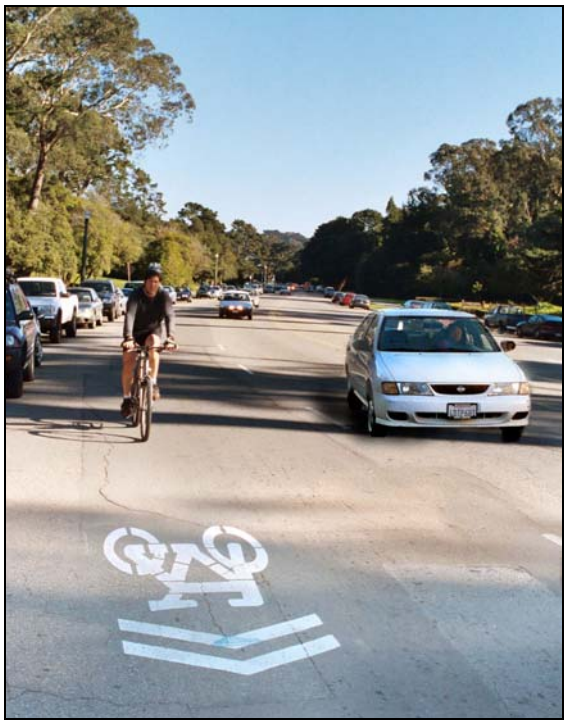
San Francisco's Shared Lane Pavement Markings: Improving Bicycle Safety



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Project Need

Traffic curb lanes on signed/shared Class III bikeways (a.k.a. "signed shared roadways" in other states) are often too narrow to be safely shared side-by-side by cyclists and passing motorists. On these routes, cyclists wishing to stay out of the way of drivers often ride too close to parked cars and risk being struck by a suddenly opened car door (being "doored"). To avoid this, experienced cyclists ride further to the left and position themselves closer to the center of narrow lanes. This is permitted by the California Vehicle Code (C.V.C. 21202), but it often irritates motorists who are not aware that this is permitted. To address this and other problems, the San Francisco Bicycle Plan recommends that Class III bike routes be delineated with on-road markings. However, no approved standard pavement marking exists for this purpose. As a result, the following problems have arisen, particularly on higher traffic volume roadways:

- High incidence of "dooring",
- Wrong-way riding,
- Sidewalk riding, and
- Motorist squeezing cyclists against the curb or parked cars, or exhibiting other aggressive behaviors.

Paris, France

Many cities have experimented with a "shared lane marking" as a potential solution. The marking does not connote a separated bicycle lane, but instead directs the bicyclist to travel outside the car door zone and encourage safe co-existence. Such cities include Denver (CO), Gainesville (FL), Cambridge (MA), Portland (OR), Oakland (CA), Paris (France), Brisbane (Australia), Zurich (Switzerland), and others (see Appendix A for details of these and other efforts.) The only city to study the effectiveness of such markings is Gainesville (FL), which found that the markings caused cyclists to shift their positions by a few inches, a positive result.

Denver, Colorado

The City and County of San Francisco has in particular experienced a high frequency of complaints and problems due to increasing volumes of bicyclists on streets with high traffic volumes and heavily-used on-street parking. In 1998, San Francisco began experimenting with a green[1] pavement marking, referred to as "bike-inside-house," similar to that of Denver (CO), on various streets. While cyclist feedback was generally positive, there was concern about the marking's low visibility. As other jurisdictions began using varying marking designs, questions also arose about the need for a standard application of spacing, size, and location, as well as whether the marking was effective, safe, and beneficial.

Portland, Oregon

Thus, the San Francisco Department of Parking and Traffic (SF DPT) undertook this study to determine the effectiveness of shared lane pavement markings in encouraging safe bicyclist and motorist coexistence. The process ideally will lead the California Traffic Control Device Committee (CTCDC) to formally approve and effective shared lane marking for use throughout the state.

[1] San Francisco used green as its marking color because it was not in use as a standard color for traffic control devices.

Goals

The purpose of this study is to determine the effectiveness of shared-lane markings in achieving three distinct goals.

Goal 1: Improve the position of both motorists and bicyclists on roadways without bicycle lanes

Measure of Effectiveness:

- Distance of bicyclist from adjacent parked cars.
- Distance of motorist when passing a bicyclist.

Note: All study streets have on-street parking; however, if there is no parked car at the study site the measurement shall be to the curb face.

Goal 2: Reduce aggressive motorist behavior

Measure of Effectiveness:

- Observable hostile behaviors such as honking, gestures or other behaviors when passing or waiting to pass a bicyclist.

Goal 3: Encourage correct bicyclist riding behavior

Measure of Effectiveness:

- Number of bicyclists riding on the sidewalk.
- Number of bicyclists riding wrong-way on the street.

Additional Objectives

Shared-lane markings may also have the following effects:

- Inform motorists to expect bicyclists on the roadway.
- Inform motorists that bicyclists may indeed legally ride further to the left in the travel lane, even if that means blocking the lane at times.
- Inform bicyclists how to position themselves in the lane with respect to the curb or parked cars to avoid hazards.
- Increase the number of cyclists as people may feel more comfortable riding on streets with markings.

Arrow Designs

Human Factors Survey: Findings

The marking design in other cities is quite varied, as seen in Appendix A. Recognizing that an infinite number of possible design variations exist (size, color, shape, etc.), SF DPT undertook a human factors survey of the three most commonly used marking designs in the U.S.. The study compared driver and bicyclist comprehension of three alternative designs for the shared-use marking. Staff presented 120 bicycling commuters and 120 motorist commuters with one of three photographs (Figure 1) showing a typical urban street with a different kind of shared lane marking. They then asked a series of open-ended questions to determine:

- what they felt they should do in that scenario if they were bicycling/driving,
- why they would react that way, and
- what they thought the pavement marking in particular meant they should to do.

Key results included:

- All three markings encourage motorists to be more aware of bicycles.
- The bike-and-separate-arrow marking was frequently conveyed the incorrect message to 'bike straight only at the intersection ahead.'
- The bike-and-chevron marking was more likely to elicit the response to slow down than the bike-in-house symbol.
- Significantly more respondents thought the bike-and-chevron marking indicated a shared use lane than the bike-and-separate-arrow marking.
- About half of the surveyed bicyclists thought they should stay in the right lane and follow the arrow.

