Investigating pedestrian safety improvements on US Rt 301 Richmond

(Technical Paper)

Social and Cultural Hurdles in Design Implementation of Autonomous Vehicles

(STS Paper)

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science

University of Virginia | Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree

Bachelor of Science, School of Engineering

Andrew Taylor

Fall 2020

Technical Project Team Members:

Christopher Hume, Ryan Barnett, Hanna Custard, Aimee Barnes

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signature _____ Date _____

Approved _____ Date _____

Brain Smith, Department of Engineering Systems and Environment

Approved _____ Date _____

Travis Elliot, Department of Engineering and Society

Introduction

Pedestrian safety in the US has increasingly become a major issue for federal, state, and local governments. The NHTSA reports that in 2018 alone, approximately 6283 pedestrians died in a traffic accident, an increase of ~3% from the previous year and the highest since 1990 (NHTSA, 2020). Considering almost everyone is a pedestrian at some point, this is an issue that resonates in the entirety of society. As more of the population moves into the suburbs (Parker et al, 2020), an increase in vehicle miles driven per day is sure to follow and so too will the number of pedestrian accidents and fatalities. As a result, pedestrian safety will only become more important to local communities. The aim of the technical part of this project is to design and implement pedestrian safety improvements in a local community. It will also aim to explore the various ways that the future of transportation and transportation infrastructure can improve pedestrian safety. As the technological infrastructure of transportation progresses, it has the ability to have a profoundly positive impact if it manages to address significant issues. The STS section will explore autonomous vehicles (AVs), a major component of the future of transportation, and the societal and industry wide issues they need to overcome in order to be fully implemented.

Investigating pedestrian safety improvements, RT. 301 Richmond.

The number of pedestrian injuries and fatalities keeps increasing year by year and according to the Governor's Highway Association, the numbers from 2019 are higher than they have been in the last 30 years (New Projection: 2019 Pedestrian Fatalities Highest since 1988, n.d.) (Annual Report, 2019). There is an ongoing societal responsibility to address pedestrian

safety issues by considering alternative infrastructure changes, societal attitudes, and technological tools to keep vehicles and pedestrians from unwantedly crossing paths.

This project takes this broad focus on pedestrian safety improvements and focuses the lens on one corridor in Richmond, VA. The corridor, on Route 301, Jefferson Davis Highway, just south of the state's capitol, has already sustained multiple pedestrian fatalities in the current calendar year (as of August 2020). In the last year alone, two people have been struck and killed by a car on this stretch of the highway (Richmond Times-Dispatch, 2019) (NBC 12 Newsroom, 2020). From a pedestrian safety perspective, the corridor's characteristics are anything but safe: it's a high-speed roadway with long distances between cross-streets which lacks pedestrian infrastructure such as sidewalks.

Another reason for our focus on this area is that it is economically disadvantaged. The median household income was $41000 compared to $70000 for all of Virginia with 32% of the population of approximately 6000 living under poverty (Bensley, n.d.). This corridor also has businesses located on both sides of traffic as well as new bus stops that are inaccessible by pedestrians unless by vehicle or by crossing the large, unmarked sections. As a result, there remains a critical need to address the equity issues in terms of access to transportation and pedestrian services (Bensley, n.d.).

Under the supervision of Professor Brian Smith and Marie Audrey Nerette, with the help of Ben Doran, Kevin O'Meara, and Thomas Ruff with Timmons Group, Ryan Barnett, Hanna Custard, Christopher Hume, Aimee Barnes, and I will examine the corridor's current operating state, and then investigate improvements to alleviate pedestrian incidents as best as possible. Any improvements will be considered, from roadway geometry, design changes, signage, and

operations alterations, to other Intelligent Transportation Systems (ITS) technologies and future Connected and Automated Vehicles (CAV) considerations, to softer solutions such as public information campaigns. This will result in a new roadway design (the Civil Engineering side) and a more generalized pedestrian safety experiment (the Systems Engineering side).

