2015

STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

Final Report

K-12 Workforce Development in Transportation Engineering at Florida International University

(2012- Task Order # 005)

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September 2015

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U.S. DOT DISCLAIMER

ACKNOWLEDGEMENT OF SPONSORSHIP

This work was sponsored by a grant from the Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE) at the University of Florida. The STRIDE Center is funded through the U.S. Department of Transportation's University Transportation Centers Program.

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ABSTRACT

The goals of this project were to (1) improve interest and comfort level of K-12 students and families with STEM subjects as applied to Transportation Engineering; and (2) develop a STEM education and training dissemination program focusing on transportation engineering. The faculty and students at Florida International University (FIU) conducted activities geared for the K-12 pipeline, professional societies, industry, families to systematically enhance the quality and excellence in STEM education.

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CHAPTER 1: INTRODUCTION

As South Florida's first urban public research university, FIU is the university of access for the region's four million residents. Ranked first in the nation in awarding baccalaureate and master's degrees to Hispanic students and third in granting bachelor's degrees to minorities, FIU has distinguished itself as one of the nation's largest, most diverse institutions of higher education. Its student body of 38,000 reflects the vibrant diversity of South Florida: 59% Hispanic, 13% Black, and 56% female. By taking advantage of FIU's composition and location, we will particularly focus on the education and recruitment of Hispanic and African American students. FIU is located in the great Miami area which serves as a large point of immigration. With a sprawling urban system of more than 380,000 students and over 333 schools, the student population in the Miami-Dade County Public Schools (M-DCPS) is composed of a large proportion of minority. Specifically, 87% of M-DCPS student population is minority (56% Hispanic and 31% African American).

The faculty in collaboration with FIU ITE Student Chapter is working with the area schools to promote transportation engineering, transportation technology, and role of transportation engineering for establishing livable communities.

PROJECT OBJECTIVES

The project had the following goals:

Goal 1: Improve interest and comfort level of K-12 students and families with STEM subjects as applied to Transportation Engineering.

Goal 2: Develop a STEM education and training dissemination program in Transportation Engineering.

The results of this research can be used for routing hazardous material cargoes, not only to minimize risks of transportation accidents which impact human health and safety, but also to avoid transportation congestions, while make the suggested routing options appealing to the carriers by finding economically viable routes.

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CHAPTER 2: PROJECT ACTIVITIES

The activities focused on use and importance of GIS, traffic safety education, traffic simulations, and educational hands on activities with direct use of science, technology, mathematics and engineering concepts. The activities targeted students specifically in elementary, middle and high schools in Dade County as well as parents. The program focused on the following:

1. **E**mphasis on science, technology, engineering, and mathematics skills for a diverse student population with examples from transportation engineering,
2. Outreach and parental educational materials,
3. Curriculum development and support,
4. Integration of technology into learning with hands-on activities,
5. Dissemination of effective science and engineering education practices focusing on transportation related subjects (e.g., safety, planning, transport of people and cargo).

In collaboration with FIU ITE Student Chapter, the elementary and middle school students were introduced to different video games which provided direct exposure to engineering aspects of traffic safety, scheduling, planning as well as demand management. In addition, the educational materials and hands on activities are being distributed and transportation engineering modules have been used by FIU's existing outreach programs operating at five elementary schools serving grades 1st - 4th as afterschool programs.

1. Outreach Effects during School Year and Summer Programs

The activities were conducted during the school year and summer months at FIU. Two computers will be purchased for training and demonstration purposes. Activities will be coordinated with FIU's Women in Transportation Student Chapter and International Transportation Engineers (ITE) Student Chapter. The program will be conducted using modules and activities emphasizing transportation engineering and transportation safety.

2. Transportation Career Day

This activity will be coordinated by the ITE Student Chapter. Over 1,400 students from Miami-Dade County elementary, middle and high schools attended the annual FIU Engineering Expo. The students participated in "engineering immersion" activities to learn about different engineering fields in a fun and interactive way. The FIU ITE student chapter helped organize the event and served as tour guides

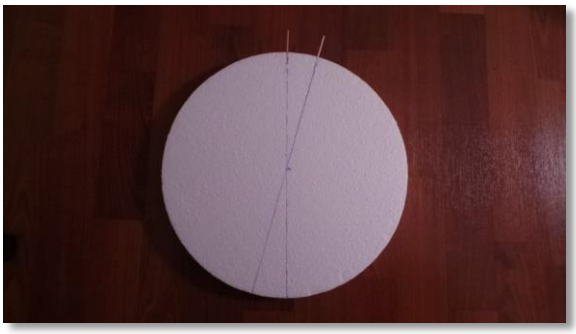
This activity was coordinated with the Annual Engineering Gala which took place during Engineers week at FIU. In addition, ITE students conducted interactive demonstrations and hands on activities with elementary and middle school students.