Bike-and-chevron marking

Bike-and-separate-arrow marking

Bike-in-house marking

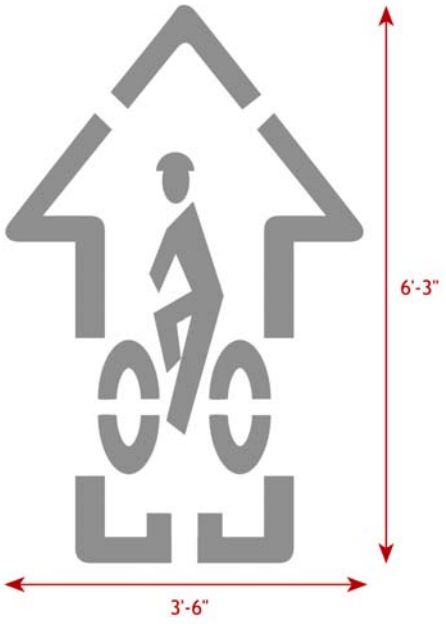
Figure 1. Survey Exhibits: Photographic Renderings

Selected Designs

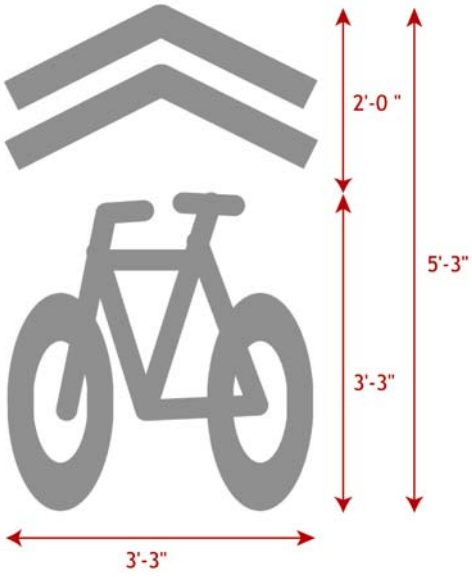
As a result of this research, as well as review from a Technical Advisory Committee, SF DPT chose to study the two designs shown in Figure 2.

The **modified bike-in-house** is 42 inches (3'-6") wide at the arrow points, 28 inches (2'-4") wide at the bottom channel, and 75 inches (6'-3") long. The rider is 28 inches wide at the wheels and 48 inches tall. Compared to the original bike-in-house used on various streets, the bicyclist is twice as large, the overall marking is 3 inches longer, and the overall width remains the same. In addition, a bike wheel channel was created at the bottom to encourage cyclists to ride on the arrow.

The **bike-and-chevron** marking is used in Paris and Chicago. Technical advisory committee members also strongly recommended studying the bike-and-chevron marking.



Modified "bike-in-house" marking



Bike-and-chevron marking

Figure 2. Selected Designs for the Study

Before-and-After Videotape Analysis

The primary approach used to evaluate cyclist and driver behavior was a before/after videotape study. In addition, the consultant team and the San Francisco Bicycle Coalition (SFBC) administered surveys to cyclists and drivers to gauge their perceptions about the effectiveness of the markings. This document presents the findings of both the video study and surveys.

The consultant team collected more than 140 hours of video, primarily during the weekday commute, at six locations (see photos starting on page 7):

- Polk Street
- 17th Street
- 2nd Street
- Market Street (weekday/midday location)
- JFK Drive (weekend/weekday location)
- Stanyan Street (weekend location)

The locations are heavily-used bicycle routes for both utilitarian and recreational cyclists. The streets have on-street parking with relatively narrow (≤22 feet) outside shared lanes (including parking) and no bicycle lanes. They have varied traffic volumes and roadway width characteristics (see Table 1). The markings were placed so that the centerline is 11 feet from the curb, or about 4 feet from parked cars (see Figure 3).

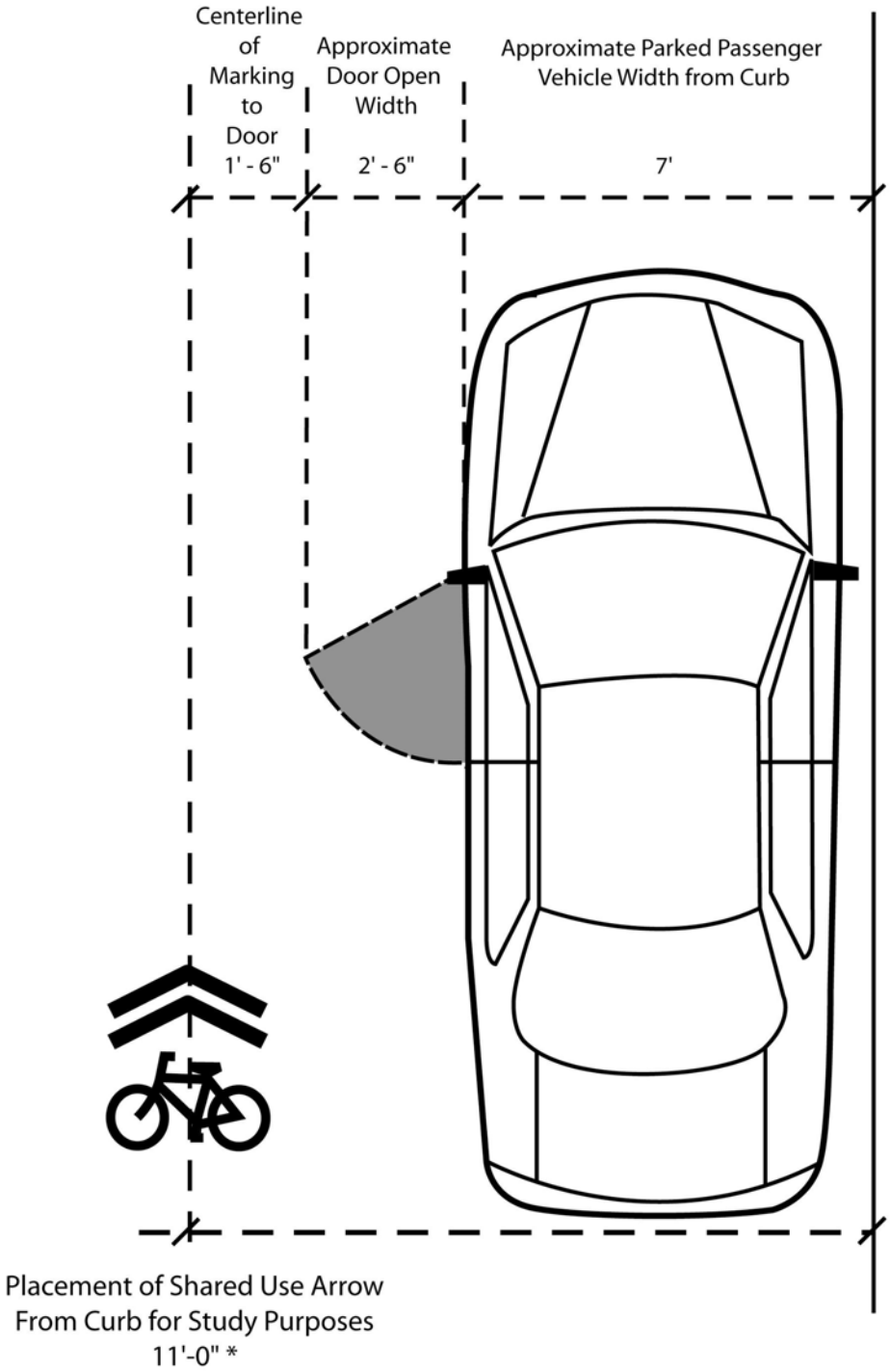
Table 1. Characteristics of Marking Locations

