

Bicycle Priority Lanes: A Proposal for Marking Shared Lanes

Peter G. Furth <P.Furth@neu.edu>

Northeastern University

January 8, 2009

accessible at https://myfiles.neu.edu/xythoswfs/webui/xy-5458369_1-t_9UyJB6TN

Negotiating for the Bike Zone Boundary

Where roadway space is too limited for dedicated bike lanes to be marked, bicyclists have to share a lane with motorists, setting up a tension between them every time a car overtakes a bicycle. Because of the mutual desire to avoid a collision, it is understood that the passing car will shift to the left, going around the bicycle. However, motorists and bicyclists have conflicting secondary interests with respect to the boundary of the “bicycle zone.” Bicyclists want the boundary to be further to the left, so that they can have a comfortable margin from hazards on the right – parked cars whose doors may open unexpectedly, curbs, gutter seams, or roadway edge. They want a generous amount of operating space that will allow them to ride more in a more relaxed manner, without the stress of holding close to straight line, and with room to maneuver around debris and pavement irregularities.

On streets with light traffic, motorists gladly yield ample space to bicyclists; indeed, motorists on such streets often ride near the middle of the road even there isn’t a bike present. But when opposing traffic is more than just an occasional car, overtaking a bicycle becomes a substantial source of discomfort, as the double-S maneuver has to be executed with tighter turning radii, and a substantial source of delay (1). Motorists can minimize those impacts by positioning the bike zone boundary as far as possible to the right. By giving the bike less space, motorists may not have to encroach on the adjacent lane; and if that isn’t possible, it will minimize the period of encroachment, making it easier to pass the bike, both in terms of comfort and delay waiting for a suitable gap in adjacent-lane traffic. Shifting the boundary further to the left will often force motorists to slow down to the bicycle’s speed and wait for a longer gap in adjacent-lane traffic.

This conflict between motorists’ and bicyclists’ interests sets up a stressful negotiation for the cyclist. Making it worse is that many motorists do not appreciate the hazards bicyclists face on the right. When they see what looks like a large margin between a bicyclist and the gutter or parking lane, they don’t understand why the bicyclists don’t move further to the right and “share the road.” Many motorists seem to hold it as a fundamental principle that cars should not be “blocked” by bicycles.

In one sense, bicyclists have the upper hand in this negotiation, because by virtue of being the slower vehicle, they are ahead of the overtaking car. They can establish their position, and by doing so establish

the boundary of the bike zone, which motorists more or less have to accept (though a small number accept it grudgingly, showing aggressive behavior toward the bicyclists, as discussed later). 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 well into the travel lane with your body, and trusting that cars approaching from behind will respect the position you chose, 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. Obviously, motorists have a lot less to lose from a collision. While Vehicular Cycling supporters and detractors have argued at length about the frequency of bicyclist-struck-by-overtaking-motorist collisions, nobody questions their severity. More pertinently, motorists have *nothing at all* to lose from passing a bike with a very small margin [except in states with a 3-foot passing rule, to the extent that the law is enforced], something which to many cyclists is terrifying. Because it’s the right side of the car that nearly touches the bicyclist, motorists are often blissfully unaware of how close they come to the body of a cyclist. Worse, some motorists are deliberately aggressive, abusing the physical superiority of their vehicle to harass vulnerable bicyclists who dare to be “in their way.” In this boundary negotiation, cyclists have no parallel power to frighten motorists, giving cars the clear balance of power in this border war. 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, rather than wait until they’re actually hit.

Even apart from the fear of collision, the idea of being an aggressive negotiator is itself repugnant to many people. Many cyclists have been bullied by aggressive motorists who honked or yelled at them for being in their way. 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. Faced with this kind of occasional aggression, they would rather be the more accommodating partner, giving motorists what they so obviously want by shifting to the right, or by just staying off the road altogether.

As bicyclists resolve this conflict with different levels of assertiveness, studies show a highly variable distribution of bicyclist lateral position (3) with respect to hazards on the right side of the road. Many bicyclists still ride in the “door zone,” playing Russian roulette with every car they pass. Others try to ride in an “optimal” position, just beyond the edge of the door zone, but not encroaching an inch more than necessary into the (presumed) auto zone. Maintaining such a position is itself stressful, because it demands considerable mental effort to try to ride in a straight line, constantly trying to avert hazards on the right and on the left.

The stress involved in lane sharing is difficult to measure objectively, but it is important because it is one of the main factors that influences bicycle use. People love low-stress riding, as evidenced by the popularity of off-road paths. But when bike riding involves the stresses just mentioned, many people would just as soon leave the bike in the garage. If, for the sake of public health, a greener environment, and economy, we are to make bicycling attractive to the mainstream population, we need a way to reduce the stress involved in lane sharing.

The Magic of Lines

Survey after survey (for example, (3)) tell us how much bicyclists like bike lanes, which separate bikes from cars by nothing more than a line. What's so special about a bicycle lane line? It provides 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 knowing that they're in their "own space."

