



**Flycycle Bike Rack 30" Bike Rack Spacing Evaluation
For: City of Cambridge Community Development Department**

Prepared by Flycycle, Inc.

July 31, 2017

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“I would love them [Flycycle racks] here in Cambridge”

– Cambridge Resident (Saturday, April 15, Cambridge Science Fair)



1. Executive Summary

The Flycycle bike rack is the product of a community engagement effort begun by the MIT Climate Co-Lab in partnership with the Cambridge Redevelopment Authority and the Kendall Square Association. This academic-public-private partnership conducted an international design competition for high-density bike parking solutions in the winter of 2015-2016. After multiple rounds of expert judging and public voting, the Flycycle bike rack emerged as both the Judge's Choice award winner and Popular Vote winner. A research and development grant was provided to the Flycycle team to develop their winning design into a market-ready product suitable for installation in Cambridge, MA.

The City of Cambridge Community Development Department (CDD) assisted the Flycycle team in developing a pilot bike rack installation program to better evaluate the performance of the design in the real world. Together with Alexandria Real Estate Equities (ARE), the Cambridge Redevelopment Authority (CRA), and Boston Properties (BP), Flycycle identified locations for bike rack installations, the first of which was installed on October 28, 2016. Additional installations followed at Galaxy Park on December 9, 2016, Technology Square on April 10, 2017, and at BP Green Garage bike cage on June 19, 2017. Each of these locations samples a different bike parking scenario, thereby contributing to a comprehensive evaluation for this report. The Flycycle team visited each installation frequently in order to take photos of the racks in use. Additional camera footage was provided by Boston Properties for the Green Garage installation.

The City of Cambridge CDD also invited the Flycycle team to participate in several community engagement events during April and May 2017, during which the team was able to conduct field evaluation surveys alongside the CDD staff. The results of these surveys have been detailed in this report, and provide valuable insight into the benefits of the Flycycle rack design.

Based on all the evidence collected and detailed in this report, the Flycycle rack performs as well as or better than conventional racks spaced at 36". This evaluation is based on the City's Article 6.100 Language regarding durability and convenience such as locking time, clearance, and stability issues. We have found that when compared to the bike racks mentioned in Article 6.105.1.a¹, the Flycycle bike rack is easier to lock up on, provides suitable clearance between bikes, and reduces the number of incidents where bikes fall over or are entangled.

The goal of this report is to provide an evidence-based argument that supports the amendment of the City of Cambridge Zoning Article 6.100 guidelines to include expanded language to accommodate high density bike racks such as the Flycycle rack. We believe that this modification will expand access to bike parking in Cambridge and help the City to continue its progress towards a more cycling-friendly future.

¹ Types of permissible bicycle racks include, but are not necessarily limited to, those commonly known as "Inverted U-shape," "Swerve" and "Post-and-Ring" racks.

2. The Flycycle at a Glance

The Flycycle rack design responds to the bike rack requirements set forth in City of Cambridge Zoning Article 6.100 guidelines to ensure accessible bike parking for all. These requirements include “[allowing] a bicycle to lean against [the rack] in an upright position”, “[making] contact with the stand at (2) two points along the length of the bicycle and shall allow one or both wheels to be locked to the stand by way of a cable, U-Lock or shackle.” In addition, Flycycle racks were designed to increase the possible density of bike racks in places that need high volumes of bike parking, such as garages in office buildings in Kendall Square. Finally, the design was intended to improve the lived experience of cyclists, who frequently struggle with bike racks that are poorly designed for keeping bikes upright throughout the duration of their stay, or that make it difficult to park two bikes on a single rack.

The Flycycle rack is made of galvanized 1.5” steel tube. On the right side, it has a ramp formed by two tubes that lead to a cradle for the wheel of the bike on the right (see image 2.1). The length of the rack mimiks the length of the elevated bike from the start of the wheel to the end of the bike frame, allowing rack space for a U-Lock, the most secure type of bike lock, to attach to the front wheel, bike frame, and back wheel (see image 2.4).



Image 2.1

On the left side of the Flycycle rack, a second bike can park with both wheels on the ground (see image 2.2). This allows the handlebars on both bikes to be staggered vertically and horizontally, as the bike on the left can roll forward or backwards along the rack as needed. By offsetting the handlebars, both bikes can rest closely on the rack along their entire length. Both bikes are more stable as a result, making it more likely that both bikes will stay in an upright position for the duration of their stay and reducing the entanglement of handlebars and fight for space that is so well-known and frustrating to cyclists. This is further assisted by the wheel of the bike on the right, usually the front wheel, being secured in the cradle and dissuaded from turning and tipping the bike over.



Image 2.2

By staggering and stabilizing the bikes, the Flycycle rack uses space more effectively than standard bike racks such as the “Inverted U” and “Post and Circle”. Thus, they can be spaced more tightly together than standard racks, while maintaining similar space for people to access the rack and for various appurtenances, such as baskets, panniers, and child seats, to fit (see image 2.3). The Flycycle team suggests a spacing of 30” between racks, 6” tighter than the traditional spacing of 36”.



Image 2.3



Image 2.4

Non-standard bikes also find a place to lock up on the Flycycle racks (image 2.5). While the elevated cradle on the right accommodates most tire sizes and widths, any cyclist who doesn't feel comfortable using the ramp can use the left side or simply park on the ground on the right side.

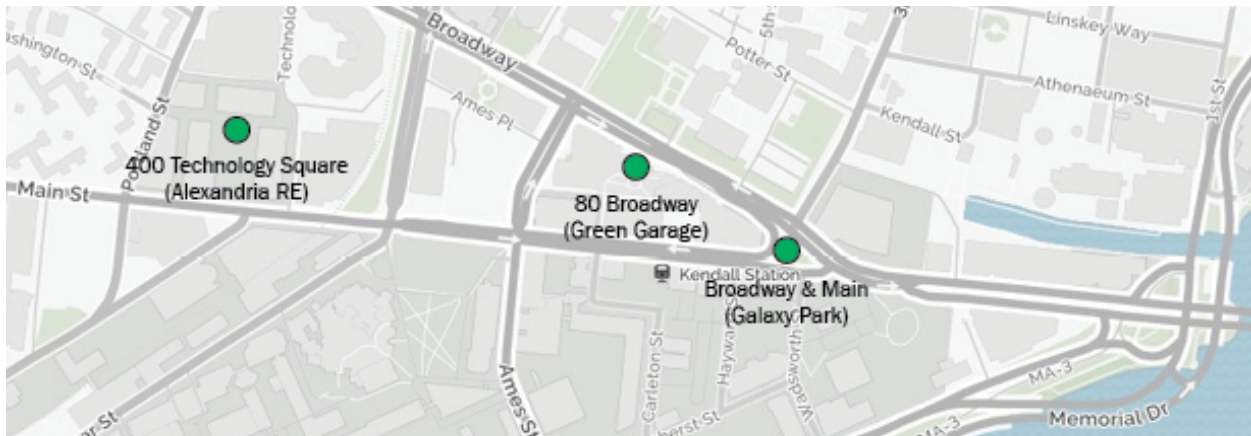
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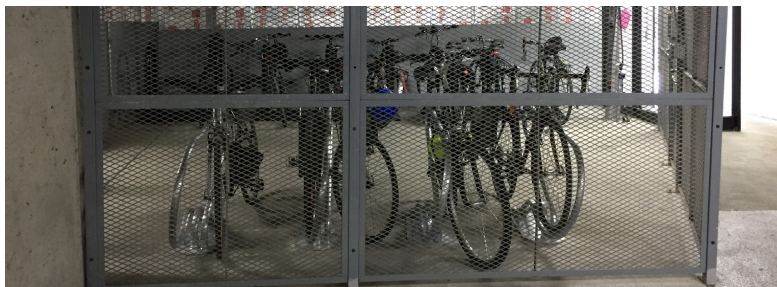
Image 2.5

3. Pilot Project Locations

Flycycle racks were installed at three locations in Kendall Square.



Alexandria Real Estate Equities Headquarters



Green Garage Bike Cage, 80 Broadway



Galaxy Park, Broadway and Main St.