Street	Location	# of Lanes	Curb Lane Width (includes parking)	ADT[1] (Volume)
Polk Street	between Washington and Sacramento	two-lane road	22'	high ADT/lane
17th Street	between S. Van Ness and Dolores[2]	two-lane road	22'	moderate ADT/lane
Second Street	between Mission and Howard	four-lane road	17'	moderate ADT/lane
Market Street	between Van Ness and Octavia[2]	four-lane road	18'-19'	high ADT/lane
JFK Drive	between 8th and 10th Ave.	four-lane road	17'-19"	moderate ADT/lane
Stanyan Street	between Haight and Frederick	four-lane road	16'10"	moderate ADT/lane

1 Heavy ADT is defined as more than 4000 vehicles per day per lane of traffic. Moderate ADT is defined as between 2000 and 4000 vehicles per day per lane of traffic.

2 17th Street (between Dolores and Valencia) and Market Street (between Octavia and Gough) were marked by DPT with green pavement arrows prior to the Before/After Study. These green test arrows were removed years prior to the initiation of the "Before" video documentation.

Note: Other streets–Fell St., 8th Ave., Transverse St., Page St. –were considered but not selected for analysis as the budget allowed for only six streets. The selected streets offer a good range of comparable issues.



* This placement is based on the following:
- 85th percentile of car doors observed opened to 9'6" from curb (per DPT field observations).
- Average width of bicycles is 2'.
- 6" clearance from door to bicycle handlebar is desired minimum "shy distance".

Figure 3. Plan View of Marking Placement

Locations of Study Markings

17th Street

eastbound

westbound

2nd Street

northbound

southbound

Market Street

westbound

eastbound

Polk Street

southbound

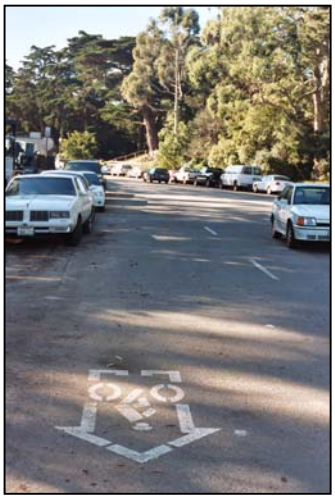
northbound

Stanyan Street

northbound

southbound

JFK Drive



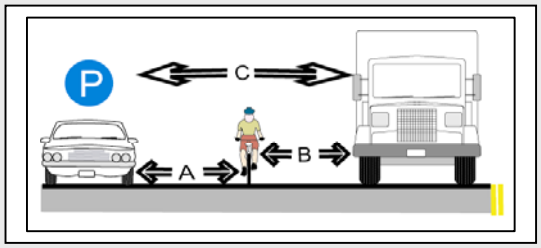
eastbound

westbound

Summary of Data Collection

Sample Size

- 6 locations
- 140 hours of videotaping
- "Before" study:
  - 1100 cyclists
  - 1000 motor vehicles
- "After" study:
  - 1300 cyclists
  - 1400 motor vehicles



Time of Study

- Spring-Summer 2003
- Various times during the day, depending on street

Variables Studied

- Number of travel lanes
- Traffic volume
- Curb lane width
- Location
- Time of day
- Marking type

Recorded Behaviors

- Cyclists' positions (A and B in the above diagram)
- Motorists' positions (B and C in the above diagram)
- Cyclist direction
- Cyclist location (street vs. sidewalk)
- Visible conflicts between cyclists and motorists

Note: Distances were measured to and from the tires of the car or bicycle. Based on review of the videotapes and the videographer's perceptions, the presence of the video camera did not seem to alter cyclists' or drivers' behaviors. However, the use of a video camera angled at oncoming cyclists did present a potential measurement error of up to 3 inches due to the inherent distortion of the view field. This measurement error could be eliminated in future studies through the use of an overhead-mounted camera or laser measurement device.

Results

Technical Results

Overall, the stencil markings significantly[2] improved both motorists' and cyclists' positions in the roadway (using the median average positions). The markings also reduced sidewalk and wrong-way riding.

Goal 1: Position of bicyclists and motorists

- Finding 1: Overall, the presence of a marking **increased the distance of cyclists to parked cars by 8 inches.** The effect of each marking on position was similar (see Figure 4).

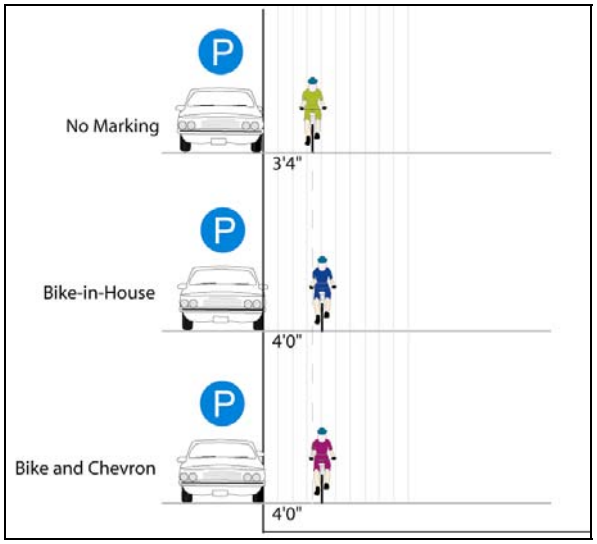


Figure 4. Effect on Bicycle to Parked Car Spacing

- Finding 2: When passing vehicles were present, the markings caused an **increase of 3 to 4 inches in the distance between cyclists and parked cars.** In addition, the markings caused an **increase of over 2 feet in the distance between cyclists and passing vehicles.** The bike-and-chevron had a greater effect (by 3 inches) on the distance between cyclists and passing vehicles (See Figure 5).

