Critique of

"Evaluation of On-Street Bicycle Facilities Added to Existing Roadways"

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Bicycling Matters

August 2008

Introduction

Evaluation of On-Street Bicycle Facilities Added to Existing Roadways is a monograph by the Center for Transportation Research at The University of Texas at Austin. It can be found at: http://www.utexas.edu/research/ctr/pdf_reports/0_5157_1.pdf The document reports on research entitled *Operational and Safety Impacts When Retrofitting Bicycle Lanes*. That project was performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.

The results of the research, found in part 4 of the report, and that of another bicycle facility evaluation tool, the *Bicycle Compatibility Index* developed by the Highway Safety Research Center at the University of North Carolina at Chapel Hill, were used to create the *Texas Guide for Retrofit and Planned Bicycle Facilities,* part 7 of the report.

Critique

1) *Evaluation of On-Street Bicycle Facilities Added to Existing Roadways* relies on previous reports that have been shown to be fatally flawed.

In section **2.4 Bicycle Facilities** on page 6, the investigators briefly review just three publications. The shallowness and bias of this literature review of bicycle facilities sets the tone of their report.

• Hunter et al. (1999) has been critiqued as flawed at:
http://bicyclingmatters.wordpress.com/critiques/critique-of-bike-lanes-vs-wide-curb-lanes-report
or
http://www.humantransport.org/bicycledriving/library/critique_blvswcl.pdf

• Harkey et al. (1997), is critiqued as flawed at:
http://bicyclingmatters.wordpress.com/critiques/critique-of-the-shared-use-report/
or
http://www.humantransport.org/bicycledriving/library/SharedUse_critique.pdf

• Harkey et al. (1998), The *Bicycle Compatibility Index,* has been criticized as methodologically fatally flawed at:
http://bicyclingmatters.wordpress.com/critiques/critique-of-the-bicycle-compatibility-index/
or
http://humantransport.org/bicycledriving/library/critique_BCI.pdf

2) The investigators performed faulty measurement of bike lane width, leading to flawed lateral position data and spurious conclusions.

The 1999 AASHTO *Guide for the Development of Bicycle Facilities* states that, "The width of the gutter pan should not be included in the measurement of the ridable (sic) or usable surface, with the possible exception of those communities that use an extra wide, smoothly paved gutter pan that is 1.2 m (4 feet) wide as a bike lane."

However, the investigators did consider the gutter pan usable bicycling space, saying on page 66, "If the seam between the gutter pan and the road is smooth, the entire width can be counted as pavement width to ride as long as a minimum of 3 feet of this width is provided by the road."

The investigators wrongly included gutter pan width into bike lane width. Figure 7.4 from the report shows that the wide outside lane width is continuous asphalt only, while in Figure 7.7 the investigators include a roughly 2 foot wide gutter pan as usable width for the bike lane.

One can see that the bicyclist in each Figure is approximately the same distance from the edge of the black asphalt, the *actual* usable surface. But the investigators measure the bicyclist in the bike lane as further from the face of the curb, then claim that it demonstrates increased bicyclist comfort in a bike lane.

Figure 7.4. The LBP (lateral position of the bicyclist) is about 2 feet.

Figure 7.7. The real LBP is about 2 feet, but the investigators wrongly consider it about 4 feet. The real width of the bike lane is about 3 feet asphalt, but the investigators also include the gutter pan width.

In Appendix A: Test Site Characteristics, the authors fail to indicate which sites had gutter pans, and which gutter pans were considered usable or unusable, crucial site features. However, the evidence indicates it is highly likely that far more bike lane roads than wide lanes had gutter pans considered usable space.

Figure 7.22 shows a wide lane with no gutter pan.