Studies of wide lane conversions (dividing a wide lane into a bike lane and travel lane) show that with bike lane lines, bicyclists demonstrate their 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 (3, 4, 5).

Most cyclists find bike lanes much less stressful than riding in a shared lane. Analysis of surveys done for developing two popular bicycle level of service measures (6, 7) found that bike lanes increased cyclists' comfort far beyond the value of space they provided; that is, the same amount of space without a separating line does not have the same effect on cyclists' sense of comfort.

Bike lane lines also benefit motorists by helping them determine the bicyclist's lateral position in advance (5). Without a line, it's hard to judge from a distance a bicyclist's lateral position, and figure out how far over to shift to safely pass. With a line, it's simple. The wide lane conversion studies reveal the increased confidence motorists had by the fact that their average lateral position when overtaking shifted slightly to the right. [Some have misunderstood this shift as a detriment to bicycle safety. However, a small *average* shift in car position to the right doesn't endanger cyclists; what endangers them is the variance in car position, and more specifically the frequency of cars riding far to the right. Unfortunately, those studies don't report on variability in motorist lateral position, but it can be expected that with a bike lane line marked, the frequency of motorists riding further right than the bike lane line is small.]

Existing Markings and Signs for Shared Lanes in the U.S.

American bicycle planners have tried to reduce the conflict inherent in shared lanes using a variety of signs and markings.

Sharrows (shared lane arrows) are an increasingly popular roadway marking for shared lanes, consisting



of a bicycle symbol topped by a double chevron. Like its forerunner, the "Bike in a House" marking developed by the City of Denver, it is intended not just to declare that bikes have a right to the lane, but further to suggest the lateral position where bikes are expected to ride. The developers of this marking hope that it will encourage cyclists to ride in a sort of "lane" centered on the

marking, and that it will encourage motorists to be accepting of bicyclists who take this position.

However, according to a San Francisco before-after study, surveys shows that few bicyclists and fewer motorists understand this latter meaning (8). Most traffic participants understand the sharrow as a declaration that bikes are expected to be on the road, or that a road is a bicycle route, but do not understand it as designating a “bicycle zone.”

In this San Francisco study, measurements of bicycle lateral position show that only part of the desired result was achieved. Sharrows were placed with their center 11 ft from the curb, or about 4 ft from parked cars. The study found that when no moving cars were present, average cyclist position shifted from 3.4 ft (before) to 4.0 ft (after) from parked cars – a substantial improvement, implying far less risk of dooring. However, when cars were passing, sharrows had little effect, as average bicyclist position changed from 2.5 ft (before) to 2.8 ft (after) from parked cars. These measurements show that after the sharrows were installed, cyclists still shifted 1.2 ft to the right when cars were passing, with many riding in the door zone.

The sharrow marking is itself about 3.3 ft wide, and markings are typically spaced about 250 feet apart. Markings with these dimensions cannot delineate a boundary; they still leave the boundary to the bike zone as something to be negotiated between bike and car. The 1.2 ft lateral shift when cars are passing is evidence that sharrows alone do not alleviate the pressure cyclists feel from passing cars.

San Francisco’s sharrow study also documents similar shared lane markings used in eight different U.S. communities and in two locations abroad (Paris and Brisbane).

Signs have also been used to try to facilitate lane sharing. The “Share the Road” sign asks motorists to think more of bicyclists’ interests, which should tilt the negotiation more in the bicyclists’ favor – but without eliminating the need for negotiation. To make matters worse, many motorists misunderstand the sign, thinking (and sometimes yelling at bicyclists) “Move over! You aren’t sharing the road!”



The “Bicycles Allowed Use of Full Lane” sign, the expected successor to “Share the Road,” 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

want to use, leaving the bike zone boundary to something to be negotiated. Some bicycle advocates have misgivings about what the sign implies for streets lacking such a sign; and some road authorities question the legality of the sign when the law requires slower vehicles to keep to the right.

At least one city (San Carlos, CA) has gone a step further, appending a plaque reading “Change Lanes to Pass” in applications on multi-lane roads (9). The addition of this plaque makes the entire shared lane the bike zone, establishing the lane line as the



boundary. In principle, this combination could be the answer to the need for a way to promote lane-sharing without forcing bikes to negotiate for space with cars.

As promising as this combination of signs may be, it cannot be applied on streets with only one lane in each direction in which passing is not encouraged because of limited sight distance or frequent intersections. The large number of words may hinder the degree to which the message is understood. Another potential weakness is that making the entire lane the bicycle zone may go too far. Because of how narrow bicycles are, most of the time motorists don't have to completely change lanes in order to pass a bike safely. That could lead to a broad interpretation of what it means to "change lanes to pass," with many motorists feeling that they are in compliance even if they only partially change lanes, thus leaving the boundary to the bike zone undefined.