4. Survey Evaluation

With input from the CDD², two surveys were developed to capture how well the Flycycle rack performs. The first, **Bike Rack Survey**, captures the qualitative experience, reactions, and preferences of people encountering the rack for the first time. The second, **Staff Observation Survey**, records the observations of City of Cambridge staff members as first-time users parked their bikes on Flycycle racks. Both surveys provide important feedback on the usability and desirability of Flycycle racks as part of the urban cycling landscape, with the “Bike rack survey” acting as the voice of the people, and the “Staff Observation Survey” offering empirical evidence collected by bike parking experts.

4.1 Bike Rack Survey

The Bike Rack Survey was conducted at the Cambridge Science Fair on April 15 and April 22 and at the start line of the Boston Bike Party bike ride on April 14. The survey also received online responses from a link in an email sent to Alexandria RE employees and posted on the Flycycle website. There were 62 total responses to the survey, with 58 coming from the Cambridge Science festival and Boston Bike Party, and 4 from the online survey. Please refer to Appendix, section 7.2.1, for the complete Bike Rack Survey.

The set up consisted of three racks spaced at 30” during the Boston Bike Party and the second date (April 22) of the Cambridge Science Festival. On day one (April 15) of the Cambridge Science Festival, there was a single rack on display. The racks installed at Alexandria RE (400 Tech Square) are a set of 6 at 30” spacing.

During the three events, the Flycycle team was present to introduce the rack to passersby, invite people to try out the rack with their bike or a borrowed bike, and encourage them to fill out the survey on an ipad or smartphone.

Results

Ninety eight percent of survey respondents said they understood how to use the Flycycle rack on their first encounter with it. Flycycle staff were present onsite to offer guidance, if needed, on how to use the rack. Given the Flycycle rack’s intuitive design, minimal intervention was needed for people to use it as intended.

² Community Development Department staff included Cara Seiderman, Justin Schreiber, Bronwyn Cooke, and Jennifer Lawrence.

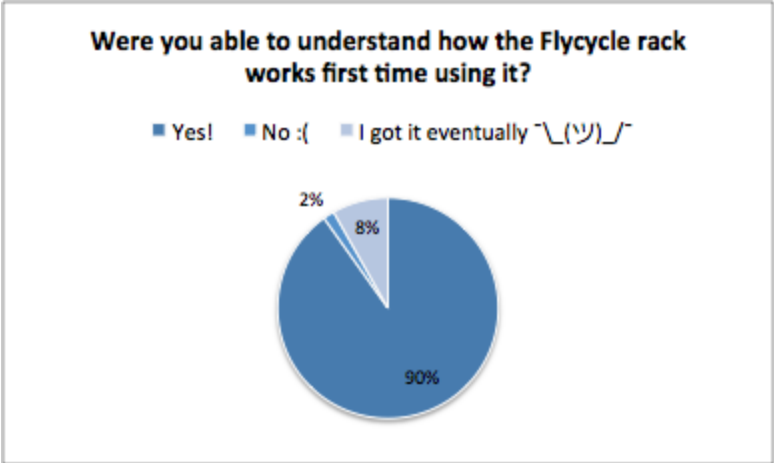


Figure 4.1

When compared to the most common bike racks in Cambridge – the Post & Circle, Inverted U, and Swerve racks – respondents thought the Flycycle rack outperformed all three. Together, those three standard racks were seen as “OK” 50-60% of the time, “Frustrating” 33-35% of the time, and “Amazing” only 6-11% of the time. In contrast, the Flycycle rack was seen as “Amazing” 85% of the time, “OK” 13% of the time, and “Frustrating” just 2% of the time (equivalent to one response).

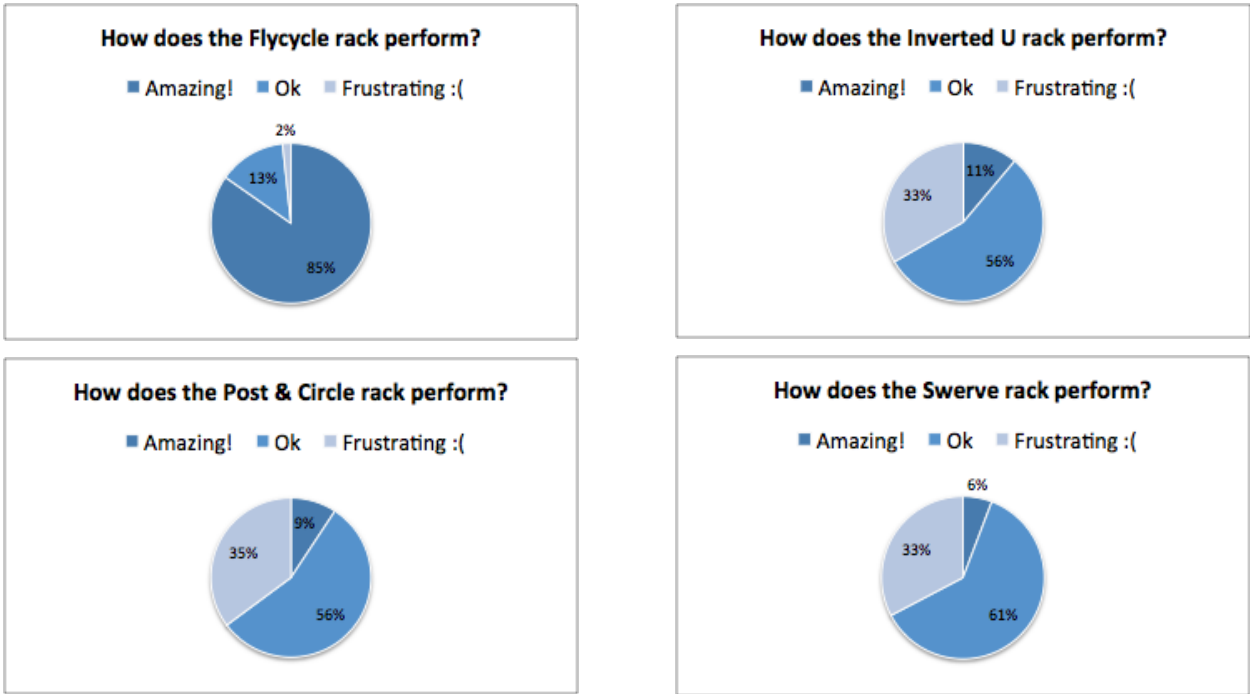


Figure 4.2

Similarly, when asked about which racks they preferred using, the Flycycle rack was the top choice, preferred by more than twice as many people as the next most preferred racks.

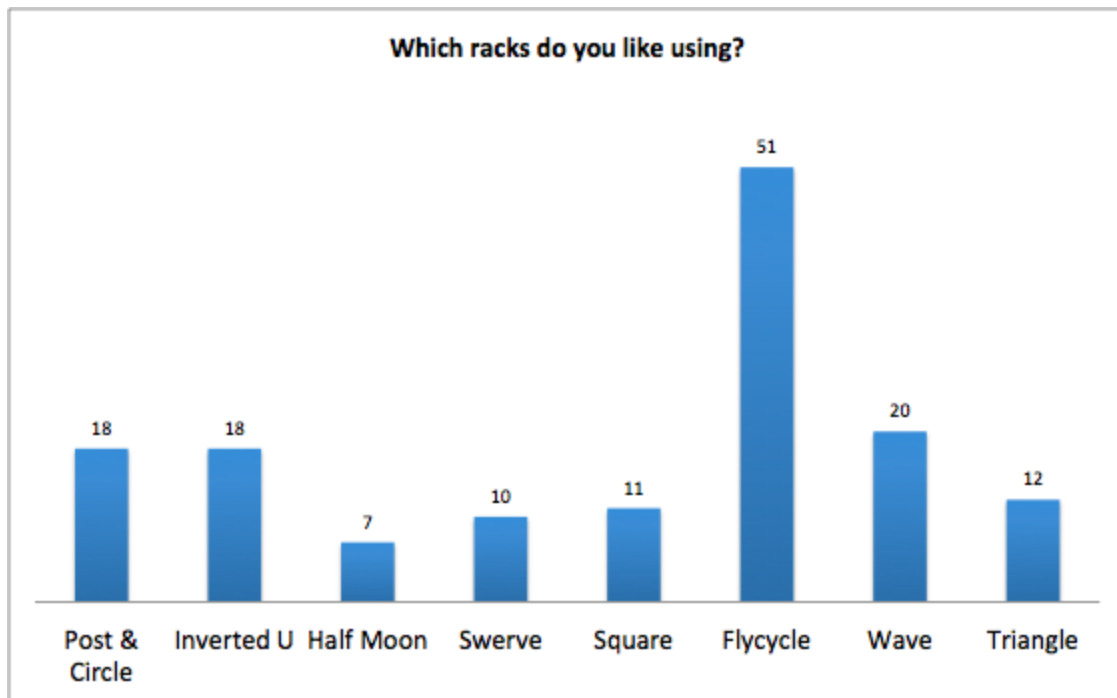


Figure 4.3

This preference could be attributable to the Flycycle rack features that are designed to be more biker-friendly. Respondents said that ease of locking up and the bike's stability while locked were essential elements to bike parking (figure 4.4). The Flycycle rack was designed with these concerns in mind – in particular, the cradle on the right side holds one bike's front wheel in place and makes the bike less likely to tip over, and the handlebar offsetting allows bikers to lock up with less entanglement with an adjacent bike.

