Undergraduate Thesis Prospectus

# Investigating Pedestrian Safety Improvements, Rt. 301 Richmond

(technical research project in Civil and Systems Engineering)

# Autonomous Vehicles and Pedestrians: A Competition for the Future

(sociotechnical research project)

by

Ryan Barnett

November 2, 2020

technical project collaborators:

Chris Hume
Andrew Taylor
Hannah 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.
*Ryan Barnett*

*Technical advisor*: Brian L. Smith, Department of Civil Engineering

*STS advisor*: Peter Norton, Department of Engineering and Society

## General Research Problem

*How can the number of pedestrian fatalities be reduced?*

Almost everyone is at least an occasional pedestrian. According to the Governors Highway Safety Association, in 2019 there were 6,950 pedestrian deaths in the United States, more than in any of the previous 30 years; they now account for 17 percent of all traffic deaths (GHSA, 2020). Phone distractions among both drivers and pedestrians have become a major contributing factor to road injuries and fatalities. According to the National Safety Council, pedestrian deaths due to distracted walking are on the rise (NSC, 2020).

## Improving Pedestrian Safety along the Route 301 Corridor in Richmond, Virginia

*How can the number of pedestrian deaths and injuries be reduced at the intersection of Jefferson Davis Highway and Sherborne avenue?*

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 (GHSA, 2020; DSV, 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 highspeed 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 (City-Data.com, 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, Andrew Taylor, 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.

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 at a later date through correspondence with the client

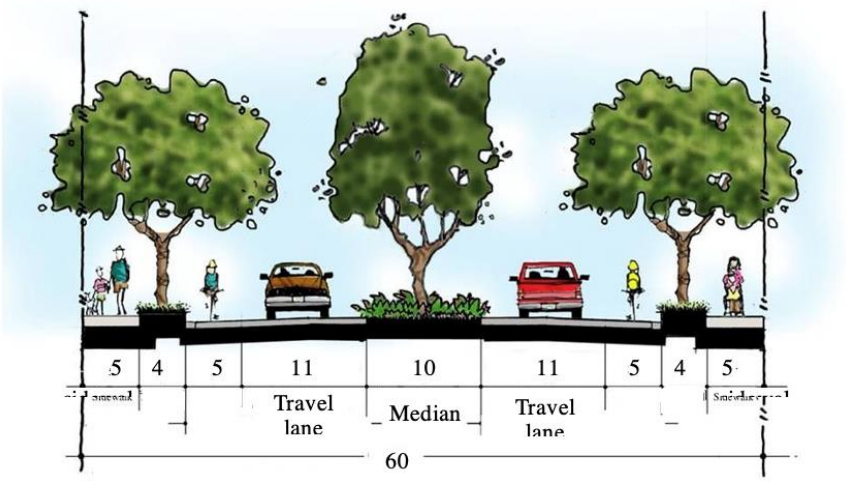


Figure 2: A visual representation of a complete streetscape including pedestrian infrastructure (Snyder et al., 2013)

(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 technological improvements (ESE students). Such "alternatives" will then be combined to have several possible alternatives – a change in roadway design (similar to the complete streetscape design) may be used in conjunction with the addition of HAWK signals, for example, which is brought to light by research from both CE and ESE students. Elements such as cost, availability, and social responsiveness will be considered in feasibility research for such alternatives.

The third stage of the project will involve testing the alternatives and collecting data to be used for ranking each option. This will be done through creating simulation scenarios in the ORCL lab at the University of Virginia, and through roadway simulations using software such as Vissim. Once data is readily collected, the alternatives may be ranked and narrowed, until there are a few alternatives for presentation ready as chosen.

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.

**Autonomous Vehicles and Pedestrians: A Competition for the Future**

*How are AV promoters (tech companies and automakers) and pedestrian advocacies competing to influence the pedestrian's place in the future city?*

Because autonomous vehicles (AVs) may become important modes of urban transport, automakers and tech companies have invested in efforts to develop them (Turon, 2020). For example, Argo AI is developing AV technology, and maintains a test site in Pittsburgh. Winston and Karpilow (2020) conclude that by relieving traffic congestion, AVs would increase economic growth 1 percent. Metz (2018), however, warns that AVs "could increase demand for car use," leading to "worsening congestion" (Metz, 2018). Yet AVs' proper place in the urban future is controversial. Many perceive them as unnecessary, and as less practical, affordable, equitable, sustainable, or healthful than their alternatives. Some parents report misgivings about

relinquishing driving to an AV while their children are on board; they want to be in control when their lives are at stake (Lee, 2018).

Researchers have called attention to AVs' limitations. Yang (2020) cautions that at night, sensors cannot reliably detect pedestrians wearing black. Novak (2020) found that AVs are a greater hazard to pedestrians than conventional cars. According to Ljungholm (2019), pedestrians worry that AVs and their operators may have no liability in the case of a collision. Haboucha (2017) found that 75 percent of Americans would be willing to use an AV. The willingness among Israelis is greater, and she predicts that young, educated people would be the likely early adopters. AVs' reliability is a controversial problem. Kalra (2020) contends that it will take "hundreds of millions of miles and sometimes hundreds of billions of miles to demonstrate their (AVs) reliability in terms of fatalities and injuries."