Criteria for a Low-Stress Shared Lane Treatment

For a shared lane treatment to provide low stress to cyclists when traffic speeds or volumes are such that simple sharing of space is too stressful, it should meet the following criteria:

- (1) The bicycle zone boundary should be recognizable to motorists and bicyclists.
- (2) It should define a bicycle zone that is safe with respect to right-side hazards, and whose width is acceptable to most bicyclists. Otherwise, many bicyclists will ride outside the defined zone, forcing them to negotiate with cars for additional space.
- (3) It should also be recognizable to motorists that they may drive in the bicycle zone when no bicyclist is present.

In short, it should be a "just-in-time" bike lane. Criteria 1 and 2 must be met in order to eliminate the need for cyclists to negotiate with cars for space. Criterion 3 is needed to ensure that the lane will genuinely be shared.

There are at least two additional, street-specific criteria for whether lane sharing of any kind is safe or practical: the bike zone must be clear of (illegally) parked cars, and traffic speed must not be too great in order to ensure motorist readiness and willingness to slow down to bicycle speed if there is no passing opportunity.

The Proposed "Bicycle Priority Lane" Marking

The proposed "Bicycle Priority Lane" has been designed to achieve the three criteria given for low-stress lane sharing treatments. It enhances the sharrow by adding dotted lines (i.e., short broken lines) to define a bicycle zone as a *lane-within-a-lane*. Bicycle Priority Lanes are shown in Figures 1 and 2 in several contexts: two-lane and multi-lane streets, next to parallel parking and next to a curb. The name "Bicycle Priority Lane" is meant to draw an analogy to priority seating for the elderly on a bus: motorists should yield the space if a bike is there, but may use it otherwise.

In order to give the impression of a bicycle lane, the proposed marking uses three devices:

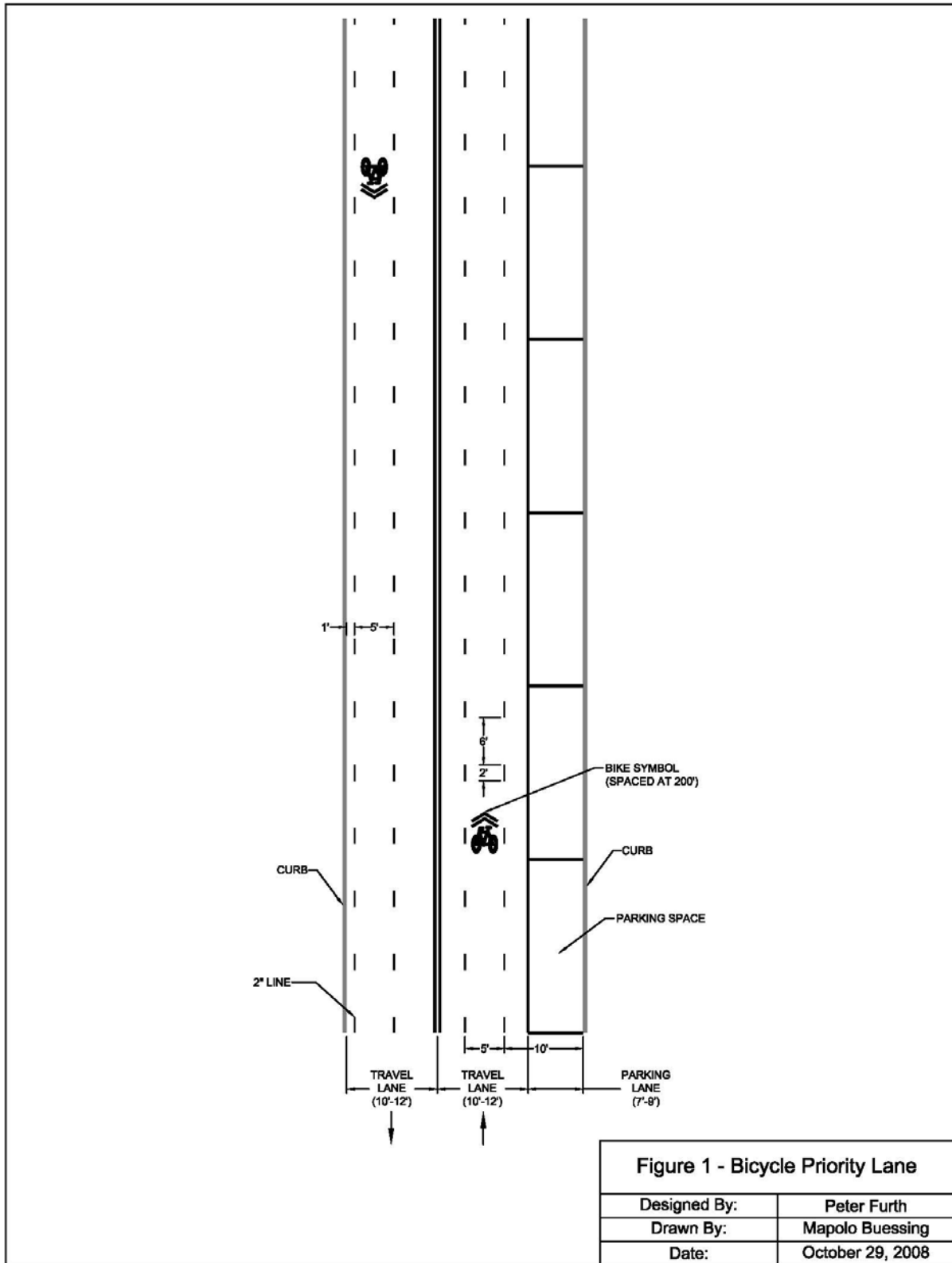


Figure 1. Bicycle Priority Lane Markings on a Two-Lane (1x2) Street. Shows suggested placement of the lane lines both with and without a parallel parking lane.

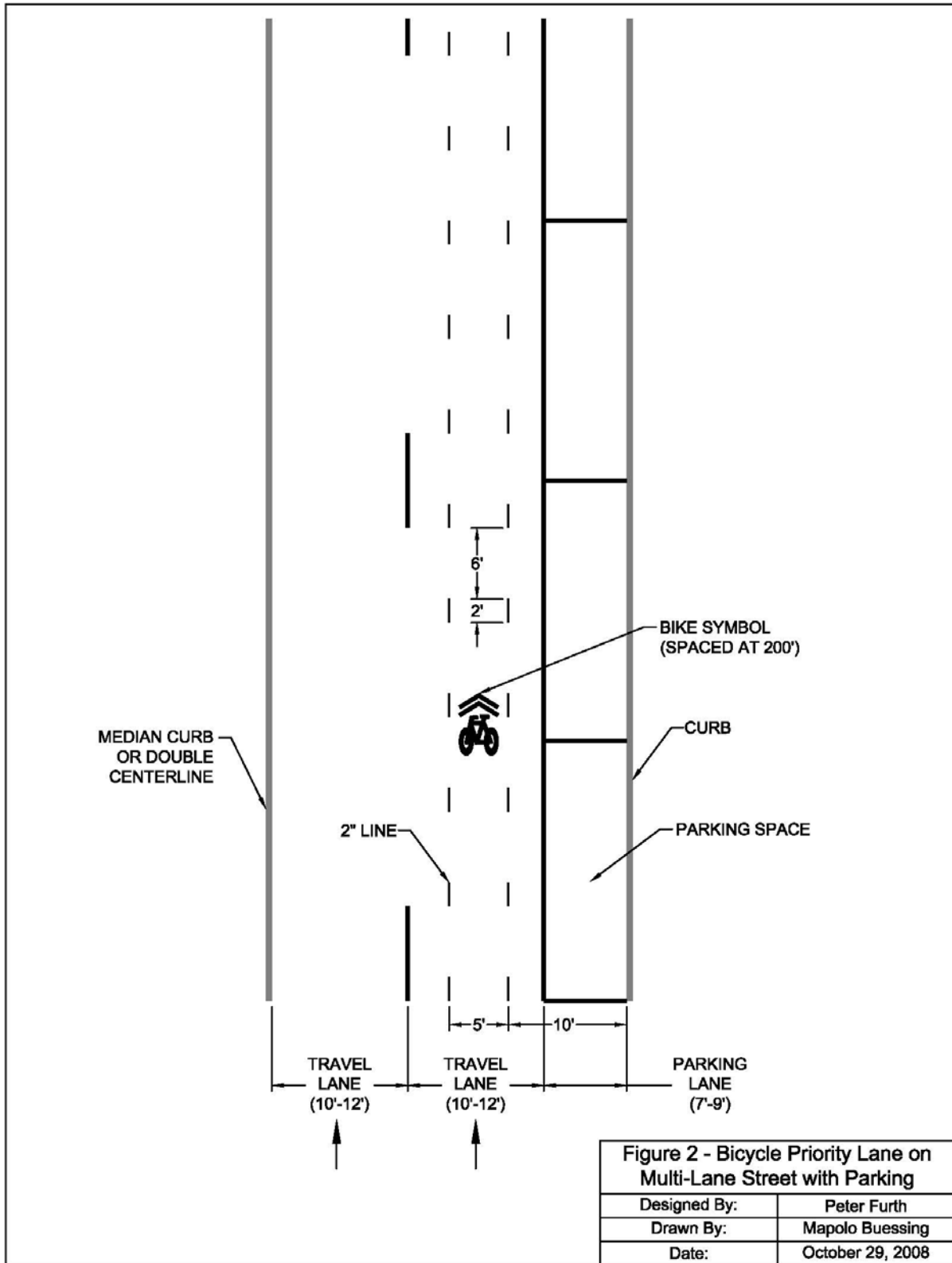


Figure 2. Bicycle Priority Lane Markings on a Multilane Street. Suggested lane placement relative to the curb is the same as on two-lane streets.