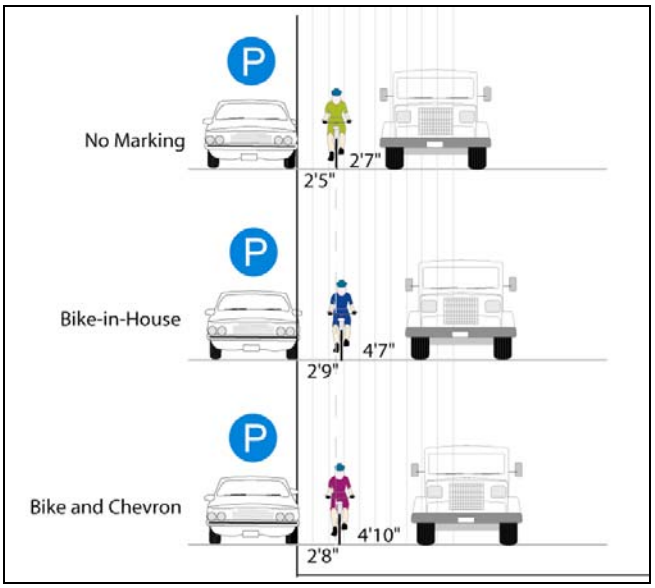


Figure 5. Effect on Motorist and Bicyclist Spacing

[2] The use of the term, "significant" means that the observed change was the result of a change in the variable (i.e., the pavement marking), as opposed to normal variance in the measurements. Significance has been determined through the use of a variety of statistical tests and tools including χ^2 (chi-squared) tests and multiple linear regression where appropriate. The χ^2 tests were used to compare the before/after results for behaviors such us cyclists' location and direction. Linear regression was used to analyze the measured results in relation to the markings.

(Goal 1 Continued)

- Finding 3: When no cyclists were present, both of the markings had a significant positive effect of about one foot on the distance between passing vehicles and parked cars (see Figure 6).

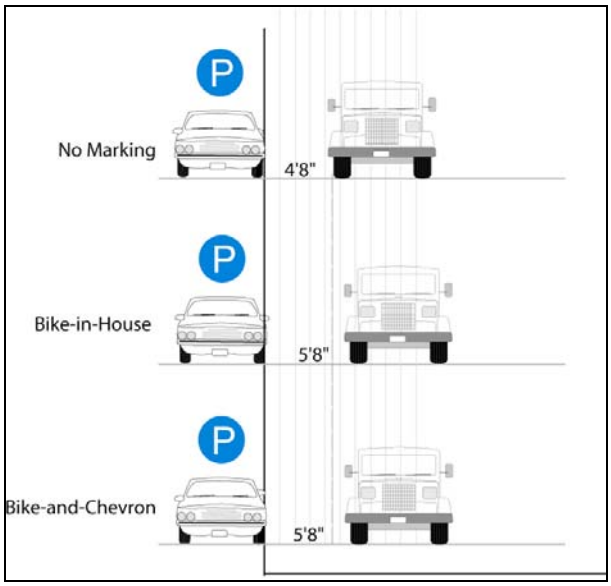


Figure 6. Effect on Motor Vehicle to Parked Car Spacing

Goal 2: Reduction in aggressive motorist behavior

- The markings neither significantly reduced nor increased the number of observable hostile behaviors between bicyclists and motorists. This was primarily due to the low number of aggressive behaviors recorded in the "before" videotapes.

Goal 3: Reduction in improper bicycle behavior

- Both the markings significantly reduced the number of sidewalk riders: the bike-and chevron by 35% and the bike-in house by 25%.
- The bike-and-chevron marking significantly reduced the number of wrong-way riders by 80%. The bike-in-house marking did not have any significant impact on the percentage of wrong-way riders.

Table 2 provides a summary of these findings. Complete results are on file with the San Francisco Department of Parking and Traffic's Bicycle Program.

Table 2. Summary of Bicyclists' and Motorists' Behavior

Behaviors	Before	After	
	(No marking) sample size=1158	**Bike-in-House** sample size=570	**Bike-and-Chevron** sample size=794
Sidewalk riders	6.5%	**4.9%**	**4.2%**
Wrong-way riders	3.0%	3.3%	**0.60%**
Hostile behaviors	0.15%	0.17%	0.12%
Distance of cyclists to parked cars	3'4"	4'0"	**4'0"**
Distance of cyclists to cars in travel lanes	2'7" sample size=150	**4'7"** sample size=59	**4'10"** sample size=150
Distance of cars in travel lane to parked cars (no bike present)	4'8"	**5'8"**	**5'6"**

Significant differences are indicated in **boldface**.

Variables Influencing Results

Various factors contributed to these study results, including:

- Number of travel lanes
- Traffic volume
- Curb lane width
- Time of day (AM Peak/PM Peak/weekday midday/weekend)

Each variable was classified in two groups (such as high/low, narrow/wide, or AM/PM). The median and mean average distances were isolated and cross-tabulated for different factors and were compared to see if the variables had an effect on distances between cyclists, parked cars, and passing cars. Table 3 summarizes the characteristics' effects on cyclists and motorist positions. A complete listing of the cross-tabulated results is on file with the SF DPT Bicycle Program.

Table 3. With Markings in Place, Significant Street Characteristics Affecting Behavior

Factor	Effect on Distance between Bicyclists and Parked Cars	Effect on Distance between Bicyclists and Passing Vehicles
More lanes (4 vs. 2)	increase	decrease
Higher traffic volume	no effect	no effect
Wider curb lane	decrease	increase
AM vs. PM	no effect	no effect
Peak Periods	decrease	decrease

In comparing the effects of the markings on rider position on streets with different characteristics, the study found that:

- The markings have a **greater effect on distance** between cyclists and parked cars **on four lane roads** than on two lane roads.
- The markings have a **greater effect on distance** between cyclists and parked cars on **heavy volume roads** than on moderate volume roads lane roads.
- Curb-lane width and time of day did not have a significant effect on how much the markings changed behavior.

Table 4 summarizes the findings of each of the markings.

Table 4. Summary Comparison of Markings

Study Issues	Bike-in-House	Bike-and-Chevron
1. Did the marking increase the distance of bicyclists from adjacent parked cars?	YES	YES
2. Did the marking increase the distance between passing motorists and cyclists?	YES	YES
3. Did the marking reduce observable hostile behaviors?	UNDETERMINED[1]	UNDETERMINED[1]
4. Did the marking reduce incidences of sidewalk riding?	YES	YES
5. Did the marking reduce incidences of wrong-way riding?	NO	YES

[1] There were too few incidents to reach a statistical conclusion.

Cyclist and Driver Survey Results

Staff and volunteers surveyed 103 San Francisco cyclists and 23 motorists about the bicycle markings at three locations: Polk Street, 2nd Street, and Market Street.[3]. Approximately equal numbers of surveys were collected for both kinds of markings (see Table 5.)

Table 5. Surveys Completed

Location	Marking Type				Sub-Totals		Totals
	Chevron		Bike-in-House				
	Cyclists	Drivers	Cyclists	Drivers	Chevron	Bike-in-House	
Market St.	20	--	45	--	20	45	**54**
Polk St.	7	11	8	12	18	20	**38**
2nd St.	23	--	0	--	23	0	**23**
Totals	**50**	**11**	**53**	**12**	**61**	**65**	**126***

The survey queried bicyclists' and drivers' understanding and perception of the markings. The results were coded in Microsoft Excel and analyzed using SPSS Statistical Software. Complete results are on file with the SF DPT Bicycle Program.

