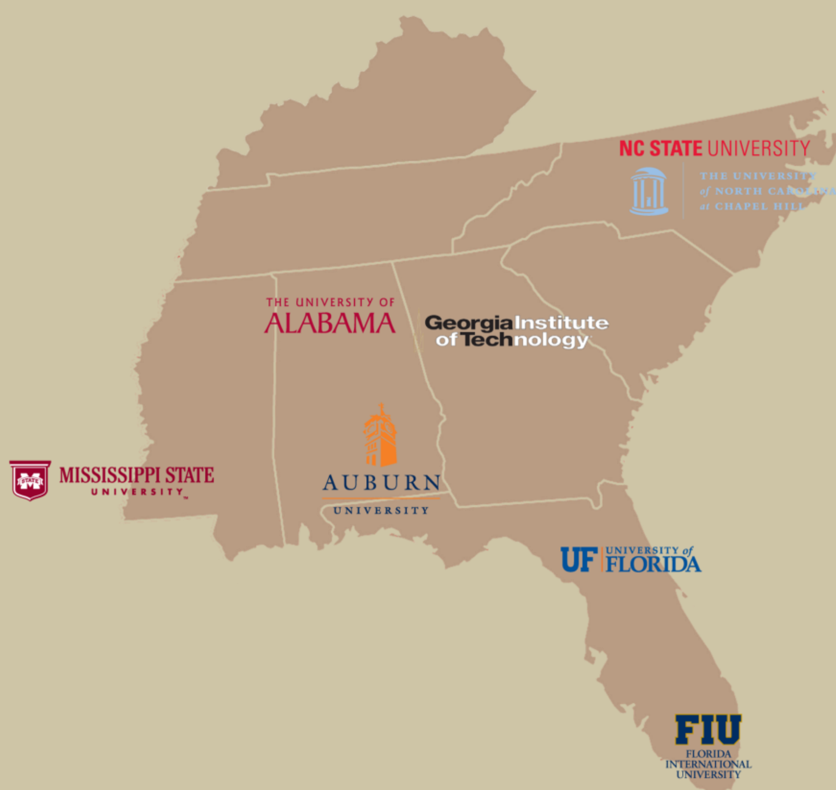
2014

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

Final Report

UF Workforce Development Efforts

(2012-00103944)



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June 2014

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Acknowledgment of Sponsorship

This work was sponsored by a grant from the Southeastern Transportation Research, Innovation, Development and Education Center, a U.S. DOT Region 4 grant-funded University Transportation Center.

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ABSRACT

Workforce development activities aim to attract new entrants into the transportation field and improve the skills of the existing workforce to effectively address today's transportation system challenges. The University of Florida Transportation Institute (UFTI) participated in three planned K-12 outreach activities for STRIDE, as well as several other activities as outlined:

LEGO® Robot Vehicle Lesson Plans for Secondary Education: UFTI used the "Introduction to Transportation" curriculum developed at UF for students in grades 5-8 in local schools, afterschool programs, and summer camps. Students learned various fundamentals of Transportation Engineering and how the use of advanced technology is integral to solving current and future transportation problems. They also learned how much transportation affects the quality of life in our society and touches safety, livability, and economic competitiveness.

Transportation Career Day: Designed to introduce high school-aged students to transportation careers, the day-long event featured a presentation, lab tour, and hands-on traffic simulation exercise.

Family Engineering Events: UFTI hosted an informal engineering education program at local elementary schools to team up children aged 7-12 and their parents or caregivers to experience fun, hands-on engineering activities. Parents and caregivers can positively influence attitudes about engineering and encourage consideration of a possible career in engineering by showing interest in and willingness to explore such engineering activities.

In addition to the programs planned for STRIDE, UFTI participated in outreach with assistance from university student chapter members and through local partnerships. Students provided a booth at the College of Engineering's Engineering Fair, and hosted morning workshops on transportation engineering in partnership with GatorTRAX, a university student run organization that hosts engineering and math workshops for K-12 students.