Waymo (2019) and General Motors are leaders in AV development. Cruise, a subsidiary of General Motors, claims its AV development efforts are committed to "improving life in our cities" (2020). Some advocacies, including the Human Driving Association (2018), oppose widespread deployment of AVs as a threat to the future of driving by humans. Some Arizonans have opposed Waymo's AV road testing in their autonomous car work (Court, 2019). The National Highway Traffic Safety Administration (NHTSA, 2019) issues road safety standards. The Self-Driving Coalition for Safer Streets (2020) is a trade association that serves the business interests of its member companies: developers of automated vehicles. SDC's board is composed of executives from Ford, Lyft, Uber, Volvo, and Waymo. In its public relations, SDC claims that it promotes "policies that safely and thoughtfully advance fully self-driving vehicles." Numerous advocacies promote walking as a practical urban mobility mode, citing its advantages in terms of affordability, sustainability, equity, and health. America Walks (2008) strives to "Make America

a better place to walk." The implications of AVs are complex and intensely controversial, and walkability advocates are important participants in the debate.

## References


America Walks (2008). About Us.

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

Court (2019). "Op-Ed: Arizona's Revolt against Self-Driving Cars Should Be a Wake-up Call to the Companies That Make Them." *Opposition to Waymo*, Los Angeles Times, 11 Jan. 2019, www.latimes.com/opinion/op-ed/la-oe-court-self-driving-cars-20190111-story.html.

Cruise LLC (2020). The GMC Cruise Origin: Everyone Is Invited.

DSV (2019). Drive Smart Virginia. Annual Report. https://www.drivesmartva.org/about-dsv/annual-report/.

Genova, Dave. "Route 61AV: What RTD Has Learned." *Regional Transportation District*, Oct. 2019, www.rtd-denver.com/news-stop/blogs/route-61av-what-rtd-has-learned.

GHSA (2020). Governors Highway Safety Administration. Pedestrian Traffic Fatalities by State: 2019 Preliminary Data.

GHSA (2020). Governors Highway Safety Administration. New Projection: 2019 Pedestrian Fatalities Highest Since 1988.

Haboucha (2017). User Preferences Regarding Autonomous Vehicles. Department of Transportation and Geo-Information Engineering, Technion – Israel Institute of Technology, Israel

HDA (2018). Human Driving Association. Human Driving Manifesto. http://humandriving.org/manifesto

Kalra, Nidhi. (2020, Sep 7). Driving to Safety. How Many Miles of Driving Would It Take to Demonstrate Autonomous Vehicle Reliability, Rand Corporation, 2020.

Lee, Y. (2018). Parents' Perspectives on Using Autonomous Vehicles to Enhance Children's Mobility. Transportation Research Part C: Emerging Technologies. Vol. 96. Pg. 415-431

Ljungholm, D. (2019). The Safety and Reliability of Networked Autonomous Vehicles: Ethical Dilemmas, Liability Litigation Concerns, and Regulatory Issues. *Contemporary readings in law and social justice 11(2): 9-14. Doi:10.22381/CRLSJ11220191*

Metz, D. (2018). Developing Policy for Urban Autonomous Vehicles: Impact on Congestion. *Urban Science. 2*, 33.

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

NHTSA (2020, June 15). Nation Highway Traffic Safety Administration. Automated Vehicles for Safety.

Novak, T. (2020). A Generalized Framework for Moral Dilemmas Involving Autonomous Vehicles: A Commentary on Gill. *The Journal of Consumer Research*

NSC (2020). National Safety Council. Safety at Home. Pedestrian Safety.

Richmond Times-Dispatch. (2019, December 2). Pedestrian killed while Crossing Jefferson Davis Highway in Chesterfield. Richmond Times. https://richmond.com/news/local/crime/pedestrian-killed-while-crossing-jefferson-davis-highway-in-chesterfield/article_bedd7629-f3e2-5e10-89d2-0156b325b3b8.html

SDC (2020). Self-Driving Coalition for Safer Streets. Policy. www.selfdrivingcoalition.org/policy.

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

Turoń, Katarzyna; Kubik, Andrzej. (2020). "Economic Aspects of Driving Various Types of Vehicles in Intelligent Urban Transport Systems, Including Car-Sharing Services and Autonomous Vehicles." *Applied Sciences* 10, no. 16: 5580.

Waymo (2020, November 12). Blog. https://blog.waymo.com/2020/11/building-safer-mobility-future.html

Winston, C., & Karpilow, Q. (2020). Autonomous Vehicles: The Road to Economic Growth?. Washington: Brookings Institution Press.

Yang, B. (2020). Lessons Learned From Accident of Autonomous Vehicle Testing: An Edge Learning-Aided Offloading Framework. *IEEE wireless communications letters*