Only 5 wide lanes were examined in this study, while 28 bike lanes were evaluated. Figures 7.4 (Page 2 above) and 7.22 (right) from the report show wide lanes with no gutter pan, meaning that at most 3 of the 5 (60%) wide lanes could have had a gutter pan that may or may not have been considered usable width. In contrast, 5 of 7 (71%) photos of different bike lanes did have a gutter pan (Figures 7.6, 7.7, 7.8, 7.12, 7.14 in the report).

Further, the average width of the bike lanes listed in Appendix A is a generous 4.9 feet. Given this substantial reported width, it is likely that most of the bike lane measurements included a gutter pan that the investigators considered part of bike lane width. This would have also distorted the Lateral Position of Bicyclist (LPB) and Lateral Position of Motorist (LPM) measurements.

Two of the investigators proudly outline a bike lane that appears to be no more than 3 feet wide. Was gutter pan width included in this bike lane’s reported width?

Thus, the wide lanes and bike lanes were measured differently, making bicyclist and motorist lateral position measurements flawed. This is a fatal flaw of the research, and renders it invalid. It is likely that the presence of a gutter pan and its erroneous inclusion in bicyclist lateral position (LPB) is largely or wholly responsible for the *supposed* increased distance that bicyclists operated from the edge of road in bike lanes, and not their alleged higher comfort level in bike lanes as the investigators assert.

3) Exactly what the investigators found is unclear; their text contradicts their data.

The investigators imply in text that bicyclists rode *further* from the curb face in a bike lane, though don't explicitly say so. Above, I explain how faulty measurements would have produced this result. In contrast, their data show that bicyclists rode *closer* to the curb face in a bike lane.

The Lateral Position of Bicyclist (LPB) variable was defined as "the distance in feet along the surface of the pavement between the cyclists (sic) front wheel and the face of curb during a passing event." The Lateral Position of Motorist (LPM) was defined as "...the distance along the surface of the pavement between the face of curb and the motorist's front wheel on the passenger side. The distance, in feet, was measured for one of two distinct moments: during a passing event at the same time the LPB was measured or during a non-passing event."

Tables 4.2 and 4.3 from the report reproduced below show the variables that had a statistically reliable effect on bicyclist and motorist lateral positions respectively.

Table 4.2. Multivariate regression results for LPB

Variable	**Coefficient Estimate (ft)**	***p*-value**
Intercept	1.7	<0.01
Residential Development	0.5	<0.01
Casual Recreationalists	-0.3	<0.01
Presence of Bike Lane	-0.8	0.01
Bike Lane Width (if present)	0.3	<0.01

Table 4.3. Multivariate regression results for LPM

	Non-Passing Events		**Passing Events**	
Variable	**Coefficient Estimate (ft)**	**p-value**	**Coefficient Estimate (ft)**	**p-value**
Intercept	-5.7	<0.01	1.7	0.14
LPB	N/A	N/A	0.5	<0.01
Residential Dvlpment	0.5	0.19	0.9	<0.01
Presence of Bike Lane	-0.9	0.33	-2.6	<0.01
Bike Lane Width	0.3	0.11	0.4	<0.01
Total Lane Width	0.8	<0.01	0.4	<0.01
Adjacent Space Is Lane with Opposing Traffic	-1.0	<0.01	-0.4	0.07
Percentage of Trucks	0.02	0.10	0.03	<0.01

Table 4.2 shows that the LPB was 1.7 feet (Intercept value) from the curb face. The variable Presence of Bike Lane resulted in operating *closer* to the curb face since the Coefficient Estimate is a negative number; -0.8.

Following Table 4.2, the investigators wrote, “The bike lane widths examined in this study ranged from 3.8 to 5.9 feet, yielding a change in LPB between 0.3 to 1.0 feet (a synthesis of the estimates in the last two rows of Table 4.2).” It is unclear how the investigators are able to make this claim that the LPB changed 0.3 to 1.0 feet *farther* from the curb face. Also, in discussing Table 4.2 the investigators decry that bicyclists rode only 1.7 feet from curb face on a non-bike lane road, implying that they rode further from the curb face when a bike lane is present. This is opposite of what their data show.