The Cade Museum for Creativity and Innovation in Gainesville provides hands-on classes and labs that focus thematic-based learning using inventors and inventions to teach and inspire creativity in the next generation. UFTI partnered with the Cade Museum to provide workshops not only with the LEGO® robotic curriculum, but also with newly-developed straw bridge challenge, roller coaster design challenge, and engineering day curricula.

Project funds provided equipment (purchased as needed) to support the STRIDE University of Florida workforce development efforts. No salaries were charged to this project.

The Council of University Transportation Centers held a National Transportation Workforce Summit April 24-26, 2012. Gerhard Salinger from the National Science Foundation stated, "Rather than developing a course for railroads or any of the modes...we can take a math problem and teach people mathematics in the context of a transportation problem. And then do a bit more exploration about transportation so students get the idea." (1) UFTI aims to expose children to transportation through exploration and activities that already interest them.

EXECUTIVE SUMMARY

A National Workforce Summit, sponsored by FHWA, Federal Transit Administration and Research and Special Programs Administration, was held in May 2002 to coordinate an initiative to preserve and advance the U.S. transportation system. The summit members outlined three critical areas that need to be addressed:

1. Ensuring that young people are attracted to the transportation jobs of the future;
2. Ensuring that workers are using the latest technologies and practices to improve transportation; and
3. Developing partnerships throughout the transportation and education communities to “institutionalize” transportation workforce development. (2)

Summit participants emphasized the need to expose students to transportation early and often, by making it applicable to coursework at hand. This need has been the key focus of UFTI’s approach to K-12 workforce development. The UFTI addresses each of the above critical issues with its K-12 workforce development efforts outlined in the following report. The programs developed and implemented through this project expose children to careers in transportation by partnering with science teachers, university engineering student chapter members, Girl Scout troops, and coordinators at afterschool programs, local churches, and a local science museum.

Increasing career awareness among the next generation requires a comprehensive approach, from industry partners to parents and neighborhood leaders. Developing tools to educate parents, teachers, and school counselors about transportation career opportunities allows children and young adults to learn about transportation in both the classroom and at home. (2)

During the first year from July 1, 2012 to October 31, 2013, the UFTI STRIDE K-12 workforce development programs exposed 1128 elementary, middle and high school students to careers in transportation with twenty five organized events utilizing a variety of activities including robots, PowerPoint presentations, videos, hands-on activities, panel discussions, lab tours and computer simulation.
Even if children exposed to careers in transportation do not choose engineering as a career, the programs are still successful in exposing kids to elements of transportation that should equip them to make better decisions in the future about transportation needs in their community.

According to Toole and Martin, “The next generation of transportation professionals is sitting in our classrooms today. It is not too early to consider what will affect their choices and how we need to support them in their development.” (3)

CHAPTER 1 BACKGROUND

PROBLEM STATEMENT

Urban and rural areas continue to see traffic growth, increasing the need for more transportation engineers. As Baby Boomers retire, the profession is losing over half of the state agency transportation engineers and many more local agency professionals. The *TRB Special Report 275—The Workforce Challenge* reviews some of the transportation workforce needs. (2) This shortage has increased demand on universities to work harder at recruiting more and brighter students to the field.

A National Workforce Summit, sponsored by FHWA, Federal Transit Administration and Research and Special Programs Administration, was held in May 2002 to coordinate an initiative to preserve and advance the U.S. transportation system. The summit members outlined three critical areas of need to be addressed:

1. Ensuring that young people are attracted to the transportation jobs of the future;
2. Ensuring that workers are using the latest technologies and practices to improve transportation; and
3. Developing partnerships throughout the transportation and education communities to “institutionalize” transportation workforce development. (2)

The University of Florida Transportation Institute (UFTI) workforce development efforts covered in this report for period July 1, 2012 to October 31, 2013 address each of these three critical issues. According to Toole and Martin, “The next generation of transportation professionals is sitting in our classrooms today. It is not too early to consider what will affect their choices and how we need to support them in their development.” (3)

RESEARCH OBJECTIVES

The objectives of the workforce development effort are to conduct outreach programs and document reporting metrics outlined in the STRIDE prospectus, including Transportation Career Day, Family Engineering, and LEGO Robotic Vehicle Lesson Plans for Secondary Education. Documentation metrics include:

- Number of events organized
- Number of participants in K-12 events
- Number of schools visited
- Number of contact hours
- Number of participant hours
- Number of K-12 lesson plans developed

Project funds provide for equipment (purchased as needed) to support the STRIDE UFTI workforce development efforts. No salaries were charged to this project.

