Evaluation of an Innovative Application of the Bike Box

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FOREWORD

The 1991 congressionally mandated National Bicycle and Walking Study set two goals: to double the percentage of trips made by bicycling and walking, and to reduce by 10 percent the number of bicyclists and pedestrians killed or injured in traffic crashes. During the past decade, the Federal Highway Administration's (FHWA) Pedestrian and Bicycle Safety Research Program has supported these goals with its activities. The FHWA's Pedestrian and Bicycle Safety Research Program has and will continue to focus on identifying problem areas for pedestrians and bicyclists, developing analysis tools for planners and engineers to target these problem areas, and evaluating countermeasures to reduce crashes involving pedestrians and bicyclists.

There is a variety of on- and off-road bicycle facilities – each with its advantages and disadvantages. A thorough evaluation of the various kinds of facilities implemented in pro-bicycling communities has been needed by the transportation engineering profession. As part of the Pedestrian and Bicycle Safety Research Program, evaluations of some innovative treatments to accommodate bicyclists were conducted. This report documents the evaluation of a unique application of the "bike box." The bike box, known in Europe as the advanced stop bar, has been shown to be beneficial to bicyclists by making bicyclists more visible to motorists and by eliminating conflicts.

The information contained in this document should be of interest to State and local bicycle and pedestrian coordinators and to transportation professionals involved in safety and risk management. Other interested parties include those in enforcement and public health.

Michael F. Trentacoste
Director, Office of Safety Research & Development

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16. Abstract

This paper is an evaluation of an innovative bike box (a right angle extension to a bike lane at the head of the intersection) with accompanying traffic signs, but no extra traffic signals, installed at a busy downtown intersection featuring two one-way streets in Eugene, OR in the summer of 1998. The box allows bicyclists traveling to the intersection on a left-side bike lane to get to the head of the traffic queue on a red traffic signal indication and then proceed ahead of motor vehicle traffic toward a right-side bike lane when the traffic signal changes to green. Cyclists traveling through the intersection were videotaped before and after placement of the box. The videotapes were coded to evaluate operational behaviors and conflicts with motorists, other bicyclists, and pedestrians. Twenty-two percent of the bicyclists who approached in the left side bike lane and then crossed to the bike lane on the right side of the street (the bicyclists for whom the box was most intended) used the box. Many more bicyclists in this target group could have used the box (i.e., they had a red signal indication and enough time to move into the box). A problem with motor vehicle encroachments into the box likely diminished the amount of use. The rate of conflicts between bicycles and motor vehicles changed little in the before and after periods. No conflicts took place while using the bike box as intended. The bike box needs to be evaluated in other kinds of intersection settings and traffic conditions.

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Introduction

In the last few years, a variety of innovative on-street bicycle treatments have been implemented. These include bike boxes; raised bicycle lanes; bicycle boulevards; use of paint to delineate paths through intersections, define bicycle-motor vehicle weaving areas, and highlight paved shoulders; and others. This report focuses on bike boxes – a special pavement-marking scheme that was pilot-tested in Eugene, OR.

Background

Bike box is a term that has gained popularity in the United States for a European treatment usually known as the advanced stop bar (figure 1). The box is a right-angle extension to a bike lane at the head of the intersection. The box allows bicyclists to get to the head of the traffic queue on a red traffic signal indication and then proceed first when the traffic signal changes to green. Such movement is beneficial to bicyclists and eliminates conflicts when, for example, there are many right-turning motor vehicles next to a right-side bike lane. Being in the box, and thus at the front of the traffic queue, also tends to make bicyclists more visible to motorists.

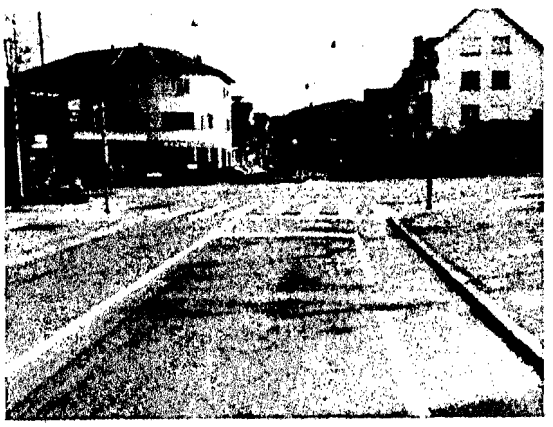

Figure 1. Example of European bike box.

In Europe, one or two traffic signals are usually part of the design. With the single-signal design, one traffic signal is placed at the box. With a two-signal design (used in the United Kingdom), motorists are held by a red signal, while a special green signal directs bicyclists ahead to the box (U.K. Department of Transport, 1993; and Zegeer et al., 1994). Bike boxes have worked successfully on roads in the United Kingdom with up to 1,000 vehicles per hour passing through the intersection. Wheeler (1995) and Wheeler et al. (1993) monitored schemes at nine intersections. Two-thirds or more of the bicyclists used the bicycle lane and the reserved waiting area. Signal violations by bicyclists were less than 20 percent. As many as 16 percent of the motorists encroached into the bike lanes (BLs). At one intersection, more than half of all lead motorists encroached into the bicyclists' reserved waiting area. It is thought that the single-signal design is probably as effective as the two-signal design if a mandatory bicycle lane and a distinctly colored road surface in the bicyclist areas are used. In Denmark, recessed stop lines for motor vehicles are used to accomplish the same purpose (figure 2). This design has been found to significantly reduce the number of crashes between right-turning motorists and bicyclists going straight through the intersection (Herrstedt et al., 1994).

