the Next Generation of Transportation Professionals				5. Report Date November 2011	
				6. Performing Organization Code Texas Transportation Institute	
7. Author(s) Melisa D. Finley and Debbie Jasek				8. Performing Organization Report No. UTCM 11-00-62	
9. Performing Organization Name and Address University Transportation Center for Mobility™ Texas Transportation Institute The Texas A&M University System 3135 TAMU College Station, TX 77843-3135				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. DTRT06-G-0044	
12. Sponsoring Agency Name and Address Department of Transportation Research and Innovative Technology Administration 400 7 th Street, SW Washington, DC 20590				13. Type of Report and Period Covered Final Report October 2010–September 2011	
				14. Sponsoring Agency Code	
15. Supplementary Notes Supported by a grant from the US Department of Transportation, University Transportation Centers Program					
16. Abstract The transportation industry, like every other profession that relies heavily on the science, technology, engineering, and mathematics (STEM) fields, faces a growing shortage of professional engineers. The purpose of this project was to investigate new methods for conducting educational outreach activities for kindergarten through twelfth grade (K–12) students and compare the effectiveness of various implementation methods. During this project, Texas Transportation Institute (TTI) researchers developed two in-class educational outreach modules and several displays that they could easily transport and exhibit at various educational outreach activities. The first in-class module introduces intermediate school students to the world of transportation and transportation engineering and teaches students about the principle of retroreflectivity. The second in-class module teaches kindergarten students about sign shapes and colors. TTI researchers also participated in 12 educational outreach activities. These activities included: <ul style="list-style-type: none"> • Four in-school events. • Four field trips to TTI facilities. • Three summer activities. • One engineering day event. The students participating in these activities ranged from kindergarten to twelfth grade. The educational outreach activities conducted introduced the fields of transportation and engineering to over 2000 students.					
17. Key Word Careers in Transportation, Careers in Engineering, Transportation Engineering Educational Outreach Programs, STEM			18. Distribution Statement Public distribution		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 26	22. Price n/a

CREATING THE NEXT GENERATION OF TRANSPORTATION PROFESSIONALS

by

Melisa D. Finley, P.E.
Texas Transportation Institute
3135 TAMU
College Station, Texas 77843-3135
Phone: (979) 845-7596
Fax: (979) 845-6006
E-mail: m-finley@tamu.edu

and

Debbie Jasek
Texas Transportation Institute
3135 TAMU
College Station, Texas 77843-3135
Phone: (979) 845-5239
Fax: (979) 845-6001
E-mail: d-jasek@tamu.edu

UTCM 11-00-62

Project Title:
Creating the Next Generation of Transportation Professionals

Sponsored by the
University Transportation Center for Mobility™

November 2011

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the Department of Transportation, University Transportation Centers Program in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

ACKNOWLEDGMENT

Support for this research was provided by a grant from the U.S. Department of Transportation, University Transportation Centers Program to the University Transportation Center for Mobility (DTRT06-G-0044). The authors would like to acknowledge the following individuals whose assistance made this undertaking possible: Melissa Tooley, Martha Raney-Taylor, Dusty Arrington, Marcus Brewer, Terry Childers, Felicia Desorcie, Gene Buth, Kay Fitzpatrick, Vichika Iragavarapu, Laura Higgins, Michelle Hoelscher, Beatrice Martinez, Jeff Miles, Devin Moore, Marla Richardson, Chiara Silvestri, Beverly Storey, Srinivasa Sunkari, LuAnn Theiss, Nada Trout, Brooke Ullman, William Williams, Christine Yager, Fan Ye, and the member of the Texas A&M University Student Chapter of the Institute of Transportation Engineers.

TABLE OF CONTENTS

List of Figures	5
List of Tables.....	5
Executive Summary.....	7
Introduction.....	9
Background.....	9
Overview of Educational Outreach Activities	9
In-School Outreach.....	10
There’s More to Road Signs than Meets the Eye	10
Description of Event	10
Conduct of Event.....	11
Assessment of Event.....	11
What’s My Sign?	11
Description of Event	11
Conduct of Event.....	12
Assessment of Event.....	12
Science Night.....	13
Description and Conduct of Event	13
Assessment of Event.....	13
Career Fair.....	14
Description and Conduct of Event	14
Assessment of Event.....	15
Field Trips.....	15
Intermediate School Visit.....	15
Description and Conduct of Event	15
Transportation and Engineering Career Awareness and Crash Test Sessions	15
Up Close with the World of Transportation Gadgets	16
TransLink® Research Center	16
Transportation and the Environment.....	17
Open Discussion with Texas A&M University Students.....	18
Puff Mobile Hands-On Activity	19
Assessment of Event.....	19
Prairie View A&M University Garrett A. Morgan Transportation Summer Camp Visit.....	20
Description and Conduct of Event	20
Assessment of Event.....	20
Science, Technology, Engineering, and Math – Residential Adventure for Young Engineers and Scientists Visit	20
Description and Conduct of Event	20
Assessment of Event.....	21
Other Outreach.....	21
Girl Scout Day Camp.....	21
Description and Conduct of Event	21
Assessment of Event.....	22