SCOPE OF STUDY

The following workforce development activities were planned and conducted with several other activities added when appropriate:

LEGO® Robot Vehicle Lesson Plans for Secondary Education: UFTI used the "Introduction to Transportation" curriculum developed at UF for students in grades 5-8 in local schools, afterschool programs, and summer camps. Students learned various fundamentals of Transportation Engineering and how the use of advanced technology is integral to solving current and future transportation problems. They also learned how much transportation affects the quality of life in our society and touches safety, livability, and economic competitiveness.

Transportation Career Day: A Transportation Career Day was designed for high school-aged students to introduce them to transportation careers through a presentation, lab tour, and hands-on traffic simulation exercise.

Family Engineering Events: UFTI hosted an informal engineering education program at local elementary schools designed to engage children aged 7-12 and their parents or caregivers together as a team in fun, hands-on engineering activities. Parents and caregivers can positively influence a child's attitude about engineering and encourage their children to consider a possible career in engineering by showing interest in and willingness to explore such engineering activities.

CHAPTER 2 RESEARCH APPROACH

TASKS

LEGO® Robot Vehicle Lesson Plans for Secondary Education: UFTI used the "Introduction to Transportation" curriculum for five seven-hour workshops with 54 total participants. UFTI instructors, Leslie Washburn and Morgan Witter, guided students through modules intended to teach students how an intelligent vehicle can help mitigate congestion by using sensors and computer programming. Exercises included programming the intelligent vehicle to move, follow a route, detect and pull over for an emergency vehicle, and detect and brake for pedestrians. Participants also learn how to calculate travel time and distance, as well as the extent to which transportation affects the quality of life in our society. The goal of the workshops was to explore the exciting field of transportation engineering and encourage students to pursue this field as a career.

Washburn also conducted a workshop for a local Girl Scout troop that later demonstrated their new robot programming and transportation career knowledge to 35 fourth- and fifth-grade students at an afterschool science club meeting.

Washburn and Witter presented the curriculum again in partnership with the Cade Museum to host three workshops. The Cade Museum's lab focuses on hands-on interactive workshops for kids designed to connect science and engineering concepts to invention in exciting ways.

Finally, Washburn and Witter delivered the curriculum to eleven middle school girls at Arlington Middle School in Jacksonville, FL, as part of the school's efforts to create an all-girls competitive robotics team for their afterschool program.

See Table 3-1 for further details on dates, locations, and participant numbers.

Transportation Career Day: UFTI developed a Transportation Career Day agenda and simulation exercise to introduce high school-aged students to transportation careers. The full day curriculum will be implemented in 2014 with a professor presentation, an interactive panel discussion with graduate students, and a signal lab tour which includes a demonstration of a signal control cabinet and city video traffic control system. In the afternoon, students will participate in a hands-on traffic simulation exercise.

Graduate students developed a traffic simulation exercise using CORSIM (CORridor SIMulation), which they piloted during a 2-hour workshop for a visiting high school student in March 2012. CORSIM is a microscopic traffic simulation software package for signal systems, highway systems, freeway systems, or combined signal, highway and freeway systems. In October 2013, eleven high school students from the Gainesville area participated in a second 2-hour traffic simulation workshop.