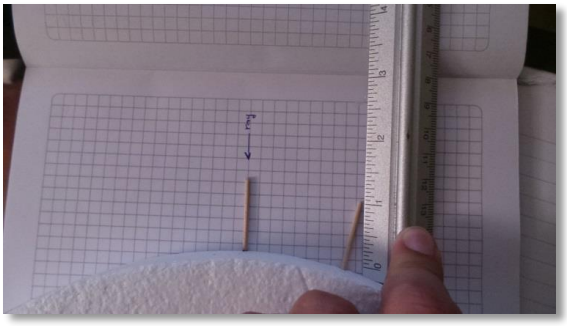
4. Activity development

Faculty in collaboration with FIU's students developed a serried of hands on activities addressing different aspects of transportation. A summary of the hands on activities that have been developed are provided below:

Activity 1: Around the World

This activity focuses on finding a geographic location by use mathematics and observations of surroundings. It also emphasizes the importance of modern tool which use satellites and Global Position Systems (GPS), and maps using "Google Earth."

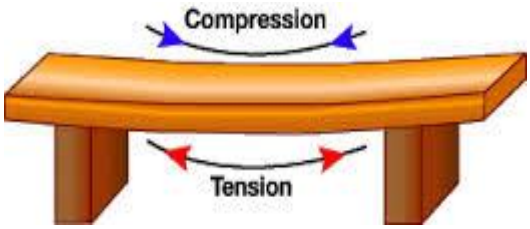




Activity 2: Building Begins with a Beam

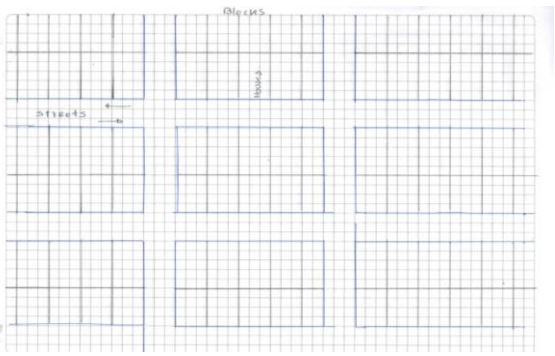
This activity focuses on building a simple-span beam (vertically supported at both ends) out of 48-inch long strips of ¾-inch foam material. The beam is tested for its ability to support as much test load as possible at mid-span without significant deflection under the load. Participants use straws to test the deflection.



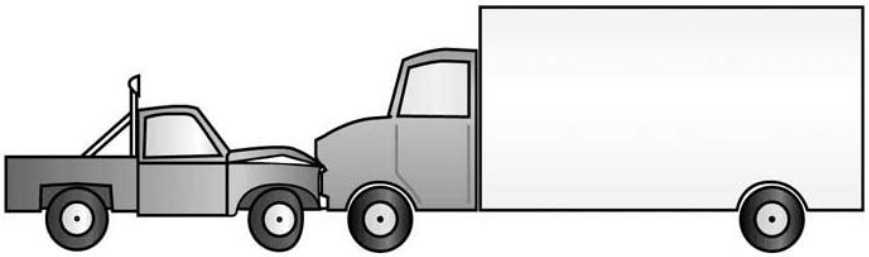
Activity 3: City Grid (team activity)

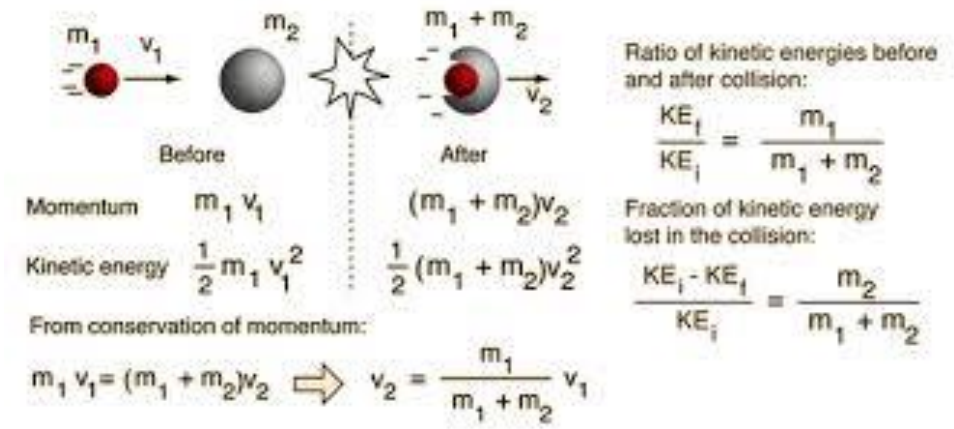
This activity emphasizes the importance of transportation engineering terms and applications in daily life. Each team develops strategies and estimates the travel times and congestion segments under different scenarios (number of people, location of schools and grocery stores, accident, etc.).

