More Than Sharrows: Lane-Within-A-Lane Bicycle Priority Treatments in Three U.S. Cities

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Abstract

When a street is too narrow to have exclusive bike lanes, cars and bikes have to share a lane. Without a clear bicyclist zone being designated, bicyclists and motorists have to negotiate for the boundary of the bicycle zone. The dynamics of this negotiation and the stresses it engenders are analyzed. Existing treatments to encourage intended motorist and bicyclist behavior in shared lanes are analyzed, including the increasingly popular "sharrow" and Dutch suggestion lanes or advisory lanes. Criteria for an effective shared-lane treatment are developed. A critical feature is longitudinal markings that delineate a bicycle zone as a lane-within-a-lane, a treatment called a Bicycle Priority Lane. Salt Lake City and Long Beach (CA) have each applied this treatment on a 4-lane road using green carpet color to indicate the priority zone, while Brookline (MA) has recently applied it on a 2-lane road using dotted white lines to indicate the priority zone. Before-after studies show that priority lane treatments have some success in shifting cyclists' position further away from parked cars and curbs and away from using the sidewalk. However, the substantial fraction of cyclists continuing to ride on the sidewalk or in the door zone suggests that the prevailing paradigm in the U.S. of bicycles never blocking automobiles is difficult to overcome.

When bicycles and automobiles have to share a lane too narrow for both to safely occupy side by side, intended behavior is for cyclists to ride without fear at a safe and comfortable margin from right side hazards such as parked cars or the roadway edge, and for motorists to pass with a comfortable margin when it's safe to do so, and otherwise slow to the cyclists' speed and drive patiently behind them until it's safe to pass. However, except on streets with very low traffic speeds and volumes, behavior often deviates from what is intended. Many motorists appear to believe that a bicycle should never block a car, and some express that attitude by harassing cyclists and passing with a very small margin. The stress created by this interaction induces many cyclists to ride close to right side hazards, and discourages many people from cycling in shared lanes, so that they ride instead on the sidewalk, or not at all.

We examine the negotiation that takes place between motorists and cyclists in shared lanes and critically review shared lane treatments in the U.S and Europe. We hypothesize criteria for a successful shared lane treatment, describe designs following those criteria that have been applied in Salt Lake City, Long Beach (CA), and Brookline (MA) , and evaluate their experience against the objective of promoting lane-sharing behavior as intended.

Negotiating for the Bike Zone Boundary

When motorists overtake bicyclists in a shared lane, they have opposing interests over the boundary of the "bicycling zone." Bicyclists want the boundary to be far enough to the left to have a comfortable margin from right side hazards such as parked cars whose doors may open unexpectedly and raised curbs. They also want adequate operating space that will allow them to ride more in a more relaxed manner with room to maneuver around debris and pavement irregularities. Motorists, on the other hand, want the boundary to be further to the right. Motorist delay when overtaking a bicycle is minimized if the bicycle stays far enough to the right that motorists can pass without encroaching on the adjacent lane; and even if the motorist must encroach in the adjacent lane, the further to the right is the boundary to the bicycling zone, the smaller is the period and extent of encroachment necessary to overtake a bicycle, reducing both the motorist's delay waiting for a suitable gap in adjacent-lane traffic and the discomfort of the S maneuvers involved in overtaking.

On streets with light traffic, motorists gladly yield ample space to bicyclists, passing with wide berth. When there is no centerline, motorists on such streets often ride near the middle of the road even when no bicycle is present. But at traffic volumes greater than 3,000 vehicles / day, opposing traffic becomes more than just an occasional car, and bicycles become a source of significant delay to motorists (1). Many motorists seem to hold it as a fundamental principle that cars should not be "blocked" by bicycles. They often do not appreciate the hazards bicyclists face on the right. When they see what looks like a large margin between a bicyclist and a parking lane, they don't understand why the bicyclists don't move further to the right and "share the road."

Who Has the Advantage?