The first part of the simulation workshop covered the basics of signal timing and phasing through building a single isolated and pre-timed intersection within CORSIM. Workshop participants created nodes and links for the intersection and entered the inputs needed such as volumes, link lengths, and free-flow speeds, as well as others. They began by selecting a timing plan for their signal that they thought would yield the best operations. Participants were required to determine the necessary yellow and all-red times for each phase of their signal phasing plan using the provided equations. Once they selected their timing plan, a CORSIM simulation was run to determine if their timing plan was adequate or needed to be improved. Participants were encouraged to obtain the best possible outputs (i.e., minimized delay) by adjusting their timing plan as needed. After the participants obtained what they felt was their best plan, UF students showed their own best timing plans along with the results from their own simulations which helped participants gain a better understanding of which inputs influence the operation of transportation systems and how traffic signals affect these operations.

In the second part of the simulation workshop, participants focused on coordinated signalized intersections using a CORSIM file containing three signalized intersections. Participants tried to select offsets and modify existing green times and cycle lengths to best improve the existing network. The amount of time needed to travel from one intersection to another based on the free-flow speed and link lengths was calculated to help determine offset values for each signal.

Washburn also participated in career day at a local elementary school and introduced 60 fifth graders to careers in transportation engineering.

See Table 3-2 for further details on dates, locations, and participant numbers.

<u>Family Engineering Events:</u> UFTI hosted an informal engineering education program at local elementary schools for elementary-aged children and their families to participate in fun, hands-on engineering activities. The activities highlighted several engineering disciplines, such as building a cantilever out of dominos, pushing a LEGO® brick into various earth samples to evaluate the best materials to use for foundations and playground coverings, and matching cards of products with the engineer who designed that product. Family Engineering activities are designed to engage children aged 7-12 and their parents or caregivers in actively working together as a team. Parents and caregivers can positively influence a child's attitude about engineering and encourage their children to consider a possible career in engineering by showing interest in and willingness to explore such activities.

UFTI teamed with the Women Transportation Seminar (WTS), Institute of Transportation Engineers (ITE) and the American Society of Civil Engineers (ASCE) Student Chapters at UF to host eight Family Engineering Events. Each two-hour event was staffed by 20-30 student chapter volunteers who interacted with a total of 511 participants, averaging to around 64 children per event. These efforts included manning a large booth at a school carnival, offering engineering activities to children in afterschool programs, and setting up multiple activity stations in school cafeterias for whole-family participation.

See Table 3-3 for further details on dates, locations, and participant numbers.

<u>Engineering Fair:</u> In addition to the outreach programs designated in the STRIDE prospectus, UFTI gained assistance from undergraduate and graduate student volunteers to host a booth at the College of Engineering, Engineering Fair. The Engineering Fair brought hundreds of

K-12 students to a large ballroom where various student chapters provided displays and hands-on activities for the students to learn about various engineering fields.

STRIDE efforts organized the booth by providing the activities and materials. UF students built an urban city out of LEGO® Education products to visually demonstrate transportation concepts to attendees, who were then encouraged to build a LEGO® car and race against their peers. Participants were introduced to the concepts of air resistance, center of gravity, momentum, and the impact of the incline plane on LEGO® car speed. Volunteers interacted with approximately 300 children who visited the booth during the events.

See Table 3-4 for further details on dates, locations, and participant numbers.

<u>GatorTRAX:</u> STRIDE encouraged and guided the GatorTRAX effort by providing materials and activities for this unique, free Saturday morning program held monthly during the regular school semester featuring a different topic each month. Each event, organized by the Engineering Honor Society Tau Beta Pi, was a math excellence initiative providing K-12 students with opportunities to learn mathematics through free hands-on activities GatorTRAX was designed to pave the way to careers in engineering or other fields that require creative thinking, as well as analytical and problem-solving skills.

With help from members of the UF WTS and ITE Student Chapters, STRIDE facilitated three morning workshops which included a PowerPoint presentation, short video, and an overview of the LEGO® urban city. Participants were given time to sketch a LEGO® car design and construct a car using LEGO® bricks. Students completed the activity by racing their car down a ramp and competing for fastest car.