Activity 4: Marbles' Momentum

This activity aims to analyze and explain the concepts of momentum and impulse as well as the relationship between them.





Activity 5: Transportation Quiz Ball

This index card game was developed to introduce participants to basic concepts and applications of the transportation engineering field. A series of question were developed for a Quiz game emphasizing the application of technology and scientific principles to the planning, design, operation and management of facilities for any mode of transportation in order to provide a safe, rapid, comfortable, convenient, economical and environmentally compatible movement of

people and goods. The questions included 1) aerospace, 2) air transportation, 3) highways, 4) pipelines, 5) waterways, port, coastal and ocean and 6) urban transportation concepts and terminology.

Examples questions are provided below. There are 10 index cards with the following information.

1. Transportation engineering applies its tools to the _____,_____, _____, and _____ of facilities for any mode of transportation.
   a) Planning, design, operation, management.
   b) Painting, gaming, entertainment, spying.
   c) None of the above.

   Correct answer: a

2. Transport engineering uses:
   a) Scientific principles
   b) Technology
   c) All of the above

   Correct answer: c

3. Transportation includes the safe and efficient movement of:
   a) People, cows and water
   b) Meat, bread, vegetables
   c) Both a and b.

   Correct answer: c

4. The following is NOT a subdivision of transportation engineering.

    a) Aerospace

    b) Highways

    c) Restaurants

    Correct answer: c

5. The following is NOT a subdivision of transport engineering.

    a) Urban transportation

    b) Waterway, ports, coastal and ocean

    c) Tablets and smart media.

    Correct answer: c

6. Which of the following scenarios pertains to transport engineering?

    a) The launch of a rocket into space in order to bring electronic instruments needed in the space station.

    b) Pipeline construction to move crude oil from Alberta, Canada to Texas, USA

    c) Both a and b

    Correct answer: c

7. Which of the following technologies will benefit the most urban transportation?

    a) A new football video game

    b) A phone app that allows drives to find alternative routes when traffic jams.

c) A new cell phone application to download free music while driving.

Correct answer: b

8. The construction of bridges, bus terminals, train stations and rocket platforms are directly related to what field?

a) Food and restaurant industry

b) Reality show business

c) Engineering

Correct answer: c

9. When a transportation engineer starts the planning process of a road from your neighborhood to school, what of the following aspects do you consider important?

a) Type of transportation used for people in the area

b) How many cars could be on the road daily

c) All of the above

Correct answer: c

10. Before the planning process begins, an inventory must be created. If you were to select important information before planning a road or rail road construction, which of the following aspects should be in an inventory?

a) Population

b) Economic activity

c) All of the above

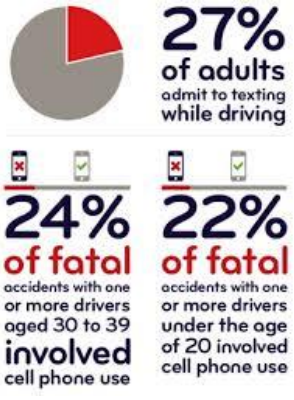
Correct answer: c

Activity 6: Wind Jammer

In this activity, participants use wind power to transport a specific load. The wind blows into the area of the object and pushes against it. The goal of the team activity is to transport two erasers form the starting point to the finish line using only the wind generated by a small fan.

Activity 7: What could happen next, if you send that text?

This activity involves increasing awareness about texting and driving. One person sits in a chair and pretends to be in the driving position with their phone within reach. A second person sits in front of them holding index cards at the driver's eye level. As the 2nd person rapidly shows different traffic related images (e.g., stop sign, person, dog, children, red light, etc.) placed on a series of index cards. The driver calls out picture that they see while they are trying to type a short text into their phone. A third person keeps a log on paper of what the driver sees (number of items) and the actual number of items have been shown from the index cards. The observers compare what the driver saw and missed. Loss of attention and the risks of texting while driving are discussed.