The project's initial steps lie in a systems framework approach. We must generalize the question at hand, determine the normative and descriptive scenarios, and generate goals before determining criteria for ranking alternative solutions. The team, an interdisciplinary team of students from the Department of Engineering Systems and Environment (ESE) and the Department of Civil and Environmental Engineering (CE), have determined the main goals of minimizing cost, optimizing the road's Level of Service (LOS) for traffic flow, minimizing pedestrian incidents, and minimizing the effects of social and political forces on safety improvement (while minimizing the effects of potential alterations on social and political forces). All of this can be achieved by designing an appropriate complete road design, similar to what is seen in Figure 2 (Snyder et al., 2013). The ranking of alternatives will then be generated based on an ordinal system to be determined later through correspondence with the client

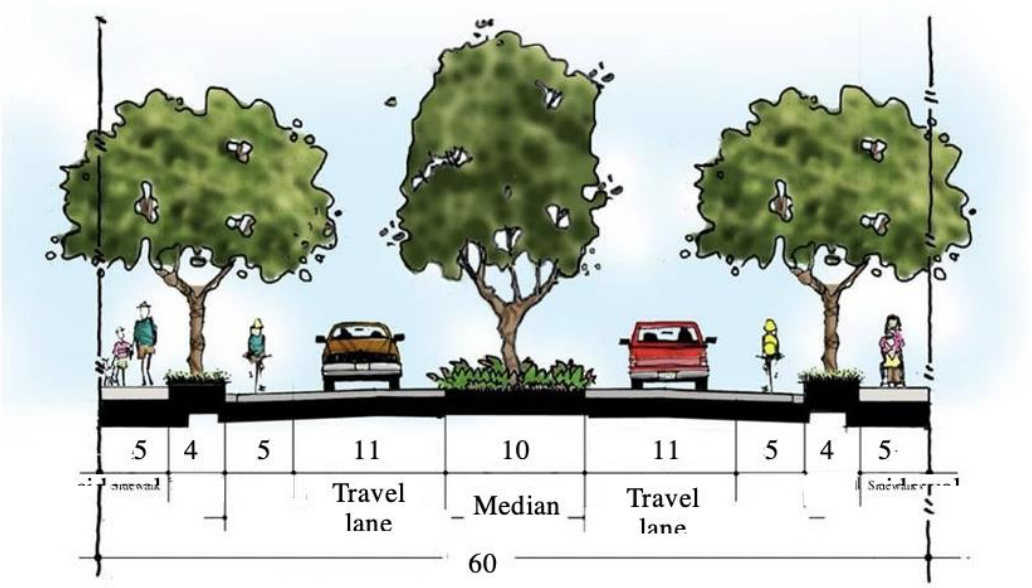

Figure 2: A visual representation of a complete streetscape including pedestrian infrastructure (Snyder et al., 2013)

(Timmons Group) and stakeholders which will allow for a clearer picture of the core value needed to make a decision.

The second stage of the project will involve research by the team on potential infrastructure improvements (CE students) and general technological adoption (ESE students). The CE students will begin developing a roadway plan in accordance with the given schematics and base map created through correspondence with the client Timmons Group; the ESE students will conduct a research experiment which attempts to determine pedestrian reaction to autonomous vehicle feedback at roadway crossings. The plan developed by the CE students is clearly applicable to the corridor in Richmond, however the experiment conducted by the ESE students is more geared towards researching the future impact of autonomous vehicles on pedestrian activity. The study conducted by the ESE students will compare pedestrian reactions in crossing the road between waiting for visual cues from a driver (a hand wave, nod, etc.) and technical cues from a mobile app when faced with crossing in front of an autonomous vehicle

without a driver present. This will be tested in virtual reality to discover the connection between the pedestrian user app and the notification system, allowing the ESE students to gain insights into whether the notification system can be effectively used on AVs to alert pedestrians. Again, although this study does not directly apply to the Rt. 301 Corridor in Richmond, it may drive future pedestrian infrastructure safety development and as such attempts to reach the end goal of providing roads which are both safe for pedestrians and efficient for drivers.

While the focused goal of this project is to improve pedestrian safety on a corridor of Route 301 in Richmond, as the alternatives will ideally do, such concepts will be applicable to other corridors nationwide. These improvements, if possible, may allow for other jurisdictions to draw from what was suggested and make pedestrian safety improvements themselves, allowing for the overarching goal of determining ways to improve pedestrian safety to be at least partially achieved.

