Prospectus

Pedestrian and Bicyclist Safety and Comfort on Water Street
(Technical Topic)

What are the Impacts of Adding Bicycle Infrastructure (i.e. Bicycle Lanes, Sharrows) on a Low Speed Road?
(STS Topic)

By

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May 1, 2020

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Introduction

The sight of a bicyclist at a busy intersection can pose quite an inconvenience to drivers because the bicyclist adds to the already crowded visual complexity of that roadway. The drivers already have to focus on driving between the painted lines, looking for other cars that may be merging into their lanes, noticing changing speed limits and traffic signals and other signage, among many other things. Digioia et al. (2017) argues that a bicyclist will cause a driver to decrease the vehicle's speed. Similarly, when bicyclists are forced to share the road with vehicles in the absence of bicycle lanes, Hunter et al. (2010) purports that "motorists often neglect to safely share travel lanes with bicyclists, which can compel bicyclists to ride closer to parked motor vehicles," as well as the curb of the road. This decreases the safety of bicyclists and increases the danger of hitting a parked vehicle or an open door of a car. Bicyclists will also have to ride extremely close to the side of the road, which can be unnerving in itself. Before the addition of any bicycle infrastructure, Hunter et al. (2010) shows that the average spacing between a car and the curb was 70.5 inches after observing 400 vehicles. With the presence of bicycle sharrows, the spacing increased to an average of 77 inches (Hunter et al., 2010). With the increase in spacing, bicyclists can be more comfortable on the road by not riding closer to the curb because of a vehicle. Thus, measures need to be taken to increase the safety of bicyclists by providing them with better methods of travel to decrease the likelihood of driver-induced crashes.

Water Street Corridor in Charlottesville, Virginia has high volumes of pedestrians and bicyclists. And many crashes have been reported because of poor existing pedestrian and bicyclist infrastructure. According to the Pedestrian Safety Action Plan (Pedestrian, 2016), there have been 10 car-pedestrian crashes from 2012-2016, as well as many other bicycle related crashes. Because the existing infrastructure along Water Street Corridor lacks sufficient bicycle and pedestrian safety measures, better infrastructure needs to be put in place to increase bicycle and pedestrian safety. The technical portion of this paper will analyze the existing infrastructure of Water Street Corridor and improvements that can be made for pedestrians and bicyclists. The sociotechnical portion of this paper will delve into what impacts bicycle infrastructure has on low speed roads.

Technical Topic

The existing design of the Water Street Corridor incorporates shared lane markings, or sharrows, and crosswalks for bicycle and pedestrian safety, respectively, see Figure 1. A sharrow is a road marking used to indicate a shared lane environment for bicycles and automobiles (Shared Lane Markings, 2016). The goal of this project is to analyze the conditions of the Water Street Corridor and offer design alternatives in order to create a safer environment for bicyclists and pedestrians. Because of the existing infrastructure at the downtown mall, and the complexity of the site, our team did not want to move construction outside of the road. Thus, our team gathered information from the city that shows the current dimensions of the roadway within our project scope. With this information, alternative designs can be created to fit within the scope of the road. The alternative designs were created using Civil 3d. Civil 3d is a design software used to create designs and plans. After creating the alternative designs, our team will be implementing the designs into the Unity software. Unity is a virtual reality gaming software which will be used to test the designs that we create. All of this work will be done alongside the ORCL lab group at UVA which is already doing work on this particular corridor.

Three proposed designs were created to try and foster a better environment for bikers and pedestrians. The first alternative design, as seen in Figure 2, was a design derived from an existing project by Toole Engineering.

Figure 1: Roadside view of Sharrow on Water Street Corridor (Google, n.d.)