Explore Engineering Summer Camps	24
Description and Conduct of Event	24
Assessment of Event.....	24
City of Waco Engineering Day.....	24
Description and Conduct of Event	24
Assessment of Event.....	25
Summary and Conclusions	25
Summary.....	25
Conclusions	22

LIST OF FIGURES

Figure 1. Signs Used during the Kindergarten Class Presentation	12
Figure 2. TTI Researcher Presenting to Kindergarten Class	13
Figure 3. Displays at Caldwell Intermediate School Science Night	14
Figure 4. Student Examining Sign Sheeting with Hand-Held Microscope	14
Figure 5. TTI Researcher Discussing TTI's Crash Testing Program	16
Figure 6. AVID Students Examining Sign Sheeting and Pavement Markings with Hand-Held Microscopes.....	17
Figure 7. TransLink® Research Center Tour.....	17
Figure 8. Transportation and the Environment Session.....	18
Figure 9. Open Discussion with Texas A&M University Students.	18
Figure 10. AVID Students Building and Racing Puff Mobiles	19
Figure 11. TTI Researcher Presenting to Girl Scouts	22
Figure 12. Girl Scouts Designing Signs	23
Figure 13. Girl Scouts Examining Sign Sheeting with Hand-Held Microscopes	23
Figure 14. Girl Scouts Building and Racing Puff Mobiles.....	23

LIST OF TABLES

Table 1. Camp Howdy Presentation Schedule and Participation.....	21
--	----

EXECUTIVE SUMMARY

The transportation industry, like every other profession that relies heavily on the science, technology, engineering, and mathematics (STEM) fields, faces a growing shortage of professional engineers. Recent studies report a troubling decline in the number of U.S. citizens that are training to become engineers and scientists. Under previous grants from the Southwest University Transportation Center (SWUTC), the team developed a half-day in-school workshop and field trip agenda for middle school students that offered an opportunity for students to gain hands-on experience and insight into what transportation engineering and other technology careers have to offer. Both types of activities (in-school workshops and field trips) provided experiences to encourage interest in engineering, science, and math, and offered exposure and mentoring from role models that currently work in transportation fields. However, budget and travel constraints limit the ability of schools to take field trips. In addition, similar constraints limited the ability of schools to participate in the in-school workshops since these activities were held outside of the classroom (typically in the library) and over multiple class periods (requiring students to miss class and in some cases the need for substitute teachers).

The purpose of this project was to investigate new methods for conducting educational outreach activities for kindergarten through twelfth grade (K–12) students. Through this project, Texas Transportation Institute (TTI) researchers developed two in-class educational outreach modules. The first in-class module introduces intermediate school students to the world of transportation and transportation engineering and teaches students about the principle of retroreflectivity. The second in-class module teaches kindergarten students about sign shapes and colors. In addition, researchers created several displays that they could easily transport and exhibit at various educational outreach activities.

TTI researchers also participated in 12 educational outreach activities. These activities included

- Four in-school events.
- Four field trips to TTI facilities.
- Three summer activities.
- One engineering day event.

Most of these activities were held in the Bryan/College Station, Texas, area; but students from other parts of Texas did participate in some of the activities. The students participating in these activities ranged from kindergarten to twelfth grade. The educational outreach activities conducted introduced the fields of transportation and engineering to over 2000 students.

Field trips continue to be a successful educational outreach activity since students can encounter professionals in their working environment and view a sampling of several aspects of transportation engineering in one setting. Break-out activities work very well, since it divides the students into smaller groups, which facilitates more interaction between students and professionals. Unfortunately, budget constraints limit public schools' ability to take field trips.

Researchers were very excited about the success of the in-class educational outreach modules. This type of educational outreach does not require financial or equipment (e.g., buses) commitments from school districts and does not require students to miss class. However, the time and effort for an individual professional is increased compared to the time and effort needed to conduct a field trip. Based on the positive experience and feedback, TTI researchers plan to identify other funding sources that would allow one researcher to conduct the in-class retroreflectivity module each year at Oakwood Intermediate School, in College Station, Texas, with the potential to expand the activity to other intermediate schools in the area.