In summary, the bicyclists surveyed see the markings as a step in the right direction and felt that the markings increased their sense of safety. However, the intended message of the markings was not fully understood. This could be remedied through a public information campaign.

The majority of the drivers surveyed claimed not to notice the markings. Since the sample size of drivers was so small, the results do not provide conclusive findings. Of the drivers that noticed the markings, there was no significant advantage of one marking over the other, but the drivers did not seem to confuse the markings with bike lanes.

[3] Surveys were administered roughly a half-block "downstream" of the markings during weekday peak travel times. The surveyors asked approaching cyclists if they would fill out the surveys on the spot (no surveys were mailed). Small warning signs (with the words, "Bike Surveys") were placed about 50 feet before the surveyors. About 25% of passing cyclists filled out the survey, which took an average of three to four minutes to complete. Drivers were surveyed as they arrived to their respective destinations along Polk Street.

Location and Rider Characteristics

Since most of the surveys were conducted on major commute routes during peak times, recreational and beginner cyclists are under-represented. Practically all of the interviewed cyclists categorized themselves as either intermediate (25%) or advanced (74%) urban cyclists. Typically, these cyclists are more likely to "take the lane" in urban traffic situations. Most of the cyclists were commuting to/from work (63%) or riding for utilitarian purposes (25%). Practically all of the cyclists were between the ages of 19-60 (60% 19-35 years old, 38% 36-60 years old).

Message

- Many cyclists believed that the markings indicated that the right lane served as a bike route or lane or that bikes have priority (30%) (see Figure 7).
- About 15% of cyclists felt that the marking indicated that bicyclists were allowed full use of the travel lane. 75% of these "take the lane" respondents had ridden over the bike-in-house marking.
- A few cyclists thought that the marking signified that a bike lane would be installed at the location in the future (2%).
- Of the motorists that responded, two out of the seven that noticed the markings understood that the marking indicate that they should allow more room for cyclists.

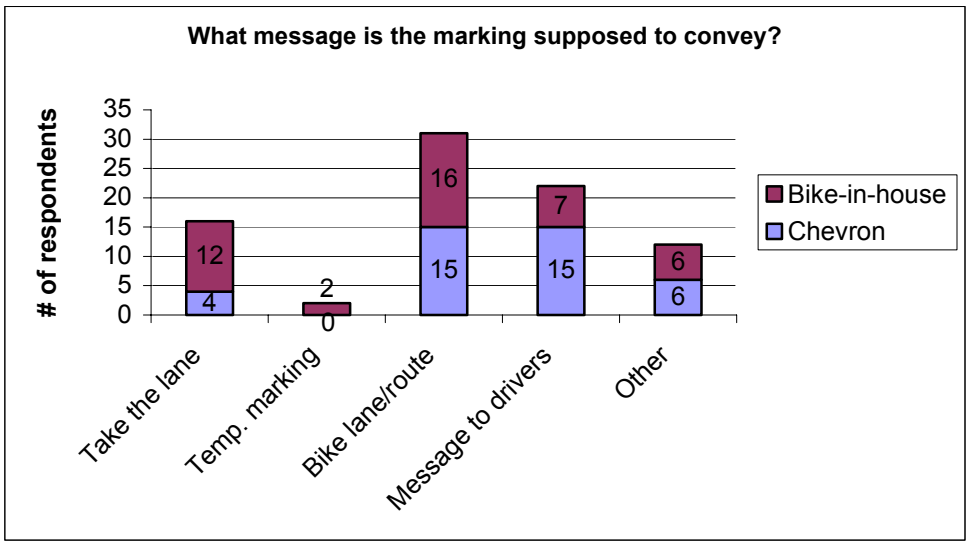


Figure 7. Cyclists' Responses to Survey - Message

Perception of Impact on Behavior

- Of the riders who noticed the markings, 33% felt that they did not change their position.
- Of the 33% of cyclists that felt that the marking affected their position (See Figure 8), 100% said that they rode closer to the center of the lane, often over the center of the marking.
- 60% of cyclists felt that the markings increased their sense of safety (See Figure 9).
- 35% felt that the marking improved driver behavior, 36% felt that the marking had no impact on driver behavior, and 29% were unsure (See Figure 10).
- Of the drivers, one-third felt that the markings improved their behavior.