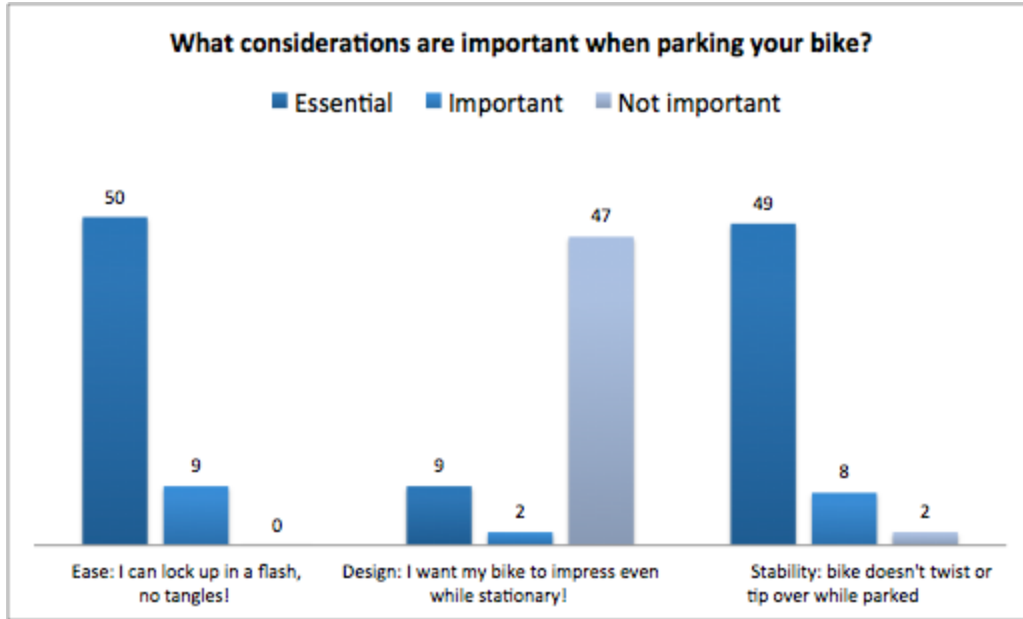


Figure 4.4

Ninety five percent of survey respondents said they would like to see the Flycycle rack installed in more locations throughout Cambridge. Many respondents also echoed this sentiment in the comments left in the optional section at the end of the survey (figures 4.6 and 4.7).

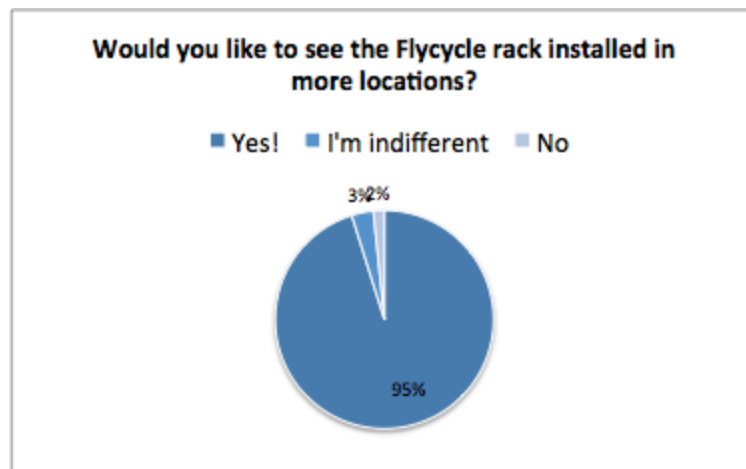


Figure 4.5

Figure 4.7 Optional Comments (selection)

“Anything that keeps the bike from falling over is a big improvement!”

“Much more bike parking needed!”

“Separation of my bike from others/ making sure that it's not tangled with others is important to me.”

“Existing bike racks are frustrating.”

“Anything that keeps the front wheel straight and bike standing with baby seat on back is great”

“I would love them here in Cambridge”

“Easy for kids too.”

“We need better bike racks!”

“Thank you for tackling this problem! the post & circle is a horrible design ;)”

“I wish bike parking were better. I'm excited for Flycycle.”

4.2 Staff Observation Survey

During the Staff Observation Survey, City of Cambridge staff, supported by the Flycycle team, observed how first-time users parked their bikes on Flycycle racks. The survey took place over the course of two events, the Boston Properties Bike Breakfast on May 18 and the Cambridge Bike Ride on May 20. For both events, there were three racks spaced at 30”. In total, 30 surveys were filled out. Please refer to the Appendix, section 7.2.2, for the complete Staff Observation Survey.

The survey questions were formatted to pick up patterns of issues experienced in a variety of possible settings. Therefore, the survey distinguishes between bikes of different shapes and with various appurtenances, and by the position the bike was parked in and the position of an adjacent bike. Overall, there was no clear pattern of specific types of bikes, or a particular parking position, that would counter that the Flycycle rack is accessible to all bikers. During the BP Bike Breakfast, the majority of bikers were younger and had commuter or road bikes, while during the Cambridge Bike Ride bikers skewed older and with larger, commuter or cruiser style bikes.

Most “issue” questions were formatted as Y/N for whether the user experienced issues or not with a particular aspect of using the Flycycle racks. To record an issue, the survey recorder

could write the observation into a free form answer box. The Flycycle team went through each observation to determine whether it reflected a challenge for the user or simply a comment to provide richer context for the user's experience. The observations that were determined to be only context comments were not included as "issues". If no answer was selected for a particular question, it was assumed that there were no issues for that part of the user's experience.

The findings of this survey suggest that the Flycycle rack helps, rather than hinders, the parking of bikes with appurtenances or uncommon shapes, and that 30" spacing between racks does not diminish the accessibility to the rack when there are multiple bikes already parked.

4.2.1 Getting to the rack

The survey looks into how first-time users understand the rack to work and their experience in attempting to access the rack according to this their understanding. The survey documents whether users experience issues in accessing the rack and getting their bike to fit and stay on the elevated portion (if parking on the right side). If users were able to access the rack and get their bike into position on the first try, even if it required some manoeuvring (which is covered in section 4.2.3), they were deemed to have had no issues for access and fit. As described below, this part of the survey finds that most first-time users are able to easily use the Flycycle rack, suggesting that the racks are likely to be used in the most efficient way, with the bike on the right in the elevated cradle.

Of the 30 trials, 16 bikes parked on the elevated ramp on the right side of the Flycycle rack (see figure 4.6, left). Of these 16, 10 were parked next to another bike on the left side of the ramp, and 6 had no adjacent bike on the left. The 6 that had no adjacent bike on the left uniformly experienced no issues in getting the bike into place. Of the 10 that had another bike to the left, 5 had no issues. Of the remaining 5 who experienced some issues, the issues expressed in 4 responses were that the user originally didn't attempt to use the ramp, but eventually realized they could park in the elevated position. These issues would presumably be solved the next time these users parked on a Flycycle rack.

Ten bikes parked on the left, 6 of which had a bike parked on the right of the rack in the elevated ramp, 3 of which had no adjacent bike on the same rack, and 1 which had a bike to the right but not in the elevated position. There were no issues with any of these parking experiences.