Researchers believe that traditional educational outreach activities, such as career fairs and engineering day events, will continue to play an important role in developing the next generation of engineers and scientists. In addition, researchers need to further explore and utilize new outreach avenues, such as science and math nights at local schools and summer camps, to reach as many students as possible.

INTRODUCTION

BACKGROUND

The transportation industry, like every other profession that relies heavily on the science, technology, engineering, and mathematics (STEM) fields, faces a growing shortage of professional engineers. Recent studies report a troubling decline in the number of U.S. citizens that are training to become engineers and scientists. Under previous grants from the Southwest University Transportation Center (SWUTC), the team developed a half-day in-school workshop and field trip agenda for middle school students that offered an opportunity for students to gain hands-on experience and insight into what transportation engineering and other technology careers have to offer. Both types of activities (in-school workshops and field trips) provided experiences to encourage interest in engineering, science, and math, and offered exposure and mentoring from role models that currently work in transportation fields. However, budget and travel constraints limit the ability of schools to take field trips. In addition, similar constraints limited the ability of schools to participate in the in-school workshops since these activities were held outside of the classroom (typically in the library) and over multiple class periods (requiring students to miss class and in some cases the need for substitute teachers).

The purpose of this project was to investigate new methods for conducting educational outreach activities for kindergarten through twelfth grade (K–12) students. Through this project, Texas Transportation Institute (TTI) researchers developed in-class educational outreach modules and participated in additional educational outreach activities that emphasized STEM fields and careers in transportation engineering and other transportation fields.

OVERVIEW OF EDUCATIONAL OUTREACH ACTIVITIES

During this project, TTI researchers developed two in-class educational outreach modules and several displays that they could easily transport and exhibit at various educational outreach activities. The first in-class module introduces intermediate school students to the world of transportation and transportation engineering and teaches students about the principle of retroreflectivity. The second in-class module teaches kindergarten students about sign shapes and colors.

TTI researchers also participated in 12 educational outreach activities. These activities included:

- Four in-school events.
- Four field trips to TTI facilities.
- Three summer activities.
- One engineering day event.

Most of these activities were held in the Bryan/College Station, Texas, area; but students from other parts of Texas did participate in some of the activities. The students participating in these activities ranged from kindergarten to twelfth grade. The educational outreach activities conducted introduced the fields of transportation and engineering to over 2000 students.

As indicated previously, the main objective of this project was to investigate new methods for conducting educational outreach activities for K–12 students. One method of interest to researchers was webinar technology, which provides an opportunity to reach more students in the classroom at more locations in a more cost- and time-efficient manner. However, after discussions with multiple teachers at various schools, researchers deemed this method

infeasible due to a lack of technology at the school or in the classroom (both webinar-related and engineering-related) and the inability to demonstrate certain engineering concepts. In addition, teachers and researchers felt that the person-to-person interaction and hands-on activities were critical to the effectiveness of the educational outreach activities. Still, in addition to more traditional outreach activities (e.g., field trips and career fairs), researchers were able to investigate new methods for conducting educational outreach activities inside and outside of the classroom.

IN-SCHOOL OUTREACH

Researchers conducted four in-school educational outreach activities to promote STEM fields and careers in transportation engineering and other transportation fields. For two of these activities, a researcher taught students in their class about traffic signs and other traffic control devices used in transportation. For the third activity, researchers manned a booth at an intermediate school science night. The fourth activity was a career fair at a local high school. The following sections describe these events in more detail.

THERE'S MORE TO ROAD SIGNS THAN MEETS THE EYE

Description of Event

As part of this project, TTI researchers developed a 50- to 60-minute in-class educational outreach module that introduces intermediate school students to the world of transportation and transportation engineering and teaches students about the principle of retroreflectivity. Retroreflectivity is a term used to describe how light is reflected off a surface back in the same direction of the original light source. Sign sheeting material uses small glass beads or prismatic reflectors and the principles of reflection and refraction to retroreflect the light emitted from a vehicle's headlamps to the driver's eyes. Through a brief history of sign sheeting, hands-on activities, and a laboratory exercise, students gain an understanding of the scientific principles behind retroreflectivity and problem-solving techniques.

For the first 10 minutes of the class, a researcher introduces him or herself and introduces the students to the fields of transportation and engineering. The presentation is designed to promote interaction between the researcher and students. Specifically, the presentation includes information about the following:

- What is transportation?
- What is an engineer?
- Why engineering?
- Engineering in transportation.
- What you need in high school.
- What else you need to become an engineer.

