What Two-Way Left-Turn Lanes Can Teach Us about Edge Lane Roads

Michael Williams
Owner
Michael Williams Company
Mount Shasta, CA 96067
Email: bikepedx@gmail.com

Submitted []

ABSTRACT

Edge lane roads (ELRs) are a new shared street treatment in the US and Canada that have the potential to transform millions of miles of low-volume roads. ELRs feature a single center lane that supports bi-directional motor vehicle traffic. This concept raises concerns for some. These concerns include:

- the potential for increased head-on crash rates,
- the potential of poor safety or operational outcomes with unfamiliar drivers, and
- appropriate signage and pavement markings.

Two-way left-turn lanes (TWLTLs) are a widely-used and well-studied form of two-way, one-lane facility. Past experience with TWLTLs appears to be an excellent analog for the developing arc of ELR use in the U.S. and Canada. Both treatments require opposite-direction drivers to share one lane. As with ELRs, TWLTLs faced early questions on their potential to increase head-on crashes, driver comprehension of a new treatment, outcomes with unfamiliar drivers, and appropriate signage or pavement markings.

Review of more than 70 publications on TWLTL performance from 1961 to 2022 and twelve years of recent ELR experience, shows that:

- ELRs and TWLTLs can improve safety compared to prior configurations,
- A new two-way, one-lane treatment plus high proportions of unfamiliar drivers can be safe,
- Observations of driver behavior show negotiation to successfully resolve head-on conflicts,
- Signage is less important than pavement markings for driver comprehension, and
- As drivers grow familiar with the treatment, signage can be reduced and pavement markings can become less fulsome.

Keywords: Edge lane roads, Two-way left-turn lanes, ELR, TWLTL

Introduction

An edge lane road (ELR) is a shared street treatment that has been used for decades globally but is a relatively new facility in the US and Canada. An ELR supports two-way motor vehicle traffic in the center area and vulnerable road users (VRUs) in the edge lanes on either side. To pass approaching cars, drivers merge into the edge lanes, after yielding to any VRUs. Following the pass, drivers return to the center. An ELR does not have a centerline. In addition to providing recognized space for VRUs, ELRs have the potential to reduce single-vehicle, roadway departure crashes on higher speed, low volume roads even where VRUs may not be common (1). A schematic diagram and a picture of an installed ELR are shown in **Figures 1 and 2**, respectively.

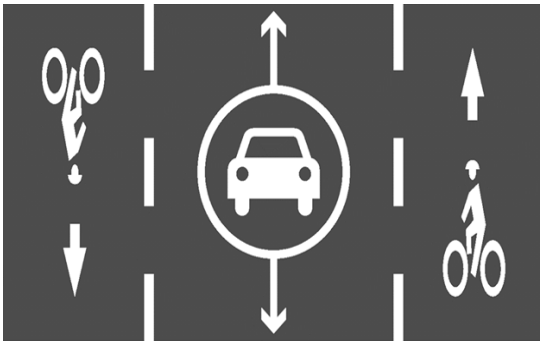

Figure 1. Schematic of an ELR (*2*)

Figure 2. ELR with colored edge lanes (*2*)

The most notable feature of ELRs is the single shared center lane for both directions of motor vehicle traffic. This feature generates concerns that include:

- the potential for increased head-on crash rates,
- the potential of poor safety or operational outcomes with unfamiliar drivers, and
- appropriate signage and pavement markings.

Two-way left-turn lanes (TWLTLs) are a widely-used and well-studied type of two-way, one-lane facility in the United States. TWLTLs are a median treatment consisting of a single lane that is shared by opposite-direction drivers (see **Figure 3**). TWLTLs provide a space away from through lanes for drivers to wait while executing a left turn and may also provide an intermediate space for drivers turning left onto a street, as from a driveway. Siting of TWLTLs often occurs where drivers traveling in opposite directions must use the same portion of lane to accomplish their turns, ensuring some conflict. Posted speed limits for successful use of TWLTLs have ranged up to 65 MPH as stated by Nemeth "...there are several examples of CTWLTMLs working properly even at 105 km/h (65 mph) (prior to imposition of the 88-km/h speed limit)." where CTWLTML is an acronym for Continuous Two-Way Left-Turn Median Lane. (*3*) State laws governing their use vary somewhat but are the same in most respects. State laws generally restrict their use to left-turn maneuvers only, prohibit the use of TWLTLs for passing maneuvers, and limit the distance a driver can travel in a TWLTL.