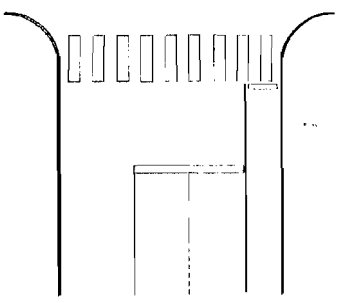

Figure 2. Recessed stop line.

Source: Safety of Cyclists in Urban Areas, 1994

Overview of Current Project

A bike box and accompanying traffic signs (with no special traffic signals to hold motorists or direct bicyclists to the box) were installed on High Street at Seventh Avenue in Eugene, OR, in the summer of 1998. The application of the bike box was innovative in the sense that the intent was to give bicyclists a safer way to change from one side of the street to the other at a busy downtown intersection featuring two one-way streets (figure 3). Prior to the box, the vast majority of bicyclists approached on High Street in the left-side bike lane adjacent to parked motor vehicles. The bike lane was on the left side to match another one-way couplet and to avoid having a right-side bike lane next to intersections with double right-turn lanes. Many of the bicyclists approaching in the left-side bike lane preferred to switch to the right-side (through) bike lane on the far side of the intersection, because, at the next block, bicyclists in the left-side bike lane must turn left. Moving from the left side to the right side after the intersection entails crossing three lanes of traffic. The average annual daily traffic on High Street is approximately 8,500 vehicles per day, and the peak-hour total is about 1,000 motor vehicles. When traffic was busy, bicyclists could have difficulty finding a gap large enough to allow an easy move from the left to the right. Some bicyclists were aggressive and used hand signals to indicate their movement from left to right (figure 4). Many, however, simply stopped in the bike lane and waited for a suitable gap. Besides the crossover from left to right after the intersection identified above (figure 5, Movement 1), there were a variety of other ways used by bicyclists to negotiate this intersection. Some would shift from the bike lane to the motor vehicle traffic lanes prior to the intersection (Movement 2). Others rode or walked their bicycle through the crosswalks on both High Street and Seventh Avenue as pedestrians would, a movement which delays right-turning motorists

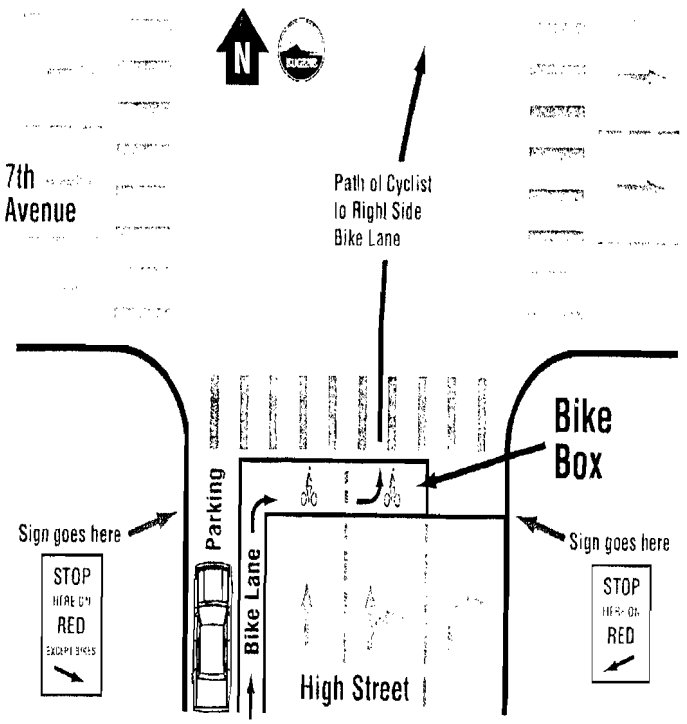

Figure 3. Bike box on High Street in Eugene, Oregon.

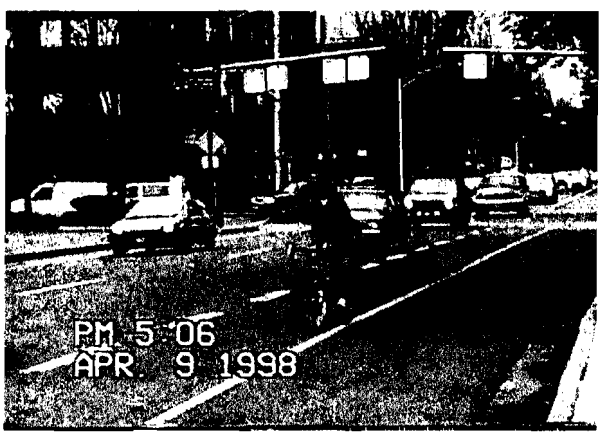

Figure 4. Bicyclist merging across traffic lanes after the intersection.

