

# **Calmer Streets, Tenser Drivers? The Mental Health Impact of Traffic Calming**

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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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## **STS Research Paper**

### **Introduction**

In the United States, drivers are being subjected to a variety of measures meant to improve roadway safety. Everything from improvements in vehicles themselves, to machine-assisted driving, to campaigns targeted at distracted or impaired driving are geared toward reducing the over 40,000 Americans that die from cars each year (Fatality Facts 2021, 2023). However, focus has been brought onto the inherent design of roadways in America (Traffic Calming, 2018).

Recent roadway designs focus heavily on reducing collisions, fatalities, and speed. Throughout this paper, I will discuss the criteria that roadway designers use when designing roads. 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.

In this paper, I will address the potential shortcomings that occur when designing roadway systems and how they arise. Primarily, I will be considering the mental health implications of changing roadway design criteria. I ask the question: “How do modern roadway enhancements to control traffic and speed impact the long term mental and physical health outcomes of its users?” When deciding to change the mechanisms at play in a road system, the burden of responsibility and duty of adherence can morph as well. I will explore how a forced shift in responsibility onto drivers can impact them negatively. To highlight this, I will examine a specific roadway that faced backlash after being redesigned.

To conclude the paper, I will address how the emphasis on creating more modern roadway systems can be to the detriment of its serviced population. The creation of these road

systems can have hidden implications and harms, which may not be fully understood or captured under the current design process.

## **Background and Significance**

### **The Intersection of Traffic Calming Methods and Mental Health**

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, n.d.). 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, 2023). Given this context of escalating deaths, 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. 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, n.d.). Systemically, this is a different approach than in the United States, where drivers are put as “at fault” 94% of the time, even in 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 on the road leads to its design and policies surrounding it being re-evaluated for safety improvements. This emphasis on design leads to a reduction in vehicle accidents through prevention of accidents versus an emphasis on crash protection as a crash occurs.

Following European design, 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, n.d.) 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). In this paper, the relationship between roadway design and driver long term outcomes will be discussed.

### **Methodology**

Holistic user safety in the context of traffic calming incorporates both on and off road outcomes that stem from the roadway experience. This is a broader scope than a traffic safety assessment which just includes on road collisions. As such, studying this 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 their actions (Actor network theory, n.d.) In the scope of drivers 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.

A key concept to frame this problem lies in the latent and manifest functions and dysfunctions framework. Manifest functions are the intended and recognized outcomes of a social phenomenon. Latent functions are the unintended, unrecognized consequences of a social phenomenon (Manifest and Latent Functions, 2024). For roadway design, it's important to understand what function the engineers that design the roads are trying to achieve. When trying to drive down traffic incidents, the manifest function is a decrease in traffic incidents. The latent functions are the mechanisms at play to cause the decrease in incidents. These latent functions are generally unrecognized or not considered. For instance, when evaluating driver sentiment toward a roadway, engineers may look at speed to determine if the road has gotten safer. (Distefano & Leonardi, 2022). While this shows the manifest effect of the car speed, it is unable to gauge the latent function of what mechanism caused the driver to go slower. This paper seeks to understand the latent functions of roadway design so that the tradeoff between safety and other factors can be known.

The primary approach to between driving through traffic calmed roads and mental health is through review of available literature figuring out the connection. The United States has

different traffic departments in each state, with the Federal Highway Administration (FHWA) overlooking them all. The FHWA maintains a research library, which provides critical information on roadway statistics and design. Studies published in research journals provide key information on driver sentiments and attitudes. To add additional context, a case study of poor traffic calming was identified. In 2022, the town of Mira Mesa, California, implemented a new traffic striping pattern on an existing road. I will explore the connection between a roadway and a community through this example.

Through the STS frameworks of actor network theory and manifest and latent functions, plus literature review and a case study, I take an all encompassing look at how traffic calming impacts roadway users. This is important to society at large, since roadway systems can be in place for decades, impacting thousands of users. I hope to highlight this issue and change the systemic thinking about how engineers think about roadway networks.