About 75% of the 129 participants were elementary school students, and the remainder were middle school students. Tau Beta Pi hosted a GatorTRAX website and developed an extensive email list of teachers, parents, and community organizers who received event announcements.

See Table 3-5 for further details on dates, locations, and participant numbers.

<u>Cade Museum:</u> The Cade Museum for Innovation and Creativity is a local start up museum with a lab for K-12 workshops. In addition to the three "Introduction to Transportation" workshops featuring LEGO® Robot Vehicle Lesson Plans for Secondary Education curriculum, UFTI teamed with the museum to host three additional workshops encouraging middle school students to consider engineering as a career choice. Washburn developed the curriculum, which Witter delivered with help from university engineering student volunteers.

The first and second two-hour workshops focused on building straw bridges and roller coasters, respectively. Six students participated in the Straw Bridge Challenge and seven participated in the Careening Coaster workshop. Washburn used these two pilot workshops to develop Engineering Day, the third workshop aimed to introduce middle-school students to engineering concepts and foster interest in engineering as a possible career option.

The fourteen attendees began the day by working in pairs to create roller coasters out of wire, construction paper, popsicle sticks, clay, and tape. Students discovered the relationship between gravity and mass, viewed videos and slides about the differences between potential and kinetic energy, and learned how engineers use these elements to build bigger and better roller coasters.

Next, the attendees learned about different types of bridges, the relationship between compression and tension, and the methods engineers use to select materials and bridge types. Pairs of students applied their new knowledge of weight, torque, force, and compression to build bridges out of drinking straws, tape, and paper clips. A competition to build the strongest bridge capable of holding the most weight in pennies concluded the activity.

Attendees then worked individually to build cars powered by the energy of a string wound around the spring of a mousetrap. Through this activity, students learned about friction, velocity, acceleration, and Newton's three laws of motion. The kids enjoyed decorating and racing their cars, and were able to take them home at the end of the day.

See Table 3-6 for further details on dates, locations, and participant numbers.

Chapter 3 FINDINGS AND APPLICATIONS

The following tables provide the dates, locations, and number of K-12 student participants for each event for period July 1, 2012 to October 31, 2013.

Table 3-1. LEGO® Robot Vehicle Lesson Plans for Secondary Education

Date of Event	Location	Participants	Contact Hours	Participant Hours
3/7/2012	Girl Scout Troop 1520	10	7	70
5/9/2012	Girl Scout Demonstration Lawton Chiles Elementary	35	1	35
10/26/2012	Cade Museum	10	7	70
2/15/2013	Cade Museum	16	7	112
7/17/2013	Cade Museum	7	7	49
10/19/2013	Arlington Middle School	11	7	77
Total		**89**	**36**	**413**

Table 3-2. Transportation Career Day

Date of Event	Location	Participants	Contact Hours	Participant Hours
3/7/2012	UF Campus	1	2	2
5/18/2012	Lawton Chiles Elementary	60	1	60
10/26/2013	UF Campus	11	6	66
Total		**72**	**9**	**128**

Table 3-3. Family Engineering Events

Date of Event	Location	Participants	Contact Hours	Participant Hours
2/15/2012	Lawton Chiles Elementary	120	2	240
3/14/2012	Chiles Afterschool Program	60	2	120
4/11/2012	Williams Elementary	10	2	20
10/25/2012	PK Yonge Research School	60	2	*10
2/7/2013	Lawton Chiles Elementary	76	2	152

10/14/2013	Lincoln Middle Afterschool	50	2	100
10/18/2013	PK Yonge Research School	85	2	*14
10/21/2013	Lincoln Middle Afterschool	50	2	100
Total		**511**	**16**	**756**

*Note: The time participants spent at the table at the PK Yonge carnival varied and participant hours are estimated based on an average of 10 minutes for each student.

Table 3-4. Engineering Fair

Date of Event	Location	Participants	Contact Hours	Participant Hours
2/21/2012	UF Campus	145	8	24
2/15/2013	UF Campus	155	8	26
Total		**300**	**16**	**50**

Note: The time participants spent at the table varied and participant hours are estimated based on an average of 10 minutes for each student.