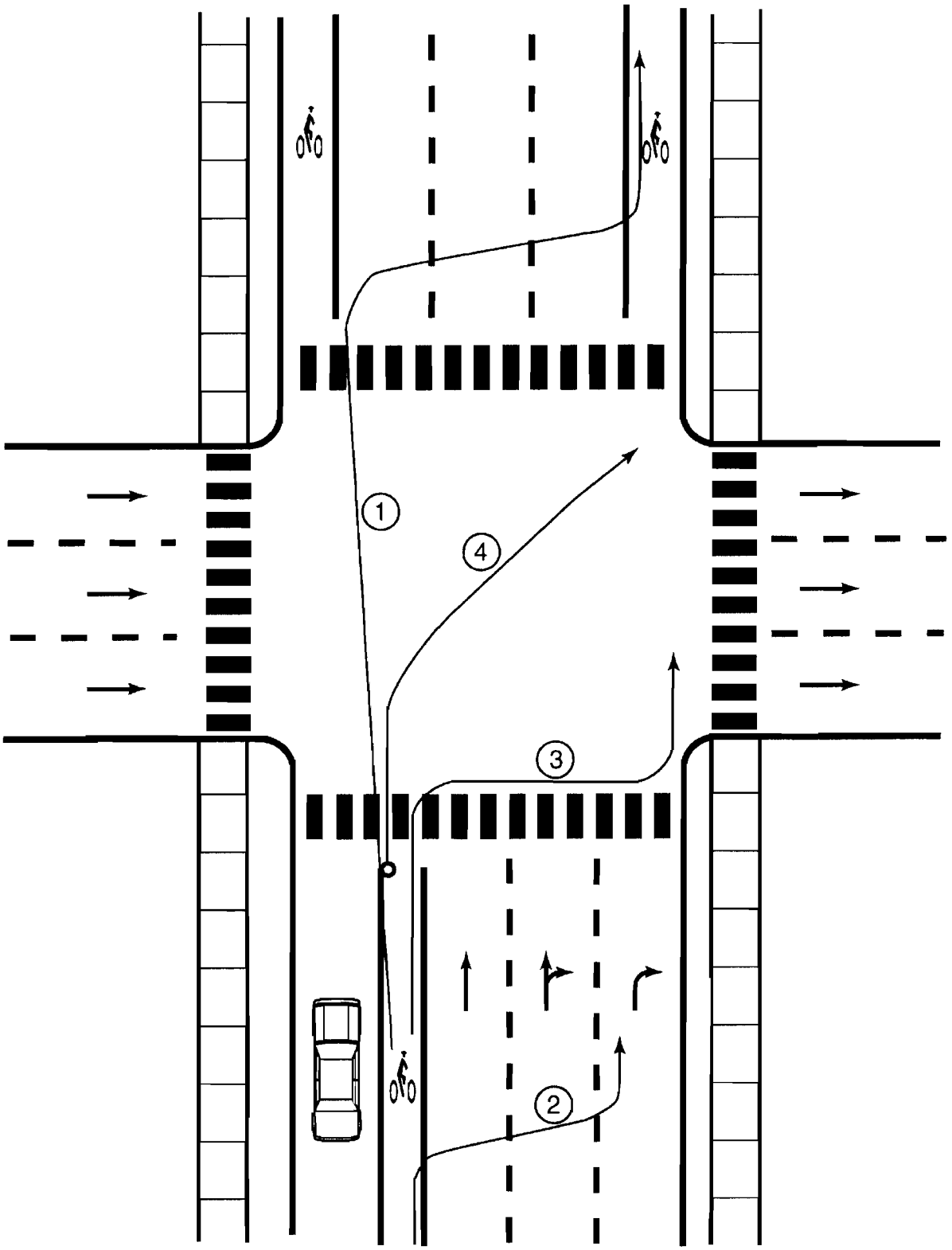

Figure 5. Typical bicyclist movements through the intersection.

(Movement 3). Some bicyclists would intentionally disobey the traffic signal at the intersection proper while motorists waited for the signal to change, move into the intersection, and then shift from left to right (Movement 4).

With the bike box in place, bicyclists desiring to change from the left to the right side of High Street can proceed to the head of the traffic queue on a red traffic signal indication and then cross over to the front of the second lane of traffic. The second lane is a combination through-/right-turn lane. The rightmost lane is right turn only. Right turn on red is not permitted; however, some motorists do not comply. The box is not meant to be used on a green traffic signal indication.

Bicyclists have the right of way when in the box. They are generally able to accelerate quickly through the intersection ahead of motor vehicles when the signal changes to green and then safely switch to the through bike lane on the right-hand side of High Street, such that motorists are not inconvenienced (figure 6).

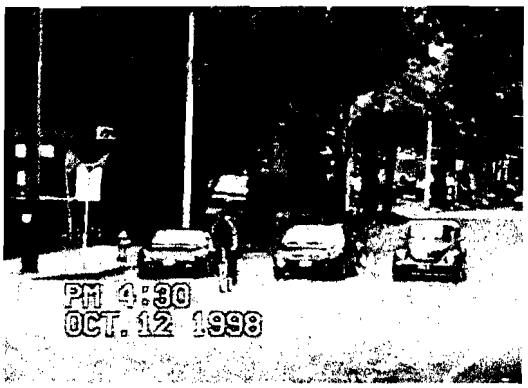

Figure 6. Bicyclist correctly using bike box.