Texting and Driving Statistics [from textinganddrivingsafety.com/]

Texting while driving is a growing trend, and a national epidemic, quickly becoming one of the country's top killers. Drivers assume they can handle texting while driving and remain safe, but the numbers do not lie.

Texting while driving causes:

1. 1,600,000 accidents per year – National Safety Council
2. 330,000 injuries per year – Harvard Center for Risk Analysis Study
3. 11 teen deaths EVERY DAY – Ins. Institute for Hwy Safety Fatality Facts
4. Nearly 25% of ALL car accidents

Texting while driving is:

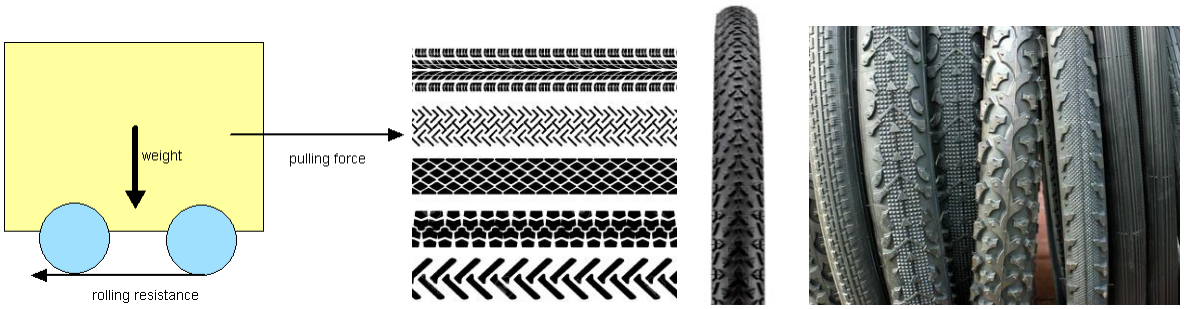
1. About 6 times more likely to cause an accident than driving intoxicated
2. The same as driving after 4 beers – National Hwy Transportation Safety Admin.
3. The number one driving distraction reported by teen drivers

Texting while driving:

1. Makes you 23X more likely to crash – National Hwy Transportation Safety Admin.
2. Is the same as driving blind for 5 seconds at a time – VA. Tech Transportation Institute
3. Takes place by 800,000 drivers at any given time across the country
4. Slows your brake reaction speed by 18% – Human Factors & Ergonomics Society
5. Leads to a 400% increase with eyes off the road.

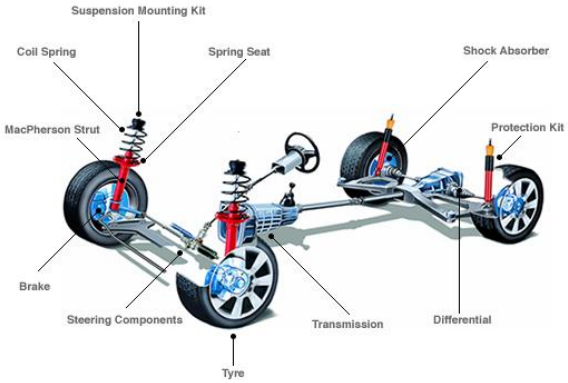
Activity 8: Where the rubber meets the road

This activity demonstrates the importance of tire design and threads on grip performance and performance on different surfaces. Depending on the type, a bicycle has either fat tires or thin tires. Most road bikes and touring bikes have thinner tires, while mountain bikes have big fat tires. Each type of tire has been adapted for the surfaces they ride on. The road tires are inflated to 100 or even 120 PSI (pounds per square inch). A firm thin tire on the asphalt surface won't flatten much. The less the tire flattens out on the bottom, the less surface area is in contact with the road. Less contact in this case means less friction, and more speed. This is why keeping tires properly inflated is so important. The treads of mountain bike tires can affect performance. Rough or "knobby" treads grip dirt trails better, but create greater friction on smooth roads. Smooth tires grip smooth roads better, with less resistance, but slip on dirt trails. Mountain bike tires manufacturers produce a variety of different patterned nobby treads. While cyclists have different preferences, there has been little scientific support for one tread performing better than another.