During the next 30 minutes, a researcher introduces the concepts of reflection, refraction, and retroreflectivity using demonstrations and presents the history of sign sheeting on a very basic level to further explain retroreflectivity and to show how engineers solve problems. The researcher utilizes a large glass bead, prism, and laser to demonstrate how sign sheeting works. The researcher also shows the class examples of signs made from the various materials discussed and has the students view three types of sign sheeting with hand-held microscopes (i.e., enclosed bead, encapsulated lens, and prismatic). Other uses of retroreflective material (e.g., clothing, conspicuity markings on buses and trains) and how pavement markings

retroreflect are also discussed, during which the researcher passes around a worker vest, pavement marking sample, container of glass beads used in pavement markings, and raised pavement markers (RPMs).

During the final 15 minutes, the students use hand-held microscopes and the information previously discussed to identify three pieces of sign sheeting material (i.e., enclosed bead, encapsulated lens, and prismatic) and rank them from the lowest to the highest retroreflectivity value. The researcher then uses a hand-held retroreflectometer to measure the retroreflectivity of the sign sheeting pieces and discussed the findings with the class.

Conduct of Event

Over a three-day period in April 2011, a TTI researcher conducted this in-class educational outreach module in 12 fifth grade science classes (four each day) at Oakwood Intermediate School in College Station, Texas. Class times ranged from 53 to 64 minutes. Approximately 300 fifth grade students and three fifth grade science teachers participated. This project funded TTI researchers' efforts to develop and deliver this in-class educational outreach module.

Assessment of Event

This in-class educational outreach activity was well received by teachers and students. One teacher commented, "Retroreflectivity is a very hard concept to demonstrate, but (the researcher) was fantastic. She devoted three full days to our students and had the ability to make it interesting and fun." Below are selected comments from thank you notes received from students:

- "I told my family all about the little glass spheres on stop signs."
- "Please come back. I would love to learn more!"
- "My favorite part was looking through the microscope at the sheeting they use on stop signs."
- "I never knew that reflection (retroreflection to be precise) could be so interesting!"
- "I learned so much yesterday. It was actually much more interesting than I thought it would be."
- "It was really amazing to think there are microscopic beads on signs – so small I couldn't imagine."
- "I learned a great deal from you about the little prisms and glass balls that are put into road signs to help people see them at night."
- "Who would have guessed that there are tiny, glass balls inside stop signs? Now I know! Thank you for teaching me that."
- "Thank you for showing us in a fun way how light reflects and refracts."
- "It's a cool job what you do."
- "I think I want to be an engineer when I grow up."
- "I think being a civil engineer is very interesting."

WHAT'S MY SIGN?

Description of Event

As part of this project, TTI researchers developed a 15-minute in-class educational outreach module that teaches kindergarten students about sign shapes and colors. Using the blank signs shown in Figure 1, the researcher had the students name the shape of the sign, the color of the

sign, and some signs that looked like the blank sign shown. The researcher would then turn the blank sign over to show a real sign and tell them what kind of sign it was (e.g., construction) and what kind of information it provided (e.g., flagger ahead). After discussing all the signs, the researcher read an age appropriate transportation-related book to the class.



Figure 1. Signs Used during the Kindergarten Class Presentation.

Conduct of Event

On November 9, 2010, a TTI researcher conducted this in-class educational outreach module in a kindergarten class at Bowen Elementary in Bryan, Texas (Figure 2). The presentation took about 15 minutes. Eighteen kindergarten students and one teacher attended the presentation. This project funded TTI researchers' efforts to develop and deliver this in-class educational outreach module.

Assessment of Event

The teacher felt that the program content was age appropriate, aroused the students' interest, and was a proper length. The teacher commented, "I liked how interactive it was for the children. They were able to touch and feel the signs and play an interactive guessing game to figure out what the purpose was of each sign. It kept the students' attention for the entire lesson while also reiterating what they already learned and teaching them new information."



Figure 2. TTI Researcher Presenting to Kindergarten Class.

SCIENCE NIGHT

Description and Conduct of Event

On May 12, 2011, two TTI researchers attended a science night at Caldwell Intermediate School in Caldwell, Texas. These researchers set up a display describing traffic signs, retroreflectivity, and various traffic control devices. The students could look at stop signs, RPMs, sign sheeting through hand-held microscopes, and a worker vest and hard hat. Researchers also showed students how traffic and pedestrian signals work. Figure 3 shows the display and Figure 4 shows a student looking at sign sheeting with a hand-held microscope. This project funded the TTI researchers' efforts to develop the display.