Figure 3. TWLTL with median island (*4*)

Because TWLTLs require opposite-direction drivers to share a single lane and because they were once new and unfamiliar to many drivers, the treatment was subject to the same concerns now expressed about ELRs. This paper reviews the published TWLTL literature along with ELR literature and anecdotal experience in an attempt to find lessons that might be applicable to ELRs.

The following are questions for which we seek answers:

1. Does a two-way, one-lane facility lead to increased head-on crash rates?
2. Does driver unfamiliarity with a novel two-way, one-lane facility cause safety problems?
3. What lessons were learned from observations of opposite-direction drivers negotiating for use of the same space?
4. What lessons were learned about signage and pavement markings?

The TWLTL literature reviewed was limited to the United States and included over 70 references spanning the time from the first American use of the TWLTL to the present and covering the years 1961 to 2022.

TWLTLs and ELRs are different treatments used in different settings for different purposes. This article does not draw exact equivalences or propose that hard-and-fast rules apply equally to both treatments. This paper draws qualitative inferences only.

TWLTL Background

History

Two-way left-turn lanes (TWLTLs) appeared in the US sometime in the early 1950's. Sawhill and Neuzil (*5*) claim the first TWLTL was installed in Seattle in 1952 while Walton and Machemehl (*3*) claim the first was installed in Michigan in 1950.

TWLTLs first appeared in the Manual on Uniform Traffic Control Devices (MUTCD) (*6*) in 1971. They appear in the 1973 AASHTO A Policy on Arterial Highways in Urban Areas (AKA the Red Book) (*7*) but are not found in the 1965 A Policy on Geometric Design of Rural Highways (AKA the Blue Book) (*8*); these versions of the Red and Blue Book were combined to create the first Green Book (*9*) in 1984.

In the approximately 20 years between their first use and their appearance in the MUTCD, TWLTLs spread across the country with jurisdictions creating their own signs and pavement markings resulting in a great diversity of appearance. Koltnow's article in ITE Traffic Engineering stated "A survey of two-way left turn lanes across the country shows a lack of uniformity which is so complete that even the expected duplications due to the laws of chance are not to be found."(*10*)

TWLTLs became sufficiently widespread that a number of studies were undertaken and published (*5*, *11*, *12*) before 1971 but most studies occurred after their appearance in the MUTCD.

Neither the 2009 MUTCD (*13*) nor the 2018 AASHTO A Policy on Geometric Design of Highways and Streets (Green Book) (*4*) provide warnings on the use of TWLTLs where opposite-direction drivers must use the same portions of TWLTLs to reach their destinations. The subject is not addressed at all.

The Green Book includes a general warning, stating "Two-way left-turn lanes may be inappropriate at many locations and conversion of existing two-way left-turn lanes to non-traversable medians should be considered." but more detail about why or where they may be inappropriate is not provided. Many TWLTLs are specifically used in settings where opposite-direction drivers must use the same portion of the facility to reach their destination. Data on the extent of this use is not known.

REVIEW OF TWLTL AND ELR EXPERIENCE

Does a two-way, one-lane facility lead to increased head-on crash rates?

The early years of TWLTL use saw significant fear over the potential for head-on crashes. The term "suicide lanes" became well-known and the term is still used more than 70 years later (14, 15) despite the excellent safety record of the treatment. Because of these concerns, early TWLTL research explicitly investigated head-on crash risks.

