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Mixing it up a bit – Can motorists and cyclists really share lanes at intersections?

Figure 3: Mixing zone, Smithe St, Vancouver

Pre-ramble

As we begin to install more separated cycleways and get a higher number and wider range of people cycling, we are faced with the challenge of how to give these people a suitable level of safety and comfort at intersections. Making this observation led to me receiving an IPENZ Transportation Group study award in 2016, which took me to the United States and Canada, to visit relevant sites and talk to people with useful experience.

I'll be presenting a paper discussing a number of possible treatment types and their relevant applications at the TG conference at the end of this month. But, as our dear Glenda only let me have 15 pages, I'm going to supplement that by focusing on a specific treatment in this Roundabout article.

Zoning in on mixing

A mixing zone (or mixing lane) is an approach lane at an intersection which is shared by motor vehicles making the short turn (i.e. left turn in New Zealand, or possibly a right turn from a one-way approach) and cyclists who may be turning or travelling straight through. The configuration of a mixing zone enables people on bikes coming from a kerbside facility to enter the kerbside lane at an intersection but still continue straight ahead.

Mixing zones are one example of a treatment that addresses conflict between through cyclists and turning vehicles when users are approaching the intersection, rather than travelling through it. The Austroads Research Report on Effectiveness and Selection of Treatments for Cyclists at Signalised Intersections[1] found that sites with exclusive left turn lanes are much safer for cyclists than those with a shared through and left turning lane.

Tim Hughes (the research project manager) later went on to analyse the data further and concluded that addressing the conflict between left turners and cyclists on the approach to the intersection is four times safer than addressing it going through the intersection. The theory is that the cognitive demand on road users is lower at the midblock than at the intersection, and therefore drivers are more likely to look for, notice, and give way to people on bikes.

Figure 1: Megan Fowler (left), recipient of 2016 IPENZ Transportation Group study award, taking her study seriously during a conference workshop in Seattle.

Another safety benefit of mixing zones comes from the fact that left turning vehicles travel more slowly than through vehicles because of the geometric constraints of making a short turn, resulting in a lower speed differential with cyclists. Therefore, it is safer for cyclists to share a lane with left turners rather than through vehicles.

[1] *Note that the research considered intersections in New Zealand and Australia with cycle lanes, which are different to the separated cycleways discussed in this article.*

Despite the theory about addressing the conflict on the approach to the intersection, and the safer speed differential between cyclists and turning vehicles, there is debate over the appropriateness of mixing zones. I'll point out some of the mixed experiences and my thoughts on the problems encountered by our North American counterparts as we go along.

Phases they go through

Mixing zones don't require any specific signal hardware or phasing. In fact, they should not be used where the turn movement is operated independently of the adjacent through movement (i.e. a lead or lag turn) unless a green cycle light is used concurrently. Otherwise, cyclists waiting to travel straight ahead will be in conflict with turning vehicles in the same lane.

Laying it out from the start: designing the entry point

Figure 2: Mixing zone, Dexter Ave, Seattle

From my observations of guidelines and sites, I've identified two key components to a mixing zone: the entry points (for both vehicles and cyclists); and the section where the mixing occurs on the approach to the intersection.

The entry point, where vehicles and cycles enter the mixing zone, should be designed to communicate to users the change in environment and hierarchy (e.g. 'first-come, first-served', or 'motorists give way to cyclists').

Some mixing zone entry designs involve a defined channelisation of motor vehicles, generally at an angle to give motorists a better view of oncoming cyclists, and a chance to slow down before encountering cyclists, whilst also getting out of the way of following through traffic. The mixing zones I saw in Chicago and those that MassDOT now recommends are designed so that the speed of vehicles is 20 mph (32 km/h) at the point where they start mixing with cyclists.

These types of designs generally have give way markings at the entry point, which not only establishes a hierarchy but makes it clear to motorists that this is not a normal turn lane.

Other mixing zone entry designs involve drivers simply crossing into the mixing zone as they would change into a turn lane (e.g. Figure 3).

Throwing them into the mix: designing the mixing section

Once drivers and cyclists have entered the section where the mixing occurs, there are several possibilities for their relative positions:

- Side-by-side, specifically either:
  - Cyclists to the left of motor vehicles (i.e. on the kerbside), or;
  - Cyclists to the right of motor vehicles
- Single file (i.e. one in front of the other, thus effectively centred in the lane)

Sharrows should be used to indicate the preferred cycling position – not just for cyclists' benefit, but also so that motorists are aware that people on bikes may be present and understand that the lane is for sharing.

In choosing between side-by-side or single file mixing, I don't think one is objectively better than the other, but it depends on the site characteristics and opportunities (which generally result in single-file being the best option for a particular mixing zone). An important aspect is that lane widths should be designed to be either so narrow that it's clear that single file use is the only possibility, or wide enough that cyclists and cars can travel safely side-by-side.

Between these two options is an unacceptable width range where users might attempt to travel side-by-side without having the space to do so safely. The appropriate widths are outlined in the CNG (the Transport Agency's Cycling network guidance[2]).

Whilst side-by-side use may be a valid option, if a lane is wide enough to accommodate a marked cycle lane it's probably best to do so and give people on bikes a dedicated space. In which case, it may be more appropriate to use a 'lateral shift' (this is another treatment described in my conference paper) rather than a mixing zone, because the lateral shift makes the transition clearer and reduces the zone of potential conflict. The MassDOT guide gives a nice solution that achieves the best of both concepts by combing the entry design for a mixing zone with the transition markings for a lateral shift (see Figure 3).

Unless the vast majority of cyclists want to turn left at the intersection, it doesn't make a lot of sense to keep cyclists on the left, i.e. the kerb side – that means the conflict isn't actually addressed on the approach but rather within the intersection.