## **Literature review**

### **Part I: The Need for Traffic Safety**

When it comes to traffic safety, there have been many solutions pursued to reduce traffic collisions. While the overall number of casualties per 100,000 vehicle miles traveled has decreased, the overall number of deaths has remained stagnant and has increased in recent years (Fatality Facts 2021, 2023). Another perspective is to increase the awareness and thoughtfulness of drivers. However, public messaging through electronic signs has been correlated with an increase in traffic incidents (Hall & Madsen, 2022). An avenue that is commonly used is enforcement of traffic laws. This can include traditional traffic enforcement, through traffic stops, or through automated mechanisms like red light cameras. This approach comes with issues such as racial disparities in enforcement (Pierson et. al, 2020), especially with human

enforcement. Other concerns include creating economic incentive and reliance on people breaking the law, and the intensity of resources needed to enforce the law.

We already know that certain measures, like speed limits, have a marked effect on roadway safety. The faster a driver is going, the greater risk of injury or death (Elvik, 2012). From 2005 to 2010, certain segments on Michigan roads had a speed limit increase. After these speed limits were increased to 70 miles per hour from 55 miles per hour in Michigan, crashes increased by 21 percent and fatal and injury crashes increased by 11.9 percent on these roadway segments (Kwayu et. al, 2020). However, speed limit reductions still rely on enforcement. On areas of mass transit, like highway systems, it often makes sense from a cost benefit perspective to have speed enforcement. On less trafficked roads, it is harder to justify enforcement unless accidents have already occurred. This makes changing roadway speeds a potentially ineffective solution for less trafficked roads if there is a lack of resources to enforce the provision.

Capping speed limits also presents issues in terms of public sentiment and willingness to follow the speed limit. The Manual on Uniform Traffic Control Devices (MUTCD) is the national standard for public roadways and governs roadway choices across the country. The MUTCD recommends setting the speed limit at “within 5 miles per hour of the 85th percentile speed” (Forbes & Xu, 2012). To clarify, the speed limit should be set to within 5 miles per hour of the speed that 85% of people do not feel comfortable driving at, given free flow conditions. This is because the MUTCD assumes a “high percentage of drivers will select a safe speed on the basis of the conditions at the site” (Forbes & Xu, 2012). This strategy being recommended by the MUTCD, which is the national standard, means that speeds should be decided based on how fast roadway users feel comfortable going. Artificially lowering the speed of a road as a way to make it safer is not an endorsed method.

There are a variety of concerns given this strategy. It assumes that drivers fully understand the complex dynamics at play during traffic incidents. By relying on drivers to intuitively understand what a “safe” speed is, the burden of understanding is pushed away from engineering calculations and instead onto intuitive judgment. Car design itself makes it harder for people to estimate their safety, with modern designs reducing speed perception by 20% (Lidestam et. al, 2019). In essence, highway engineers are relying on people’s intuitive perception of speed and its relationship with safety, which is not a task that humans are designed for.

With this in mind, it is important to understand the linkage between both speed as a risk factor by itself and between vehicles. While absolute speed itself can lead to an increase in the number of crashes, as shown in the Michigan road study discussed earlier, there are benefits that are present with user-derived speed limits. One of which is increased predictability of speed compliance. Uniformity in speed on certain roadways, such as highways, is linked with a significant reduction in crashes (Apostoleris et al., 2023). It may be safer to have roads be faster than to have a mix of drivers at a safe speed and a different population at an unsafe speed.

In this context, a solution that would cause drivers to naturally want to go slower would theoretically be very effective at preventing crashes. In a neighborhood setting, there are a variety of factors available for impacting roadway speed and reducing traffic incidents. “Traffic calming” is a collection of tools available to roadway designers to calm a road down. This includes a variety of measures, ranging in level of intrusiveness, cost, and effectiveness in reducing traffic incidents. The Virginia Department of Transportation breaks down methods into the categories of non intrusive, vertical, horizontal, and narrowing devices (Traffic Calming, 2018). Non intrusive designs can include measures like community welcome signs, restriping of



roadways, the introduction of real time speed limit gauges, and signs indicating fines if speeding occurs. There are a variety of vertical designs, including speed humps, speed lumps, speed tables, raised intersections, and raised crosswalks. Horizontal designs include chicanes (one or two way travel), median islands, crosswalk refuges, and crosswalk offsets. Narrowing designs include chokers and curb extensions. VDOT has ruled out a variety of traffic calming measures for reasons including cost, and effectiveness, including stop signs, enforcement, devices that restrict traffic, speed reduction, markings, zig zag pavement markings, in-roadway warning lights, roundabouts, and traffic Circles.

