Board 37A: Driving Simulators as Educational Outreach for Freight Transportation

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Driving Simulators as Educational Outreach for Freight Transportation (WIP)

Introduction

The US continues to face a shortage of truck drivers. Recently the shortage has been aggravated by the COVID-19 pandemic which contributed to inefficiencies in the freight system. The ongoing driver shortage is a top critical issue according to annual industry reports [1]. Many complex factors such as lack of awareness of the trucking profession, misinformed public perception of the truck driver profession, technological advances in freight and driver retirement are some of the leading causes of this driver shortage [2]. Recruitment and workforce retention in the freight transportation industry, fed through career pathways in civil engineering, are critical for the industry to thrive [2].

The truck driver shortage can be addressed in part through specialized and engaging workforce outreach activities. Such outreach efforts are devoted to early mentoring and recruitment to attract a new generation of freight professionals, including drivers and engineers especially in the areas of civil, industrial, and mechanical engineering [2]. While many STEM outreach programs and college engineering curricula centered on transportation topics focus on the careers of engineers and planners, the roles of front-line workforce of our freight systems (drivers, pilots, and operators) are rarely highlighted. Yet, students may better connect with the impacts of engineering and planning work by witnessing how transportation projects impact front line workers like truck drivers. **This work developed an outreach program designed around the use of a driving simulator to enhance outreach efforts for middle and high school student groups for freight career awareness.** The pre-teen demographic is a challenging group for transportation education within the civil engineering discipline as they have not become drivers and can have a hard time understanding the impacts of transportation engineers and planners on their daily life. Through active learning using a driving simulator, this project highlights the important roles of engineers, planners, drivers, and operators to advance workforce development initiatives.

This work shares the lesson plans and lessons learned in engaging middle school students in driving simulator-based activities. The central goals of the lesson plans are for students to be able to list transportation careers, identify transportation system challenges, and describe the benefits of transportation systems for everyday life. Active learning approaches included in the lesson plans include brainstorming transportation industry careers and reasons for the current shortage of truck drivers, operating driving simulators including a truck, forklift, excavator, and car. Beneficially, commercial driving simulators are becoming increasingly affordable and thus more ubiquitous across university research programs and workforce training centers. **This project leveraged the popularity of driving simulators to engage the middle and high school students to be more aware of careers across the freight industry including, among many areas, traffic engineering, transportation planning, and commercial driving.**

Background

Driving Simulators

The success of the transportation industry depends on recruitment and employee retention. To achieve this, it is important to develop an interest in young people [2]. The use of driving simulators is one of the latest strategies of recruitment [3], [4]. Simulators used for training and education show many benefits, including reduced risk, reproducibility of scenarios, time savings, and lower expenses for training [4]. Driving simulators are also becoming more affordable and many universities are purchasing the technology for research purposes. While many labs may use the simulators for outreach simply by providing a lab tour, these impressive technology systems can be more impactful if used within active learning programs for educational outreach.

The City of Fayetteville recently completed an 82,500 square foot expansion of its library facilities to include, among other facilities, a Center for Innovation [5]. Key to this paper, the Center for Innovation includes a simulation lab and a virtual reality lab which includes a truck driving simulator in addition to simulators for a passenger vehicle, forklift, excavator, and a flight simulator. The truck driving simulator, EF-Truck NG, is made by Simulator Systems International and is full motion (3-axis) with OEM truck cab components, an ultra-wide screen system, and has automatic and manual (multi-speed synchronized) transmissions [6]. The accompanying software contains ready-to-go lessons with different scenarios, geared at driver training towards earning a Commercial Driver's License (CDL). Many truck driving schools around the U.S. operate similar simulators for training. During Covid-19 pandemic there was discussion among regulators of allowing simulators to be used for CDL requirements to alleviate the need for in-person licensing tests due to the high increase in the shortages [7]. Other simulators available at the Fayetteville library and common in technical schools include the Exail's EF-Car driving simulator, the 3-in-1 Virtual Reality Forklift Simulator and the CAT Hydraulic Excavator Simulator. In each of these simulators the user can adjust settings including time of day, weather, and traffic conditions.