I think that's why the mixing zones in New York City (generally wide lanes with sharrows placed on the kerb side) don't seem to be working so well. Let's just say, at the mixing zones there I saw some 'interesting' interactions (admittedly, mixing zones weren't the only location on New York streets where I'd apply that term, or something stronger).

I was told that crash histories for mixing zones aren't as good as for other treatments in the toolbox for left[3] turning crashes with pedestrians and bicyclists, and that their mixing zone design is still a "work in progress".

[2] https://nzta.govt.nz/walking-cycling-and-public-transport/cycling/cycling-network-guidance/

[3] Note that New York City has an extensive one-way network, which means the left turn is often a short turn, but with the driver on the kerb side of the vehicle, making it different to the short turn in New Zealand.

The mixing zone designs given in the current NACTO Urban Bikeway Guide resemble those on the ground in New York City, which happens to be where NACTO's head office is located. Because of what I learnt over there, I'd caution New Zealand designers against applying the NACTO mixing zone designs at this stage.

They still have the benefits of slowing motorists down and making users more aware of the potential for conflict, but I think we could do better by guiding people on bikes and motorists to the intended positions within the mixing zone.

The best examples of I saw of mixing zone markings were in Chicago – these had sharrows leading cyclists away from the kerb side to the opposite side of the lane and a defined entry point for vehicles, with a deceleration lane and give way markings.

Toronto also had mixing zones with sharrows on the opposite side to the kerb, but drivers had to pull in directly from the through lane, without any dedicated space to slow down in.

Unfortunately, motorists in both Chicago and Toronto seemed to like to use these mixing zones as loading zones, and other motorists would drive around the parked vehicles – this highlights another problem with dropping physical separation of a cycle facility on the approach to an intersection approach.

The majority of North American mixing zone designs I've seen have a turn arrow marked in the mixing zone, either at the entry point or within the section of mixing. This helps to increase motorist awareness of the purpose of the lane and avoid through traffic trying to use the lane.

The current New Zealand Road User Rule prohibits the "use of any lane except for the manoeuvre appropriate to its marking or signage", which means cyclists cannot travel straight through from a lane where a turn arrow but no straight through arrow is marked.

Modifications to the rule to allow cyclists to travel straight ahead from a marked turn lane are currently being considered; if these are adopted, it would be preferable to mark turn arrows in mixing lanes in New Zealand.

How many, if any?

The appropriateness of mixing zones comes back to the principle that a large proportion of the population prefers to be physically separated from high-speed and / or high-volume motor traffic when cycling – i.e. mixing zones are suitable at low speeds and low volumes.

I suggest that we should adopt a maximum vehicle entry speed of 30 km/h for our designs, based on the guidance from Chicago and MassDOT mentioned above. We should consider including this in legislation rather than just making it a recommendation.

FHWA (2015) recommends that mixing zones may be most effective at intersections with 50-150 turning vehicles in the peak hour. It's not clear why there's a lower limit, and I suggest there's no reason that mixing zones shouldn't be an option for locations with fewer turning vehicles.

The upper limit volume also happens to be the North American industry's rule of thumb for the threshold between filter turning and full signalised protection (but that's another story – and another plug for my conference paper).

We could adopt this upper limit as a starting point, but should monitor our mixing zones to check whether it is appropriate in New Zealand. The best outcome would be to establish a threshold based not only on motor vehicle volumes but also on cycle volumes.

That said, even at lower vehicle volumes and speeds, there may be more appropriate treatments; the viability of which generally comes down to space. As mentioned above, where width allows it is generally preferable to provide a lateral shift transition than a mixing zone (although the mixing zone entry concept could be retained, as per Figure 3).

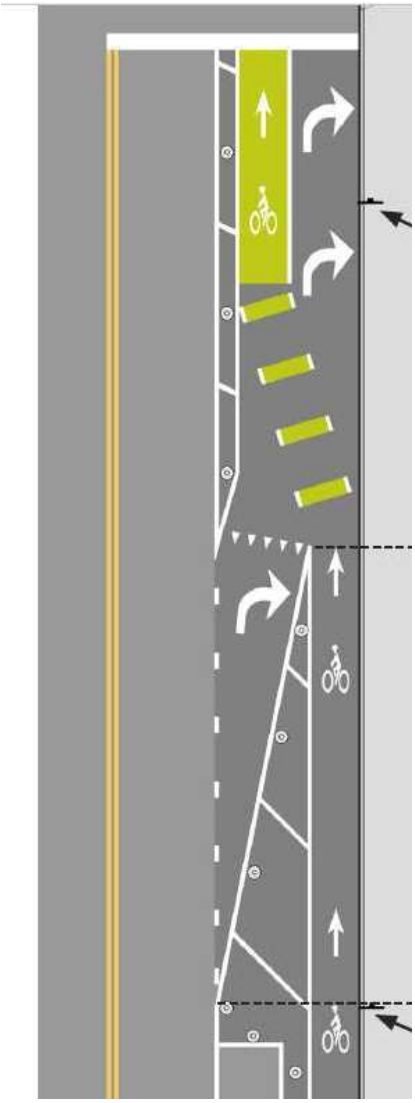

Figure 4: MassDOT (2016) solution for 'mixing zone with bike lane' (mirrored for NZ context)

If even more space were available, a 'protected intersection' design could be considered, as these are arguably more effective at reducing motor vehicle speeds, increasing motorist awareness and increasing intervisibility between motorists and people on bikes.

Overall, it seems that a well-designed mixing zone in an appropriate location is a useful treatment to throw into the mix in our intersection design toolbox.

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