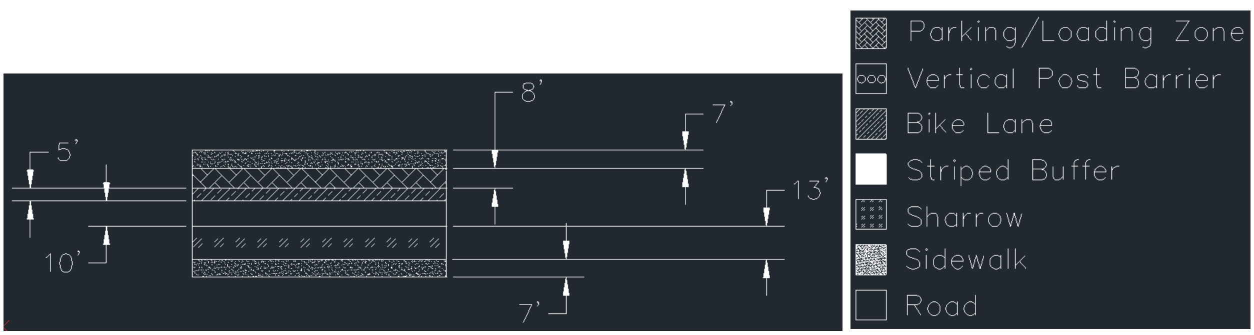

Figure 2: Alternative Design 1, with Legend (Capstone Group, 2019)

Toole Engineering group is a civil engineering firm that already created an alternative design for the Water Street Corridor. The ORCL lab group obtained these plans and sent them to our team for reference purposes. Alternative design one adds a bike lane running along the westbound side of the road, while keeping the sharrow on the eastbound side of the road. This design offers more bicycle infrastructure along the westbound lane. This is important because the westbound lane goes away from the downtown mall, so when people are leaving work or travelling past the mall, they can have more protection and experience a safer ride. Likewise, the shared use lane is wider than an average lane width (about 10-11 feet), which will allow the bicyclist to feel more comfortable when biking alongside other vehicles.

The second alternative design (see Figure 3) turns the Water Street Corridor into a one-way road going westbound. This is how the Water Street Corridor used to be laid out when it was first built. This is the most idealistic design, however diverting all of the eastbound traffic elsewhere may bring up some concerns. The road would feature a wide 12-foot lane that would accommodate all vehicular and bus related travel. Next to the road would be a 10-foot cycle track separated from the road by a vertical post barrier, see Figure 4.

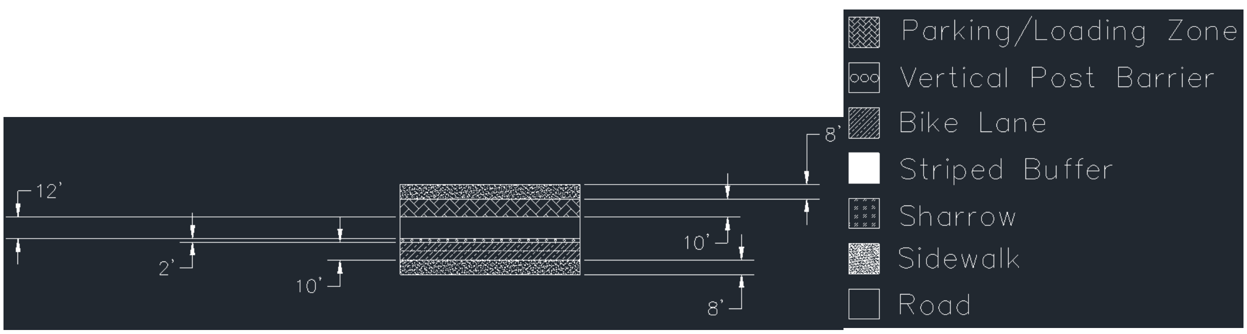

Figure 3: Alternative Design 2, with legend (Capstone Group, 2019)

Figure 4: Cycle Track Separated by Barrier (Two-Way Cycle Tracks, 2019)

A cycle track, as seen above, is a road paved specifically for bicycle travel, ensuring the safety of the bicyclist.

The third alternative design (see Figure 5) removes the street parking in order to create more space for bike lanes going both directions.