Because a TWLTL is normally lower volume than the through lanes on either side and because it provides a buffer space between opposite-direction through lanes, it is not surprising that adding a TWLTL to an undivided roadway provides a reduction in head-on crashes. But TWLTLs are often located where opposite-direction drivers must use the same portion of the TWLTL to reach their destination. Drivers are expected to resolve any head-on conflicts that arise. Despite these built-in conflicts, studies are unanimous regarding TWLTL impact on head-on crash rates. The addition of TWLTLs to undivided roads reduces head-on crash rates, sometimes overwhelmingly.

No reviewed study showed an increase in head-on crashes following TWLTL installation and most found a substantial reduction in that crash type. Findings from some of the larger studies are excerpted below.

The review of TWLTL research in the 1990 NCHRP Report 330 (*16*) concluded "The published literature on the safety effectiveness of TWLTLs universally discounts the possibility of substantial increases in head-on accidents between vehicles traveling in opposite directions trying to use the TWLTL to turn left at the same time (1)." Reference (1) in the quoted text refers to NCHRP Report 282 (*17*).

Parker's 1991 review of TWLTL research (*18*) states "Throughout the literature, in every accident investigation, field observation, and in every survey of traffic engineers, the evidence is that head-on accidents in the center lane of a two-way left-turn median are an uncommon occurrence and of negligible concern".

The 1999 NCHRP Report 420 (*19*) cites 3 studies that provide data on head-on crash rate changes following TWLTL addition to undivided roads. These studies showed reductions of 67% (*20*), 42% (*21*), and 46% (*22*), respectively.

The 2003 NCHRP Report 500, Volume 4: A Guide for Addressing Head-On Collisions, includes TWLTLs as a strategy for reducing head-on crashes and states "When they are used in response to a safety concern, the use is traditionally to reduce driveway-related turning and rear-end collisions. However, because studies have also indicated a positive effect on head-on crashes, the strategy is included here." (*23*).

FHWA-HRT-08-042, the report for a 2008 pooled fund study on the addition of TWLTLs to two-lane roads stated "There were very few reported head-on crashes, but a cursory analysis revealed that the treatment might be quite effective. In the after treatment period for all four States combined, there were only 14 crashes classified as head-on; however, the cursory EB analysis estimated that approximately 36 crashes would have occurred in the after period without treatment." (*24*)

One wrinkle discovered in this work is the inclusion of crashes with various root causes as "head-on". A crash involving two opposite-direction drivers within the TWLTL is classified as head-on and is the crash of interest in this work. Crashes with other root causes can be, and are, classified as head-on as well, e.g. a driver leaving the TWLTL and colliding with a through lane driver. The fact that crashes not involving opposite-direction drivers within the TWLTL contribute to head-on crash rates makes the low incidence of head-on crashes even more notable.

Head-On Crashes on ELRs

These findings parallel the results of ELR studies in the U.S. There is no evidence of a head-on crash in any of the ELR safety reports to date. In fact, the largest study of ELR safety to date found a reduction in the number of crashes after two-lane roads were converted to ELRs. This study used an Empirical Bayes analysis to examine 11 roads across the U.S., covered more than 60 million motor vehicle trips, and included crash data from 5 years pre- and 3 years post-ELR conversion. (*25*) Final reports from six cities participating in the FHWA's experimentation program showed no safety problems associated with the treatment. (*26–31*)

Does driver unfamiliarity with a novel two-way, one-lane facility cause safety problems?

Another concern expressed about TWLTLs was the problems resulting from unfamiliar drivers. As with head-on crashes, this aspect was explicitly investigated by early TWLTL studies. Findings of early studies and studies conducted when the treatment was newly installed, when unfamiliarity was highest, are presented below.

A 1961 study documented zero head-on crashes in the first year of a TWLTL despite the facility being expressly designed to allow access to opposed driveways that required shared use of TWLTL space by opposing drivers. (*12*) The authors concluded that driver unfamiliarity with the treatment was high since 20% of left turning drivers were observed decelerating in the through lane and executing a left turn through the TWLTL rather than using the TWLTL in the intended manner.