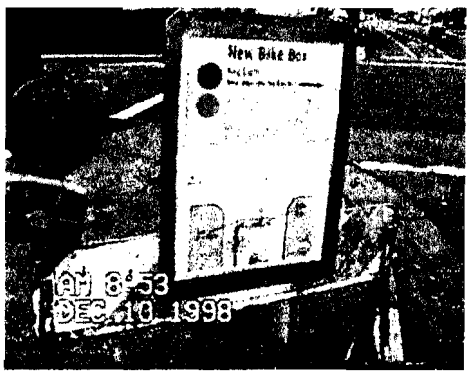

Figure 7. Educational sign near bike box.

Several other steps were taken to help bicyclists and motorists understand the use of this innovative treatment at this intersection. A press release was prepared and stories were run in the local newspaper and in the University of Oregon student newspaper. A special sign board with information about how to use the bike box was placed on a construction barricade near the intersection pedestrian crosswalk (figure 7). The barricade with an educational sign also had a flashing light attached.

Traffic signs with orange diamond attachments added for conspicuity (figure 8) were placed at the intersection to indicate that all traffic, except bikes, should stop prior to the box on a red signal indication (STOP HERE ON RED, with EXCEPT BICYCLES mounted below).

Figure 8. Sign indicating where motor vehicles should stop on red signal.

A yellow diagrammatic sign with a BICYCLES MERGING message was already in place (figure 9).

Figure 9. "BICYCLES MERGING" sign.

The original configuration of the bike box was relatively short in length, about 1.8 m. A standard bicycle logo was placed in the box in front of both the through-lane and through- and right lane (figure 10).

Figure 10. Smaller first box with lane lines removed.

It was determined through observation that the box should be lengthened to promote understanding and visibility by motorists and easier use by bicyclists. This was accomplished by removing about 1 m of the pedestrian crosswalk. The original layout by the paint crew also had lane lines within the box, rather than a large rectangular box in front of two traffic lanes. This was corrected when the box was enlarged, but the result was a box that extended across all three lanes. This was not ascertained until some time later, and the decision was made to leave this configuration in place. Thus, this evaluation pertains to a bike box that extended across all three travel lanes on the street (figure 11).

Figure 11. Enlarged bike box extending across all three lanes of traffic.

While the bike box should only have been extended in front of the combination through-/right-turn lane, and not in front of the right turn only lane, bicyclists tended to use the box correctly anyway (i.e., positioning themselves in front of the combination lane). Thus, the evaluation was not jeopardized. (Note: When the evaluation ended, the bike box was reconfigured to extend across only two traffic lanes.)

Methods

Bicyclists traveling through the intersection were videotaped before and after placement of the box. The videotapes were coded to evaluate operational behaviors and conflicts with motorists, other bicyclists, and pedestrians. Other data concerning bicyclists' characteristics and experience, as well as their opinion of how the bike box functioned, were obtained through short oral surveys. These surveys were performed on days when videotaping was not being done.

Results

Using the methods described above, this section presents results of the analysis of the data. The sections that follow are descriptive and focus on bicyclist characteristics, information about movement through the intersection and the use of the bike box, and conflicts.

Videotaped Bicyclist Characteristics

Several variables describing the videotaped bicyclists are presented in the tables or text that follow. The variables are cross-tabulated by whether the bike box was in place or not (i.e., before or after the box). Frequencies and column percentages are routinely presented. Totals differing from 747 bicyclists in the before period and 686 bicyclists in the after period are due to missing values.

Statistical testing of relationships was done using chi-square tests to determine if differences between the before and after periods were significant or due to chance alone. When the distributions were significantly different, asterisks (*) were placed beside the name of the variable, and the level of significance (p-value) was shown with the appropriate number of asterisks at the bottom of the table. For example, a p-value of <0.05 means that the differences in the distributions could be due to chance less than 5 times out of 100.

Generally, the tables show all levels of a variable to convey more information to the reader; however, categories were grouped when necessary to permit appropriate statistical testing. In the text that follows, a single triangle (▾) is used to indicate a major individual cell chi-square contribution to a significant chi-square value for the overall distribution. Chi-square testing was not performed in cases where the distributions produced zero cells due to all the effects of a variable being directly related to the before or after period (i.e., presence or absence of the bike box).

Table 1 shows that slightly more than 70 percent of the bicyclists observed on the videotapes were male. There were no differences in the distributions before and after placement of the bike box.

Table 1. Gender of bicyclists in before and after periods.

Gender	Before Bike Box	After Bike Box	Total
Male	519 (70.8)[1]	504 (74.0)	1023 (72.4)
Female	214 (29.2)	177 (26.0)	391 (27.7)
Total	733 (51.8)[2]	681 (48.2)	1414 (100.0)

[1]Column percentage
[2]Row percentage

The ages of the bicyclists were estimated from observing the videotapes and were categorized into the following groups: <16, 16-24, 25-64, and >64 years of age. Overall, 52 percent of the bicyclists were 16-24 years of age and 47 percent were 25-64 years of age (table 2), and the

Table 2. Age of bicyclists in before and after periods.