Traffic calming systems are a solution to the critical problem of reducing collisions and decreasing the severity of collisions. The primary mechanism in which this occurs is through reduced speed (Traffic Calming, 2018), which in turn drives down rates of traffic incidents. A speed decrease of multiple miles per hour has been recorded on several types of these roadways. For example, traffic humps can cause a reduction in traffic speeds of 5-8 miles per hour (Traffic Calming, 2018). Garnering traffic safety results can be a difficult task, primarily because the rate of traffic incidents on a neighborhood scale is statistically small with or without traffic calming designs. However, looking at several roadway stretches reveals a correlation between traffic calming and fewer collisions (Ewing, 2001).

## **Part II: The Hidden Implications of Calming Traffic**

The potential for issues becomes apparent when considering the latent effects on drivers. The framework of manifest and latent functions and dysfunctions was first proposed by anthropologist Bronisław Malinowski and later enhanced by Robert K. Merton. Merton defines manifest functions as “those objective consequences contributing to the adjustment or adaptation of the system which are intended and recognized by participants in the system” (Helm, 1971).

For this issue, these manifest functions would be the traffic calming solutions which intend to reduce harms resulting from traffic. The latent dysfunctions are defined as “those which are neither intended nor recognized.” Here, the latent dysfunctions are the side effects of traffic calming that are both not intended to be produced and not recognized. In this case, I propose that there are latent dysfunctions as a result of traffic calming, which take the form of negative psychological effects on the users of traffic calmed roadways.

For metrics such as a reduction in speed, gathering data is relatively straightforward and deemed highly relevant to the design of a roadway. Observationally, this is a solved problem with very little room for interpretation. A variety of in-roadway sensors and over-roadway sensors, sensors and tools are at the disposal of designers (Mimbela & Klein, 2007). It is relatively trivial to collect this data, and reduced speeds are highly linked with safer driving outcomes.

While traffic studies do routinely measure effectiveness of roadways for driving characteristics like speed and travel time, driver sentiment is typically excluded. The Federal Highway Administration has “identified seven basic measures of effectiveness” (MOE) which evaluate highway effectiveness, none of which gather information on driver sentiment or long term outcomes (Dowling, 2007). There have been four MOE’s identified as needing more research, none of which identify driver perception. Simply put, the effectiveness of a highway excludes the experiences of those who use it and only focuses on outcomes.

For a metric such as how a roadway can cause anxiety, gathering results is more intensive and typically are not within the scope of study. Due to the less immediate impact of anxiety and stress on a driver, there is less attention to and less incentive to analyze and study this impact. Research studies, use surveys to gauge roadway perceptions, which presents complexities.

Surveys about one's own mood can exhibit low test-retest reliability and can be manipulated by question phrasing (Hudson et al., 2020). The information on how roads make people feel usually isn't gathered, and when it is, the methods used are limited and lead to variable results.

This difficulty of testing how a road causes stress lends to the idea that the full latent ramifications of roadways are not fully recognized or known. The Actor Network Theory (ANT), proposed by Bruno Latour, asserts that "everything exists in a network of interactive relationships, including people, technology, and non-living or inanimate objects" (Actor Network Theory, n.d.). Under this framework, the drivers, roadway designers, and roadways themselves exist in a network that all interact with each other. Each has the ability to exert influence on the other, and can have a real tangible impact. Through ANT, the psychological impacts experienced by drivers can be attributed to the roadways they drive on.

The exact mechanisms by which traffic calming devices work are complex. The changes to driving methods due to traffic calming are a combination of the driver's physical ability and the driver's persuasion to act a certain way (Domenichini et al., 2019). For example, in the use of chicanes. Drivers are physically unable to drive straight in an area with a chicane due to the roadway being interrupted by patches of grass or raised concrete. Vision can also be also artificially hampered through the addition of bushes or trees in the chicane patch (Marek & Walgren, 1998). Drivers are physically unable to go straight when a chicane is in the way, but they also have no idea if there's an obstruction or child at play that's hidden behind the bush. A roadway that drivers originally could easily drive down has been made intentionally harder to physically traverse and made to require more mental processing.