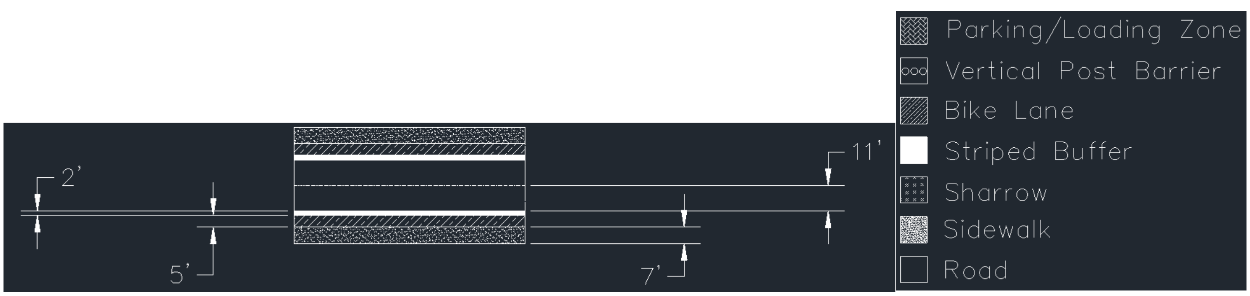

Figure 5: Alternative Design 3, with Legend (Capstone Group, 2019)

Our team thought that parking was disposable, because of the numerous parking spots in the large parking garage located along the Water Street Corridor. By removing street parking, there is more room to add bike lanes on both sides of the road. There will also be a striped buffer between the vehicular travel lane and the bike lane. A striped buffer is a painted buffer that separates sections of a road. Monsere et al. shows how more bicycle infrastructure leads to an increased awareness of what is available for bicyclists to use as well as the safety of those bicyclists (Monsere et al., 2014).

The three alternative designs aim to increase the safety of the roads, and also the awareness of bicycle infrastructure. By increasing awareness, more bicyclists are likely to use the bicycle infrastructure. Likewise, more people are likely to ride bikes on the street because of the increase in safety.

Sociotechnical Topic

The framework of coproduction was used to describe the mutual shaping of bicyclists and drivers, as well as the influence of constitutive powers on the roadway that these users ride or drive on. Jasanoff (2004) describes coproduction as "the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it". Bicycles and vehicles have to adjust to the use of one another, thus shaping the ways that each system is evolved throughout time. Daly (2014) describes the negative social impact that bike riders experience while riding on the streets without bicycle infrastructure. Daly (2014) states how the presence of bicyclists on the streets and the annoyance they cause to drivers creates a negative perception and almost discourages bicyclists from riding on the streets. The bicyclists adjusted to the drivers by avoiding the streets. However, negative perceptions of infrastructure will not have a great effect on how it will be built. Constitutive powers such as the National Association of City Transport Officials (NACTO) and the Virginia Department of Transportation (VDOT) create roads in order to gain monetary value out of the use of the road. Thus, it can be assumed that some bicycle infrastructure will be built regardless of some dissenting public opinion.

Bicycle infrastructure changes the perception of bicycle ownership and rideability (Habib et al. 2014). After studying bicyclist behavior in different cities around the world, Hull and O'Holleran (2014) concluded that better design of bicycle infrastructure will encourage bicycle ridership. Likewise, when cities lacked adequate or any bicycle infrastructure, bicyclists were deterred from riding on the streets (Hull and O'Holleran, 2014). Viewing the argument presented by Daly, in conjunction with arguments from Habib and Hull and O'Holleran, there is a stigma created by bicycle lanes and general bicycle infrastructure. Bicyclists are more encouraged to ride on the streets in the presence of bicycle infrastructure, and are discouraged when a road lacks bicycle infrastructure. Hull and O'Holleran (2014) go on to describe the disparity between experienced riders and inexperienced riders on certain roads with bicycle infrastructure. A lot of bicycle infrastructure in cities with complex intersections and roadways may be adequate for someone who has been riding a bicycle for many years. However, when inexperienced riders begin to traverse these complex designs, though the bicycle infrastructure is existent, there is no consideration for inexperienced riders. This idea is further expounded by Vreugdenhil and Williams (2013) who argue that the implementation of bicycle infrastructure needs to take into account the considerations of the community. A study in Tasmania, Australia was realized by Vreugdenhil and Williams that analyzed recently created bicycle infrastructure and the response of the community. They argue that this negative social response to bicycle infrastructure can deter bicyclists from wanting to bike (Vreugdenhil and Williams, 2013).

However, this is another instance where negative social responses, described by Vreugdenhil and Williams, will not stop the constitutive powers such as NACTO and VDOT from creating projects for monetary gain. Thus, more bicyclists will inevitably be on the road because of this increase in infrastructure. Because of this, drivers and bicyclists will have to interact with one another, regardless of the negative social response to bicycle infrastructure. NACTO and VDOT and the bicyclists and drivers will continue to mutually grow and affect one another. Drivers and bicyclists will continue to mutually affect one another with intentional interactions while the constitutive powers will affect the ways that drivers and bicyclists interact with the infrastructure.