This event was held after school from 5:30 p.m. to 7:00 p.m. The number of third through fifth grade students who attended this event and viewed the TTI displays was unknown. However, many students visited the display and interacted with the researchers. Although the interactions were brief, students were introduced to the field of transportation.

Assessment of Event

The event coordinator was pleased with the content and interactive nature of the displays. Positive feedback was also received from parents and students. The researchers thought the displays garnered the attention of students and parents and noticed that the display had a constant stream of visitors.



Figure 3. Displays at Caldwell Intermediate School Science Night.



Figure 4. Student Examining Sign Sheeting with Hand-Held Microscope.

CAREER FAIR

Description and Conduct of Event

On March 11, 2011, three TTI researchers attended a career fair at Bryan High School in Bryan, Texas. The TTI booths covered transportation careers and Drive Clean Across Texas©. This project funded the TTI researchers' efforts to develop the displays and attend the event.

This event was held during the school day. Students could visit booths between classes and during designated times. Approximately 500 high school students visited the TTI booths and interacted with the researchers. Again, although the interactions were brief, students were introduced to the field of transportation.

Assessment of Event

Researchers did not receive feedback from the event coordinator, teachers, or students. The researchers thought the displays attracted the attention of students.

FIELD TRIPS

Researchers hosted four field trips to the TTI facilities at the Texas A&M University campus in College Station, Texas, to promote STEM fields and careers in transportation engineering and other transportation fields. The following sections describe these events in more detail.

INTERMEDIATE SCHOOL VISIT

Description and Conduct of Event

On May 6, 2011, 37 sixth grade Advancement Via Individual Determination (AVID) students and 9 teachers from Cypress Grove Intermediate School and Oakwood Intermediate School in College Station, Texas, visited TTI. AVID is an in-school academic support program for grades 4–12 that prepares underserved students (predominantly minority and economically disadvantaged) in the academic middle for college eligibility and success. The field trip lasted approximately 4.5 hours. During the field trip, students attended a transportation and engineering career awareness session, a crash test session, and the following break-out sessions:

- Up close with the world of transportation gadgets.
- TransLink® Research Center.
- Transportation and the environment.
- An open discussion with Texas A&M University students.

For the break-out activities, team members divided students into four groups. The break-out activities were conducted simultaneously, with students rotating to a different activity every 30 minutes. After the break-out activities, students constructed and raced puff mobiles. This project funded the TTI researchers' efforts to develop the agenda, coordinate activities, and host the event. The following sections describe the field trip activities.

Transportation and Engineering Career Awareness and Crash Test Sessions

The field trip began with a TTI researcher making a 15-minute presentation to the entire group about the transportation industry and careers in engineering. Researchers designed the presentation to promote interaction between the researcher and students. Specifically, the presentation included information about the following:

- What is transportation?
- Transportation modes (interactive).
- Transportation system (interactive).
- What is an engineer?
- Why engineering?
- Engineering in transportation.
- Great civil engineering achievements (interactive).
- Engineering college degrees, additional training, and professional licensure.

Next, a different researcher discussed TTI's crash testing program. This 30-minute presentation included video from the numerous crash tests performed by TTI and allowed TTI team members to discuss with students the science behind crash testing. Figure 5 shows a TTI researcher presenting this material to AVID students.



Figure 5. TTI Researcher Discussing TTI's Crash Testing Program.

Up Close with the World of Transportation Gadgets

For this activity, the students toured the TTI Traffic Control Device Visibility Research Laboratory, during which a TTI researcher discussed how the human eye works, driver visual needs at night, and retroreflectivity (the ability of an object to redirect light back to its source). As Figure 6 shows, the students then used hand-held microscopes and flashlights to examine the following:

- Beads used in pavement markings.
- Retroreflective sign material.
- Retroreflective pavement markings.
- Retroreflective RPMs.
- A retroreflective construction worker vest.

TransLink® Research Center

The students also toured the TTI TransLink® Research Center, which is a national, multi-modal, multi-agency public-private program of research, development, and professional education. During the tour, a TTI researcher discussed how traffic signals and intelligent transportation systems (ITS) work. Figure 7 shows AVID students during the TransLink® Researcher Center tour.



Figure 6. AVID Students Examining Sign Sheetting and Pavement Markings with Hand-Held Microscopes.



Figure 7. TransLink® Research Center Tour.