Science, Technology, and Society (STS) Topic: Social and Cultural Hurdles in Designing and Implementing Autonomous Vehicles

Autonomous vehicles have the potential to change the way millions of Americans live, commute, and work. With our current car-centric society, we would see a radical shift in how we exist as a society. The purpose of this STS paper is to investigate the societal and cultural hurdles that this technology would have to overcome to in order to expand its user base. The paper will explore these by use of the Social Construction of Technology (SCOT) framework. Specifically, it will explore the general lack of awareness of AVs and the systems used to rate them and general mistrust in the technology. The SCOT framework argues that a technology, in this case autonomous vehicles, is deemed successful not solely because it is described as “the best” by

those in the industry, but also due to how the various groups in the society it is present interact with and define its capabilities and benefits. Using this argument, the paper will explore the wariness of the various groups that will use AVs (consumers), as well as those who govern its rules (developers and politicians), and what can be done to overcome these inhibitors and determine how successful AVs will be.

Awareness

The impact that autonomous vehicles could have on our lives, especially with regards to commute times, is projected to be significant. With the average American now commuting about 25 minutes every day (~45 round trip daily excluding extraneous travel), a significant amount of time is spent in our cars (Noguchi, 2017). Autonomous vehicles have the potential to help commuters reclaim that time for personal use or to get a head start on work. While the benefits of these vehicles are many, a large percentage of Americans do not understand how these vehicles work. Many are misled in believing that systems such as Tesla's Autopilot and GM's SuperCruise are considered self-driving vehicles when they are in fact just driver assistance systems. Fueling this lack of awareness are some of the main industry players as well who intentionally label their products as capable of self-driving when in fact, they are merely there to supplement the driving. An example of this is with Tesla's system that it labels as Autopilot (Autopilot, n.d). This naming convention is similar to that used in the aviation industry for aircraft systems that provide the capability for an aircraft to fly and land by itself. However, those systems require constant monitoring by the crew in an aircraft's cockpit and require numerous hours of training to master as well as retraining to avoid complacency. This is not the case in Tesla's or most other manufacturers systems. They are marketed as being able to handle themselves in most driving situations, but in reality, they can only perform just as and if not

slightly better than a human in particular scenarios such as highway cruising. Often, it is only in the very fine print that manufacturers warn that these systems are not capable of driving themselves in all situations and that drivers must constantly be vigilant about their surroundings. This false sense of security can lead consumers into believing that the systems implemented in their vehicles can allow them to delegate the driving to the vehicle and when they fail, can lead to unnecessary injury and loss of life. The consequences that arise form the lack of awareness of the capabilities of current systems will only serve to convince the public that these vehicles are unsafe and do more harm than good. If manufacturers wish to have their AVs compete successfully in the market, they must develop strategies and push for policies that mandate transparency on current capabilities in order to usher in the future.

Mistrust

A recent survey by the Brookings Institute found that while a majority of Americans understood the benefits of autonomous vehicles, only about 20% would ride in one (West, 2019). This disconnect between the perception of the safety of autonomous vehicles and the reality of actually riding in one is a topic that has increasingly become a priority for researchers in the field. An intel study from 2017 found that for many passengers, being familiar with how the AV worked reduced their unease with interacting with it as either passengers or pedestrians (Intel, 2018). In his article, Matthew Hutson explores how the intel study sought to increase familiarity and how that research pioneered new scientific inquiries into human factors innovation. Hutson first describes how the study was conducted, using a diverse group of 10 volunteers. These volunteers were given a brief overview of the vehicle and its capabilities after summoning it in the same way that ride hailing companies currently work. They then set off on a short drive on a closed course designed to mimic city streets. During and after the drive, almost of these

volunteers had expressed a more positive view of the system, with many applauding the ability for the system to communicate not just to the engineers but the passengers as well (Hutson, 2018). Many even argued that the system was giving too much information at times, stating that they had become comfortable enough with knowing the internal decision-making process that they would prefer the vehicle keep that information to itself (Hutson, 2018). Although this was a small sample size, it does illustrate that by being able to understand how the systems work, humans are more likely to trust it and try to find ways to make their lives easier which will further increase buy in from skeptical consumers.