Age***	Before Bike Box	After Bike Box	Total
< 16	5 (0.7)	7 (1.1)	12 (0.9)
16-24	428 (62.1)	270 (40.9)	698 (51.7)
25-64	254 (36.9)	376 (56.9)	630 (46.7)
> 64	2 (0.3)	8 (1.2)	10 (0.7)
Total	689 (51.0)	661 (49.0)	1350 (100.0)

*** $p < .001$

before and after differences were significant. In the before period, 62 percent of the bicyclists were 16-24 years of age versus 41 percent in the after period (▾). Conversely, 37 percent of the bicyclists were 25-64 years of age in the before period versus 57 percent in the after period (▾). To some extent, this was probably a function of when the videotaping was done. The before data were obtained throughout the month of April 1998, when the University of Oregon was in session

and many students were bicycli ng on High Street. The bike box was then installed in July 1998. The after data were collected over a longer period, from August through December 1998. Students were much less prominent in the December data because the semester had ended. At this point, there were more commuter bicyclists using the intersection. In addition, the identification and placement of bicyclists into age groups younger or older than 25 years of age was quite difficult, especially as the weather turned colder and the bicyclists wore more clothing.

Observed helmet use was 46 percent and did not differ before or after the bike box. None of the riders were carrying passengers in either period.

Characteristics of Surveyed Bicyclists

In addition to the videotapes, data concerning bicyclists' characteristics were obtained through short oral surveys administered near the intersection soon after the bike box had been installed. While these surveys provided additional data about the bicyclists using the intersection, the surveys were mainly done to see how well bicyclists thought the bike box was being understood. Results from the oral survey included the following:

- 67 percent of the bicyclists were male.
- The age distribution was 1 percent <16 years of age, 43 percent 16-24 years of age, 55 percent 25-64 years of age, and 2 percent >64 years of age. This distribution was very similar to that for the bicyclists videotaped using the intersection after the bike box was installed.
- Helmet use was 38 percent.
- 56 percent considered themselves to be *experienced* bicyclists. *Experienced* was defined as the following: "I feel comfortable riding under most traffic conditions, including major streets with busy traffic and higher speeds."
- Just more than half rode more than 25 mi (40 km) per week.
- While 39 percent correctly indicated that the purpose of the bike box was to enable bicyclists to more easily get from the left to the right side of the street (and another 1 percent said the box was there to get bicycles to the front of traffic), another 59 percent were not sure of the purpose. This prompted the educational sign shown earlier.
- 31 percent said they had used the box.
- 35 percent said the box was large enough.
- About half of those using the box said they had encountered difficulties. Typical complaints were that motor vehicles were in the box, that drivers wanted bicycles out of the way so they could ignore the no-turn-on-red signs, and that it was uncomfortable going out in front of cars.
- 35 percent offered suggestions for improving the bike box. Typical comments were: delineation or signing should be more prominent so that cars would stay out of the box; the box needed to be bigger and more visible; the box should be painted; and drivers needed more education about the box.
- 23 percent had further comments, including: motor vehicles were not really aware of bikes; the intersection itself was difficult to negotiate; the project was fine and it was drivers that needed to change; and more bike boxes were needed.

Maneuvers Through the Intersection and the Use of the Bike Box

Table 3 shows bicyclist maneu vers through the intersection before and after the placement of the box. Before the box was in place, 53 percent of the bicyclists approached in the left-side bike

Table 3. Bicyclist maneuver through the intersection in before and after periods.

Maneuver	Before Bike Box	After Bike Box	Total
Left to right before the intersection†	31 (4.2)	55 (8.0)	86 (6.0)
Left to right after the intersection	392 (52.6)	238 (34.7)	630 (44.1)
Left to right in pedestrian crosswalk	34 (4.6)	30 (4.4)	64 (4.5)
Used bike box after approaching from left-side bike lane	0 (0.0)	74 (10.8)	74 (5.2)
Stayed on left side of street	197 (26.4)	192 (28.0)	389 (27.2)
Approached on right side of street in the traffic lane†	25 (3.4)	35 (5.1)	60 (4.2)
Approached on right side of street in the sidewalk†	48 (6.4)	46 (6.7)	94 (6.6)
Other	18 (2.4)	15 (2.2)	33 (2.3)
Total	745 (52.1)	685 (47.9)	1430 (100.0)

† Some bicyclists used the bike box from these non-standard approach maneuvers.

lane, went straight through the intersection, and then crossed from left to right after the intersection. This movement was reduced to 35 percent after the installation of the bike box (figure 12). Four percent went left to right prior to the intersection in the before period, compared to 8 percent in the after period. Four percent went left to right in the crosswalk both before and after. Some 26 to 28 percent of the riders stayed on the left side of the street before and after, such that the bike box was of no use to them. About 6 to 7 percent approached from the right side of the street on the sidewalk both before and after, while another 3 to 5 percent approached from the right side of the street in the traffic lanes. The vast majority of the "other" category involved bicyclists shifting from the left-side bike lane to the through-traffic lane prior to the intersection

