Old Ivy Road Residential Development

Acute and Persisting Ramifications of Traffic Calming Measures on Driver Stress and Anxiety

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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.

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Introduction

In Charlottesville, Virginia, the issue of affordable housing is contentious (Armesto, 2023). The University of Virginia supplies a steady stream of people who require housing, making economic bargaining harder for residents who call Charlottesville their permanent home (Whitton, 2023). Our technical project focuses on a plot of land near Old Ivy Road that is to be developed into a housing development with mixed-use elements. As a part of this development, we aim to incorporate a mixture of affordable housing. However, concern has been raised about the broader impacts of increasing density of people on the roads near Old Ivy Road. Safety along the corridor is the chief concern of opponents, due to its poor existing record during rainstorms and traffic (*Public Safety Issues*, 2022). While the site is in a prime location near the University of Virginia, our goal is to create a development that will serve the community at large, not just UVA students.

A pressing issue facing the United States is the rate of traffic fatalities. The overall gearing of improvements has been towards car design and safety; however, more attention has been drawn in recent years to the design of infrastructure itself. Traffic calming measures, such as intentionally narrowing roads, aim to make drivers more aware of their driving habits. When assessing if these measures work, studies typically consider the impact of the system on road system users' rate of injury and crashes (Chimba et al., 2022). However, wider and longitudinal impacts go largely unnoticed and unconsidered. With drivers spending over an hour daily on roads (Tefft, 2022), and chronic stress leading to issues such as reduced brain matter and reduced immune system functions (Yaribeygi et al., 2017), these downstream impacts need to be considered to encompass all impacts of roadway safety. By not considering the broader

externalized impacts of these roadway systems, I hypothesize there may be a critical undercount of issues associated with traffic calming roadways.

Civil engineering is ultimately a service to the public. Perhaps more than any other discipline, the decisions made by civil engineers have far-reaching trickle-down effects for its users and the general public at large. Decisions must be made with the correct context and information to be able to best serve the public. The field of civil engineering is as broad as it is important. Through the design of a community, and the development of its land, a culture, a community, and a spirit can either thrive or die, with no direct impact on its designer. Likewise, the design of a roadway system can lead to a reduction of injuries, deaths, and the stress and anxiety of its users, or it can lead to an increase in problems. It puts the civil engineer and their team squarely in the middle of an important decision, of which the answer may be ambiguous. In the issues of the Old Ivy Road development and traffic calming, the concern is integrating community values and safety. There is the possibility that in attempting to tie the community together, the safety of its people is jeopardized.

Old Ivy Road Land Development

The Old Ivy Road project tasked our team with designing and developing a 36 acre parcel of mixed-use residential and commercial development along Old Ivy Road. The client requested 250 to 300 housing units divided into single family homes, townhomes, and apartment buildings with adequate parking. A minimum of two commercial buildings are required for the lot, as well as amenities for the housing. The development must be fully fleshed out through the design phase and the pre and post construction phases. Total elements for the project include the site plan, grading plan, stormwater management plan, construction Gantt chart, Rivanna trail relocation, and traffic plan.

The primary elements of the design, including the site plan, grading plan, stormwater management plan, and construction Gantt chart, are mostly self-contained. Our team will design these elements in partnership with industry professionals to meet the goals of the site owner. In particular, we will be providing affordable housing as a component of the site. This is especially important given the lack of affordable housing in Charlottesville. While 90% of white residents find their housing affordable, more than two thirds of black residents do not ("The Impact of Racism", 2020). This is a staggering disparity between experiences, and it is important that our project help to address this issue.

Elements that have an external impact, such as the Rivanna trail relocation and traffic plan, will require more of a nuanced approach. These elements will interact more heavily with the existing Charlottesville community and will require greater transparency and engagement with the public. The development's site contains a portion of the Rivanna trail, a 20 mile volunteer-maintained stretch beloved by the Charlottesville community. The trail is self proclaimed as "America's Best-Disguised Hiking Trail", and currently comes within yards of other existing developments(*America's best-disguised hiking).* Fortunately, the trail is near so many urban areas already that it should not be hard to move the trail around the environment our development will make. However, given the trail's significance and community involvement, it is important to take care to relocate it responsibly.

One of the largest present concerns in the community involving this development is safety and traffic (*Public Safety Issues*, 2022), The community opposition is worried that the increase in volume of traffic will further congest the roads, and decrease safety. Indeed, the VDOT scoring of some neighboring intersections has already been ranked as F on an A-F scale (Ruff, 2021), and this development will likely increase overall traffic. As such, a clear plan for

accommodating increased traffic from the residents as well as the commercial property is needed. We intend to ensure that existing VDOT roads can meet driving standards in combination with our project, and to also design the private roads within the project to meet usability requirements. While adjusting all of the nearby roads is outside the scope of the technical portion of our proposal, it is still our intent to minimize the burden on the traffic in the area through thoughtful design.