Conclusion

To design a system that improves pedestrian safety for our local community, my team must not only look at the infrastructure in its present form, but also consider the implementation of new technologies and the impacts they could have on the citizens of the surrounding area and society at large. With the technical project, my team hopes to improve the lives and safety of the community of Bensely and reduce pedestrian fatalities significantly. The information we gather from this aspect of the capstone will be beneficial in giving us insight into how societies interact with their vehicle-pedestrian infrastructure and help me further explore other obstacles that could impede the development and full-scale implementation of autonomous vehicles as well as possible solutions to some of the current hinderances. The STS paper will then explore what and how AV's can overcome the current obstacles that it will face as it tries to reach wider audiences. It will explore the lack of awareness that leads to driver complacency and civilian injuries/deaths as well as mistrust in AV technology that could hinder its success and ability to benefit all of society

References

Annual Report. DRIVE SMART Virginia. (2019). https://www.drivesmartva.org/about-dsv/annual-report/.

Autopilot. (n.d.). Retrieved December 11, 2020, from http://www.tesla.com/autopilot

Bensley, Virginia. (n.d.). Retrieved October 19, 2020, from https://www.city-data.com/city/Bensley-Virginia.html

Hutson, M. (2018, October 23). Latest Intel Study Finds People Expect Self-Driving Cars to Be Common in 50 Years. Retrieved October 19, 2020, from https://newsroom.intel.com/news/latest-intel-study-finds-people-expect-self-driving-cars-common-50-years/

Intel. (2018, October 23). Latest Intel Study Finds People Expect Self-Driving Cars to Be Common in 50 Years. Retrieved October 19, 2020, from https://newsroom.intel.com/news/latest-intel-study-finds-people-expect-self-driving-cars-common-50-years/

Lynberg, M. (2020, June 15). Automated Vehicles for Safety. Retrieved October 19, 2020, from https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

NBC12 Newsroom. (2020, April 7). Chesterfield police identify man hit, killed by vehicle. NBC 12.

New Projection: 2019 Pedestrian Fatalities Highest Since 1988. https://www.ghsa.org/resources/news-releases/pedestrians20.

Newsroom, N. (2020, April 07). Chesterfield police identify man hit, killed by vehicle. Retrieved October 19, 2020, from https://www.nbc12.com/2020/04/06/chesterfield-police-identify-man-hit-killed-by-vehicle/

NHTSA. (2020, September 30). Pedestrian Safety. Retrieved October 19, 2020, from https://www.nhtsa.gov/road-safety/pedestrian-safety

Noguchi, Y. (2017, February 10). Self-Driving Cars Could Ease Our Commutes, But That'll Take A While. Retrieved October 19, 2020, from https://www.npr.org/sections/alltechconsidered/2017/02/10/514091049/self-driving-cars-could-ease-our-commutes-but-thatll-take-a-while

Parker, Kim, et al. “Demographic and Economic Trends in Urban, Suburban and Rural Communities.” *Pew Research Center's Social & Demographic Trends Project*, 30 May 2020, www.pewsocialtrends.org/2018/05/22/demographic-and-economic-trends-in-urban-suburban-and-rural-communities/

Richmond Times-Dispatch. (2019, December 2). Pedestrian killed while Crossing Jefferson Davis Highway in Chesterfield. Richmond Times.

Snyder, T., Schmitt, A., & Goodyear, S. (2013, August 16). 500+ Complete Streets Policies in Place, But Not the Most Important One. https://usa.streetsblog.org/2013/08/16/500-complete-streets-policies-in-place-but-not-the-most-important-one/.

West, D. (2019, October 25). Brookings survey finds only 21 percent willing to ride in a self-driving car. Retrieved October 19, 2020, from https://www.brookings.edu/blog/techtank/2018/07/23/brookings-survey-finds-only-21-percent-willing-to-ride-in-a-self-driving-car/