Transportation and the Environment

For this session, a TTI researcher discussed the connection between transportation and the environment. Students watched a video about landscape architecture and the beautification of roads. The researcher then discussed erosion and the need for mitigation actions during road construction and maintenance operations. Researchers passed around samples of various materials used to prevent erosion and capture silt and other pollutants during storm water runoff. The researcher also discussed the need for wise decisions during construction in

environmentally sensitive areas, such as wetlands. Figure 8 shows AVID students during the transportation and the environment session.



Figure 8. Transportation and the Environment Session.

Open Discussion with Texas A&M University Students

During this session, AVID students openly discussed with current Texas A&M University students what it is like to be in college (Figure 9). Items covered included:

- Inspiration for going to college.
- Inspiration for studying engineering.
- College life.
- Admissions.
- Classes.
- Studying.
- Challenging things about going to college.



Figure 9. Open Discussion with Texas A&M University Students.

Puff Mobile Hands-On Activity

The puff mobile is an activity that the American Society of Civil Engineers created for Public Broadcasting System (PBS) Kids activities during National Engineers Week. The activity encourages students to be creative and to work as a team in designing a vehicle that can travel the farthest distance possible when a team member puffs or blows on it. A TTI researcher gave each two-person team three straws, four lifesavers, one piece of paper, two paper clips, a roll of tape, and scissors. In order for the vehicle to work properly, the team had to design a vehicle that functioned well mechanically (i.e., the wheels move freely and aerodynamically). At the end of this activity, the teams raced their vehicles and discussed the advantages and disadvantages of the vehicles' designs. Figure 10 shows AVID students building and racing their puff mobiles.



Figure 10. AVID Students Building and Racing Puff Mobiles.

Assessment of Event

The team evaluated the effectiveness of the field trips based on feedback from the AVID teachers and TTI team members. Both AVID teachers thought the field trip was a great opportunity for the AVID students to see how professionals use science and math in their jobs. The teachers felt that the program content was age appropriate, aroused the students' interest,

and was a proper length. Team members felt that the duration of the field trip was appropriate and that sessions with more interactive aspects were better received. Also, team members liked the simultaneous format of the break-out activities since it divided the students into small groups, which facilitated more interaction between students and team members.

PRAIRIE VIEW A&M UNIVERSITY GARRETT A. MORGAN TRANSPORTATION SUMMER CAMP VISIT

Description and Conduct of Event

On July 12, 2011, 21 ninth and tenth grade students and 4 chaperons from the Prairie View A&M University (PVAMU) Garrett A. Morgan Transportation Summer Camp in Hempstead, Texas, visited TTI. On July 19, 2011, 16 eleventh and twelfth grade students and 4 chaperons from the same camp visited TTI. Each field trip lasted approximately 2.5 hours. During these field trips, students attended the following 30-minute activities:

- Transportation and engineering career awareness session.
- Career path discussion.
- Sign retroreflectivity session.
- Crash test session.
- TTI TransLink® Research Center tour (first field trip only).
- Transportation and the environment session (second field trip only).

Researchers conducted the first four of these activities for each field trip. Due to scheduling conflicts, the last two activities were only conducted for one of the field trips. The transportation and engineering career awareness session, crash test presentation, tour of the TTI TransLink® Research Center, and transportation and the environment session consisted of the same material discussed in the previous field trip section. The sign retroreflectivity session was adapted from the in-class educational outreach module. The career path discussion with led by a TTI researcher. During this activity, the researcher discussed career paths and his personal story about how he decided to become a City Manager that oversaw various transportation-related activities. This project funded the TTI researchers' efforts to develop the agendas, coordinate activities, and host the events.

Assessment of Event

The team evaluated the effectiveness of these field trips based on feedback from the chaperons and team members. The chaperons thought the program content was age appropriate, kept the students mildly interested, and was a suitable length. Team members agreed with these comments.

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH – RESIDENTIAL ADVENTURE FOR YOUNG ENGINEERS AND SCIENTISTS VISIT

Description and Conduct of Event

On July 20, 2011, approximately 50 eighth through twelfth grade students and 10 chaperons from the Science, Technology, Engineering, and Math – Residential Adventure for Young Engineers and Scientists (STEM-RAYES) summer camp hosted by the Texas A&M University College of Education and PVAMU visited TTI. The field trip lasted approximately 2 hours.

During this field trip, students attended a session about transportation and engineering careers and the following break-out sessions:

- Up close with the world of transportation gadgets.
- Transportation and the environment.
- Crash testing.

For the break-out activities, team members divided students into three groups. The break-out activities were conducted simultaneously, with students rotating to a different activity every 30 minutes. Previous sections describe all of these activities. This project funded the TTI researchers' efforts to develop the agenda, coordinate activities, and host the event.