Table 3-5. GatorTRAX

Date of Event	Location	Participants	Contact Hours	Participant Hours
3/17/2012	UF Campus	47	3	141
9/29/2012	UF Campus	27	3	81
9/28/2013	UF Campus	55	3	165
Total		**129**	**9**	**387**

Table 3-6. Cade Museum

Date of Event	Workshop	Participants	Contact Hours	Participant Hours
3/17/2012	Careening Coasters	7	3	21
9/29/2012	Strawbridge Challenge	6	3	18
9/28/2013	Engineering Day	14	7	98
Total		**27**	**13**	**137**

Performance Metrics for STRIDE

- Number of events organized 25
- Number of participants in K-12 events 1128
- Number of schools visited 5

- Number of contact hours 99
- Number of participant hours 1871

Note: While five schools were visited, many more students from other schools were reached at events where students came to the university campus for engineering fairs, career days, and GatorTRAX.

- Number of K-12 lesson plans developed 3

Note: New PowerPoint presentations were developed for Careening Coasters and Strawbridge Challenge, as well as curriculum for the traffic simulation exercise (see Appendix A).

Chapter 4 Conclusions, Recommendations, and Suggested Research

Conclusions and Recommendations

The UFTI K-12 workforce development program will continue as developed and implemented to expand and accommodate additional students. UFTI will follow the action items outlined as follows in the 2012 National Transportation Workforce Summit in order to achieve the goal of reaching out to the future transportation workforce:

- "Build on existing outreach programs, activities, and publications
- Develop tools to educate parents, teachers, and school counselors about the industry
- Create a Web portal identifying educational opportunities, curricular, and extracurricular transportation activities, industry internships, and career profiles
- Address transportation opportunities in STEM courses beginning in elementary school
- Work with parents, politicians and neighborhoods to reinforce the importance and relevance of transportation to youth" (1)

UFTI has made efforts to disseminate information on the workforce development programs by providing poster presentations at the 2012 National Transportation Workforce Summit, the annual STRIDE reception at the Transportation Research Board Annual Meeting in January 2013, and the Regional Conference for University Transportation Centers (UTCs) in the Southeastern Region in April 2013.

The LEGO® Robot Vehicle Lesson Plans for Secondary Education curriculum is available for download and has been downloaded by 62 different individuals as of the end of October 2013.

Suggested Research

The LEGO® Robot Vehicle Lesson Plans for Secondary Education course could be expanded to include "Building your Intelligent Vehicle," "Picking up and Delivering Cargo," "Delivery Truck Plan a Route," and a "Competition Module." With these new lessons, the course could run as a weekly after school program for a semester, or as a two-day summer camp. Lesson plans could be tailored for a younger audience or for high school students.

Additionally, the instructors noted that elementary school students exhibited a great deal of interest in designing and building their own intelligent vehicle. A workshop could be developed to accommodate the younger student's interests.

The Family Engineering program could be expanded to more elementary schools in the area, while the Transportation Career Day program could try different days of the week during the year to accommodate high school students' busy schedules.

Continued effort should be made through presentation at local, regional, and national levels to disseminate these programs and the associated findings and curriculum. Opportunities to work with additional school districts should also be explored.

REFERENCES

1. Council of University Transportation Centers. “National Transportation Workforce Summit Summary of Results.” April 24-26, 2012

2. Transportation Research Board (TRB). “The Workforce Challenge: Recruiting, Training and Retaining Qualified Workers for Transportation and Transit Agencies.” TRB Special Report 275 (2003).