A road being physically harder to navigate is not the only factor at play when drivers reduce speed. Several Chicago roads had chicanes introduced and their speeds measured after

implementation (Marek & Walgren, 1998). After an immediate sharp decline in speeds, speeds slowly started to increase after a few years, despite the roadway remaining the same. This points to drivers becoming more familiar with the roadway and the psychological component becoming less relevant as they become used to it. This further indicates that driver actions are impacted by both physical limitations and perceived risks. This shift causes an increased requirement of engagement on behalf of the driver.

Travel and driving remain a standard in America, with the average American driving for over an hour a day (Tefft, 2022). Americans are virtually forced to interact with the transportation networks created by traffic engineers, despite having little input into their creation and design. The ramifications of people being exposed to a system that they cannot control nor foreseeably escape are large. Faced with objections to their roadways, people have the option of not using them, protesting them, or leaving the area altogether. Given the extent by which Americans rely on roads to travel for work and pleasure, opting out entirely is not typically a viable option. Even opting to use public transportation, bicycling, or walking often puts users on the very same roadways that would be avoided by cars. To not use roadways means to effectively isolate. Users can protest, however, this relies on others experiencing the same problems or being sympathetic to their issues. With this in mind, subjecting roadway users to conditions that require heavy mental engagement brings concerns.

### **Part III: Mira Mesa Case Study**

In April 2022 in Mira Mesa, California, parts of Gold Coast Street were converted without warning. Overnight, sections were turned into “advisory bike lanes”, and became the first road in California to have this design (Feather & Summers, 2022). The restriping converted the former two lane road into a single lane road with bike lanes on either side. The new road

featured no yellow center lines, and was not wide enough for each direction of traffic to drive on the lane at the same time. This design had cars driving head-on at each other in the same lane. When two cars approached, the design intent was for each car to swerve into the bike lane. In order for drivers to properly navigate the road, they must both avoid colliding with a car traversing in the other direction and any cyclists that may be occupying the bike lane.

In this case of traffic calming, the mechanism at work is the avoidance of a head on collision, which the driver perceives as dangerous and negative. At the same time, drivers must ensure that they will not collide with vulnerable road users. This method of traffic calming does not rely on “involuntary” actions, such as the turning of the wheel when approaching a sharp turn. This design does not physically make the road hard to traverse. The road is just as flat as before, with the overall width being the same. Instead, it relies fully on the voluntary action of the driver avoiding a crash which would otherwise deliberately occur.

It is very important to note that this design remains empirically effective. In an Ottawa, Canada study, motor vehicle speed decreased under this design (Kassim et al., 2019). Additionally, vehicles gave cyclists more room when passing. In a Mineta Transportation Institute study, risk of collision on edge lane roads was lowered by an estimated 44% (Williams et al., 2021). These factors are great for roadway safety, and have benefits for both drivers and other road users alike.

Though this design can improve immediate safety during the use of the road, it isn't without secondary effects. Given that the roadway experience is precipitated on fear of collisions, driver and cyclist sentiment toward this roadway design was primarily negative. After the implementation on Gold Coast Street, one resident described it as “playing chicken” (Feather & Summers, 2022). Another resident stated “It's false safety to stripe a bicycle lane that cars can go

into as needed and it really is, with this level of car traffic, an accident waiting to happen” (Gregorczyk, 2022).

These sentiments give a nod toward the anxiety and stress that a road like this can cultivate. Drivers are put in a condition where the perceived risk is extremely high and the consequences for failure are massive. However, since driver sentiment and outcomes are not measured for design, they are deprioritized compared to easily measurable factors like rate of collisions.

Later that same month, Gold Coast Street had its striping reverted to its prior layout. Mayor Todd Gloria remarked “Why we undid gold coast is we didn't follow our process... We should have informed the community. We should have advised them of what was coming” (Mecija, 2022). While it is true that the City did not inform their residents, the characterization of the failure as being due to a lack of communication is indicative of the way in which factors are prioritized in roadway design. The measurable outcomes of stress are not included in the scope of roadway design.