A 1963 study found only one head-on crash in three years following addition of a TWLTL to three 4-lane roads in Seattle. That single head-on crash involved a drunk driver. (*5*) ADTs were 15,800, 20,900, and 27,500. Field observations found approximately 20% of drivers made left turns through the TWLTL rather than from within the TWLTL, implying a substantial misunderstanding of the treatment.

In 1974 Hoffman published a 1-year-before/1-year-after study of four 4-lane corridors to which TWLTLs had been added.(*32*) Head-on crashes dropped by 43%. ADTs ranged from 15,000 to 30,000. With respect to head-on crashes, he concluded "The reduction in numbers and seriousness substantiates our position that this type of accident is not a problem in the two-way, left-turn facility."

Nemeth's oft-cited 1978 study (*33*) of TWLTLs stated, "The head-on collision, which has been a major concern underlying every decision to install a TWLTL because of deadly past experience with the old median bidirectional passing lanes, has been proved in every study to be an uncommon occurrence and of negligible concern (12)." The nationwide expert opinion survey conducted in this work showed 93% of respondents found TWLTLs improved safety with the remainder finding no improvement.

A 1978 study found a 67% reduction in head-on crashes over seven TWLTL segments totaling 12.2 miles in the first year following installation. (*20*)

These early TWLTL studies, conducted when unfamiliarity was highest, universally demonstrated improved safety after installation. No operational problems, other than non-use of the TWLTL when making a left turn, were reported in these studies. The decreased head-on crash rate seen on early TWLTLs and the safety improvements seen in early studies support the position that driver unfamiliarity did not create problems.

Unfamiliar Drivers on ELRs

These findings parallel the experience of early ELR use. As cited previously, a Mineta Transportation Institute study found a decrease in crashes after conversion of two-lane roads to ELRs.(*25*) Across all of the American ELR studies available to date, no head-on crash has been recorded and all facilities have been successful in the judgment of the responsible agency.(*25–31*, *34*) The author maintains a database of ELR facilities in North American and interviews agency representatives to gather information on those installations. Over more than 40 interviews (there are more than 80 installations as of May, 2023), it was not uncommon to hear representatives comment on the high rate of driver compliance with the treatment and the lack of problems arising from the small number that misunderstand. This type of feedback has been heard even from agencies that conducted no public education activities prior to installation of the facility.

What lessons were learned from observations of opposite-direction drivers negotiating for use of the same space?

Few TWLTL studies report on direct observation of driver behavior and only one was found that addressed the resolution of conflicts between opposite-direction drivers attempting to use the same portion of a TWLTL. Walton's 1978 study (*21*) included observations of head-on conflicts in the CTWLTML, an acronym for Continuous Two Way Left Turn Median Lane on twenty sites in Austin and Fort Worth, TX. He observed "Conflicts that occurred on a CTWLTML were usually resolved by the involved motorists without difficulty." and concluded "The fear of conflicts and a resultant high increase in accidents after implementation are unfounded. In fact, most 'anticipated' conflicts rarely occur and when or if they occur are handled with typical driver judgement."

Because TWLTLs are consistently shown to reduce head-on crashes and significantly reduce crash rates over undivided roads despite requiring opposite-direction drivers to share portions of the facility, it is clear that drivers are negotiating to resolve head-on conflicts.

Negotiation for space on ELRs

As mentioned earlier, over 40 interviews have been conducted with representatives of agencies with ELRs in the U.S. and Canada. It is common for these representatives to comment on the drivers' abilities to negotiate for road space when passing opposing drivers. Even on ELRs for which no public outreach was performed, drivers avoid crashes as substantiated by the lack of reported problems. This is supported by anecdotal reports from a number of agency representatives noting that passing maneuvers between opposite-direction vehicles appear to leave more space between vehicles than on standard two-lane roads. As theorized earlier, a heightened sense of alertness among drivers on an ELR may be responsible for the increased safety.

What lessons were learned about signage and pavement markings?

Given the wide variety of signage and pavement markings seen in early TWLTLs, there was interest in the promotion of effective, uniform signage and pavement markings.