3. Joseph S. Toole & Clark C. Martin. “Developing Tomorrow’s Transportation Workforce.” ITE Journal, March 2004, p 26-30. 99

Appendix A

CORSIM Traffic Simulation Course Material

High School CORSIM Simulation Workshop

Part A

This part of the simulation workshop will help students begin to learn the basics of signal timing and phasing through building a single isolated and pre-timed intersection within CORSIM. Students will create nodes and links for the intersection and enter the inputs needed such as volumes, link lengths, and free-flow speeds as well as others. They will also begin to select a timing plan for their signal that they think will yield the best operations. Students will be required to determine the necessary yellow and all-red times for each phase of their signal phasing plan using equations provided to them. Once they select their timing plan, they will then run a simulation in CORSIM to determine if their timing plan is adequate or needs to be improved. Students are encouraged to obtain the best possible outputs (i.e., minimized delay) by changing their timing plan. After students have obtained what they believe is their best plan, UF students will show their best timing plan along with the results from their simulation. This will help students gain a better understanding of which inputs influence the operation of transportation systems and how traffic signals affect these operations.

Part B

This part of the simulation workshop will focus on coordinated signalized intersections. Students will be provided with a CORSIM file that contains three signalized intersections. Students will try to select offsets and modify existing green times and cycle lengths to best improve the existing network. Students will be able to calculate the amount of time that is needed to travel from one intersection to another based on the free-flow speed and link lengths. This time will help when determining offset values for each signal.

High School Traffic Simulation Workshop

1. Introduction to traffic and simulation
    a. Talk about simulation and importance
        i. Not always able to implement changes in transportation network to see the effect
        ii. Simulation allows us to make these changes and evaluate their effect on the network
        iii. Less expensive
            1. Decreases cost of studying network
            2. Reduces time of study as collecting lots of field data is not needed
    b. Give examples of how simulation is used in transportation engineering
    c. Introduction to CORSIM and what it can do
2. Constructing a network in CORSIM
    a. Show how to create nodes and links
    b. Need 8000 nodes for traffic to enter and exit the network
    c. Need to define Network Properties (i.e., time period duration and vehicle entry headway which will be Erlang distribution with a = 1)
    d. Link properties
        i. Free-flow speed (40 mph for E/W and 50 mph for N/S)
        ii. Lanes at intersection
            1. Northbound – 2 full lanes and 1 left turn lane (180 ft)
            2. Southbound – 2 full lanes and 1 left turn lane (160 ft)
            3. Westbound – 1 full lane
            4. Eastbound – 1 full lane
    e. Node properties
        i. 5 regular nodes
            1. 1 node for intersection and 4 nodes for different directions of traffic each 2000 ft from intersection node
            2. 4 8000 nodes (1 for each of the 4 nodes mentioned above)
            3. 8000 node flows
                a. 600 vph EB (west most node)
                b. 400 vph WB (east most node)
                c. 1250 vph NB (south most node)
                d. 900 vph SB (north most node)
        ii. Intersection node
            1. Turn volumes
                a. EB – 75 left, 400 through, 125 right
                b. WB – 50 left, 250 through, 100 right
                c. NB – 250 left, 700 through, 300 right
                d. SB – 175 left, 600 through, 125 right
            2. Control
                a. Use pre-timed control
                b. Calculate yellow and all red times using ITE equations
                    i. $Y = t + [\frac{v}{2a+2Gg}]$
                        1. t = reaction time (typically 1 sec)

2. v = design speed (ft/s)
3. a = deceleration rate (typically 10 ft/s^2)
4. g = acceleration due to gravity (32.2 ft/s^2)
5. G = grade of approach (assume no grade)

ii. $R = \frac{w+L}{v}$
1. w = width of stop line to far side no-conflict point (ft)
2. v = design speed (ft/s)
3. L = length of vehicle (typically 20 ft)

iii. Use 3 seconds of yellow for N/S left turn only phase since approach speed is smaller
iv. Use 5 seconds of yellow for N/S combined through/right phase
v. Use 4 seconds of yellow for E/W combined through/right phase
vi. Use 1 second of all red for both N/S phases
vii. Use 2 seconds of all red for E/W phase

3. Coordinated Network
   a. Select offsets
      i. Can get an estimate of offsets using free-flow speed of links the length of links between intersections
   b. Modify green times and cycle lengths to try to improve the network
      i. Look at vehicle delay at each intersection