- 🚲 parallel dotted lines spaced 4 to 5 feet apart, the usual width of a bike lane;
- 🚲 lines whose dimensions are smaller in both length and width than regular lane lines, suggesting that the lane they define is intended for small vehicles; and
- 🚲 the shared lane arrow (sharrow) symbol, consisting of a bicycle and double chevron.

The shortness and close longitudinal spacing of the lines makes them “dotted lines” that offer “guidance,” as opposed to “broken lines” used to delineate regular traffic lanes. According to the *Manual on Uniform Traffic Control Devices* (10, Section 3A.05), “A dotted line provides guidance,” and “A dotted line shall consist of noticeably shorter line segments separated by shorter gaps than used for a broken line.” The typical broken line used to separate lanes alternates 8 ft of line with 32 ft of space. With the proposed dotted line, not only are the lines (2 ft) and spaces (6 ft) shorter, but the space-to-line ratio (3:1) is smaller as well. We also propose that the dotted lines be 2 inches wide instead of the usual 4 inches for regular lane lines. Therefore, in the absence of a bicycle, motorists will understand that the regular lane line has precedence, and that the dotted line is meant to guide bikes, not them.

Why does the Bicycle Priority Lane have a pair of lines, when only the left line serves as “bike zone boundary?” For three reasons. First, to better give the impression of “bike lane.” For applications next to a curb, a zone delineated by a pair of parallel lines is more recognizable as a bike lane than a zone delineated by a curb and a line. For applications next to a parking lane, omitting the right line leaves a space about 7 ft wide between the priority lane boundary and the parking lane boundary, a width that is not as recognizable as a bike lane. Second, a single line demarcating the bike zone would appear to split a travel lane into two zones, which would be confusing to motorists. Third, without a right line motorists might get the impression of a parking lane.

Next to a parking lane, the suggested placement of the bicycle priority lane lines is 10 ft and 15 ft from the curb. Putting the bike zone boundary 15 ft from the curb may seem overly generous compared to the standard bike lane which extends 12 to 14 ft from the curb. However, the standard dimension still leaves a level of dooring risk that should be avoided if possible. San Francisco’s study (8) found that the 85-percentile reach of the door zone was 9.5 ft, indicating that for 15% of parked cars, doors reach farther still. It is not unusual, especially in cities with a flat topography, for cars to park 1.25 ft from the curb; add a 6.25 ft car width, plus 2.8 ft for a door, and the practical reach of the door zone extends to 10.3 ft. Providing bicyclists a reasonable shy distance, width, and wheel track to account for natural wobble suggest placing the bike zone boundary about 15 ft from the curb, as shown in Table 1.

[With bike lanes marked 12 ft or 13 ft from the curb next to a parking lane, one can observe many bicyclists riding very close to the edge of the lane line, with their body overlapping into the travel lane; and a non-insignificant number ride just outside the bike lane. These bicyclists are claiming space beyond the bike lane, using their bodies to “push” passing cars a little further to the left. This is the kind of negotiation the Bicycle Priority Lane aims to avoid. Nevertheless, in defense of bike lanes that reach only 12 or 13 ft from the curb, it should be remarked that the negotiation for additional space where a

bike lane is marked involves far less stress than if no bike lane is marked at all, because with a bike lane the amount that a bicyclist “pushes” a car leftward is marginal, often smaller than the usual buffer cars and bikes keep between each other. That mechanism helps explain why cyclists ride further from parked cars when a bike lane is marked.]

Table 1. Offset needs for a low-stress bike zone next to a parking lane.

Curb to car (high percentile value)	1.25
Car width	6.25
Door extension	2.8
Shy distance	1.0
Bike / cyclist width	2.2
Wheel track width (natural wobble)	0.6
Shy distance	1.0
Total	15.1

A drawback of the recommended dimensions next to a parking lane is that the dotted line on the right will be in the wheel path of motor vehicles, leading to faster wear and therefore greater need for maintenance. The expense of restriping is still tiny, however, compared to the cost of widening the road to create an exclusive bike lane.

Where a Bicycle Priority Lane is next to a curb or roadway edge, the lines can be placed further to the right, with the right line 1.0 ft from the curb, and the left line 5 or 6 ft from the curb. The more generous dimension (6 ft) gives cyclists more leeway around drain grates, debris, and other surface irregularities that often occur near the edge of the road. These positions are less in the wheel path of motor vehicles.

One American example of a “lane within a lane” is a marking used in Oregon to indicate a through bike “lane” within an (otherwise) exclusive right turn lane, where there is insufficient space to mark a pocket bike lane to the left of the right turn lane. There, a dotted line is used to indicate the through bike zone within the right turn lane (Figure 3).



Figure 3. Lane-Within-a-Lane in Oregon. A portion of this right turn lane has been marked as a shared lane for through bicyclists. Notice the customized sign. (Photo: Michael Ronkin)

Using Carpet Coloring to Mark a Bicycle Priority Lane

In September, 2008, Salt Lake City implemented a marking that can be considered a bicycle priority lane, using the simple term “shared lane,” on 200 South Street, a multi-lane arterial, between Main and State Streets. Instead of dashed lines, it uses green coloring, applied as continuous 4-foot wide swath, to designate the bicycle zone, supplemented by sharrows, as shown in Figure 4.