Four bikes parked on the right on the ground (without using the elevated ramp) and also experienced no issues. Of these 4, 2 were adjacent to another bike parked on the left. The other 2 had no adjacent bikes to the left of the rack and parked in reverse, which is compatible with the desired use of the rack. They may have parked in reverse because there were no contextual indicators of direction, given the demo setting.

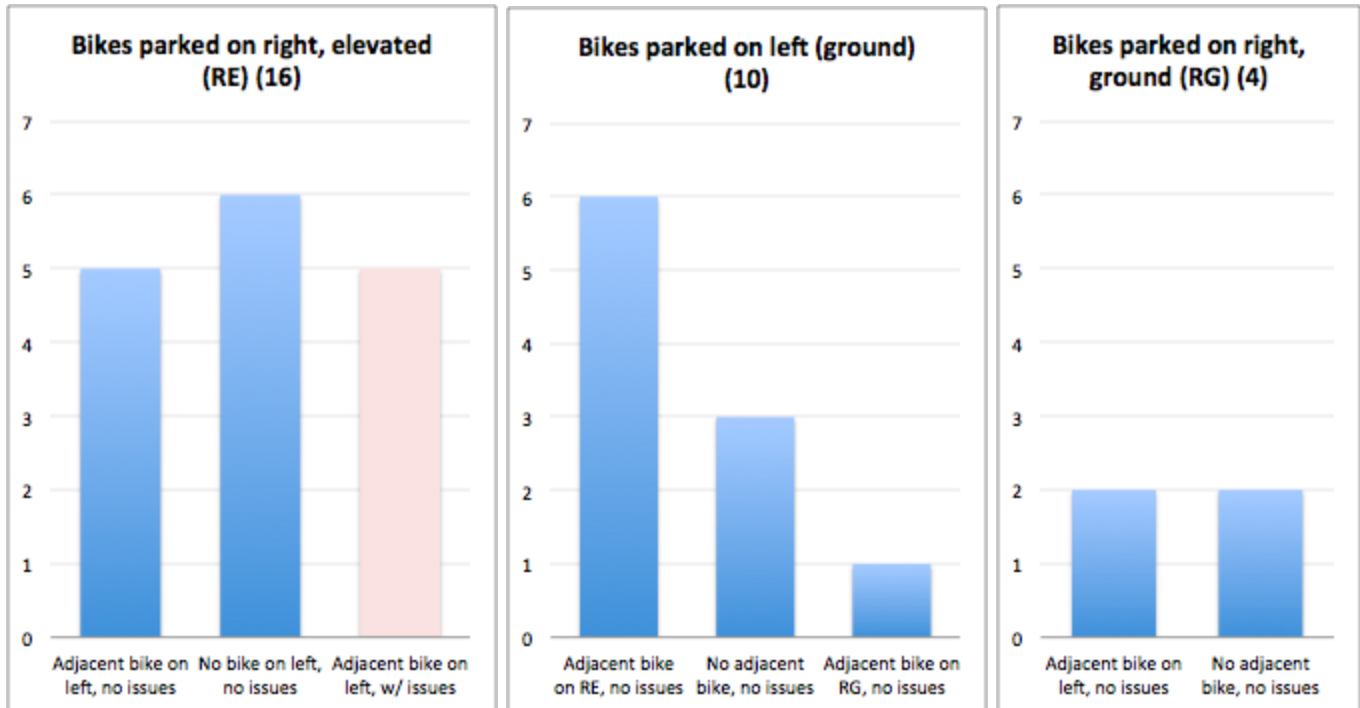


Figure 4.8

Based on this data, and since all trials were with first-time users, the issues in deciding where and how to park stemmed mostly from unfamiliarity with the rack. This data point correlates with the finding from the self-reporting in the Bike Rack Survey that 98% of users would understand how the rack works immediately or eventually, as well as evidence from the Green Garage that will be discussed further on in this report.

4.2.3 Accessibility at 30" spacing

The survey shows that Flycycle racks are accessible even at 30" spacing, and even for larger bikes or bikes with appurtenances such as panniers, saddlebags, child seats, or baskets, or when people park in unintended positions.

An important part of bike parking (as verified by the Bike Rack Survey) is the ability to quickly lock the bike to the rack. This includes the bike resting in a balanced position while being locked up and the lock fitting around the rack easily, even if another bike is parked on the same rack. Therefore, the survey focused on documenting the length of time required to lock the bike to the Flycycle rack, the need for adjustments, and the presence of challenges (such as manoeuvring around other bikes and their appurtenances) during the parking experience.

Locking time

Sixteen, or a little over half of the observed users, locked their bikes to the rack. Ten were able to lock up in under 10 seconds, with 8 having "a piece of cake" experience and 2 having "small challenges." The remaining 6 users experienced small challenges, but were able to

lock up in under 30 seconds. The time it took to lock up correlated closely, but not exactly, to the number of adjustments the user had to make when attaching lock to rack (Figure 3.8). For example, some people took 30 seconds to lock up but had to make one or no adjustments. This indicates that some people are just naturally faster in the locking up process.

Of the remaining 14 users who didn't lock up their bikes, only one person was unable to lock up due to an unusually thick U-lock (this person had big challenges overall). Thirteen users got their bikes into place on the rack without attempting to use a lock.

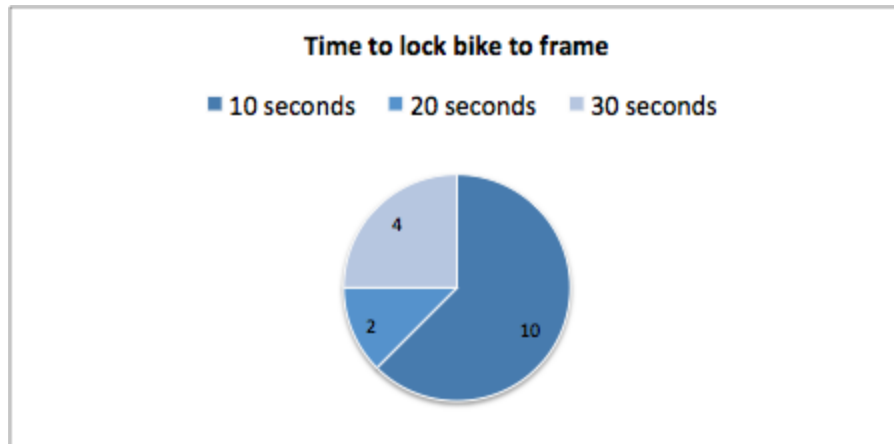


Figure 4.9³

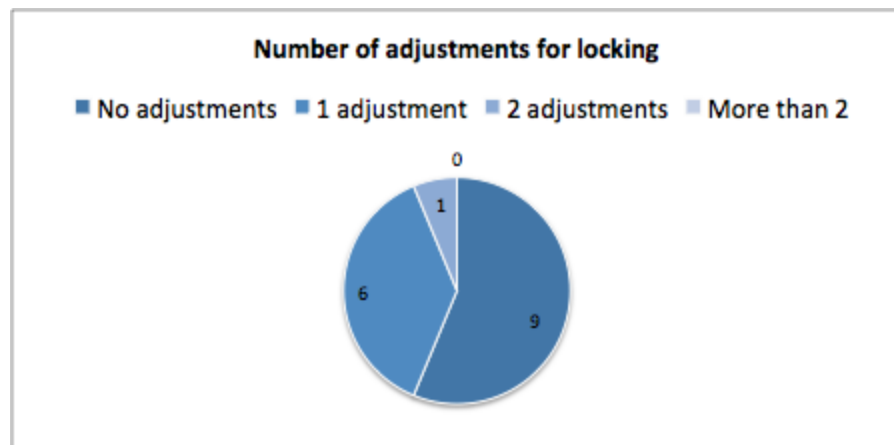


Figure 4.10

³ Figures 4.9 and 4.10 include data for the 16 people who locked up. Figure 3.9 includes the 17th person who attempted to lock up but whose U-lock was unusually thick and couldn't get her lock around the wheel and frame.