Assessment of Event

Researchers received positive feedback from the chaperons and students. Team members felt that the presentations were appropriate in length and content, and again felt the simultaneous format of the break-out activities worked well.

OTHER OUTREACH

Researchers participated in four other educational outreach events to promote STEM fields and careers in transportation engineering and other transportation fields. Researchers conducted age appropriate activities at a Girl Scout Summer Day Camp, at two Explore Engineering Summer Camps hosted by the Engineering Student Services and Academic Programs, Dwight Look College of Engineering at Texas A&M University, and at the City of Waco Engineering Day event. The following sections describe these events in more detail.

GIRL SCOUT DAY CAMP

Description and Conduct of Event

On June 7, 2011, six TTI researchers traveled to Camp Howdy in Bryan, Texas, to make five 35-minute presentations concerning transportation and engineering at a Girl Scout Summer Day Camp. The event began at 9:00 a.m. and ended at 1:20 p.m. (30 minutes were provided for lunch). Table 1 shows the presentation times, activities, number of anticipated Girl Scouts for each presentation, and the grade level of the Girl Scouts.

Table 1. Camp Howdy Presentation Schedule and Participation.

Schedule	Activity	Number of Anticipated Attendees	Grade Level of Anticipated Attendees
9:00 a.m. – 9:35 a.m.	Sign	46	1 st and 2 nd
9:45 a.m. – 10:20 a.m.	Puff Mobile	40	6 th
10:30 a.m. – 11:05 a.m.	Puff Mobile	43	3 rd , 4 th , and 5 th
11:15 a.m. – 11:50 a.m.	Sign	50	2 nd and 3 rd
12:45 p.m. – 1:20 p.m.	Puff Mobile	76	3 rd , 4 th , and 5 th

Researchers conducted two activities dependent upon the grade level of the group. For Girl Scouts in first and second grade, researchers briefly introduced the fields of transportation and engineering, discussed the colors and shapes of traffic signs, and discussed how drivers see traffic signs at night at an age appropriate level. Interactive portions of the presentation

included having the Girl Scouts name modes of transportation and colors of traffic signs. Researchers also passed around various traffic control devices (e.g., pavement markings and RPMs). Figure 11 shows a researcher making the initial presentation.



Figure 11. TTI Researcher Presenting to Girl Scouts.

Next, the Girl Scouts in first and second grade were divided into two-person groups. Each group received a large piece of drawing paper and crayons. Researchers instructed each group to design a sign for the entrance of Camp Howdy. While the Girl Scouts were designing their signs, researchers brought small groups to the front to look at different types of sign sheeting with hand-held microscopes. Other researchers helped the girls design their sign. Figure 12 shows Girl Scouts creating signs and Figure 13 shows Girl Scouts looking at sign sheeting.

For Girl Scouts in the third through fifth grade, researchers conducted the same interactive presentation but expanded on some topics (e.g., retroreflectivity). These Girl Scouts also got to look at sign sheeting with hand-held microscopes. Instead of designing a traffic sign, these Girl Scouts designed and raced puff mobiles (previously described). Figure 14 shows Girl Scouts building and racing puff mobiles.

Overall, researchers estimated that 255 Girl Scouts attended the presentations. In addition, approximately 35 Girl Scout aids (seventh to twelfth grade students) helped the younger Girl Scouts with the hands-on activities. This project funded the TTI researchers' efforts to develop the presentation, assemble the materials for the hands-on activities, and attend the event.

Assessment of Event

Researchers did not receive feedback from the camp leaders, aids, or students. The researchers thought the presentation and activities held the attention of the Girl Scouts and were appropriate for the time allotted.



Figure 12. Girl Scouts Designing Signs.



Figure 13. Girl Scouts Examining Sign Sheeting with Hand-Held Microscopes.



Figure 14. Girl Scouts Building and Racing Puff Mobiles.

EXPLORE ENGINEERING SUMMER CAMPS

Description and Conduct of Event

On July 11, 2011, and July 18, 2011, a TTI researcher participated in the E12 Explore Engineering camps and Women Explore Engineering (WEE), respectively. These camps were hosted by the Engineering Student Services and Academic Programs, Dwight Look College of Engineering at Texas A&M University and held on the Texas A&M University Campus in College Station, Texas.

During each camp, a researcher made three 30-minute presentations. The presentations were about the concepts of reflection, refraction, and retroreflectivity and how transportation engineers use these concepts to design traffic signs and other traffic control devices. During the presentation, students were able to view and touch traffic signs, sign sheeting, pavement markings, RPMs, and a worker vest and hard hat. This project funded the TTI researchers' efforts to develop the presentation and attend the events.