In Table 4.3, Presence of Bike Lane was -0.9 during a Non-Passing Event and -2.6 during a Passing Event. It is unclear how a bike lane makes motorists operate closer to the curb face. The 2.6 foot shift closer to curb face is greater than the Intercept figure of 1.7 feet for Passing Events. How is that possible?

Table 4.3 also shows the LPM during a Passing Event was the same 1.7 feet from curb face as the LPB Intercept. How is that possible? This indicates motorists striking bicyclists. Further, Table 4.3 shows motorists have an Intercept lateral position of -5.7 feet during a Non-Passing Event. How is a negative position possible?

The investigators make the outlandish underlined statement, “For example, adding a 4-foot-wide bike lane to a 25-foot-wide curb lane without any additional width added to the road will decrease CLP by 1.3 feet. This decrease in CLP coincides with a decline of nearly 20 percent in the probability of encroachment in the same scenario.”

Thus, according to the investigators’ model, reconfiguring a 25 foot lane into a 4 foot bike lane and a 21 foot lane decreases the change in lateral position (CLP) of the motorist by 1.3 feet and reduces the likelihood of encroachment. It’s obvious that the CLP of 1.3 feet is irrelevant, and that the likelihood of a motorist encroaching when in a 21 foot wide lane is vanishingly small. So the investigators’ assertion is irrelevant at best, but fanciful at worst. Do 25 foot wide lanes even exist?

The data seem inexplicable. Repeated attempts to get clarification from the investigators were ignored.

4) The investigators do not recognize and report the implications of some of their own findings.

Pages 5 and 6
Section 2.3 of the report cites literature that wide lanes generally result in faster speeds than narrow lanes, though it acknowledges the results are inconclusive. However, Appendix A shows that in this study the average speed on the bike lane roads with their comparatively narrow motor vehicle lanes was 37.0 mph, which was slightly *faster* than the 36.2 average of the wide lane roads. In fact, the widest lanes at 19.5 and 18.2 feet had speeds substantially less than average; 33 and 31 mph respectively. The investigators do not discuss the implications of these findings.

See:
http://bicyclingmatters.wordpress.com/infrastructure/do-bike-lane-stripes-calm-motor-traffic/

Page 22
The investigators wrote, "The observations (encroachments) excluded motorists who moved to an inside lane on four-lane roads to pass the cyclist, which was a regular occurrence."

Criticism: It is likely that more motorists fully changed lanes when passing at the two four-lane wide lane sites than at the four-lane bike lane sites since there is little need or incentive for motorists to change trajectory or speed when a bike lane exists. It is also likely that the investigators did not include full lane changes in passing distance calculations. Thus, the passing distance of motorists was likely underestimated in wide lanes.

The investigators also did not report the "encroachments" with respect to lane width (so-called "encroachments" are more aptly termed "straddle passes"). The reported increased "encroachments" in wide lanes likely occurred in the substandard 13.7 and 13.8 foot "wide" lanes (these are not technically wide lanes by AASHTO standards, but the investigators erroneously considered them as such) and likely not in the 15.0, 18.2, and 19.5 foot lanes.

Page 25.
"Cyclist position on the roadway is most influenced by the presence or absence of a designated bike lane, the width of the bike lane if present, and the **experience level** of the cyclist."

Criticism: The investigators recognize that bicyclist experience plays a role in positioning, but do not examine the implications of this. They do not describe how their paid bicyclists' experience level differed, only that "casual recreationists" were defined by "at least 70 percent of cycling trips made for recreation and exercise."

Hunter and Feaganes (2004) measured (but did not recognize and report their finding) that more experienced, club bicyclists operated further left in a 14 foot wide lane than did inexperienced bicyclists when this space was partitioned into an 11 foot lane and a 3 foot "undesignated lane."
http://bicyclingmatters.wordpress.com/critiques/critique-of-conversions-report/

http://www.cyclistview.com/overtaking/index.htm has videos showing the importance of bicyclist lateral position.