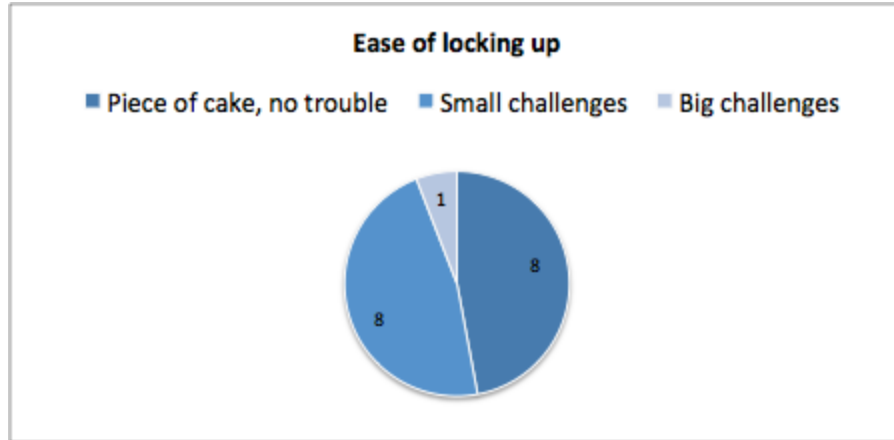


Figure 4.11

There were very few difficulties with fitting the lock to the frame, with only two users experiencing any issues.

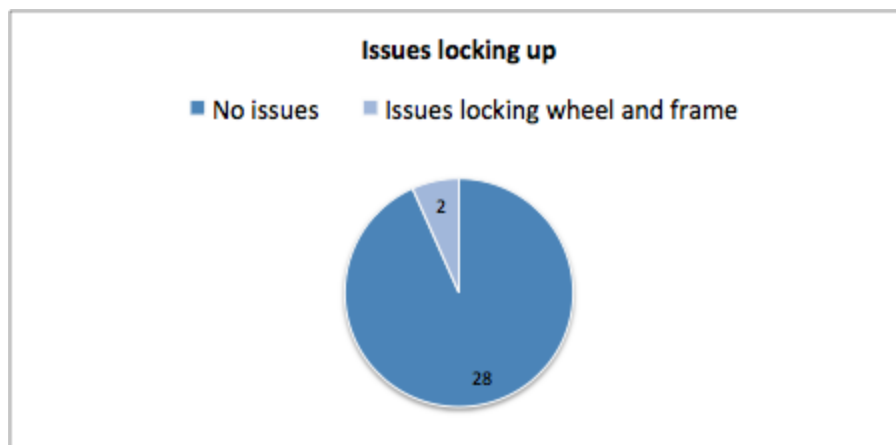


Figure 4.12

Bike type and size

The type of bike didn't seem to matter much in terms of ease of locking up. The majority of bikes that were tested (19) were commuters (with wide, flat handlebars), 6 were cruisers (swervy, wide handlebars) and 5 were road bikes (drop handlebars). There were uniformly no issues with bikes being too big to park in the 30" spacing, regardless of the side they were parked.

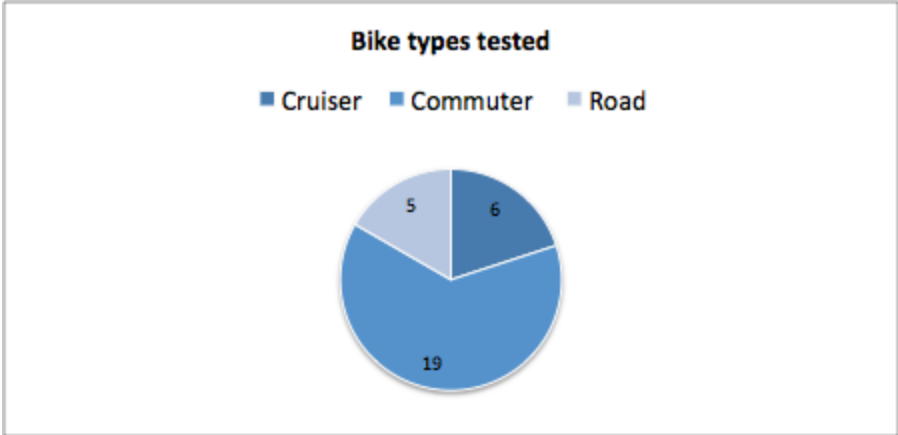


Figure 3.13

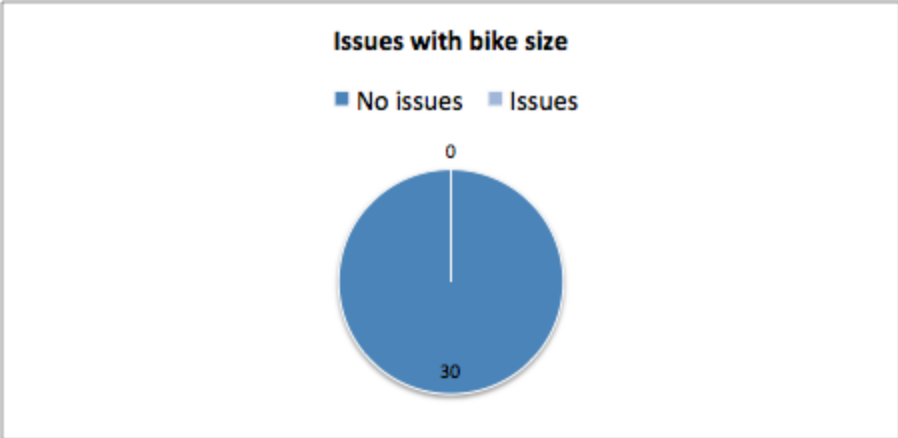


Figure 3.14

Of the 10 bikes that locked up in under 10 seconds, 9 were commuter bikes and one was a cruiser. The bikes that took 20 seconds to lock up included 1 cruiser and 1 road bike, while the bikes that took 30 seconds to lock up were 2 commuters and 2 cruisers.

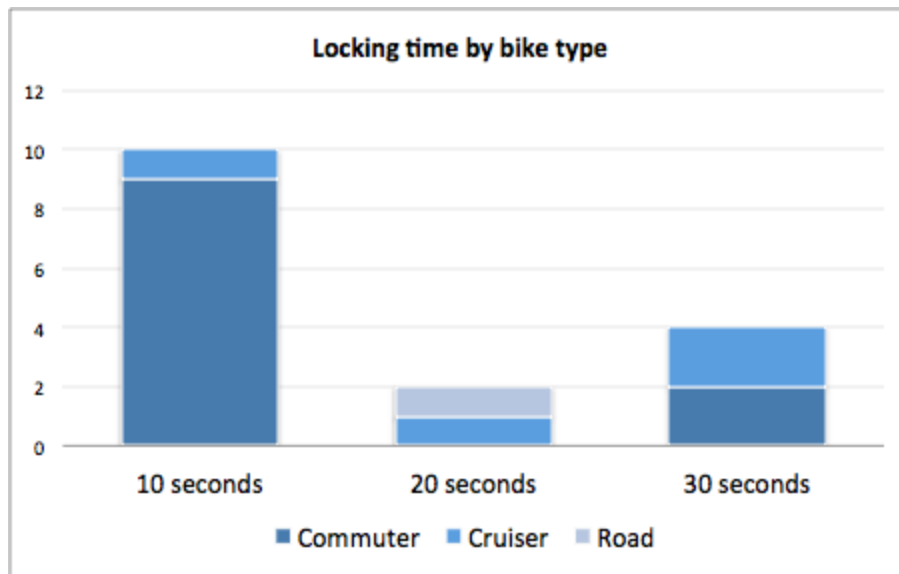


Figure 3.15

Due to their varying handlebar heights and widths, cruisers may be the most difficult of bikes to lock up in a high density setting. However, half of the cruisers that attempted to lock up had success in under 20 seconds, and the other half in under 30. Two other cruisers were tested on the rack but didn't attempt to lock up.

Appurtenances

The bikes tested had a range of appurtenances: there were 10 bikes with panniers only, 4 bikes with baskets only, 2 bikes with panniers and a basket, 3 bikes with a basket and rear childseat, and one bike with a basket and uncommonly sized or shaped handlebars. Ten bikes had no appurtenances.

Of the 30 bikes tested, only 3 had issues with fitting the appurtenances around the rack, with or without any adjacent bikes present. There was only one issue with panniers, but these were "huge panniers", larger than what the City of Cambridge staff member had ever seen!