This conflict between motorists' and bicyclists' interests sets up a negotiation between cyclist and motorist each time a car overtakes a bike. It may seem that bicyclists have the upper hand in this negotiation, because, by virtue of being the slower party, they are ahead of the overtaking car – i.e., they were there first. They can place their body where they want the bike zone to be, and motorists have to accept it. It is a well-known theme of the "Vehicular Cycling" school of bicycle education (2) to

encourage bicyclists to use that advantage, positioning themselves safely away from right side hazards, and trusting that motorists' primary interest in avoiding a collision will ensure their safety.

However, the notion of staking out a position with your body, and trusting that cars' and trucks' operators approaching from behind will respect your position, is a perilous and blind game of "chicken" that most cyclists would rather avoid than play. Physically, motorists are the far stronger party in this negotiation and have a lot less to lose from a collision. While being struck by an overtaking motor vehicle is not one of the more common collision types, it tends to be very severe. A review of bicyclist fatalities on the island of Montreal for the period 2000 to 2008 found that 8 out of 43 fatalities (19%), about 1 per year, involved being hit from behind or sideswiped.

Motorists have another advantage: an unmatched power to frighten a cyclist by passing with scant clearance. To bicyclists, a near-miss is terrifying; to motorists, it is a non-event. While a few states including Utah have established laws requiring that motorists pass with a 3 foot margin, enforcement is too impractical to be a meaningful deterrent. Motorists are often blissfully unaware of how close the right side of their car comes to touching a bicyclist's shoulder. Worse, some motorists are deliberately aggressive, intentionally harassing bicyclists who dare to be "in their way." In this negotiation, cyclists have no parallel power to frighten motorists. It's only necessary for a small number of passing cars to abuse their size, bullying the cyclist intentionally or unintentionally by passing too close, for the cyclist to surrender and shift further to the right.

Some assert that if cars are passing too close, cyclists should move still further toward the center of the road in order to make motorists understand that in order to pass they should completely change lanes. However, research done in the UK using sound sensors to measure passing distance found that the trend is just the opposite – when riding further toward the center of the road, cars overtake at a closer distance (3).

Aggressive Negotiation and Low-Stress Cycling

Apart from the fear of collision and the terror of near-collision, the idea of being an aggressive negotiator is itself repugnant to many people. Cyclists who ride at a comfortable distance from the right edge of the roadway often encounter motorists who honk or yell at them for being in their way, or pass aggressively and then cut the bicyclist off. While some people find it easy to dismiss this sort of aggression ("don't worry; if they honk, it means they see you"), most find it unnerving. Being an aggressive negotiator has no place in low-stress cycling (1). Faced by a challenge from occasional motorists, many cyclists would rather be the accommodating partner, giving motorists what they so obviously want by shifting to the right, even at their own peril, or by riding on the sidewalk, or – probably the reaction of most people – by leaving their bike at home and traveling by another mode.

Bicyclists vary in training and demeanor, and as they enter this negotiation with different levels of assertiveness, studies show a highly variable distribution of bicyclist lateral position (4) with respect to hazards on the right side of the road. Many bicyclists still ride in the door zone, risking injury or worse with every parked car they pass. Others try to find an "optimal" position, just beyond the edge of the door zone, but not encroaching an inch more than necessary into the traffic lane. Maintaining such a position is itself stressful, because it demands considerable mental effort to try to ride with minimal wobble (5). For low-stress cycling, bicyclists need an adequate operating margin, with a tracking width of

about 9 inches plus shy distance on right and left. As this operating margin is squeezed, riding becomes more mentally demanding and stressful.

The stress involved in lane sharing is difficult to measure objectively, but is unquestionably one of the main factors that influences bicycle use. If, for the sake of public health, a greener environment, less congested cities, and economy, cities want to make bicycling attractive to the mainstream population, as well as to reduce the incidence of dooring and other crashes involving right side hazards, it would be valuable to have a tool that reduces the stress involved in lane sharing.

The Magic of Lines

Surveys (for example, (4)) reveal how much bicyclists like bike lanes, which separate bikes from cars by nothing more than a line. The effectiveness of a lane line comes from providing an *objective boundary of the bicycle zone*. No more need for negotiation; the conflicting interests of bicyclists and motorists have been arbitrated by a higher authority. A bicyclist riding in a bike lane feels no pressure from passing motorists to yield space to them. Bicyclists can relax, allowing their bike to make its natural wobble, knowing that they're in their own space. By the same token, in bike lanes that are too narrow, cyclists often feel the need for more operating space, and therefore negotiate with passing cars for a wider bicycling zone by riding outside of or along the edge of the bike lane.