A 1978 study that examined driver behavior in TWLTLs concluded "It is the opinion of the authors that signing contributes marginally to driver awareness and that pavement markings (lane delineation and symbol messages) are mandatory."(*21*)

By the early 1990s, the city of Phoenix, AZ had reduced TWLTL signage to 2 signs per mile per direction and had eliminated both the word messages and turn arrows normally placed within the TWLTL. This was deemed appropriate given their widespread use in the city and the driver familiarity built up over 2 decades of use. (*35*) The article notes that "Another clue that drivers do not need TWLTL signing is that unlike other regulatory traffic signs, 'missing' TWLTL signs almost always go unreported by motorists and police."

ELR Signage and Markings

Experience with ELRs indicates that signage plays only a minimal role in the success of the treatment. Use of little to no signage on American ELRs is already seen on a not-insignificant number of facilities. One example is Minneapolis, MN which has seven ELRs. These include some of the highest volume and oldest ELRs in the U.S. East 14th Street, installed in 2011 and arguably the first ELR in the U.S., sees average daily traffic volumes of 4,700. A two-way traffic sign (MUTCD W6-3) is used on Minneapolis ELRs. No other signs, including bicycle route or lane signs, are used. Minneapolis deems their ELRs successful in their final report to the FHWA. (*26*) Another example is Port Townsend, WA with seven ELRs as of October, 2023. Port Townsend features a picturesque downtown which hosts a vibrant tourist industry. Their main street is an ELR and serves all of the restaurants, shops, and hotels one finds in a tourist destination. Their main street has seen average daily traffic measurements of more than 6,200 motor vehicles in the peak season. This implies a high proportion of new drivers on what may be the nation's busiest ELR. Port Townsend uses no signs at all on this ELR and has experienced no safety or operational problems. Port Townsend does use W6-3 (two way traffic) and D11-1 (Bike Route) signs on their residential ELRs. Some agencies, including

Port Townsend, use large, temporary signs (see **Figure 4**) in the first weeks of a facility's existence for driver familiarization and use no custom signage afterwards.

Figure 4. Canadian example of a large format, temporary sign used to familiarize drivers, courtesy Kate Whitfield

For early ELR use, it may be more important to provide clear pavement markings similar to the example in **Figure 5** rather than create an ELR-specific sign that attempts to communicate a series of specific behaviors.

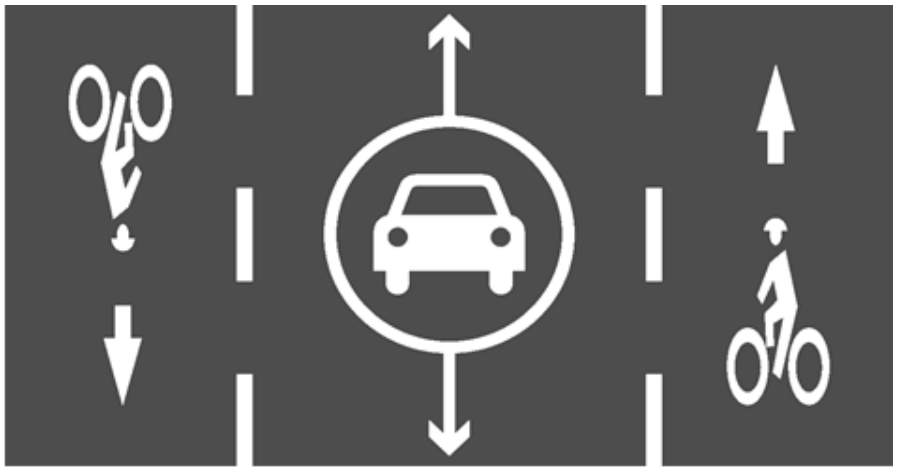

Figure 5. ELR Pavement Marking Proposal (*2*)

Phoenix's TWLTL experience also indicates that, after driver familiarity reaches a critical point, it is possible to reduce signage and rely on a sparser marking pattern. This practice is seen in countries, e.g. The Netherlands, where ELRs have been widespread for decades and familiarity is high. In the Netherlands, no signage is used and the pavement markings normally omit road user symbols. The primary difference there is that the edge lanes are often colored red (as seen in Figure 2), indicating a bicycle facility.