Figure 7.22 on page 65 of the report (Page 3 above) demonstrates a very poor riding position by a bicyclist ignorant of proper lateral positioning. He is riding within pedal strike distance from the curb face, and in debris. Yet the caption on the photo states, "Typical cyclist and motorist lateral position on a wide outside lane (14 ft wide outside lane)." The investigators marginalize all bicycle users by claiming that such poor positioning is typical. Note too that the lane cannot be 14 feet wide since lanes of 13.7, 13.8, 15.0, 18.2, and 19.5 feet were examined.

Page 48
"Since cyclists generally try to avoid passing cars by moving towards the face of curb, increases in lateral distance between the cyclist and the curb face are interpreted as an increase in comfort for the cyclist along the given roadway segment."

Criticism: A more accurate statement would be "Since *unknowledgeable* cyclists generally try to avoid passing cars by moving towards the face of curb...." Knowledgeable cyclists operate further left laterally because they recognize the benefits (better sightlines, improved conspicuity, induced caution in passing motorists) of such positioning. Teaching the advantages of an assertive leftward lateral position is a cornerstone of bicycling education.

Again though, the data in Table 4.2 of the report shows bicyclists operated *closer* to the curb face in bike lanes than in wide lanes.

Page 66
The investigators wrote, "TxDOT requires a minimum width of 14 feet for wide outside lanes, the standard recommended by the American Association of State Highway and Transportation Officials (AASHTO). For roadways where cyclists need more room for maneuvering, 15 feet of width is preferred; such roadways can include those with steep uphill grades, roadside objects such as drainage grates, and on-street parking (AASHTO 1999). On roadways without such problems, outside lanes with continuous stretches wider than 14 feet will often prompt sharing of the lane by two cars. For these roadways, the creation of a bike lane should receive serious consideration."

Criticism: In the present CTR study, two of the wide lanes were 13.7 and 13.8 feet wide, which is narrower than the 14-foot *minimum* specification that TxDOT and AASHTO require, which itself is too narrow. The investigators do not state the obvious methodological error of examining substandard width wide lanes, and the implications for their research.

Further, wide lanes of 19.5, 18.2, and 15.0 feet width were examined, but there is no reporting of two cars sharing the lane. The authors fail to acknowledge this, and are yet another organization that perpetuates the myth of cars lane sharing in wide lanes.

See http://bicyclingmatters.wordpress.com/infrastructure/how-wide-should-a-wide-lane-be/ which dismisses the figment of motorists doubling up in lanes of 15 or 16 feet and discusses appropriate wide lane width.

http://www.humantransport.org/bicycledriving/library/passing/index.htm also examines suitable wide lane width.

5) The investigators make fabrications in a biased endorsement of bike lanes.

Page 10
"Rural areas are known to have high cyclist fatality percentages because of the higher motor vehicle speeds and the lack of bicycle facilities."

Criticism: This is unfounded conjecture. There is no evidence that the lack of bicycle facilities in rural areas results in high bicyclist fatality percentages.

Page 16
"• Bike lane crashes tended to produce fewer than their share of fatal/incapacitating accidents."

Criticism: Hunter et al. (1996), the cited reference for this statement, make no mention of injury severity in bike lanes.

Page 17
"The results from Hunter et al. (1990) (sic) and DPS/H-GAC suggest that roadway design and motor vehicle traffic factors have an influence on bicycle safety. The most notable factors appear to be presence/absence of a median, presence/absence of a bicycle lane, traffic volume, and density of intersections and access points."

Criticism: Hunter et al. (1996) [Note: the authors mis-attribute as Hunter et al. 1990] do not suggest bike lanes have an influence on bicycle safety. They merely reported statistics. The statistics are not adjusted for exposure. The DPS/H-GAC as reported in section 3.2 of the report makes no mention at all of bike lanes!