Negative social responses to bicycle infrastructure can be further extended to a study done on the recent surge of bike share options in Shanghai. Bike share options are becoming more realized because of a conscious push towards greener transportation (Bao et al., 2017). By studying the Mobike bike share company in Shanghai, Zhang and Mi (2018) concluded that bike sharing saved nearly 8358 tons of petrol and decreased 25240 tons of CO_2 emissions in 2016. Thus, with a city as large as Shanghai, a simple change from vehicular travel to bicycle travel would cause a lot of new bicyclists to appear on the road. And with the emergence of new bicyclists, there may be a portion of riders who are either novice or casual riders. Bike share users in Shanghai tend to ride bikes during the peak hours of traffic when it is most busy (Bao et al., 2017), so the bicycle infrastructure needs to be designed to accommodate these new or inexperienced riders.

The emergence of a more environmentally conscious community is clearly evident from the data Zhang and Mi and Bao et al. presented. Mobike, as well as other bike sharing options, on its own is growing in large cities akin to Shanghai. Bike sharing is a cheap option that is convenient and available and used by many people to get to a place quickly without having to wait for the bus or a taxi or Uber. Likewise, with the growing environmental concerns and how we as humans affect the environment, there are communities that are trying to do whatever they can to reduce their carbon footprint. Thus, more people will be willing to ride bicycles instead of motorized vehicles to save energy and help the environment. With both of these areas growing at a rapid rate, there is an increased need for bicycle infrastructure to accommodate all of these new bikers on the roads.

Research Question and Methods

The research question being analyzed in this paper is: What are the Impacts of Adding Bicycle Infrastructure (i.e. Bicycle Lanes, Sharrows) on a Low Speed Road? With a rise in bicycle ownership and ridership, there needs to be a greater investigation of the infrastructure on which the bicyclists will ride on. Without such infrastructure, bicyclists are put into greater danger and greater risk of injury. In order to analyze this question, case studies such as the evaluation of bike lanes under the USDOT by Hunter et al., the investigation of infrastructure in Toronto by Habib et al., and the sociotechnical study in Tasmania by Vreugdenhil and Williams were reviewed and digested in order to gain a real-world knowledge of this issue. These case studies will give insight on what types of bicycle infrastructure is beneficial and efficient and what types are not. It will also be wise to not just study the design of a bike lane but to see how bikers actually interact with different bicycle infrastructure and what their responses are. Under the framework of coproduction, the mutual interaction of bicyclists and drivers can be noted in these case studies. Likewise, the impact of state and local governments can be seen in the ways that the infrastructure is built and how it is implemented into a roadway. Constitutive powers will continue to create projects for bicycle infrastructure, and more bicyclists will continue to ride on roadways. Studying the case studies under the framework of coproduction will give greater insight into how a design is created and what is the most effective design.

Conclusion

This paper analyzed the technical topic of bicycle and pedestrian safety along Water Street Corridor, while I extend this to understand how bicycle infrastructure can impact a low-speed road. For the technical topic, different design alternatives were offered as solutions to ameliorate the safety issue of bicyclists and pedestrians. Each design alternative incorporated a new type of bicycle infrastructure used to increase the safety and comfort of bicyclists. Once successfully completed, the design alternatives should offer bicyclists and pedestrians safer options to travel. I further studied the addition of bicycle infrastructure with the framework of coproduction. The rise in bicycle ownership and ridership and the increase in awareness of environmental issues contribute to the design of newer, more inclusive bicycle infrastructure.

For the technical project, a preliminary design review will be given in December 2019. A final design review will be expected by May 2020. In order to test the alternative designs, user testing will be done from around January 2020 to February 2020. Synthesis of the data will be done from February 2020 to April 2020. Outcomes of the technical project will include a final design review, as well as an alternative design for the Water Street Corridor. For the sociotechnical paper, more evidence and data will be collected from January 2020 to March 2020. The final paper will be due in April 2020. Upon delivery of the final paper, a comprehensive study of bicycle infrastructure will be established.

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