#### **Part IV: Implications of Stress from Roadway Use**

The implications of stress from driving, and stress in general, can be far reaching and large in scope. Interestingly, short term stress, which can occur when traversing a traffic calmed roadway, can increase mental and physical performance (Dhabhar, 2018). This is a major benefit for roadway safety. Tapping into the ability of drivers to be more reactive in an area where unexpected conditions occur, such as a child running into the street, can directly lead to safer conditions. Given just this information, it appears that a dosage of stress could be beneficial for roadway users.

Unfortunately, these conditions do not occur in a vacuum. Given that traffic calming measures are neighborhood implementations, people start and end their day with stress as they leave and return to their home. The amount of Americans who experience stress has risen over time, with 49% of people now reporting that they frequently experience stress in their daily lives (Fioroni & Foy, 2024). Chronic stress leads to issues such as reduced brain matter and reduced immune system functions (Yaribeygi et al., 2017). Counter-intuitively to the results found from Dhabhar, individuals that possess a high level of chronic anxiety cause more crashes than those with low or medium anxiety levels (Dula et al., 2010). The addition of roadways which introduce unmeasured levels of stress onto its users only exacerbates an issue that Americans already struggle with.

In the case of certain roadways, like the one at Mira Mesa, the level of discomfort can trickle so high that it becomes a reportable and fixed problem. However, if a roadway does not reach a critical threshold for action, its users will be left subjected to its effects. This leaves users left with little recourse to opt out of a stressful situation, since avoiding traffic calming may not be possible.

For specific groups or people which have a harder time with stress and anxiety, these roadways may present outsized effects. For example, the number of 18 year olds with licenses dropped from 80 percent in 1983 to 60 percent in 2021 (Gibson, 2023). According to Joanna von Staden, a licensed clinical mental health counselor, “The disinterest is really stemming from a level of anxiety — specifically around getting older, and having this huge responsibility.” Nudging drivers towards experiencing stress while driving only amplifies the concerns of responsibility that come with driving, and serves to make it an avoided activity. Another at-risk group are adults in the range of 55-70 years old. A 2017 report from Hempel et al. found that

driving anxiety was linked to poorer mental health, physical health, and a lower quality of life for younger senior adults. Introducing stress through traffic calming roadways negatively impacts these two groups.

## **Conclusion**

The roads people use are always a work in progress to become safer, more robust, and to provide a better experience for their users. Infrastructure is critical, and the ability of roadways to safely get Americans where they need to be, consistently, is key. However, in the race for progress in safety, the roadway user experience has been left as an afterthought. The latent effects of new roadway designs, such as traffic calming strategies, have the potential to leave roadway users afraid to embrace safer designs. There is, in some ways, a shift from creating intuitive designs to designs that create intentional ambiguity. This leaves drivers with the burden of creating safe driving conditions, and with the long term effects of the stress created by the roadways. In this way, the intrinsic roadway harms are externalized onto the roadway users, leaving roadways statistically safer but leaving users with its effects.

Perhaps the intent is to leave drivers in a more ambiguous position while driving. Surely, if drivers were a little more hesitant when driving down the street, they might be aware enough to not strike a pedestrian that they otherwise would have. However, if creating anxiety among drivers in certain situations (like neighborhoods) is the end goal, it is imperative to gauge what a healthy and reasonable amount of induced anxiety is. The lack of research into the driver experience leaves the door open to designs that create diminishing safety at higher levels of stress. A threshold for anxiety and stress harms outweighing the roadway benefits of traffic calming needs to be established. The implementation of these roadways also needs to be done in a more measured way, with consultation of the public being a minimum standard. Perhaps a cost



to reward matrix could guide engineers on when the induced stressors are justified by the increased safety. Identification and acknowledgement of potential alternatives that meet the same safety goals while inducing less stress is key.

The benefits of slower and safer roadways cannot be overstated, but their drawbacks are currently understated. Without research into what degree road designs stress users, users are being subjected to conditions that have potentially severe unmeasured consequences. In the pursuit of making roadways calmer, we must also ensure that we are keeping drivers calm, too.

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