6) *Evaluation of On-Street Bicycle Facilities Added to Existing Roadways* has data reporting and editorial errors.

Page 6
Hunter et al. (1999) and Harkey et al. (1997) are cited in Section 2.4 and their findings noted, but they are not listed in the References.

Pages 10-17
Numerous times in Sections 3.2 to 3.4 the investigators cite Hunter et al. (1990) when the correct citation is Hunter et al. (1996).

Page 19
"For this reason, the 24 sites selected for this study were from three of the largest cities in Texas: Austin (9 sites), Houston (9 sites), and San Antonio (6 sites)."

Only 8 sites are shown for Austin in Appendix A, making the total 23 sites.

Page 20
Table 4.1 shows bike lane widths of 3.7 - 5.9 feet, on page 24 a range of 3.8-5.9 feet is stated, Appendix A shows a range of 3.8 - 6.3 feet, while in Table 7.2 a PEM Range of 3.8 - 6.0 feet is given.

What exactly is the range? The investigators don't seem to know for sure. And, which bike lanes had gutter pans erroneously considered as part of their width?

Page 47
Table 7.2 reproduced below.

Table 7.2. Range in inputs for which the predictions from each model are statistically valid

Valid Range of Inputs		
Variable	**BCI Range**	**PEM Range**
Curb Lane Width (no wide outside lanes)	10.0–18.5 ft	9.5–18.0 ft
Wide Outside Lane Width	unknown	13.75–18 ft
Bicycle Lane / Paved Shoulder Width	3.0–8.0 ft	3.8–6.0 ft
Curb Lane Volume	90–900 vehicles/hour	60–700 vehicles/hour
Percentage of Trucks	0.0–10.0%	0.0–12.0%
Speed	25–55 mph	30–60 mph

The Wide Outside Lane Width PEM range of 13.75-18 feet was developed by the investigators. However, in the field research leading to development of this range, lanes of 18.2 and 19.5 feet were used, which exceed the PEM upper limit. Further, lanes of 13.7 and 13.8 feet were also used, but these are less than the ASSHTO and TxDOT 14 foot minimum.

The lower PEM Range of 3.8 feet for a Bicycle Lane is less than the AASHTO minimum of 4.0 feet. The investigators examined 4 bike lane sites that were listed in Appendix A as less than 4.0 feet wide. Moreover, given that they erroneously included the gutter pan width in bike lane width, many other bike lanes were actually less than 4.0 feet even though they are shown as wider than 4.0 feet in Appendix A.

7) The authors of *Evaluation of On-Street Bicycle Facilities Added to Existing Roadways* come to specious conclusions.

Page 26
The investigators wrote, **"Assumption 1:** Cyclists move laterally away from objects that cause discomfort or are considered to be dangerous. In this way, lateral position can indicate the comfort level of a cyclist, which also determines the suitability, or operational level, of a shared roadway." From this assumption and their findings the investigators conclude, "1) Designated bike lanes of four feet or more are operationally superior to wide outside lanes for both cyclists and motorists."

Criticism: This declaration is based on the investigators' supposition that a bike lane results in an estimated 0.3-1.0 foot shift to the left in the Lateral Position of the Bicyclists (LBP), and their rationale that this shift means the bicyclist is more comfortable. The investigators also believe that this shift provides ample buffer from striking a roadside object, like the curb face. It is more accurate to say that the gutter pan present on bike lanes provided this buffer.

For motorists, the claimed superiority of bike lanes is because they made fewer straddle passes, and this indicates increased motorist comfort according to the investigators.

Page 26
"Assumption 2: Motorists place themselves on a roadway in a lateral position that provides the greatest comfort and operational level. Temporary deviations from this path that can be attributed to the presence of an object or situation— in this case, a cyclist— indicate a reduction in the level of comfort and operational level caused by it. The magnitude of the deviation indicates the magnitude of this reduction."