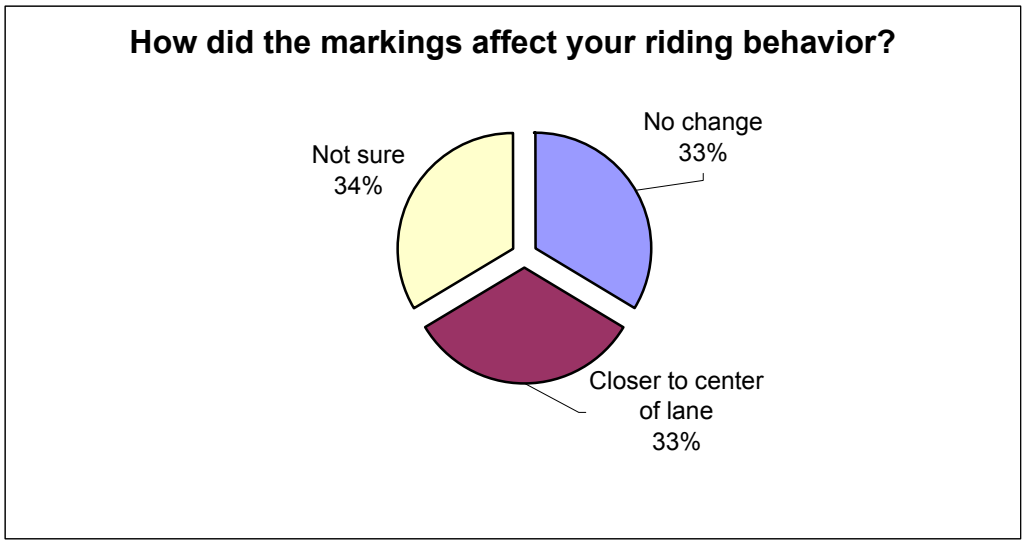


Figure 8. Cyclists' Responses to Survey - Riding Behavior

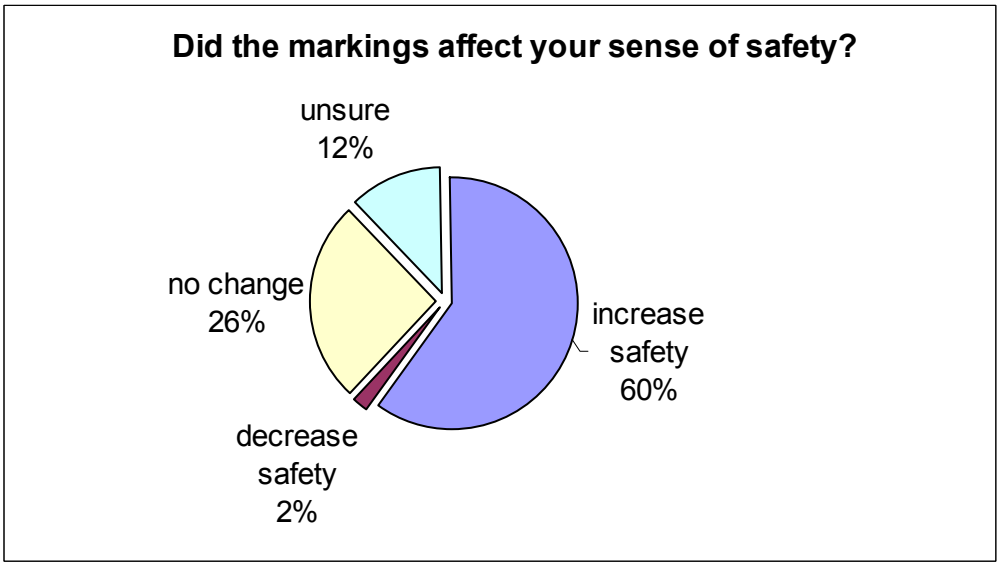


Figure 9. Cyclists' Responses to Survey - Sense of Safety

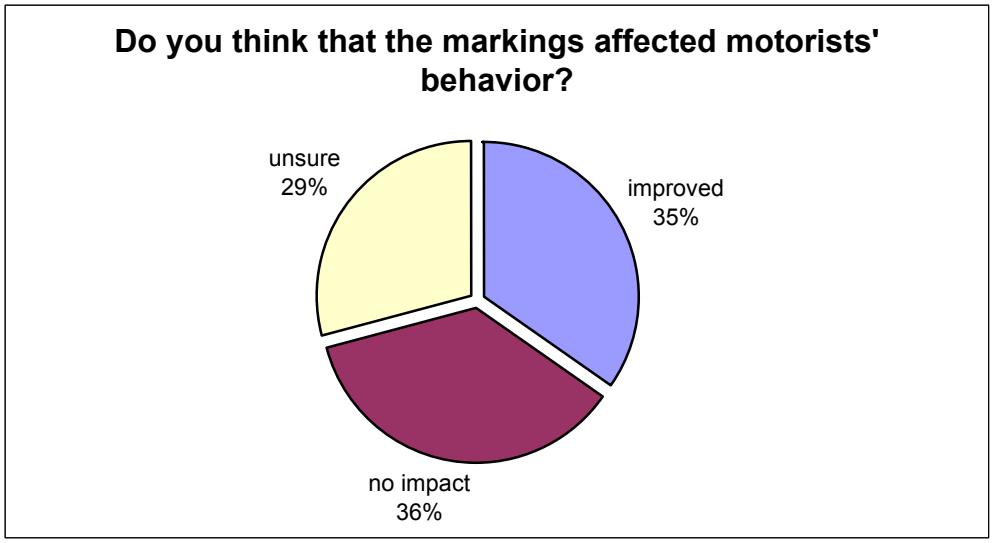


Figure 10. Cyclists' Responses to Survey - Motorists' Behavior

Visibility

- Of the 105 surveyed cyclists, 76 (72%) noticed the markings. About the same percentage of cyclists noticed each of the markings. When prompted, cyclists preferred the bike-and-chevron marking over the bike-in-house marking by a two to one ratio.
- Many cyclists also commented that the large, white markings are more visible and preferable to the green bike-in-house markings painted on San Francisco streets in the past.
- Of the 23 motorists that were surveyed on Polk Street, only seven (30%) noticed the markings. None of the respondents mentioned a preference for either marking. It should be noted that from the perspective of the driver, the chevrons appear "flat." Several cyclists made this comment as well. Many of the motorists felt that there was not enough room for cyclists on Polk Street.

Conclusion

This research has proven that shared lane pavement markings in San Francisco have a positive impact on motorist and cyclist behavior, positions, and safety. These results are complementary to a 1999 Florida study (Florida Department of Transportation, *Evaluation of the Shared-Use Arrow*). While both studies found that such markings significantly reduce wrong-way and sidewalk riding, the Florida study found a much smaller impact on cyclists' positions. In contrast to San Francisco, the Florida study measured rider positions on roadways with no on-street parking, and on streets where cyclists were less likely to "take the lane".

The bike-and-chevron marking had a stronger impact on motorist positioning and in reducing wrong-way riding and is preferred by cyclists surveyed. **Based on these findings, the project team recommends the bike-and-chevron marking be used as a standard marking for shared-use lanes on appropriate streets in San Francisco.** Based on comments received, the pitch of the chevron should be increased by approximately 6 inches (see Figure 11.) The project team also recommends that the California Traffic Control Devices Committee adopt this marking as an optional marking for Class III bikeways throughout California.

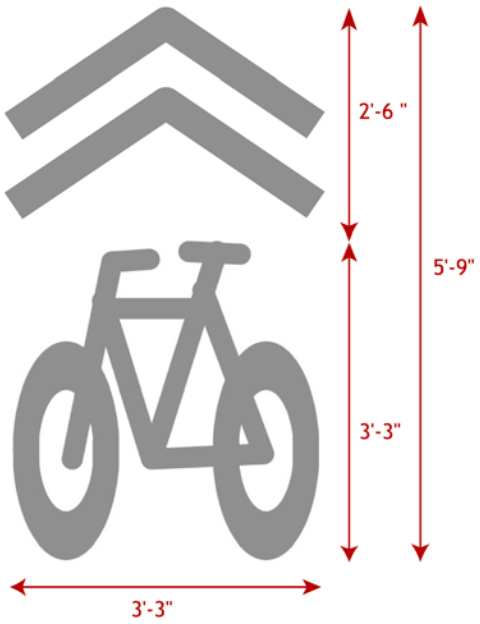


Figure 11. Recommended Modified Bike-and-Chevron

Appendix A: Pavement Markings in Other Cities

Various symbols have been tried by cities in the U.S., Europe and Australia. The symbols have been installed where bike lanes cannot be installed for various reasons including:

- Not enough cyclists;
- Too expensive;
- Requires loss of parking; and/or
- Requires road widening or other unacceptable trade-off.