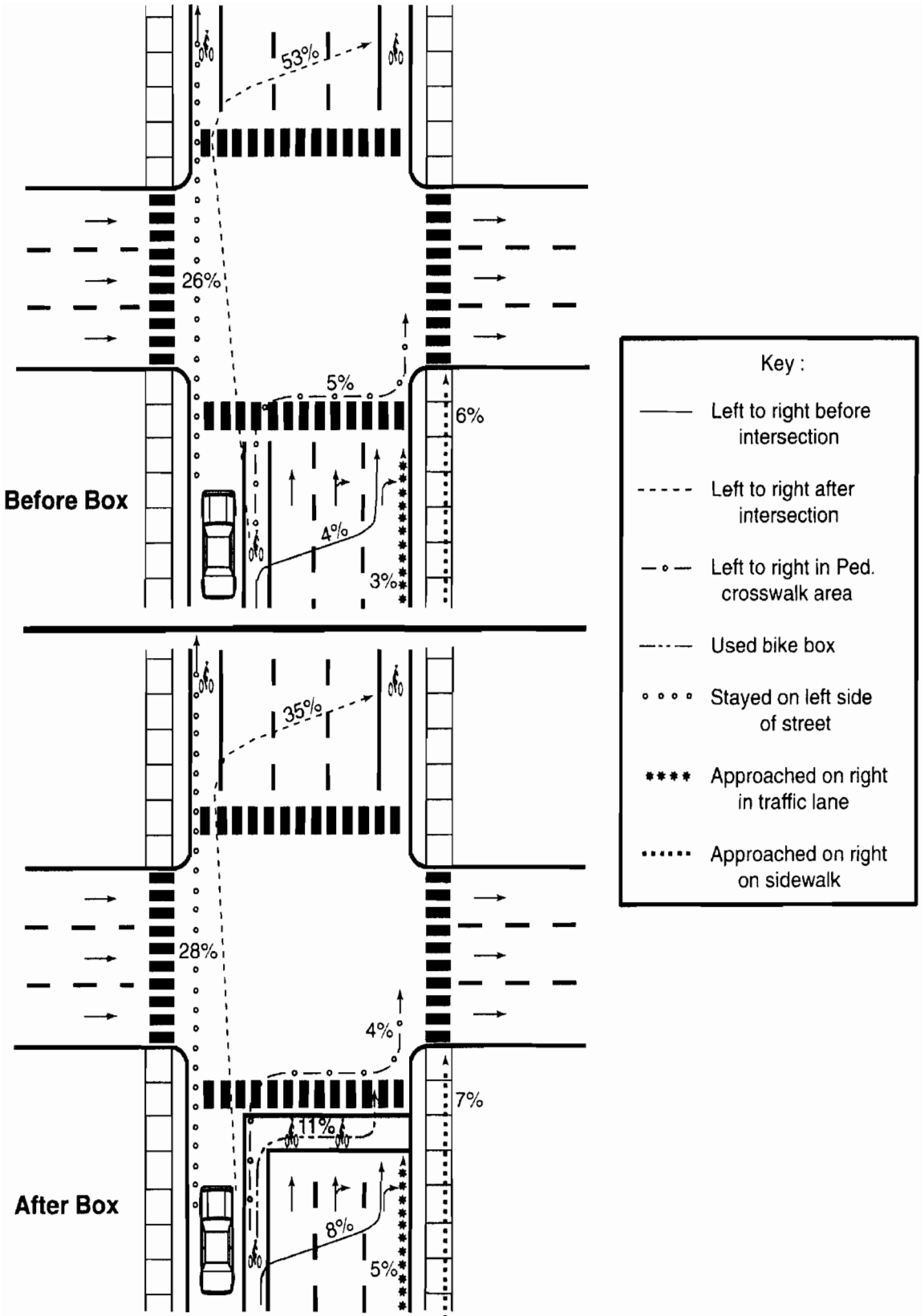

Figure 12. Bicyclist maneuvers through the intersection before and after the installation of the bike box.

and then crossing the other two traffic lanes after the intersection. Of all the bicyclists coming through the intersection in the after period, 11 percent used the bike box as intended (i.e., approaching from the left-side bike lane and then moving in front of traffic and into the box on a red traffic signal).

Bicyclists sometimes used the bike box in non-standard ways, such as: (1) moving from left to right prior to the intersection and then maneuvering into the box, (2) approaching from the right side of High Street and then moving forward into the box, or (3) approaching from the right sidewalk and then moving into the box. An additional 5 percent of the bicyclists used the box in these three non-standard ways. When these were added to the standard bike box users, 16 percent of all bicyclists coming through the intersection used the box. Eliminating the bicyclists who stayed on the left side of the street (and thus had no need for a bike box to help them cross over to the right side of the street), 29 percent of the bicyclists who went through the intersection used the bike box.

The bike box was targeted for bicyclists who approached in the left-side bike lane and then crossed to the right side of the street. Use of the box by this group in the after period amounted to 22 percent.

Another 105 bicyclists (or 15 percent of the total in the after period) who made the left to right shift could have used the box, but chose not to. Had all of these used the box, the use rate would have been 52 percent, perhaps approaching the practical upper limit for this situation. However, for 38 of these 105 bicyclists (36 percent), a motor vehicle was encroaching into the box from either the far left through-lane or middle combination lane on High Street. The extent to which this affected use of the bike box is unknown, but it is logical to assume that motor vehicle encroachment diminishes use.

Motor Vehicle Encroachment

A separate set of motor vehicle data pertaining to encroachment into the bike box on a red traffic signal were gathered on 3 days in December 1998, some 5 months after the box had been installed. Times of data collection were varied and covered mid-day, early afternoon, and late afternoon. The camera was positioned at a right angle to the side of the intersection such that motor vehicles would be unaware of videotaping. Encroachments on a red traffic signal indication (figure 13) were coded as minor (up to 1/4 of the motor vehicle in the bike box), moderate (1/4 to 1/2 of the motor vehicle in the box), and severe (>1/2 of the motor vehicle in the box). Results were the following:

Level of Encroachment	N	Percent
No encroachment	97	48.0
Minor encroachment	41	20.3
Moderate encroachment	32	15.8
Severe encroachment	32	15.8
Total	202	100.0

(202 total signal cycles)

Table 4. Traffic signal violations by bicyclists in the before and after periods.