Criticism: Motorists change lateral position due to bicyclists in the roadway because they do not want to strike the bicyclist, much as they change position for any other stopped, slowed, or slow vehicle such as busses, delivery vehicles, or farm vehicles. To attribute such changes to a reduction in comfort is disingenuous, particularly since the investigators did not measure motorist comfort level. Further, to characterize a change in position as a "swerve," as is done throughout the report, is a clear attempt to aggrandize and demonize the event. Does passing another motorist always cause discomfort and swerving, or is it just bicycle users?

Page 28
"The increased swerving, or change in lateral position of the motorist, is likely not a reflection of reduced operational or comfort level, but actually the opposite, as extremely low volume levels and reduced activity in the area allow motorists to offer cyclists more room out of courtesy."

Criticism: The authors have a schizophrenic definition of "swerving" to pass a bicyclist. It can either be due to lack of comfort or to an abundance of comfort, resulting in increased courtesy.

Page 51
"Change in Lateral Position of Motorist (CLP)
Motorists who swerve around a passing (sic) cyclist do so because the proximity of the cyclist reduces their level of comfort, particularly in terms of safety."

Criticism: The word "swerve" suggests abruptness, as in "He swerved to avoid hitting the dog." Swerving to avoid a bicyclist traveling in the same direction is vanishingly rare, even on narrow roads. Almost all passing of bicyclists is a calculated, benign maneuver. Characterizing the passing of bicyclists as swerving is disingenuous and sensationalistic, and suggests an ulterior motive by the authors.

It is unclear what the authors mean by the phrase "particularly in terms of safety." The motives of the authors must be questioned.

Page 66
"Lastly, if the bike lane is not segregated from onstreet (sic) parking facilities by an outside line or parking stalls, 11 feet of width should be allotted to this combined facility in the absence of a curb face and 12 feet in the presence of one."

An 11 or 12-foot combined parking/bike lane is an exceedingly dangerous facility, placing bicycle users directly in the "door zone."
http://www.humantransport.org/bicycledriving/library/AASHTO_DZBL.pdf

Page 67
7.4 Conclusion
The investigators wrote, "The Texas Bicycle Facility Retrofit Guide represents the synthesis of much information regarding the design of bicycle facilities. Almost a dozen individuals from TxDOT and the Center for Transportation Research, several of whom commute by bike daily, met to evaluate research findings for the purpose of forming an effective final product. The field research component represented nearly 200 hours of observations and the hard work of many cyclists, both activists and casual riders. The research team exhausted literature on the topic and probed local sources of information such as crash records for all that could be gleaned from them and used in retrofit operations. The incorporation of the BCI and the help of its authors were invaluable. The addition of information regarding cyclist and motorist behavior from the PEM to the BCI greatly increased the efficacy of both. Without exaggeration, the creation of the Texas Bicycle Facility Retrofit Guide represents a bold move forward in incorporating rigorous research into the process of providing better bicycle facilities for the sake of all road users."

Criticism: Almost a dozen individuals missed a myriad of obvious mistakes in the report. The self-congratulatory hyperbole lauding this report is ironic given its failings.

The paper makes numerous specious assumptions, uses the results of flawed methodology to come to the conclusion that bike lanes are operationally superior to wide lanes. It attempts to substantiate this alleged superiority by citing an alleged very slightly further left bicyclist position (and therefore alleged reduced danger from right lateral objects), and reduced motorist straddle passing on bike lane roads. Yet, no real evidence that these minor changes actually increase safety is offered. It is merely conjectured.

More important, the faulty methodology used to measure bicyclist lateral position, in which a gutter pan on bike lanes was considered usable space, renders the results of the research invalid. Further, the data in Tables 4.2 and 4.3 are inexplicable, and inexplicably counter to statements made in text.

The research team did not do an exhaustive literature review as stated, and the numerous editorial errors are testimony to sloppy work.

Evaluation of On-Street Bicycle Facilities Added to Existing Roadways is not research; it is junk science.