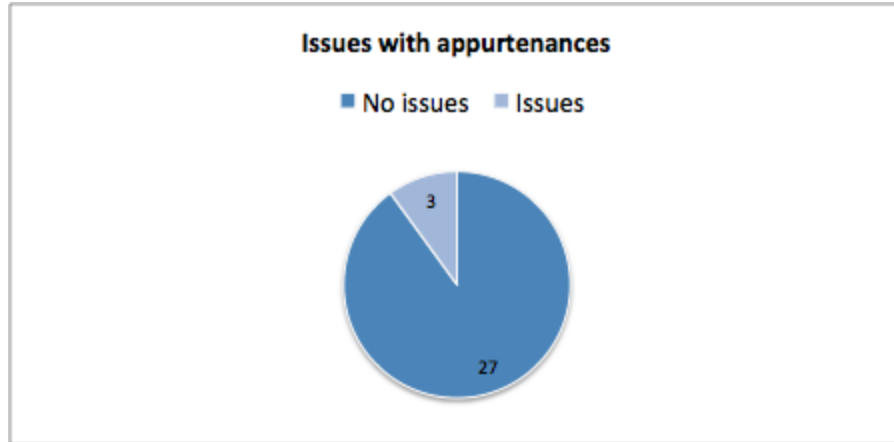


Figure 3.16

Pedals, tires, fenders and handlebars

In the 30 trials, there were no issues to speak of in terms of pedals fitting. Only two people made adjustments to their pedal position in order to park their bikes comfortably, which is to be reasonably expected, and the rest reported no issues whatsoever.

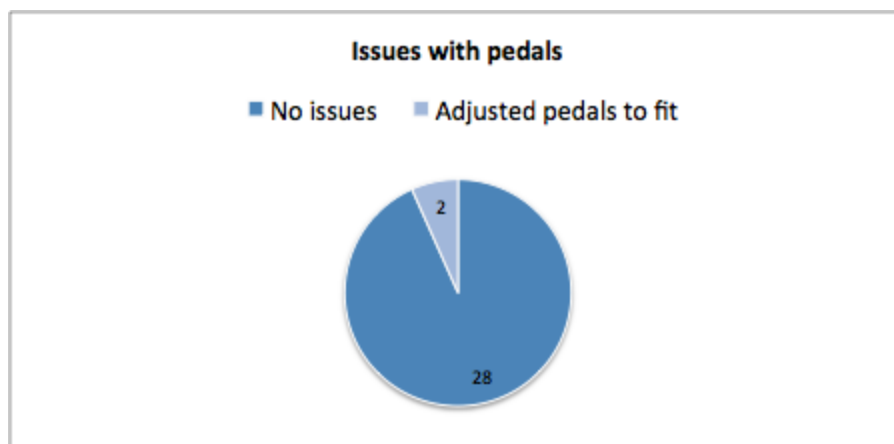


Figure 3.17

Similarly, there were no issues to speak of in terms of the Flycycle rack interfering with bikes' tires or fenders. The only issue reported in this section was that of one bike falling out of the cradle once the biker walked away. This was the only instance of the bike slipping out of the elevated cradle and is probably a result of the tire not having been properly placed in the grooves of the elevated portion. Minor aberrations are to be reasonably expected, especially in a pool of first-time users.

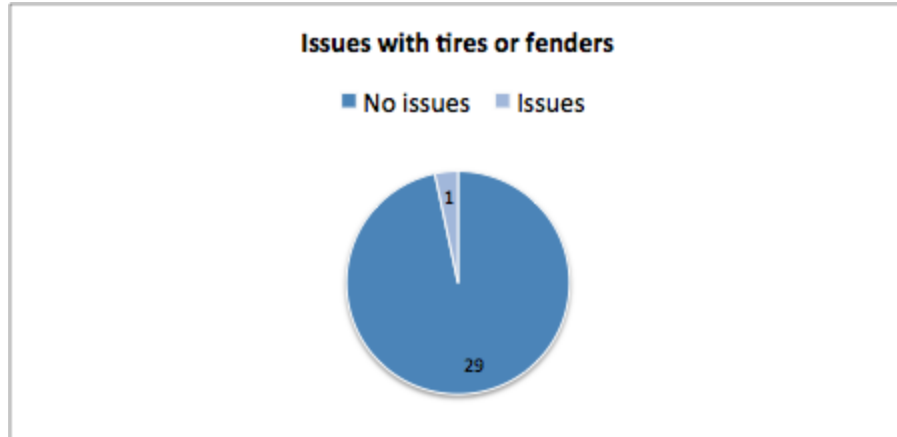


Figure 3.18

Four users experienced difficulty with maneuvering the handlebar situation while parking. Three of the four had cruisers, two of which were still able to park in the elevated cradle with an adjacent bike on the left. The one commuter bike, parking on the left, found a solution in moving their bike forward enough along the rack to avoid entanglement with an adjacent elevated commuter.

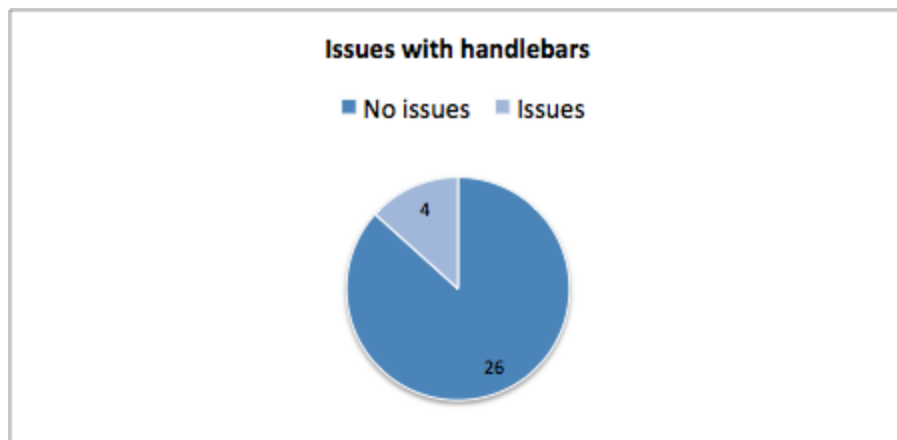


Figure 3.19

Conclusion to the Staff Observation Survey

Overall, 18, or 60% of all bikes, experienced no issues whatsoever when using the Flycycle rack for the first time. The bike parts which gave the most issues were the handlebars, but users found ways of resolving those issues that let them use the rack comfortably. Even when users experienced issues, they were able to resolve them in under 30 seconds. Some people used the rack in an unintended way, e.g. by parking in reverse or parking in the ground position on the right side of the rack (not using the elevated cradle). However, this didn't prevent them from parking effectively and easily, or prevent other bikes from accessing the rack or

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parking securely. This means that the Flycycle rack, spaced at 30", works at 100% efficiency even in the face of unintended behavior.

5. Green Garage Evaluation

On June 15, four Flycycle racks were installed in the bike cage in the Green Garage at 80 Broadway for the purpose of gauging the effectiveness of the Flycycle rack in garages and other high-density settings. A security camera was in place that captured several weeks of footage of cyclists when entering the bike cage and using the Flycycle rack. Additionally, Flycycle staff frequently stopped by during or after morning rush hour to take pictures of how the racks were being used.

To assist cyclists with intuiting how to use the elevated portion of the Flycycle rack, the installation included chevrons and the word “tire” attached to the ramp and inner front loop, respectively. About a week later, a sign was put up in front of the racks with a schematic drawing of a bike in the elevated position and the words “roll front wheel up ramp / rest wheel in cradle” (see image 5.1).