Figure 4. Shared Lane in Salt Lake City. It is a bicycle priority lane using carpet coloring instead of dashed lines to delineate the bike zone (Photos: Dan Bergenthal).

Because of a narrowed right-of-way, this downtown block was the missing link in what are otherwise continuous bike lanes along 200 South. City officials wanted a lane-sharing scheme that gave the “feel” of being a bike lane, and that reinforced a state law requiring that motorists pass bicycles with a 3-foot clearance. According to a project summary statement, “Since a 12-foot lane is too narrow for a motorist to pass a bicyclist within the lane while providing 3 feet of clearance as required by law, motorists should not attempt to pass bicyclists in the same travel lane on this block.... The purpose of Shared Lane Markings is to remind motorists that bicyclists have the legal right to position themselves in the center of a travel lane when the lane is too narrow for a bicycle and automobile to safely travel side by side within the lane” (“200 South Shared Lane Markings Project,” unpublished press release, Salt Lake City, 2008).

According to the project director, Dan Bergenthal, the markings have been very positively received by the public, and seem to be working, with the majority of bicyclists riding in the marked bicycle zone. It has been suggested that a brighter green may be preferred for night-time visibility. A formal before-after study will be completed later in 2009.

Using carpet color instead of dashed lines involves considerably greater cost. At about \$2 per square foot, and assuming a lifetime of 5 years, the annual cost of maintaining a pair of 4-ft wide colored priority lines is about \$16,000 per mile per year. Dashed lines, at about \$0.75 per linear foot for thermoplastic 2 inches wide and assuming a life of 8 years, cost about \$500 per mile per year to maintain. One might consider supplementing carpet coloring with dashed lines for night-time visibility.

Dutch “Suggestion Lanes”

The primary inspiration of the Bicycle Priority Lane marking is the “suggestion lane” marking used in the Netherlands, shown in Figures 5-7. Like the proposed Bicycle Priority Lane, suggestion lanes delineate a bicycle zone within an automobile travel area using a broken line boundary and sometimes colored pavement. Like the proposed Bicycle Priority Lane, they have no legal standing (i.e., they neither require bicycles to ride in them, or motorists to stay out of them) (11). Suggestion lanes differ from formal bike lanes in that the former have no bicycle symbol marking, nor do they have a sign indicating bicycle lane. Their name, “suggestion lane” (Dutch: suggestiestrook) deliberately omits the word “bicycle.”



Figure 5: Suggestion lanes on minor rural roads. Notice how the centerline has been obliterated. The road on the right, with a narrower cross section, has narrower suggestion lanes so that the central zone will appear wide enough to seem like a normal-width driving lane.

However, the power of lines to suggest a bike lane is strong; virtually all road users, bicyclists and motorists, recognize it as a bike lane, and also recognize that cars may enter when doing so wouldn't interfere with a bike. Some suggestion lanes are paved with red asphalt, the color used routinely on formal bicycle lanes and roadside bike paths, further adding to the power of suggestion.



Figure 6. Suggestion lane on a busy suburban two-way road in Nootdorp. Cars stay out of the suggestion lane when passing bikes, and then enter it in order to pass oncoming traffic. The two cars passing bikes are bunched because they were waiting behind the bikes until the car departing in the background had passed.

As the figures suggest, Dutch suggestion lanes are only used on two-lane roads that are not marked with a centerline, and are too narrow to fit two bike lanes and two travel lanes. The longitudinal markings divide the road into two side zones and a central zone, the latter being wide enough for cars to travel in

one direction, but not wide enough for cars to pass in both directions. They encourage the kind of motorist positioning that takes place naturally on many narrow, low volume roads – motorists ride near the middle of the road by default, and shift to the right when needed to pass oncoming traffic. The side zones become the default bike zone. When cars have to enter a side zone because of oncoming traffic, bikes in the bike zone benefit from the natural yielding that occurs when motorists change lanes. The net effect, then, is to give bicyclists a zone in which they have priority over motor traffic – all by the power of suggestion, using the magic of lines.



Figure 7. Choker reinforcing suggestion lanes in the Westland. The choker reinforces the idea that cars are to drive in the middle, leaving the suggestion lane for bikes, except when they need to shift to the right for oncoming traffic. When the government (as roadway owner) uses marking and devices like this to assert bicyclists' right to operating space on the road, bicyclists using the lane don't have to feel assertive. Speed limit is 60 km/h (37.5 mi/h).

National guidelines recommend that suggestion lanes be marked as wide as regular bike lanes, specifically rejecting the practice of making suggestion lanes narrower than regular bike lanes, with the following exception. If the road is narrow, generous suggestion lanes could leave a central zone that is so small that cars overtaking a bicycle will encroach on the *opposite side* bike zone, possibly endangering opposite direction bicyclists. Therefore, guidelines recommend narrower suggestion lanes as the roadway cross section becomes narrower.