The activities involving the simulators include ready-to-go programmed lessons that aim to teach the basics of driving, such as shifting gears, as well as providing opportunities for "free driving" since the participants are new drivers. These driving simulators allow users to program the size of vehicle, type of transmission, weather, traffic, and urban or rural roads to be experienced during free driving. Extreme events can also be programmed, like a popped tire or other maintenance issues. The screens in the front of the simulators view the road, unless manually switched to look in the mirrors or beside the truck. The truck simulator produces audio to simulate the environment chosen and depicted, from horns to wind to the revving of engines. Another feature of the truck driving simulator is that the seat allows for motion. This reclines the seat as the truck moves up a hill or jerks the seat when braking is too aggressive or when the car hits an object.

Workforce Challenges for Freight Trucking

The trucking industry has suffered from driver shortages and high turnover over the last several decades. This situation was further exacerbated during the COVID-19 with trucking employment falling by 6% in March and April, 2020 [8]. This has far reaching supply chain impacts since trucks deliver nearly 70% of all freight in the US [9]. Some of the industry issues can be addressed through re-examining the potential labor pool through targeted attraction, training, and retention programs for truck drivers [10], [11]. There is also a significant shift in what it may

mean to be a truck driver given the future of driving automation. The digitization of the transportation services evolving in the truck industry is one of the major causes of these shortages. Additional factors causing a shortage of truck drivers include misinformed public perception of the truck driving profession, low wages, low job satisfaction among others [10], [11].

Recruitment of qualified and highly skilled personnel is both expensive and time-consuming. The cost of recruiting a driver is approximately 30% of the truck driver's annual salary [12]. Workforce development for trucking and, more generally, for freight careers takes place after K-12 schooling at technical workforce centers, community colleges, and carrier programs. However, research shows that early introduction to transportation and freight careers, especially in trucking, can help expand workforce markets and work to attract underrepresented groups including women [2]. Additionally, at four-year colleges, topics related to transportation that relate to operation, design, planning, and construction of freight infrastructure are typically included in civil engineering curriculum.

In Arkansas, an organization called the Associated Industries of Arkansas is tackling career awareness for the trucking profession. They created the 'Be Pro, Be Proud' workforce development initiative that features a 53-foot semi-trailer which houses a dozen driving simulator stations, a locomotive driving simulator, and construction equipment (backhoe, excavator) simulators [13]. The trailer visits schools and community events and touts serving over 98,700 students from Fall 2020. The goal of the initiative is to attract students to skilled jobs as truck drivers and diesel mechanics, fields which have experienced labor pool shortages. Georgia, Kentucky, North Carolina, Tennessee, and New Mexico either have or are developing similar programs.

The research work built on these workforce development efforts by extending outreach to student as early as middle school and by creating a series of learning modules that faculty and other driving simulator owners can use for freight career awareness outreach events. This is an important extension to existing outreach programs, as it is designed to be offered through four-year colleges during summer recruitment programs and camps, many of which are hosted by civil engineering departments. To this effect, more than twenty-five middle school girls through a university sponsored summer camp called, GirlTREC, participated in our driving simulator outreach program. GirlTREC is sponsored by the Maritime Transportation Research and Education Center (MarTREC) which is a US Department of Transportation Tier 1 University Transportation Center.