Studies in which wide lanes have been converted into a bike lane and travel lane show that with bike lane lines added, bicyclists demonstrate greater confidence by riding further from the hazards on the right, thus actually riding closer to the moving cars – because they know that motorists will see and respect the bike lane line as the boundary of the bicycle zone (4, 6, 7). In both the Bicycle Level of Service (8) and the Bicycle Compatibility Index (9) models, which are based on surveys of cyclists' stress level in different roadway and traffic situations, delineating the cyclists' space with bike lane lines increases cyclists' comfort.

Bike lane lines also benefit motorists by helping them determine the bicyclist's lateral position in advance (9). Without a line, it's difficult to judge from a distance a bicyclist's lateral position and to predict how the bicyclist will move while being overtaken. The wide lane conversion studies cited reveal the increased confidence motorists had by a large decrease in the proportion of cars encroaching on the adjacent lane while overtaking.

Sharrows and Share the Road Signs

American bicycle planners have devised several shared lane treatments to engender the desired motorist and bicyclist behavior.

Sharrows (shared lane arrows or shared lane markings) are an increasingly popular roadway marking for shared lanes, consisting of a bicycle silhouette topped by a double chevron, as shown in Figure 1. Sharrows are intended to give two messages: that bikes are to be expected, and that bikes should be positioned directly over the sharrows, which are centered 11 ft or more from the curb where there is a parking lane (10). However, according to a San Francisco before-after study, it appears that few bicyclists and fewer motorists understand the latter meaning (11). In that study, sharrows were spaced 250 ft apart and centered 11 ft from the curb, or about 4 ft from parked cars which are assumed

to occupy 7 ft from the curb. When cars were overtaking, average bicyclist position changed only from 9.5 ft (before) to 9.8 ft (after) from the curb, well short of the sharrow position at 11 ft, and with many cyclists still riding in the door zone. By comparing cyclist position in the presence versus absence of an overtaking motor vehicle, cyclists were still shifting on average 1.2 ft to the right when being passed after sharrows were installed. Because they fail to delineate a recognizable bicycling zone, sharrows still leave intact the stressful negotiation between cyclists and motorists that results in cyclists yielding space.

Figure 1: Shared Lane Arrow or "Sharrow"

Signs have also been used to try to facilitate lane sharing. The "Share the Road" sign, like the sharrow, makes it clear that bikes are allowed on the road, but says nothing about *where* on the road they are expected to ride, maintaining the need for negotiation. More than once, this author (PF) has been harassed by motorists who misunderstand the sign, yelling "Move over! You're not sharing the road!" They believe that for cyclists, "sharing the road" means riding as far as possible to the right.

The "Bicycles Allowed Use of Full Lane" sign (BAUFL), authorized in the 2009 MUTCD (10), declares the full lane to be *potentially* the bicyclist zone. However, because most bicyclists don't use the full lane – and considering that lanes are sized for cars and trucks, it seems obvious that bicyclists don't need the full lane – the initiative still lies with the bicyclist as to how much of that lane they will claim, leaving the bike zone boundary up to negotiation. Observation of a 2-lane bridge between Boston and Cambridge (MA) outfitted with this sign and sharrows in the middle of the lane shows most cyclists still keep far to the right; however, motorists appear to show less aggressiveness, driving behind cyclists with less impatience and passing more carefully. It seems that the implied message of the BAUFL sign successfully counteracts the prevalent misunderstanding that bikes should never block a car.

At least one city (San Carlos, CA) has gone a step further, appending to the BAUFL sign a plaque reading "Change Lanes to Pass" on a multi-lane road (12). This combination declares the entire shared lane to be the bike zone, with the lane line meant to be the boundary. This treatment may prove successful, especially where lanes are narrow. To our knowledge, "Change Lanes to Pass" has not been applied to two-lane roads; it could be confusing on urban streets where passing motor vehicles is prohibited or discouraged.