Discussion

With respect to whether a two-way, one-lane facility leads to increased head-on crash rates, both treatments appear to improve overall safety. A significant reduction in head-on crash rate is seen with many

TWLTL installations and none showed an increase in head-on crash rate. Early experience with ELRs includes no reports of head-on crashes to date. The assumption often made is that the safety improvements associated with these facilities are due to the increased attention being paid by the driver due to the perception of heightened risk. Though plausible as an explanation, no data is known regarding that theory.

With respect to whether driver unfamiliarity with a novel two-way, one-lane facility causes safety problems, it is clear from the safety records of both facilities that drivers are able to safely navigate these facilities, even when they are ignorant of the facility's purpose and expected driver behavior. Two early TWLTL studies observed driver behavior indicating that at least 20% of drivers misunderstood the intent of the treatment with no resulting safety issues. Anecdotal evidence from agency representatives with ELRs include stories of drivers that were obviously unclear on expected behavior transiting the facility in a safe and cautious manner.

With respect to the lessons learned from observations of opposite-direction drivers negotiating for use of the same space, current ELR experience and long-term TWLTL experience show that drivers can safely negotiate for road space when required. This is true even when drivers are unfamiliar with the treatment.

The lessons on signage and pavement markings tell us that signage is less important than markings for both facilities with some installations relying almost exclusively on pavement markings. In addition, as drivers grow accustomed to the treatment, the need for signage decreases and the extensiveness of the markings can be reduced without adverse impact.

It should be noted that TWLTLs were specifically targeted in this paper because of the wealth of studies that narrowly address the treatment. TWLTLs are not the only facilities that require drivers to share and negotiate with other road users. Neighborhood roads with well-used, on-street parking that leave only a narrow space for bidirectional traffic are a common equivalent. Drivers must sometimes move into driveway gaps to allow approaching cars to pass and move into the left-hand side of the road to pass vulnerable road users. Unfortunately, no studies of this street setting are known.

Conclusion

The intent of this work was to review U.S. experience with two-way left turn lanes (TWLTLs) from their initial deployment to the present in the hope of finding parallels or lessons that could be applicable to edge lane roads (ELRs). Both facilities require opposite-direction drivers to negotiate a shared, single lane and both facilities faced the same concerns about safety and driver comprehension in their early years. This work reviewed more than sixty years of TWLTL research and twelve years of research and anecdotal experience with ELRs. Experience with ELRs appears to be closely following the early trajectory of TWLTL development. If one considers the similar trajectories seen in the early years of both facilities and the dominant feature of both facilities requiring opposite-direction drivers to share one lane, it may be reasonable to assume that ELRs will continue to follow or closely approximate the arc of TWLTL development as use of the treatment expands.

As with early TWLTLs, ELRs face questions about their potential to increase head-on crashes, safety outcomes with unfamiliar drivers, drivers' abilities to resolve head-on conflicts, and appropriate signage or pavement markings. Review of TWLTL and ELR experience highlights close parallels between the development arc of both facilities. Lessons from the country's experience with TWLTLs appear applicable to ELRs. These lessons are:

- These facilities improve overall safety and reduce crashes compared to pre-existing configurations,
- A new two-way, one-lane treatment plus high proportions of unfamiliar drivers can be safe,
- Observations of driver behavior show negotiation to successfully resolve head-on conflicts,
- Signage is less important than pavement markings for driver comprehension, and
- As drivers become familiar with the treatment, signage can be reduced and pavement markings can become less fulsome.

The observed success of ELRs may be attributable to the simple mechanism described by Koltnow in his 1964 article on TWLTLs, "Thus, while engineers have been worrying over fine shades of meaning which some drivers might ascribe to a traffic device message, motorists have been concentrating on such fundamental, self-preserving tasks as 'don't hit the other guy and don't get hit'."(*10*)

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