Approximately 20 eleventh and twelfth grade students participated in each presentation. Thus, a total of 120 students were exposed to the field of transportation engineering and the science behind traffic signs and other traffic control devices.

Assessment of Event

Feedback from the event coordinator was positive. In the future, researchers need to focus more on the transportation engineering aspect; specifically why they chose to become a transportation engineer, what they do, etc. Event staff asked the researchers to conduct a presentation/demonstration, but the students were more interested in learning about the various types of engineering and hearing personal stories.

CITY OF WACO ENGINEERING DAY

Description and Conduct of Event

On October 19, 2010, two TTI researchers attended the City of Waco Engineering Day event at the Waco Convention Center in Waco, Texas. The purpose of this event was to provide an informal opportunity for middle and high school students to meet a broad spectrum of representatives in engineering fields; hopefully generating student interest in the field of engineering at a time when students begin to look at career choices.

The TTI booth covered various aspects of transportation engineering (e.g., traffic control devices and crash testing). This project funded the TTI researchers' efforts to develop the displays and attend the event.

This event was held from 8:00 a.m. to 4:00 p.m. Five large groups of students visited throughout the day. Each group had approximately 1.5 hours to visit 30 firms' booths. Approximately 700 middle and high school students visited the TTI booth and interacted with the researchers. Again, although the interactions were brief, students were introduced to the field of transportation.

Assessment of Event

Researchers did not receive feedback from the event coordinator, teachers, or students. The researchers thought the booth attracted the attention of students and noticed that the booth had a constant stream of visitors.

SUMMARY AND CONCLUSIONS

SUMMARY

The purpose of this project was to investigate new methods for conducting educational outreach activities for K–12 students. One method of interest to researchers was webinar technology, which provides an opportunity to reach more students in the classroom at more locations in a more cost- and time-efficient manner. However, after discussions with multiple teachers at various schools, researchers deemed this method infeasible due to a lack of technology at the school or in the classroom (both webinar-related and engineering-related) and the inability to demonstrate certain engineering concepts. In addition, teachers and researchers felt that the person-to-person interaction and hands-on activities were critical to the effectiveness of the educational outreach activities. Still, in addition to more traditional outreach activities (e.g., field trips and career fairs), researchers were able to investigate new methods for conducting educational outreach activities inside and outside of the classroom.

During this project, TTI researchers developed two in-class educational outreach modules. The first in-class module introduces intermediate school students to the world of transportation and transportation engineering and teaches students about the principle of retroreflectivity. The second in-class module teaches kindergarten students about sign shapes and colors. In addition, researchers created several displays that they could easily transport and exhibit at various educational outreach activities.

Overall, TTI researchers participated in 12 educational outreach activities. These activities included:

- Four in-school events.
- Four field trips to TTI facilities.
- Three summer activities.
- One engineering day event.

Most of these activities were held in the Bryan/College Station, Texas, area; but students from other parts of Texas did participate in some of the activities. The students participating in these activities ranged from kindergarten to twelfth grade. The educational outreach activities conducted introduced the fields of transportation and engineering to over 2000 students.

CONCLUSIONS

Field trips continue to be a successful educational outreach activity since students can encounter professionals in their working environment and view a sampling of several aspects of transportation engineering in one setting. Break-out activities work very well, since it divides the students into smaller groups, which facilitates more interaction between students and professionals. Unfortunately, budget constraints limit public schools' ability to take field trips.

Researchers were very excited about the success of the in-class educational outreach modules. This type of educational outreach does not require financial or equipment (e.g., buses)

commitments from school districts and does not require students to miss class. However, the time and effort for an individual professional is increased compared to the time and effort needed to conduct a field trip. Based on the positive experience and feedback, TTI researchers plan to identify other funding sources that would allow one researcher to conduct the in-class retroreflectivity module each year at Oakwood Intermediate School, in College Station, Texas, with the potential to expand the activity to other intermediate schools in the area.

Researchers believe that traditional educational outreach activities, such as career fairs and engineering day events, will continue to play an important role in developing the next generation of engineers and scientists. In addition, researchers need to further explore and utilize new outreach avenues, such as science and math nights at local schools and summer camps, to reach as many students as possible.



University Transportation Center for Mobility™

Texas Transportation Institute

The Texas A&M University System

College Station, TX 77843-3135

Tel: 979.845.2538 Fax: 979.845.9761

utcm.tamu.edu