Outreach Program Curriculum

This work produced five learning plans implemented at the summer program which will generate publishable data on the success of the modules in increasing awareness of freight transportation careers. All of the lessons were created with middle school and high school students in mind, but they may be adapted to fit diverse age groups. Many of these students are not drivers and can also have a hard time understanding the impacts of engineers and planners on their daily life. Each module includes: learning objectives, a short overview presentation slide deck, a series of

activity-based learning tasks, and a closing/debrief handout, group activity, and/or presentation. With the different amounts of time allotted for each of the five modules, the outreach program is anticipated to be finished in 2.5 hours, e.g., an approximate morning or afternoon session for a typical summer camp program. A trial program was hosted in July 2022 with the participation of 25 middle school girls. This work is considered Work-In-Progress, so this paper focuses on the module structure.

Module 1: "What's the Shortage? What's the Solution?"

By the end of this module, participants should be able **to explain the current state of the freight transportation industry and identify solutions to reduce the shortage's impact**. Participants are given a general overview of the outreach program which involves a short two-minute video on the transportation industry. Important information and facts learned from the video such as the various careers in transportation and the function of freight transportation are utilized as the basis for brainstorming and exchanging ideas on the causes and solutions of the truck driver shortage. The participants are then asked to brainstorm using a word web, in small groups, possible solutions for the issues raised. Participants then attempt to link transportation career suggestions offered by the instructor to the suggested solutions. As an example, during the 2022 session, participants brainstormed causes such as low pay, being away from home, and not seeing family as reasons for the shortage to which participants suggested better scheduling (logistics) as a possible solution. This module is approximately 20 minutes.

Module 2: "What Careers Exist in Transportation?"

By the end of this module, participants should be able **to identify three separate transportation careers and two aspects that make each career unique.** The first activity is a one-minute brainstorming challenge for participants who can come up with the most transportation-related occupations. These careers identified are shared between the participants. A career 'BINGO' game is used in the second part of the lesson. The goal of the game is for participants to identify nine transportation careers based on clues provided by the instructor. Careers include logisticians, mechanical and automotive engineers, dispatchers, freight loaders, software engineers, transportation engineers, data analysts, diesel mechanics, and warehouse managers. The details include a brief description of the career, median annual salary, required skillset and education. The driving career is focused on through a video and further discussion. This module is approximately 25 minutes.

Module 3: "What's it Like to be a Truck Driver?"

By the end of this module participants should be able **to demonstrate beginner level driving skills that a commercial truck driver must possess.** This lesson utilizes the driving simulators to enable participants get hands-on experience of being truck drivers. Basic operations of a truck or car include gas and brake pedals, gears, steering, and headlights. The use of the simulator is first demonstrated by the instructor (Figure 1). Participants are split up into smaller groups and are allowed to attempt using the simulators on their own with one student as the operator and the others as observers. Scenarios based on weather, traffic, other driving conditions can be adjusted. Once every participant has had a chance to use a simulator, the participants switch between the

simulators. This module's time is dependent on the number of simulators available. For a group of 25 students with access to four simulators, the activity took approximately 40 minutes.

Figure 1. (Left) A participant been assisted through a lesson on the CAT Excavator Simulator, (Middle) Participant completing a Forklift Simulator lesson, (Right) Participant using the truck driving simulator to complete a custom skill task.

Module 4: "What Can WE do to Make it Better?"

By the end of this module participants should be able **to identify difficult situations freight drivers experience and develop ways that engineers and planners could contribute positive outcomes**. This lesson builds up from the lesson on driving simulators where the participants have a broader understanding of driving challenges. Participants are asked to think of an example of a difficult driving situation, e.g., "I think drivers would struggle with.... Because when I drove, I…" and create a case study poster. Then as a peripatetic exercise, participants rotate the case study poster every 90 seconds to generate solutions that an engineer or planner could address. Examples from the 2022 session included topics such as: (1) weather, (2) driver availability, (3) angry customers, (4) vehicle maintenance, (5) utilizing multiple drivers, (6) environmental concerns, (7) warehouse delays, (8) traffic, (9) truck parking, and (10) trucker health. This module is approximately 25 minutes.