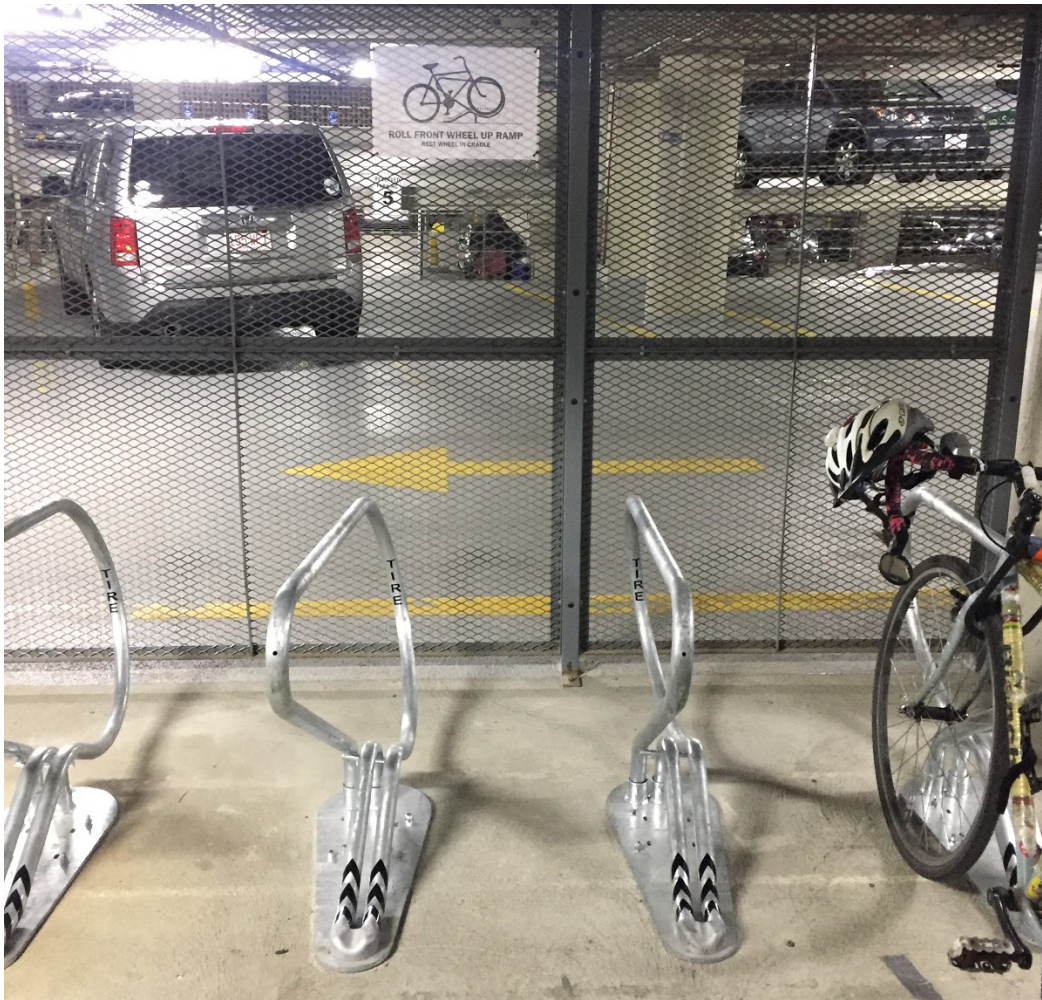


Image 5.1

Boston Properties recorded 12 videos between June 30 and July 27 during the morning rush hour, between 7:30 and 10:00 am (see Section 8, the Green Garage Appendix, for a record of observations from the videos). The footage shows that cyclists use the elevated cradle when parking on the right hand side most of the time, but not always. There is footage of people who look like they are using the rack for the first time, without encountering issues, as well as return users. For example, on June 11 at 8:10 am, a man initially parks on the left, then switches sides and parks with his front wheel in the elevated cradle, then turns his bike around and locks up with the back wheel in the elevated cradle, appearing satisfied with how he's left his bike for the day. Several videos show cyclists deftly using a U-Lock to secure both the back wheel and frame to the rack.

The video footage available for this report captures mostly lower density scenarios, with all cyclists locking up on an otherwise empty rack. During those times, the bike cage is generally empty as well, indicating that cyclists are using Flycycle racks spaced at 30" with the same or more preference than the other racks in the bike cage that are spaced at 36".

The images captured by Flycycle staff show higher some higher density use, in which racks are frequently used as intended, with the bike on the right parking in the elevated position. When bikes on the right are parked on the ground, there appear to be no issues for that bike or adjacent bikes. The images 4.2 to 4.5 provide evidence that 30" is sufficient for bikes to park correctly when using Flycycle racks, even when the bike on the right is not in the elevated position.



Image 5.2

2 of 2 parked bikes are on the right side, in the elevated position



Image 5.3

4 of 4 bikes parked on the right are in the elevated position, a fifth bike is parked on the left. 30" is sufficient for all bikes to be parked securely.



Image 5.4

2 of 2 bikes parked on the right are in elevated position, 3 bikes parked on the left show that 30" is sufficient for all bikes to be parked securely.



Image 5.5

3 of 4 bikes parked on the right are in the elevated position, 1 bike parked on the left shows that 30" is sufficient for all bikes to be parked securely, even when helmets and panniers are attached to bikes.



Image 5.6

3 of 3 bikes parked on the right are in elevated position.

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The observations from the Green Garage indicate that frequent users understand how to use the Flycycle rack to it's greatest effect, and are willing to do so. The successful trial in the Green Garage is probably the strongest evidence that the Flycycle racks spaced at 30" performs as well or better than the standard Cambridge racks spaced at 36".

6. Special Permit & Cambridge Zoning Article 6.105.4 Amendment for Acceptable High Density Bike Parking

As currently written, Cambridge's zoning regulation allows for innovative bike parking solutions to be approved by special permit in *Article 6, Section 6.108 Modification of Requirements by Special Permit* (see Section 9, Zoning Appendix). The evidence in this report shows that the Flycycle rack, when spaced at 30" or 36" meets the objectives set forth in *Section 6.108.3.a⁴* and provides "equal or greater benefits for bicycle users". One objective of this report is to receive confirmation that projects that implement Flycycle racks spaced at 30" as part of their bike parking requirements would be granted such a special permit, as long as the project meets the other requirements laid out in the zoning ordinance.

The special permit process necessitates separate applications for separate projects, each subject to approval by the Planning Board. Keeping in mind the City's long-term goal to promote bicycling as a means of transportation, which is dependent on increased bike parking capacity, the Flycycle team believes that the code should more easily allow for proven high-density bike parking solutions, such as the Flycycle rack, to be put into effect without going through the special permit process each time.

The existing code provides an excellent foundation for establishing a new high-density bike parking standard for the City of Cambridge. A proposed amendment has been included below as "*Section 6.105.4: Acceptable High-Density Bike Parking Designs*" & "*Section 6.105.5: High Density Bike Racks.*" These new sections are modeled on the language used in the existing code *Sections 6.105.1 Bicycle Racks & 6.105.3 Unacceptable Bike Racks* (see Section 9, Zoning Appendix) with proposed amended language for high density bicycle parking in **underlined bold**.

6.105.4 Acceptable High Density Bicycle Parking Designs. Bicycle Parking Spaces shall not be deemed to meet the requirements of this Section 6.105.4 if any of the following are true:

- a. Bicycles must be stored lying down or require a kickstand to remain upright.
- b. Bicycles must be "hung" with one or both wheels suspended in the air.
- c. Bicycles must be lifted off of the ground or floor without any physical assistance provided.

⁴ Article 6.108.3.a "Where an alternative design or layout of Bicycle Parking Spaces is proposed, the Planning Board shall determine that such design or layout shall be durable and convenient for the users whom it is intended to serve. Where new technologies are proposed, the Board may require that the Applicant demonstrate such technologies for review by City staff."

6.105.5 High Density Bicycle Racks. Long-Term Bicycle Parking or Short-Term Bicycle Parking requirements may be satisfied by the installation of High Density Bicycle Racks according to the standards set forth below. Other design options may be allowed pursuant to Section 6.108 further below.

- a. A Bicycle Rack shall mean a fixed-in-place stand, solidly anchored to the ground or other fixed object, which allows a bicycle to lean against it in an upright position **with front wheel and bike frame both supported by the rack.** A bicycle shall make contact with the stand at two (2) points along the length of the bicycle and shall allow one or both wheels to be locked to the stand by way of a cable, chain, U-lock or shackle.
- b. Each Bicycle Rack, if designed to the spacing requirements set forth herein, may provide up to two Bicycle Parking Spaces, with one Bicycle Parking Space provided on each side of the Bicycle Rack. If a Bicycle Rack meets the spacing requirements on one side of the stand but not the other (as may be the case where a Bicycle Rack is attached to a wall), then it may provide one Bicycle Parking Space.
- c. A single interconnected structure may provide parking for more than two bicycles, in which case the term Bicycle Rack as applied in this Ordinance shall refer to any vertical element of the structure upon which one or two bicycles may be secured and which otherwise meets the layout standards set forth herein.
- d. To provide adequate space to store and remove a standard bicycle, there shall be at least **thirty inches (2.5')** clear horizontal distance from the center point of the Bicycle Rack in a direction perpendicular to the length of the bicycle, and at least four feet (4') clear horizontal distance from the center point of the Bicycle Rack in each direction parallel to the length of the bicycle.
- e. Where twenty (20) or more Bicycle Parking Spaces are required, at least five percent (5%) of the required spaces must provide an additional two feet (2') of space parallel to the length of the bicycle to

accommodate tandem bicycles or bicycles with trailers.