Dutch “Suggestion Lanes”

On roads too narrow to mark a bicycle lane, the standard Dutch treatment is the “suggestion lane” (Dutch: suggestiestrook, sometimes translated as “advisory lane”). Using a broken white line, it suggests a bicycling zone in an area that motorists must use when encountering an opposite direction motorist (Figures 1-2). Sometimes they are marked with red pavement (the color of bike lanes in the Netherlands) in order to make the suggestion even stronger. Suggestion lanes have no legal standing (i.e., they neither require bicycles to ride in them, nor motorists to stay out) (5); the name deliberately omits the word “bicycle.” However, the power of lines and color to suggest a bike lane is strong; virtually all road users, bicyclists and motorists, recognize suggestion lanes as a preferential zone for bicycles, while also understanding that motor vehicles may enter when doing so wouldn’t interfere with a bike.

Figure 2: Suggestion lanes on rural and suburban roads in the Netherlands. Notice how the centerline has been obliterated**.** Cars stay out of the suggestion lane when passing bikes, but enter it when facing oncoming motor traffic.

Dutch suggestion lanes are only used on roads not marked with a centerline. They encourage motorists to ride near the middle of the road by default, and shift to the right only when encountering oncoming traffic. When cars have to enter the side zone because of oncoming traffic, bikes benefit from the natural yielding that occurs when motorists change lanes. The net effect, then, is to engender the desired lane-sharing behavior, giving bicyclists an adequately wide zone on the right in which their priority over motor traffic is recognized – all by the power of suggestion, using the magic of lines and, in some cases, color.

Occasionally, color and lines aren’t enough, and Dutch suggestion lanes are reinforced with medians that form a choker, as shown in Figure 3. Those medians serve as a 24-hour “sleeping bicyclist” forcing cars to stay out of the bicycle zone at the choker location, preventing motorists from feeling

ownership of the suggestion lane and helping cyclists to feel that they are not out of place in forcing cars to wait to pass them.

Figure 3. Choker reinforcing suggestion lanes.

Suggestion lanes are used in both urban and rural areas. As part of the national "Sustainable Safety" program adopted in 1997, the standard treatment for minor rural roads was changed to using suggestion lanes and no centerline, while at the same time lowering the speed limit from 80 km/h to 60 km/h (13). While some officials were initially skeptical of the safety impact of removing centerlines, a large scale before-after test involving more than 700 km of rural roads found that this new layout, combined with the speed limit change, reduced the overall crash rate by 17%. The crash rate involving bicycles had a small, statistically insignificant drop (13). A before-after study of user behavior (14) found that after suggestion lanes were applied, the fraction of motorists encroaching on the right side bike zone when a bicyclist was present fell from 3% to less than 1%, and that the fraction shifting so far to the left that they encroached in the opposite direction bicycle zone fell from 65% to 34%.

Design for a Low-Stress Shared Lane Treatment

Considering the stress mechanisms involved in lane sharing, an effective shared lane treatment should meet the following criteria:

(1) It should indicate a bicycling zone whose boundary is recognizable to motorists and bicyclists.
(2) The defined bicycle zone should provide sufficient operating space for bicyclists to ride safe from right side hazards.
(3) Motorists should understand that they may drive in the bicycle zone when no bicyclist is present.
(4) It should make it seem natural for bicycles to block cars.

In short, it should demarcate a "lane-within-a-lane."

Independently, designers in Salt Lake City and at Northeastern University conceived essentially the same lane sharing scheme based on these principles. In Salt Lake City, a 4-lane street named 200 South has continuous bike lanes except through one block in the downtown area, where bicyclists must

share the lane. There is no parking lane. A large fraction of cyclists used the sidewalk (illegally), and most of those using the street rode close to the curb, leading many motorists to pass with zero or minimal departure from the right lane (12 ft wide), passing bikes with less than the legally mandated 3-foot clearance. The goal was to encourage cyclists to ride in the middle of the lane in order to induce motorists to completely change lanes to pass. The chosen design was to use color to denote a bicycle priority zone, painting a 4-foot wide green swath in the middle of the right lane in both directions, with a sharrow marked near the head of the block (Figure 4). The scheme was not given any formal name; informally, it's known as the green lane. Implementation was on September 17, 2008. The city plans to apply the treatment to two more streets during summer, 2010.