The Intersection of Traffic Calming Methods and Mental Health

The science, technology, and society question I have involves roadways and safety. I specifically ask: "How do modern roadway enhancements to control traffic and speed impact the long term mental and physical health outcomes of its users?" The United States has been trying to solve the issue of motor vehicle related fatalities for decades. Many landmark safety improvements in cars have occurred over this time frame, ranging from the law mandating the 3 point seatbelt in 1968 and airbags in 1998, to electronic stability control and backup cameras in 2011 and 2018, respectively (*Newer Cars are Safer Cars*). Unfortunately, these measures have been rather unsuccessful in addressing overall mortality. The overall motor vehicle death rate per 100,000 people has decreased by 39% since 1975. However, the actual number of motor vehicle fatalities in the United States remains high. The number of annual deaths reached its lowest point in 2011 with 32,479 but increased to 42,939 in 2021 (*Fatality Facts 2021*, 2023) One death from motor vehicles is too many, and the current rate and recent escalation is a cause for great concern. Given this context, it appears that a continual increase in car safety is not adequate to drive down motor vehicle fatalities to our goals.

In the mission to bring the incidence of fatalities down to zero, there has been a change in mentality among some thought leaders in the US, and a shift towards European mentality. For

instance, in Europe, Vision Zero has asserted since 1990 that traffic crashes are better addressed under a systems approach to traffic incident reduction, instead of placing blame on individuals.(*What is Vision Zero*) Systemically, this is a different approach than in the United States, where drivers are put as "at fault" 94% of the time, even with the context of poor roadway design (Zipper, 2021). This approach emphasizes the importance of an iterative cycle, where system planners and policy makers bear the burden of prioritizing safety in designs and policies. While individual road users are responsible for following rules, an accident leads to the designs and policies being re-evaluated for safety improvements. This emphasis on design leads to a reduction in vehicle accidents through prevention versus a sole emphasis on crash protection.

In the US, there has been an increased focus on traffic calming measures. Traffic calming is "a full range of methods to slow cars, but not necessarily ban them, as they move through commercial and residential neighborhoods." (FHWA Course) Their designs can include anything from a speed limit reduction to the reduction of lane width and the introduction of curves. While there are many motivations behind traffic calming, including aesthetics and crime reduction, a large driver of their implementation is safety. These methods typically attempt to increase driver attention and cause the driver to realize that speeding in this situation is unsafe.

When implementing traffic calming, the considerations are the outcomes of the system at the moment. For example, a reduction in speed, accidents, and fatalities is typically achieved (Reid, 2001) and these are considered benchmarks of success. However, these studies traditionally have no consideration for what happens to drivers before they're on the road, after they're on the road, or their mental state while driving (Chimba et al., 2022). Under such constraints, any mental issues caused by these roads are unconsidered. Given that driving is already a stressful experience for a portion of the population (Hempel et al., 2017), it is

important to recognize that traffic calming measures, including lane narrowing and sharp turns, could enhance this stress. These elements, which are common in backroads environments, can be especially stressful for some drivers (Ageas, 2021). Additionally, road conditions such as weather, visibility, and inter-driver interactions increase stress of drivers (Hill and Boyle, 2007), which may be augmented by traffic calming measures. Unfortunately, anger or anxiety is linked to worse driving practices (Dula et al., 2010). Over time, these long term stressors can convert to physical health problems in the form of structural brain changes and memory disorders (Yaribeygi et al., 2017).

The problem of longitudinal user safety in the context of traffic calming measures is complex and hard to separate from confounding factors. Due to the web in which this problem lies, there are many conflicting actors. For analysis and interpretation, I will utilize the science, technology, and society framework of actor network theory. The actor network theory asserts that under the scope of the question, everything that has the potential to act is an actor (including non-humans) and the network is the interconnection of the actants. In the scope of driver safety on roads, I seek to understand the impact of roads that have traffic calming measures on user wellbeing. While these are the two primary actors I intend to understand, I will also look at other actors in the network, including traffic engineers, law enforcement, roadway technology, advocacy groups, and regulatory bodies. To understand this problem, I will look at published research in addition to firsthand actor perspectives to gain a wider sense of sentiment. To assist in interpretation of results, Dr. Donna Chen will be asked to provide her expertise in civil engineering.

Conclusion

The technical portion of our research involves the development of a residential and commercial area on Old Ivy Road. The science, technology & society portion involves research into traffic calming's impact on road users. Both portions have the ability to impact communities, and present an opportunity to lay out a framework when developing a community or improving roads. With better community designing standards, civil engineers have a better opportunity to positively impact the world. Combining these two topics, the roadways in a residential community can be designed to create long lasting, across the board safety for all its users. I expect that the technical portion will result in a well developed community for Old Ivy Road and Charlottesville at large. I expect the STS portion to reveal that traffic calming practices have hidden mental health ramifications that are not yet being considered. Armed with this knowledge, future improvements to roadways and communities can be researched.

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