Signal Violations	Before Bike Box	After Bike Box	Total
None	658 (88.3)	595 (87.1)	1253 (87.8)
Ran the red signal	47 (6.3)	49 (7.2)	96 (6.7)
Red signal at start-up	40 (5.4)	39 (5.7)	79 (5.5)
Total	745 (52.2)	683 (47.8)	1428 (100.0)

Conflicts

A conflict between a bicycle and a motor vehicle or another bicycle was defined as an interaction such that at least one of the parties had to make a sudden change in speed or direction to avoid the other (figure 14). Conflicts were infrequent, and there were no differences in the before and after distributions (table 5). Conflict rates were quite similar – 1.3 per 100 entering bicyclists before and 1.5 after. One of the 10 conflicts in the before period was a bike/bike conflict, while all other conflicts in both periods

Figure 14. Bicycle/motor vehicle conflict.

Table 5. Conflicts in the before and after periods.

Conflict Occurrence	Before Bike Box	After Bike Box	Total
No	737 (98.7)	676 (98.5)	1413 (98.6)
Yes	10 (1.3)	10 (1.5)	20 (1.4)
Total	747 (52.1)	686 (47.9)	1433 (100.0)

were bike/motor vehicle. In addition, 1 of the 10 before conflicts was coded as serious, while all other before and after conflicts were coded as minor.

The location of the conflict was also coded. In the before period, two conflicts occurred within the intersection proper (one while crossing from left to right in the crosswalk and one while approaching from the right in the road) and eight after the intersection. The eight conflicts after the intersection involved the bicyclist crossing from the left-side to the right-side bike lane. In the after period, two conflicts occurred prior to the box, six within the intersection proper, and two after the intersection. No conflicts occurred while using the bike box as intended (i.e., approaching from the left-side bike lane and then moving into the box). It appeared that the bicyclists were able to gauge the timing of the signal quite well. One conflict in the after period occurred when a bicyclist was crossing from left to right in the crosswalk and the signal changed from red to green. Three of the after-period conflicts resulted from bicyclists approaching from the sidewalk on the right-hand side of the street, continuing straight ahead, and then crossing in the Seventh Avenue pedestrian crosswalk. This placed the bicyclist in a position where he/she was difficult to see by motor vehicles making a right turn, particularly motor vehicles turning right from the combination through-/right lane in the middle (figure 15).

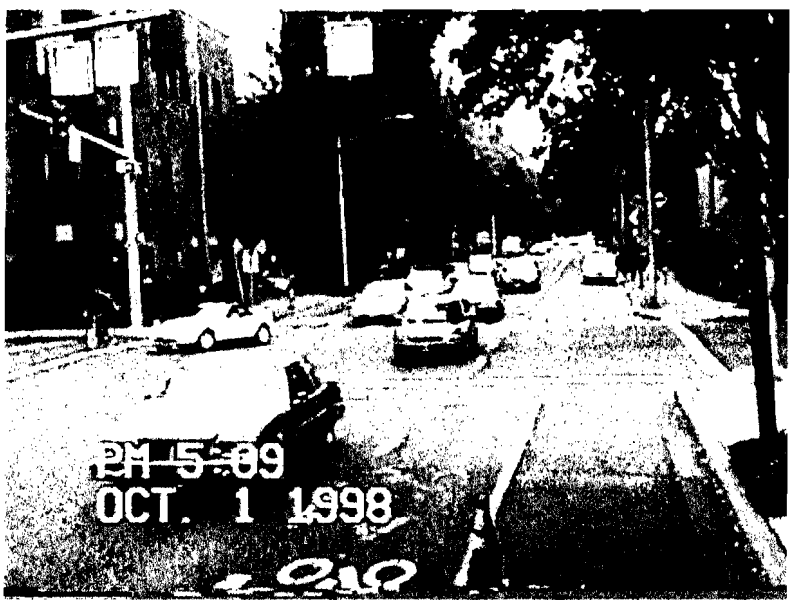

Figure 15. Conflict when bicyclist comes off right sidewalk into street.

Figure 13. Motor vehicles encroaching into bike box.

There was some variability across the three time periods. It appeared that severe encroachment was somewhat related to the amount of traffic. During heavier traffic, vehicles near the end of the signal cycle who were unable to get through the signal tended to encroach well into the box.

Totaling all three data collection periods (202 total signal cycles) shows that vehicles were encroaching into the box in slightly more than half of the signal cycles. Sixteen percent of the encroachments were severe, meaning more than half of the vehicle was in the box. These percentages are similar to those reported earlier in the United Kingdom.

Signal Violations

Bicyclist signal violations were coded in the before and after periods (table 4). Overall, no signal violations occurred 88 percent of the time a bicyclist approached the intersection. In the before period, bicyclists would occasionally run the red signal to make the move from right to left across the intersection. It was thought that having the box in place might reduce the frequency with which bicyclists either: (1) ran the red signal indication or (2) anticipated the signal change and started moving forward shortly before the red signal changed to green to get ahead of traffic and cross to the right side of the street. However, this was not the case. There were no differences in the before and after distributions.