Figure 4. Priority Lane on 200 South in Salt Lake City.

Long Beach (CA) adopted the Salt Lake City design, with the green swath widened to 6 ft, and applied it on Second Street in the Belmont Shore commercial district on June 25, 2009. Second Street has a high turnover parking lane, and the motivation there was to empower cyclists to ride away from the door zone, as well as to encourage sidewalk cyclists to ride in the street. Long Beach plans to apply the treatment to five other streets in commercial districts in the near future.

At Northeastern University, a "bicycle priority lane" scheme was proposed in Fall, 2008 as an adaptation of the Dutch suggestion lane, and recommended to the Town of Brookline (MA) for application on Carlton Street and Longwood Avenue, two-ways streets with average daily traffic of about 8,000 vehicles per day that were important links in the bicycling network but were too narrow for bike lanes in both directions. By shifting the centerline, a regular bike lane could be provided in one direction, and the other direction would be marked with a bicycle priority lane. The name alludes to priority seating on a bus: if a cyclist is there, motorists should yield the space, but if not they are free to use it.

The original scheme proposed delineating the bicycling zone using continuous dotted lines. The line dimensions chosen (4 inches wide, 2 ft on, 4 ft off) makes them "dotted lines" that, consistent with the *MUTCD* (10, Section 3A.05), offer guidance, as opposed to "broken lines" that delineate regular traffic lanes. However, because of concerns that a lane full of dotted lines might be confusing to motorists, the adopted marking scheme uses intermittent modules of dotted lines bracketing a sharrow;

modules are 20 ft long and 80 ft apart, as shown in Figure 5. The short (80 ft) interruption between modules was believed to be small enough to give the impression of a continuous priority zone with a clear boundary. Along a parking lane, the dotted lines are at 10 and 15 ft from the curb; where there is no parking, at 1 and 6 ft from the curb. On Longwood Avenue, the dashed lines went down in November, 2009, and the sharrows on May 27, 2010. The Carlton Street treatment was approved in May, 2009 and is expected to be marked in summer 2011.

Figure 5: Bicycle priority lanes on Longwood Avenue in Brookline, MA. The bracketed sharrow modules are 5 ft wide and 20 ft long, with an 80 ft gap between modules.

Evaluation

200 South, Salt Lake City

A one block section of 200 South was treated, in the downtown, where it is a 4-lane undivided street with speed limit 30 mph. Average weekday traffic volume is 20,000 automobiles and 200 bicyclists. The objectives were to encourage cyclists to ride in the middle of the lane, thereby encouraging motorists to change lanes to pass; to promote motorist acceptance of cyclists riding in the middle of the lane; and to decrease the fraction of cyclists using the sidewalk by making it seem less stressful to cyclists to ride in the street. This block has a frontage road in one direction.

Bicycle counts recording bicyclist position were conducted on 3 weekdays before (September, 2008) and three weekdays after (August, 2009) the September 17, 2008 implementation. Results (Table 1) show that the green lane brought about a remarkable shift away from the right edge of the lane. Eleven months after implementation, the fraction of in-street cyclists riding in the preferred zone, at least 4 ft from the curb, had risen from 17% to 92%. There was no direct test of motorist acceptance; however, the very high cyclist compliance indicates a high level of acceptance by motorists. To date, the objective of reducing sidewalk use has not been achieved, suggesting that a large number of cyclists still

consider it unacceptably stressful to share the lane with cars even with this treatment. Casual observation shows that motorists continue to use the lane. One bicycle-related crash has been recorded in the 22 months since the green lane was installed.