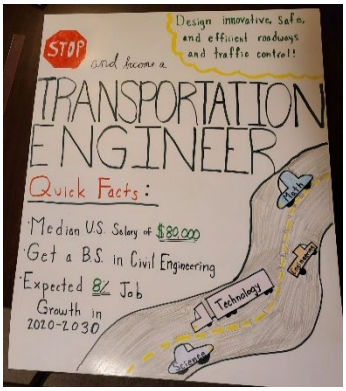

Figure 2: Example career poster.

Module 5: "How Can I Help?"

By the end of this module participants should be able **to design a step-by-step process on how to transition from camp to the first day in the role of a transportation career of choice.** Participants will create and present a promotional poster on how to become a professional in the transportation career of choice (Figure 2). This activity serves as a debrief of the session. This module is approximately 30 minutes.

Conclusions

Freight transportation is vital to US supply chains and the global economy. Driver shortages have plagued the industry in recent years which worsened due to the recent COVID-19

pandemic. To address the issue of driver shortage, strategies include re-examining the potential labor pool through targeted attraction, training, and retention programs for truck drivers.

Instructional modules related to engineering and planning for multimodal transportation systems were developed to recruit middle and high school students to the truck driving industry. This work developed an outreach program with active learning approaches designed around the use of a driving simulator. This project would also contribute to the multimodal transportation body of knowledge by advancing methods for workforce development.

The developed lesson plan was carried out in July 2022 during the MarTREC GirlTREC summer camp targeting sixth grade girls. Twenty-five students participated with the help of four graduate students and faculty. The critical challenge anticipated for the session was the lack of driving experience among 12-year-old students and the physical size of students which may limit their ability to operate the simulators. However, these challenges did not limit the experience or success of the session. Girls easily and eagerly engaged with the simulators, discussions, and presentations. Anecdotally, we noted high engagement with the material, with students suggesting creative and thoughtful content related to driver challenges, professions, and solutions.

As we continue this work, we plan to implement a pre- and post-session survey to gauge career awareness and to gather feedback on module activities. Through these efforts, the project would advance students awareness of careers in freight transportation as planners, engineers, and system operators. The survey will target students' knowledge of the civil engineering discipline as it relates to transportation career development. Often, students have a narrow perception of civil engineering in thinking that structural engineering is the only discipline. Through programs such as the one presented in this work, the goal is to emphasize the diversity of the content within civil engineering, namely transportation engineering and planning by connecting these topics to ongoing, real-world problems such as truck driver career challenges. A longitudinal survey tracking the career ambitions of the participating students would be an ideal means to capture the impact of the activity, however, a study of that scale was beyond the current scope (time and budget) of the current work. Future proposals will consider how to implement long term career tracking.

This project is still ongoing and learning modules will be made publicly available through the author's website, the MarTREC website, and the University of Arkansas ScholarWorks research repository for further utilization by any university and/or workforce center equipped with a driving simulator to organize their own outreach events.

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Reviewer's Comments

Comment:
It is not clear how this study relates to the civil engineering profession. The word "civil" is not included in the text.

Response:
This work is sponsored by the Maritime Transportation Research and Education Center (MarTREC) which is a US Department of Transportation Tier 1 University Transportation Center. In relation to the objectives of the MarTREC research program, this project contributes to the areas of maritime and multimodal transportation education and workforce development activities by (1) developing instructional modules and case studies (2) developing resource banks of pertinent data sources, publications, organizations, and educational programs. This is part of Civil Engineering. We added several sentences to better emphasize how the work relates to civil engineering.

Comment:
Provide the major of the undergraduate and graduate students and faculty that performed this work. Are these students' members of the ASCE student chapter?

Response:
The faculty and graduate students involved in this work are all part of the Civil Engineering program at the University of Arkansas. The faculty and students are not part of ASCE, but are active members of the Institute of Transportation Engineers (ITE). ITE is an international professional organization for transportation engineers and planners.