Discussion

The use of a bike box to facilitate the movement of bicyclists from a left-side bike lane, through an intersection, and across several lanes of a one-way street to a right-side bike lane was an innovative approach. During periods of busy traffic, moving from the left to the right side of the roadway after the intersection can be difficult for bicyclists to negotiate. The use of the box is so recent in the United States that, at present, no official design standards are in place. Thus, this pilot effort was a valuable learning experience in many ways.

The data indicated that the use of the box was reasonably good. Bicyclists utilized the box several ways:

- For all bicyclists coming through this intersection, 11 percent used the box as intended (i.e., approaching from the left-side bike lane and then moving into the box on a red traffic signal indication).
- Including bicyclists who used the box through other maneuvers, such as crossing from left to right before the intersection and then moving into the box, 16 percent of all bicyclists used the box.
- Of the bicyclists who approached in the left-side bike lane and then crossed to the right side of the street (the bicyclists for whom the box was most intended), 22 percent used the box.
- Many more bicyclists in this target group could have used the box (i.e., they had a red signal indication and enough time to move into the box). Had these bicyclists done so, then some 52 percent would have used the box. This last percentage thus approximates the upper limit of bike box use for this pilot location and left-to-right maneuvering during this time period.

A problem with motor vehicle encroachments into the box probably diminished the amount of use. Overall, encroachments occurred in 52 percent of the red traffic signal indications after the box had been in place for 5 months. While this is not uncommon, even in Europe where the design has been in place for some time, it is troubling, and remedies should be sought. Bicyclists surveyed about the pilot location tended to complain frequently about the encroachment problem.

The bike box had no effect on signal violations. Some 6 to 7 percent of bicyclists violated a red signal indication both before and after placement of the box.

The rate of conflicts between bicycles and motor vehicles changed little in the before and after periods. The rate was 1.3 conflicts per 100 entering bicyclists before the bike box and 1.5 conflicts per 100 entering bicyclists after. However, the pattern of the conflicts did change. Eight of the 10 conflicts in the before period involved a bicyclist moving from left to right across the travel lanes after the intersection. Two of the 10 conflicts in the after period were of this type. Six after-period conflicts took place within the intersection proper, but three of these involved bicyclists coming off the right sidewalk and conflicting with right-turning motor vehicles. No conflicts took place while using the bike box as intended.

Conclusions and Recommendations

Use of the bike box to help bicyclists negotiate a difficult maneuver at this intersection was considered to be a rigorous test. All things considered, the innovative treatment worked reasonably well. More evaluations should be conducted in other settings and for other maneuvers to further understand how well this design works in the United States and how it might be improved. For upcoming evaluations, a number of recommendations can be made:

- **Education of both bicyclists and drivers as to the proper use of the box is important.** This can be accomplished through newspaper stories, radio and television public service announcements, brochures in bike shops, etc. The educational sign posted at the Eugene intersection came about after it was learned in the oral survey of bicyclists that the box was not well understood. One of the bicyclists participating in the oral survey suggested use of a banner across the roadway. This would be an excellent way of drawing attention to the presence of the box and the expected movements, especially for motorists.

- **Bold demarcation of the box is vital.** This could involve wider striping than the norm or perhaps painting the box a bright color.

- **Steps should be taken to limit motor vehicle encroachment.** Setting stop bars back a short distance from the box might lessen encroachment. Offset (or staggered) stop bars would also be beneficial, not only for encroachment purposes, but also to help motorists see bicyclists moving into the box. Some police presence may also be necessary to instruct, warn, or ticket motorists with regard to encroachment.

In summary, the bike box is a promising tool to help bicyclists and motorists avoid conflicts due to certain kinds of intersection movements (figure 16). More boxes need to be installed and evaluated to further enhance their effectiveness in different settings. Pilot testing the Danish treatment of recessed stop bars for motor vehicles is also recommended.

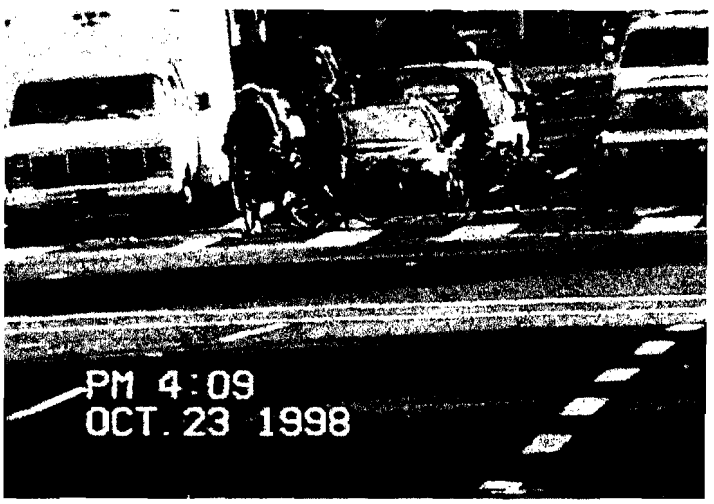

Figure 16. Three bicyclists correctly using the bike box.

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