To better understand these bicycle pavement symbol efforts, staff gathered information regarding (a) their use, (b) their effectiveness, (c) preferred installation locations, and (d) types of material, size, and color used. This report is a summary of the information gathered from:

- Brisbane, Australia
- Chicago, Illinois
- Oakland, California
- Denver, Colorado
- Cambridge, Massachusetts
- Paris, France
- Portland, Oregon
- Gainesville, Florida
- Warren and Waitsfield, Vermont
- Las Vegas, Nevada.

Location:	**Brisbane, Australia**
Photo:	 
Size/Shape:	The idea is derived from the 4'0" wide Denver arrow, but instead Brisbane adopted a 1200-1500 mm wide yellow bicycle symbol as shown above.
Color:	Yellow (was considered an advisory color; distinguishable from the mandatory white bike lane symbols also in use)
Material:	Paint
Source:	Michael Yeates, Convener, Cyclists Urban Speed limit Taskforce, An initiative of the Bicycle Federation of Australia Inc ph +61 7 3371 9355, michaelm@myoffice.net.au , www.yeatesit.biz/transfiles/bfaurbanspeedlimits.pdf
Other Sources:	Bicycle Federation of Australia. Associated report “Towards A Safe Urban Speed Limit: Report Of The Cyclists Urban Speed Limit Task Force”: www.bfa.asn.au/cyclist/201speed.htm City of Brisbane, Australia. "Making Space For Cyclists By Sharing The Road: Brisbane City Council's "Bicycle Friendly Zone" report: www.brisbane.qld.gov.au/getting_around/bikes/bikeways/signs.shtml www.ourbrisbane.com/brisbane/traffictrans/bicycles.htm
How Used:	A yellow bike symbol system has been under development on Brisbane streets since 1995. They are called Bicycle Friendly Zones (BFZ). On existing roads where there is not enough space to provide a bike lane, BFZs are created to alert motorists of “the likely travel corridor for bicyclists”. These zones are marked with a yellow bicycle symbol that warns other road users that cyclists commonly use the route. The intention is to clearly delineate the parking

areas so that the areas between the parked vehicles and the through traffic can be utilized by cyclists. The reduced speed (50km/h) and the bike symbols show where cyclists are expected.

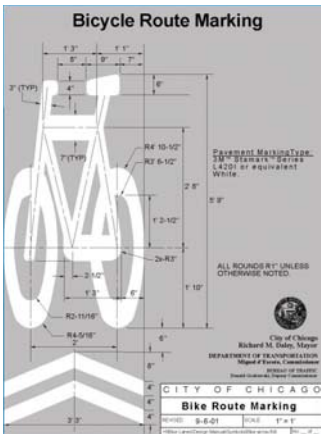
The yellow symbols are placed (using standard road-marking stencils) 1800-2000 mm from the curb where parking is allowed, and closer to the curb where there is no parking. On single lane roads where edge lines are installed, the lines are regularly broken to accommodate the yellow bike symbols (see photo). In all cases, the symbols are repeated at regular intervals on the road.

According to the Bicycle Federation of Australia, the major benefit of the BFZ is adaptability. It can be used to "make room for the cyclists" in combinations of lower speed areas in areas such as shopping strips to reduce traffic speed by integrating all relevant urban design elements. Used in various combinations, it preserves space for cyclists without "separation", an example of "sharing the road". From a technical perspective, correct placement of the BFZ allows its use on roads that, if bike lanes were used, would require widening traffic lanes that, according to traffic design theory, results in increased speed of the adjoining traffic. The development and use of the BFZ illustrates the relationship between speed limits, speeding, perceptions of safety and provision of facilities. Despite not being able to reduce the speed limit on main roads from 60 to 50km/h, reduced traffic speeds when cyclists are present have been achieved by use of the BFZ.

Effectiveness: Brisbane's use of the bike symbols has been an ongoing "trial" without any specific evaluation processes. To see if the concept worked intuitively or subjectively, no education was provided before or after the installation of the symbols. Michael Yates believes that they appear to be working intuitively and no negative effects have been identified.

Location: **Chicago, Illinois**

Photo:



Size/ Shape: 5' 9" high by 3' 3" wide bicycle above 1' 8" high by 3' 3" wide double chevron. Randy Neufeld modeled it after a design photographed in Paris a couple of years ago by a Chicagoland Bicycle Federation member. (Bike-in-House symbols previously installed in 1999 were considered too small to be understood by cyclists.)

Color: White

Material: They upgraded their symbols to an intersection grade quality material in 2002. In general, their 3M thermoplastic symbols have lasted 5 years or more, depending on wear.

Source: Nick Jackson, Director of Planning, Chicagoland Bicycle Federation
(312) 427-3325 x 27, nick@biketraffic.org

How Used: The symbol has been used by the Chicago DOT Bike Program in two places for shared lanes, both short connections between bike lanes. It is also planned for use in conjunction with directional signage to lead cyclists across large intersections to a facility in an area where many cyclists ride on the sidewalk.

Effectiveness: unknown at this time

Location: **Oakland, California**

Photo: Not available

Size/ Shape: Not available

Color:	White
Material:	Paint
Source:	Kathryn Hughes, City of Oakland Public Works Agency, Transportation Services Division ph 510-238-6493, khughes@oaklandnet.com
How Used:	White bike stencils were placed on a shared-use connecting link between two bike lanes on Grand Avenue in Oakland. The project is called the Grand Avenue Commuter Bikeway. The bike lanes extend from El Embarcadero to Webster, then the stencils/shared lane from Webster to Broadway, and bike lanes from Broadway to Market. SG 45 signs were also installed on the entire route and Share the Road signs on the stenciled portion.
Effectiveness:	unknown at this time

Location:	**Denver, Colorado**

Photo:

Size/ Shape:	Bike-in-a-house design (the original, designed by James Mackay), 4’ 3” long x 4’ 0” wide, with a left-bound cyclist
Color:	White
Material:	One of the reasons for the "Bike in the House" symbol was to reinforce the correct direction of travel. Additionally, there was a desire to reduce the typical pavement marking costs of bike lanes. The original symbols were painted, but since the paint abraded away quickly from winter sanding operations, they have been replaced with thermoplastic solid outlined symbols as shown above (cost is $50 each).
Source:	James Mackay, P.E., Denver Bicycle Planner, 201 West Colfax Avenue, Department 509, Denver, CO 80202, ph 720-865-3171, fax 720-865-2676, James.Mackay@ci.denver.co.us http://www.denvergov.org/Bicycle_Program/59810116template3jump.asp
How Used:	As part of Denver’s 1993 Bicycle Master Plan development, a “Shared Use Lane Pavement Marking Arrow”, commonly called the “Bike in the House”, was designed. The symbols are used in shared use lane conditions where bike lanes are not provided, but where it is desired to define the likely travel corridor for bicyclists. Symbols are placed approximately every 180 feet on-center along roads, often with “Share the Road” signs. They are placed so the center of the arrow is 9’ 6” off the curb line with an adjoining 7 foot parking stall.
Effectiveness:	Not available