Suggestion lanes are used in both urban and rural areas. As part of the national "Sustainable Safety" program adopted in 1997, the default treatment for minor rural roads at least 4.5 m (15 ft) wide is to use suggestion lanes and no centerline, while at the same time lowering the speed limit from 80 km/h (50 mph) to 60 km/h (37.5 mph). On minor rural roads all over the country, centerlines are being removed and suggestion lanes marked. While some officials were skeptical of the safety impact of replacing centerlines with suggestion lane lines, a large scale before-after test involving more than 700 km of rural roads owned by water boards found that this new layout, combined with the speed limit change, reduced the overall accident rate by 17%, while the accident rate involving bicycles had a small but statistically insignificant drop (12).

Informally, any visitor to the Netherlands can readily see how Dutch suggestion lanes meet the three criteria stated earlier for low-stress lane sharing: respected by motorists as a bike zone, sized large

enough that nearly all cyclists stay in them (except when riding two abreast), and used by motorists when it doesn't interfere with cyclists. A before-after study of road user behavior on minor rural roads (13) found that, like formal bike lanes, suggestion lanes have a strong canalizing effect, but only when bicyclists are present. Nearly all bicyclists (97%) rode in the suggestion lanes, whose width varied from 3.7 to 4.3 ft. (In the before case, "in the lane" refers to being in the space that in the after case was defined by the marking.) In the absence of a bicyclist, 61% of motorists drove on or over the suggestion lane marking, down only slightly from before the marking was laid down (69%). However, in the presence of a bicycle, the lines tended to channel the motorists away from the bike zone, but without an undue shift to the left. After suggestion lanes were applied, the fraction of motorists riding in or just next to the bike zone fell from 3% to less than 1%, while the fraction shifting so far to the left that they encroach in the opposite direction bicycle zone fell from 65% to 34%.

In urban areas, within traffic-calmed 30-km/h zones which have proliferated in the Netherlands since 1997 as part of the Sustainable Safety program, it is desired that cars and bikes share space without any lane markings (and therefore no centerlines or suggestion lane markings). However, the desire to provide the highest level of comfort to bicyclists has led to the development of a new street arrangement, borrowed from Germany, called the "bicycle street:" a street intended chiefly for bicycle traffic but on which autos are allowed "as guests." One of the three approved layouts for a bicycle street has the familiar three-zone arrangement, with suggested bicycle zones on the sides indicated by red pavement and a middle zone in black pavement, as shown in Figure 8.

Dutch suggestion lanes meet the criteria that make them a low-stress layout for shared lanes. Their popularity and safety record make them a good model for facilitating lane sharing in a way that is safe, not stressful to cyclists, and clear to motorists. The proposed Bicycle Priority Lane adapts the features of the suggestion lane to create a design that should achieve the same benefits on American streets with centerlines, multiple lanes, and on-street parallel parking.



Figure 8. Bicycle streets in Culemborg (left) and Zwolle. While there is no broken line marking, the pavement colors clearly suggest bike zones on the sides of the road. The narrow central zone in the figure on the left is a visual cue to drive slowly because drivers cannot get out of the bike zone. The sign reads "drive at walking speed."

Suggested Application of the Bicycle Priority Lane

The Bicycle Priority Lane is intended for use where space constraints make it not possible to provide bicyclists with a dedicated lane or separated path, and where traffic speeds and volumes make road-sharing without signs or markings stressful. In such situations, it is a design option for a “just-in-time” bike lane with the potential to offer bicyclists a level of safety and comfort that approaches that of an exclusive bike lane.

There is no upper limit to traffic volume for applying the Bicycle Priority Lane. For a lower limit, its need should be questioned at volumes under 3,000 vehicles per day on roads without centerlines; in such situations, simple road-sharing without any marking may be an adequate accommodation for bikes. On roads with fewer than 3,000 vehicles per day with centerlines and insufficient space to mark exclusive bike lanes, it should first be considered whether the centerline can be removed in order to help promote lane sharing.

There is a maximum speed beyond which it is not responsible to encourage lane sharing. The successful Dutch experience with suggestion lanes on urban streets with 50 km/h speed limits and on rural roads with 60 km/h speed limits indicates the Bicycle Priority Lane is certainly appropriate for urban streets with speed limits up to 30 mph, and that it might be considered for streets with speeds up to 35 mph. On rural roads with low traffic volumes and long sight distances, application might even be considered for speed limits up to 40 mph.