Comment:
I am very curious to see the actual assessment of this work and somewhat skeptical. Students can be quite excited about participating in a simulated activity but that does not mean they will have career ambitions in that direction. In fact, part of the fun of such activities is that it is a fantasy and not a reality. I would love to see how the authors attempt to address this.

Response:
This project is still ongoing and we plan to implement a pre- and post-session survey to gauge career awareness and to gather feedback on module activities. A longitudinal survey tracking the career ambitions of the participating students would be an ideal means to capture the impact of the activity, however, a study of that scale was beyond the current scope (time and budget) of the current work. Future proposals will consider how to implement long term career tracking. In the short term, we are able to track the number of civil engineering students enrolled at the University of Arkansas and see if they participated in our programs during high school.

The graduate student mentors who assisted during the outreach agreed that the objectives of the outreach were achieved. Some students also mentioned having family members in the freight transportation industry which already creates an awareness about these careers. The use of the simulators, in combination with other lesson plans, has enabled students to gain a deeper understanding of these careers through active learning. The simulators allow users to program real

word situations such as the size of vehicle, type of transmission, weather, traffic, and urban or rural roads to be experienced during free driving. Extreme events can also be programmed, like a popped tire or other maintenance issues. All these experiences and activities help to highlight real-world conditions under which drivers operate and help to connect with participating students who may not have realized that civil engineering sub-disciplines, like transportation engineering and planning, can have an impact of driver's daily lives. We've added a couple sentences to this effect within the paper.

Comment:
Probably the most interesting piece of the WIP are the simulators in Figure 1 and the paper provides relatively little information about these: what are participants playing exactly?

Response:
Figure 1 shows participants being assisted by student mentors while using the excavator, truck driving, and virtual reality forklift simulators. The simulators available are the ECA Group EF-Truck NG simulator, Exail's car driving simulator EF-Car, a 3-in-1 Virtual Reality Standalone Sit Down CB Forklift Simulator and the CAT Hydraulic Excavator Simulator. The activities involve ready-to-go programmed lessons that aim to teach the basics of driving, such as shifting gears, as well as providing opportunities for "free driving" since the participants are new drivers. These driving simulators allows users to program the size of vehicle, type of transmission, weather, traffic, and urban or rural roads to be experienced during free driving. Extreme events can also be programmed, like a popped tire or other maintenance issues. The screens in the front of the simulators would show down road, unless manually switched to look in the mirrors or beside the truck. The truck simulator produces audio to simulate the environment chosen and depicted, from horns to wind to the revving of engines. Another feature of the truck driving simulator is that the seat allows for motion. This reclines the seat as the truck moves up a hill or jerks the seat when braking is too aggressive or when the car hits an object. These statements were added to the paper.

Comment:
In contrast, I feel the WIP has too much background information throughout the paper emphasizing issues related to COVID and the industry. I think this emphasis could be reduced.

Response:
While not the central focus of this paper, the COVID-19 pandemic is worth highlighting as it has had a significant impact on the freight industry. The pandemic has further emphasized the critical role of freight transportation in society, showing some of the challenges facing the industry. The pandemic has made it clear that the freight industry plays a crucial role in the economy even in the face of unprecedented challenges.

Comment:
I am curious why exactly middle and high school students are targeted. I get this is an outreach program but is this the critical target audience for addressing the issue?

Response:
To tackle the issue of truck driver shortage and promote freight transportation careers, the focus on targeting middle and high school students is part of early mentoring and recruitment strategies.

By engaging in with this target audience, misinformed perception of freight transportation careers especially the truck driver profession are dispelled while increasing their awareness and interest in these careers as they consider future career paths. As such, these students are considered as a crucial demographic to address to this issue. From a practical standpoint, the activities were initiated through the Martrec GirlTrec summer camp program which includes middle school girls. We were able to piggyback with this camp to alleviate logistical and legal burdens of having our own camp. For the summer of 2023, we are hosting our activity during another camp that targets high school students. We will be able to compare our experiences across age groups.