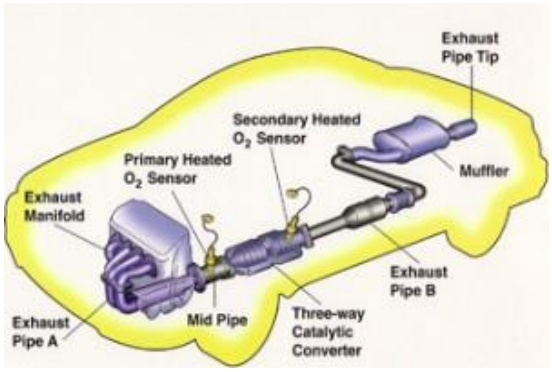
Activity 9: Shock absorber

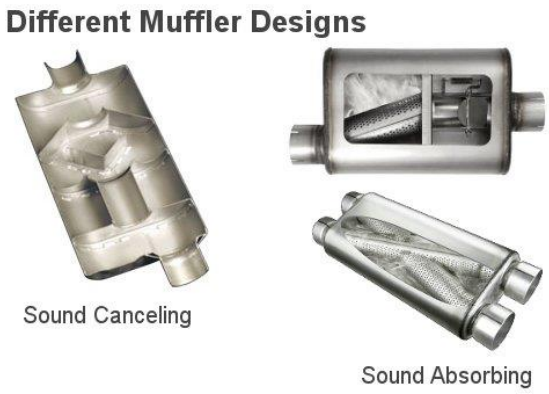
This activity emphasizes the importance of shock absorbers in vehicles. It is illustrated with different activities.



Activity 10: How a muffle works

This activity involves building a muffler using commonly found materials. Noise control and different types of muffling mechanisms are discussed.

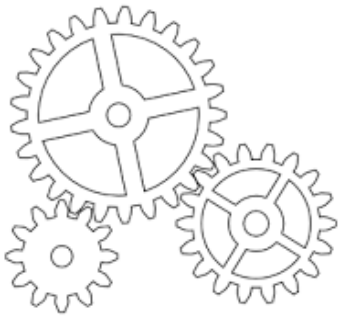




Activity 11: Gears on your bicycle

This experiment is designed to test what we learned about gear ratios, using a bicycle.

Using the tape measure or ruler, the radius of the gear on wheel is measured. This is the distance from the center of the gear to where the chain sits on the teeth of the gear. Then, the radius of the gear on the pedals is measured.



Data Table 1

	Wheel gear radius	Pedal gear radius	Wheel revolutions after 1 pedal revolution	Wheel revolutions after 5 pedal revolutions
Trial 1				
Trial 2				
Trial 3				

Gear ratio is the reciprocal of the ratio of revolutions.

Gear Ratio = Wheel gear radius ÷ Pedal gear radius

Data Table 2

	gear ratio	Ratio of Revolutions: 1 pedal revolution	Ratio of Revolutions: 5 pedal revolutions	Ratio of Revolutions: average	Reciprocal of average
Trial 1					
Trial 2					
Trial 3					

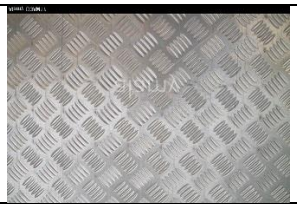
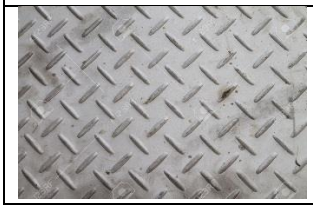
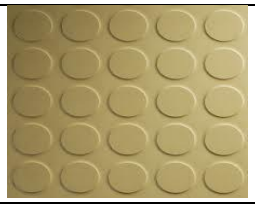
Activity 12: Slippery when wet

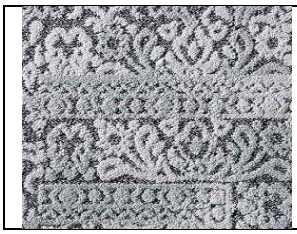
This activity involved a set of hands on activities that were designed to demonstrate the participants to change in friction forces. Activity involved shoes with different types of soles, a flat surface with adjustable height (inclination). Effect of moisture of friction forces was observed.

Activity 13: Comparing surface friction

This activity is used to illustrate effect of surface characteristics on friction. Participants feel different surfaces and guess which type of surface would have the highest friction and which types of shoes may be suitable to walk on those surfaces.

		
a	**b**	**c**
		
d	**f**	**f**




Activity 14: Raft rally

This activity involves designing a "raft" from a 20 cm x 20 cm piece of aluminum foil that will hold the highest amount of sand. Each team is provided with 1 sheet of foil and 6 straws. The raft is expected to move by blowing air by one person to travel 30 cm distance. Participants can use part of the foil as sail.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