On signalized intersection approaches, providing bike boxes (queuing areas for bikes between the crosswalk and a set-back stop line for motor traffic) should be considered in combination with the Bicycle Priority Lane where the lane is wide enough for cyclists to advance past a queue of cars. Bike boxes offer cyclists a less-stressful place to queue than in shared lane, and they guide cyclists who have advanced to the stop line to wait in the middle of the lane and ahead of cars, in full view of the lead vehicle in the queue which, if turning right, could pose a threat to a cyclist waiting at the curb. If space permits, it would be ideal for a Bicycle Priority Lane to transition to an exclusive bike lane on the intersection approach in order to give bicyclists a channel on the right to advance past the queue. Where an exclusive lane on the intersection approach cannot be provided, it seems best to continue the Bicycle Priority Lane all the way to the stop line, consistent with Dutch practice with suggestion lanes, because bicyclists may arrive during green, and because queue lengths vary over the day.

Because it does not consume any roadway space, and can be applied on roads of varying number of lanes with or without parallel parking, the Bicycle Priority Lane is a flexible tool with enormous potential for developing bicycle networks. While exclusive bicycle lanes, separated paths, and use of low speed / low volume streets are preferred, it is often not possible to complete bicycle networks or to satisfy bicycle accommodation objectives without lane sharing on streets that exceed “low stress” thresholds for speed or traffic volume. For such situations, the Bicycle Priority Lane offers a treatment that should reduce bicyclist stress to a level approaching that of an exclusive bike line. It should also improve safety by reducing the pressure cyclists feel to ride too far to the right, by guiding motorists overtaking bicyclists, and by drawing motorists’ attention to bicyclists and to likely path. The Bicycle Priority Lane

marking can be used to enhance bicyclist safety and comfort on bike boulevards (bike routes along low speed / low traffic streets) with or without centerlines.

Next Steps

We hope to interest cities and other roadway owners to test the proposed marking with respect to bicyclist and motorist lateral position, bicyclist and motorist understanding of the marking, bicyclist and motorist comfort, and bicyclist and motorist reaction, in a variety of settings. Persons interested in participating in such an experiment are requested to contact the author. Comments and suggestions for improving the design are also welcome.

References

1. Furth, P.G. "On-Road Bicycle Facilities for Children and Other 'Easy Riders': Stress Mechanisms and Design Criteria." Presented at the Transportation Research Board Annual Meeting, Washington, January, 2008.
https://myfiles.neu.edu/xythoswfs/webui/xy-5106359_1-t_sVw0xIMZ
2. Forester, J. *Effective Cycling*. MIT Press, 1992.
3. Van Houten, R. and C. Seiderman. "How Pavement Markings Influence Bicycle and Motor Vehicle Positioning: Case Study in Cambridge, Massachusetts." *Transportation Research Record* 1939, pp. 3-14, 2005. Preprint version available at
http://www.cambridgema.gov/~CDD/et/bike/bike_hamp_study.pdf
4. Hunter, W.W., J.R. Feaganes, and R. Srinivasan. "Wide Curb Lane Conversions: The Effect on Bicycle and Motor Vehicle Interaction." *TRR* 1939, 2005, pp. 37-44. https://myfiles.neu.edu/xythoswfs/webui/xy-5117180_1-t_F6zhAogG
5. Hallett, I., D. Luskin, and R. Machemehl. "Evaluation of On-Street Bicycle Facilities Added to Existing Roadways." Report FHWA/TXDOT-06/0-5157-1, Center for Transportation Research, University of Texas at Austin, 2006.
http://www.utexas.edu/research/ctr/pdf_reports/0_5157_1.pdf
6. Carter, D.L., W.W. Hunter, C.V. Zegeer, and J.R. Stewart. "Pedestrian and Bicyclist Intersection Safety Indices: User Guide," 2007. <http://www.tfhr.gov/safety/pedbike/pubs/06130/06130.pdf>
7. Landis, B.W., V.R. Vattikuti, and M. T. Brannick. "Real-Time Human Perceptions: Toward a Bicycle Level of Service." *Transportation Research Record* 1578, 1997. <http://www.enhancements.org/download/trb/1578-15.PDF>
8. Alta Planning & Design. "San Francisco's Shared Lane Pavement Markings: Improving Bicycling Safety." Report to San Francisco Department of Parking and Traffic, 2004.
http://www.bicycle.sfgov.org/site/uploadedfiles/dpt/bike/Bike_Plan/Shared%20Lane%20Marking%20Full%20Report-052404.pdf
9. Rosenberg, M. "New Road Rules Expand Bike Lanes in San Carlos." *San Francisco Examiner*, October 22, 2008.
10. *Manual on Uniform Traffic Control Devices*. Federal Highway Administration, 2003.
11. *Design Manual for Bicycle Traffic*. CROW (Netherlands), 2007.
12. "New Type of Layout for 60 km/h Rural Roads." Fact Sheet. SWOV (Netherlands), 2007.
http://www.swov.nl/rapport/Factsheets/UK/FS_Driving_strips.pdf
13. van der Kooij, R.M. and A. Dijkstra. "Some Behavioural Effects of Non-Compulsory (Bicycle) Lanes on Narrow Rural Roads." SWOV (Netherlands), 2003. (In Dutch, with English language summary). <http://www.swov.nl/rapport/R-2003-17.pdf>