	All Cyclists Users		Cycling in the Road	
Cyclist Position	Before	After	Before	After
Salt Lake City, 200 South				
Sidewalk	46%	46%		
0 to 4 ft from curb	31%	3%	83%	8%
Elsewhere in right lane (includes green lane)	7%	41%	17%	92%
frontage road	16%	9%		
TOTAL	100%	100%	100%	100%
n	674	834	253	369
Long Beach, Second Avenue				
Sidewalk	40%	25%		
Door zone	46%	40%	78%	53%
Elsewhere in right lane	12%	34%	20%	45%
Left lane	1%	1%	2%	2%
TOTAL	100%	100%	100%	100%
n	1320	1662	787	1247

Table 1: Before-after comparison of bicyclist position on Salt Lake City and Long Beach streets with priority lane treatments.
Source for Long Beach data: (15)

Second Street, Long Beach

Long Beach installed a green lane-within-a-lane on a 0.6 mile section 2nd Street, a 4-lane divided street in a commercial district carrying 35,000 automobiles and 400 bicycles daily. It has a parking lane in both directions, and is congested with traffic speeds at or below 25 mph much of the day. The green lane is 6 ft wide, centered in the right travel lane. Along with the marking, customized Share the Road signs were erected with a pictogram showing a bicyclist in front of a car. The objectives of the project were to encourage cyclists to ride outside the door zone (defined as the area to the right of the green lane), encourage motorist acceptance of those who do, and to encourage sidewalk cyclists to ride in the street.

Four months after implementation, counts showed bicycle use up 30%. Table 1 shows the change in cyclist position, with substantial decreases in sidewalk riding and in the percentage of road users riding in the door zone. Nevertheless, the data show that there's still a long way to go before behavior matches intended use. About half the roadway users were still riding in the door zone (down from 78%), and 25% were still using the sidewalk. The program manager reports that 10 months after implementation, total crashes on the road section are down 50% compared to the same period the year before.

Longwood Avenue, Brookline

The tested section of Longwood Avenue is 0.25 miles long, from Kent Street to St. Paul Street. This section of Longwood is residential, with a mix of single-family dwellings and apartment buildings. There is one lane in each direction. The treated lane runs westbound, and was studied during the p.m. peak, when bicycle volume in that direction is greatest. The speed limit is 30 mph, however the typical speed during the p.m. peak is probably closer to 25 mph. Daily traffic volume is 8,000 vehicles and approximately 700 bicycles. The treated lane, measured at the data collection point, is 19.8 ft wide, including parking, with priority lanes lines marked at 10.33 and 15.25 ft from the curb (all measurements are to the center of the line). Unlike Long Beach and Salt Lake City, this application involved no signs.

The objectives were to encourage cyclists to ride away from the door zone; to encourage motorist acceptance of those who do; and to increase the number of cyclists by lowering the level of stress involved in bicycling on these streets. The time frame is insufficient to assess the final objective. To assess the first objective, bicyclist position was measured visually by placing chalk lines on the road at 0.5 ft intervals on weekdays between 4 and 6 pm. The chalk lines were not believed to influence bicyclist behavior, since they were visible only a very short distance in advance. Counts are not necessarily exhaustive, because periods in which the parking lane near the data collection point was unoccupied for 75 ft or more were discarded. Using a grid of chalk marks, bicycle wheel position was recorded in ranges of 0.5 ft. It was also recorded whether or not there was a passing car immediately nearby. We made sure that near the data collection point, the car extending furthest from the curb extended between 82 and 84 inches (sometimes by parking a car deliberately with the desired offset). Counts were done on three days shortly before the sharrows were marked (which was 6 months after the dotted lines, which few people understood, had been marked), on two days 1-2 weeks after the sharrows had been marked, and on one day 5 weeks after the sharrows had been marked.

Results (Table 2) show almost no difference in cyclist position after 1-2 weeks, but after 5 weeks a statistically significant difference can be seen. Among cyclists influenced by a passing car, mean bicyclist offset from the curb increased by 0.8 ft, and the fraction of cyclists riding at least 10.5 ft from the curb rose from 42% to 68%.