Location:	**Cambridge, Massachusetts**

Photo:

Size/ Shape:	Bicycle stencil placed in a break of a continuous white line
Color:	White

Material:	Paint
Source:	Cara Seiderman, cseiderman@Spike.CI.Cambridge.MA.US Wayne Amaral, Cambridge Traffic Department, (617) 349-4723 Bryce Nesbitt, Bicycle Committee member, bryce2@obviously.com
How Used:	Pavement markings have been installed on Mt. Auburn Street in Cambridge. The travel lane is 11 feet and the guideline is 10' out from the curb.
Effectiveness:	No formal study completed yet, but these comments were passed on: "I find this lane treatment highly appropriate for intermediate width streets (too narrow for a full bike lane, too wide for cyclists to take the entire lane). In particular I find: "1. It seems to keep cyclists out of the door zone. Cyclists ride within inches of the line. "2. Motorists don't seem to get mad when a cyclist deviates from the line. With conventional double-stripe bike lanes, motorists often seem to insist that bikes stay within the bike lane. This does not happen on Mt. Auburn."
Location:	**Paris, France**
Photo:	
Size/ Shape:	Similar to the Chicago, IL symbol (5' 9" high by 3' 3" wide bicycle above 1' 8" high by 3' 3" wide double chevron)
Color:	White
Material:	Thermoplastic
Source:	Marc Jolicoeur, Research Coordinator, Velo Quebec tel.: (514) 521-8356 #394, fax: (514) 521-5711, marc_jolicoeur@velo.qc.ca
How Used:	The city of Paris is using arrows and bike symbols repeated along the line of travel of cyclists in intersections, about the same way colored lanes have been used in Portland and Montreal.
Effectiveness:	unknown at this time
Location:	**Portland, Oregon**
Photo:	 
Size/ Shape:	Standard markings for inside bike lane
Color:	White
Material:	Thermoplastic
Source:	Mia Birk, Principal, Alta Planning + Design, 144 NE 28th Avenue, Portland OR 97232 ph (503) 230-9862, fax (503) 230-9864, cell (503) 238-4745, miabirk@altaplanning.com
How Used:	Portland used the bike lane marking without the bike lane line in one case in February 1998. This case involves a street with bike lanes that lead up to a 26' wide bridge, on which there is not adequate room for bike lanes. The city retained the marking on the outer 3' of each of the

	13' lanes to encourage motorists to travel toward the left of the lane.
Effectiveness:	No specific study. Anecdotal evidence suggests that motorists are indeed giving cyclists room: the markings are still there after almost five years of application and show little signs of motorists' driving on them.
Location:	**Gainesville, Florida**
Photo:	 
Size/ Shape:	bike-in-a-house, 4' 0" wide x 6' 0" long
Color:	White
Material:	Paint
Source:	Dennis Scott, Florida Pedestrian and Bicycle Coordinator ph (850) 410-4927, dennis.scott@dot.state.fl.us
How Used:	Their shared-use arrow was intended to address deficiencies in wide outside curb lane bike facilities. The wide curb lanes are frequently not recognized as a facility by bicyclists. The shared-use arrow informs the cyclists about where to ride and in which direction. The symbols were put down as part of a November 1999 usage evaluation, performed by the University of North Carolina Highway Safety Research Center (HSRC), to compare the riding positions of bicyclists and the position of motorists on sections marked with the shared-use arrow to unmarked sections. The arrow was placed by Gainesville Public Works at 3.5 feet from the curb face at four locations along 13th Street (US 441). In this study area, 13th Street has 4 lanes, a 30 mph speed limit, and carries approximately 35,000 vehicles per day. The four locations were examined using videotaping equipment to record bicycles and motor vehicles.
Effectiveness:	For this evaluation, the measures of effectiveness pertained to before and after measurements of bicycles and motor vehicles from the curb and from each other. Bicycle to Curb was the only measurement that showed a statistically significant difference between the BEFORE and AFTER conditions. Although the difference between the BEFORE mean measurement of 1.58 feet and the AFTER of 1.83 feet was statistically significant, this .25 feet (1.83 - 1.58), or 3 inches, is not practically significant. This does not represent enough of a meaningful shift in distance for real world application. Furthermore, this amount may fall within the measurement error of the software/data reducer, especially considering that BEFORE measurements were made with the bicyclist farther from the camera. More trials in other locations are recommended and should result in more conclusive findings.
Location:	**Warren and Waitsfield, Vermont**
Photo:	Not available
Size/ Shape:	Bike-in-a-house design (4' x 4' approximately – some maybe smaller due to narrow shoulders of 3' or less)
Color:	White
Material:	Paint
Source:	Amy Bell, Vermont Bicycle and Pedestrian Coordinator, ph (802) 828-5799
How Used:	Symbols were placed experimentally along the shoulders of a scenic tourist 4.5 mile stretch of US Route 100. Share the Road signs were installed with the pavement symbols. The symbols have not been replaced since their first application, and many are worn away, covered over or scraped off from winter equipment. The signs are still in place.
Effectiveness:	No specific study. Casual verbal survey of approximately 200 local citizens and 50 bicyclists led to conclusion that bicyclists felt the symbols were too small to be effective and local drivers rarely noticed them. The Vermont DOT decided to not encourage their use, to not replace them, and to not include them in future plans
Location:	**Las Vegas, Nevada**
Photo:	Not available

Size/ Shape:	MUTCD standard bicyclist and arrow symbol
Color:	White
Material:	Retroreflective film with glass beads
Source:	Mike Colety, P.E., Kimley-Horn and Associates ph (702) 862-3609, fax (702) 735-4949, mike.colety@kimley-horn.com
How Used:	Pavement stencil markings are only used with bicycle lanes (not shared lanes
Effectiveness:	Not available

Location:	**Sacramento, California**
Photo:	Not available
Size/ Shape:	Not available
Color:	White
Material:	Paint
Source:	Ed Cox, Alternative Modes Coordinator, City of Sacramento, ph (916) 264-8434, fax (916) 264-8357, ecox@cityofsacramento.org
How Used:	For several years Sacramento has been using a painted arrow and legend that says “Bike Route”. It is almost identical to markings used for bike lanes (Highway Design Manual figure 1004.3) that says “Bike Lane”. Sacramento’s symbols are used for streets that are on their Bikeway Master Plan, primarily on Class 3 routes where they are combined with the Green and White Bike Route signs (California State Department of Transportation, Caltrans, G93). They have also put them on streets where it was not possible to install Class 2 bike lanes.
Effectiveness:	No study. They do provide route guidance to bicyclists.

Other Locations

Freiburg, Germany

San Anselmo, California