Cyclists (n = 20) and motorists (n = 14) were surveyed 3 weeks after the sharrows were installed, by intercepting them when stopped for a red light at the end of the treated section. Cyclists were shown a photograph of the road over which they had just ridden, and asked whether they believed the marking indicated a preferred zone for bicycling, how confident on a scale of 1 to 10 they were of that meaning, and what fraction of motorists they though also perceived that meaning. While the sample size is too small to make statistical inferences, the responses help explain the data obtained in the counts. 75% of cyclists understood that the markings indicated a preferential zone for cyclists, and 40% said that it had emboldened them to ride further from parked cars. Still, only 35% said they rode in the priority lane,

including some who rode in that position before, and the cyclists as a group estimated that only 50% of the motorists understood the correct meaning of the marking. A few telling comments were:

- I know what it means, but I don't ride in it … not yet
- I think they're great; I just don't know if people driving cars get it.
- I won't ride out there because I don't want drivers to think I'm an [expletive].
- Drivers might not know what it means, but it makes them less likely to honk at you.

	All bicycles			Bicycles influenced by passing car		
	n	mean offset from curb (ft)	% with offset ≥ 10.5 ft	n	mean offset from curb (ft)	% with offset ≥ 10.5 ft
Before	213	10.4	51%	147	10.3	42%
After 1-2 weeks	151	10.6	51%	98	10.4	45%
After 5 weeks	83	11.1	72%	44	11.1	68%

Table 2: Before-after comparison of bicyclist position on Longwood Avenue, Brookline

Our survey of motorists show the cyclist concerns to be well founded. Of the motorists surveyed, only 21% noticed the markings *and* were at least 70% confident that the markings indicated a preferred zone for bicycling. Still, 50% said the marking had made them more considerate of how they passed cyclists. Some representative comments were:

- The area in the middle couldn't be the bike zone, because that's in the middle of the lane.
- I think it's wonderful that they're marking things to get people to look out for bikes.
- I'm confused by it

A common suggestion was to add signs making the meaning of the marking more explicit.

Discussion

The lane-within-a-lane treatment appears to be effective in bringing about a shift in bicyclist position away from right-side hazards. Stronger shifts were seen in the applications on multilane roads than on a 2-lane road, perhaps because a cyclist in the middle of the lane seems to be more of an obstacle to motorists on a 2-lane street than on a multilane street.

The width of the Longwood Avenue travel lane – almost 20 ft including the parking lane – may have limited the effectiveness of the shared lane treatment, because on sections in which the parked cars were narrow and parked close to a curb, the lane was wide enough that a narrow car could pass a bicycle with 7 ft between parked car and passing car, calling into question the necessity of a cyclist blocking the lane. Making the travel lane narrower so that it seems more reasonable for a cyclist to be

blocking a lane might make the treatment more effective. Based on this experience, Brookline's second bicycle priority lane, installed on Washington Street in November, 2010, uses only an 18-foot parking + travel lane, while keeping the bracketed sharrows centered at 12.5 ft from the curb (Figure 6). Using a narrower travel lane is more in keeping with the fourth principle of a shared lane treatment, namely, that is should seem natural for bike to block a car. Studies of the effectiveness of this narrower dimension are planned.

It is not possible to compare the color treatment to the dotted line treatment, since their contexts (2-lane or multilane) were very different. Using both, as do many Dutch suggestion lanes, may be the best approach, because color is a powerful way of indicating a special zone, while dotted lines help improve visibility at night.

Figure 6: Bicycle priority lanes on Washington Street in Brookline, MA. The narrower travel lane (reaching 18 ft from the curb instead of 20 ft as on Longwood Avenue) is expected to make it seem more natural for a bike to be blocking a car

While the different applications all show movement in the right direction, they have so far fallen short of achieving intended behavior on a population level. The large percentage of cyclists still riding in the door zone and on the sidewalk suggests that the paradigm that "bicyclists must not block autos" is deeply entrenched in the American psyche, and that undoing it will take more than road markings in a few isolated locations. The effectiveness of shared lane treatments depends on a chain of understanding – first, motorists must understanding how they are to respect cyclists, and then cyclists must believe that motorists have understood that. Therefore, lane-sharing treatments should be accompanied by public information campaigns, including signs, educating motorists about the cyclists' right to road and their need to avoid right-side hazards. And because lane-sharing treatments (markings, signs) in one place help reinforce the legitimacy of those in other places, their widespread application should lead to greater success than a single isolated application.

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