- f. Bicycle Racks shall generally be arranged either in rows (where bicycles are parked side-to-side) or in alignment (where bicycles are parked end-to-end). Where Bicycle Racks are arranged in rows, they shall be spaced at least **thirty inches (2.5')** apart on-center. Where Bicycle Racks are arranged in alignment, they shall be spaced at least eight feet (8') on-center.

The Flycycle team would like to work with the City of Cambridge to amend the zoning code to reflect the fact as the need for bike parking increases, especially in new development areas in Cambridge, more efficient bike parking solutions will be required to help ensure the best designs and use of space in new development.

7. Survey Appendix

7.1 Bike Rack Survey

Bike rack survey

**Have you tried out the Flycycle bike rack?
We welcome your feedback.**

1. Were you able to understand how the Flycycle rack works first time using it?

- Yes!
- No :(
- I got it eventually ټ_(^▽^)_



FLYCYCLE



POST & CIRCLE



INVERTED U



SWERVE

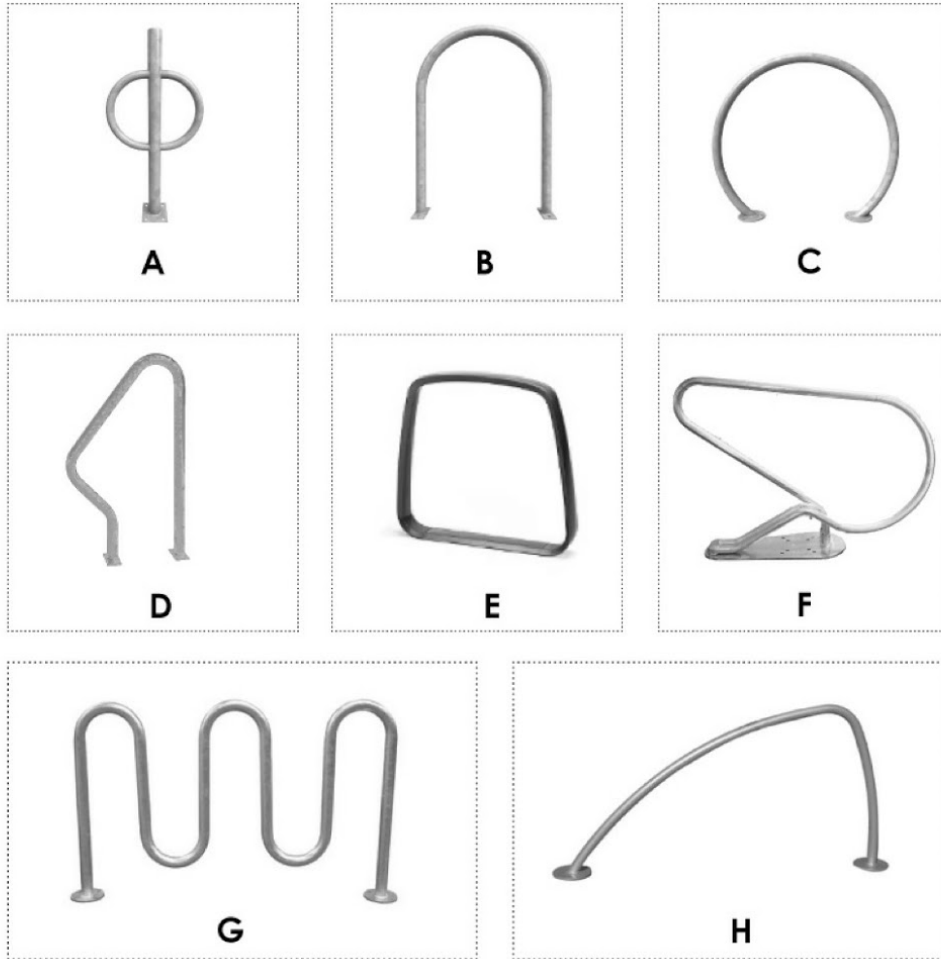
2. How do these racks perform (e.g. ease of locking up, preventing bike falling over or getting entangled, etc.)?

	Amazing!	Ok	Frustrating :(
Flycycle	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Post & circle	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inverted U	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Swerve	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. Would you like to see the Flycycle rack installed in more locations?

- Yes!
- I'm indifferent
- No

FLYCYCLE



4. Which of these racks do you like using? (can select multiple)

- A B C D E F G
 H

5. What considerations are important when parking your bike?

	Essential	Important	Not important
Ease: I can lock up in a flash, no tangles!	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design: I want my bike to impress even while stationary!	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stability: bike doesn't twist or tip over while parked	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Anything to share about bike parking?

7. May we follow up with you about your answers? If so, please leave your email address.

7.2. Staff Observations Survey

Staff Observations

1. Description of bikes already parked when used

- Left Side
- Right Side Elevated
- Right Side Ground

Comments:

2. Where did the user park their bike?

- Left Side
- Right Side Elevated
- Right Side Ground

Comments:

3. What type of bike did they have?

- Commuter (flat handlebars)
- Road (drop handlebars)
- Cruiser
- Other (please specify)

4. Did the bike have any of the following?

- Panniers
- Basket
- Uncommon handlebar size or shape
- Rear childseat

5. How long did it take for them to lock up?

- 10 seconds
- 20 seconds
- 30 seconds
- Other (please specify)

6. How many times did they need to make locking adjustments?

- No times, they got it on the first try
- 1 adjustment
- 2 adjustments
- Other (please specify)

7. How easy was it for them to get the lock around the bike and the rack?

- Piece of cake, no trouble
- Small challenges
- Big challenges
- Other (please specify)

8. Were there any issues with handlebars (e.g., interfering with adjacent bike)

- No issues
- Issue Description:

9. Were there any issues with appurtenances (saddle bags, child seats, panniers, etc.)

- No issues
- Issue Description:

10. Were there any issues with pedals

- No issues
- Issue description:

11. Were there any difficulties with the bikes fitting on the "raised ramp" side of the rack (e.g., someone trying to fit it on but unsuccessful)

No issues

Issue description:

12. Were there any issues with locking the bike?

No issues

Issue description:

13. Were there any issues with accessing the rack (e.g., spacing too tight for people to get to the rack)

No issues

Issue description:

14. Were there any issues with tires or fenders?

No issues

Issue description:

15. Did the size of the bike matter when trying to fit the bike in?

No issues

Issue description:

8. Green Garage Appendix

Observations from Boston Properties security camera footage in the Green Garage

Date	Time	Park Position (RE = right side elevated, RG = right side ground)	Adjacent bike on rack?	Other bikes parked on F racks?	Cage full or empty?	Appurtenances (P = Panniers, B = Basket)	Issues (Y/N)	Notes
6/30	8:56 AM	RG	N	Yes, 1 RE, 1 L, 1 RG	Empty mostly	P (1)	N	Locks to top bar with ULock, adds cable lock to front wheel
7/10	8:00 AM	RE	N	Yes, RE (2)	Empty	P (2), B (1)	N	Uses rack on end, then changes to rack in middle
7/11	8:09 AM	RE	N	N	Empty mostly	N	N	First time user, tries L, then RE with front wheel, then RE with back wheel, adjusts pedal, looks satisfied as he leaves
7/12	8:55 AM	RG	N	Yes, RE (2)	Half	N	N	Uses ramp, locks to top bar
7/24	7:39 AM	RE	N	N	Empty	N	N	Looks like first time user, first goes to left, moves to right, lifts bike into place, locks back wheel
7/24	8:57 AM	RE	N	Yes, RE (1)	Empty	N	N	Lifts bike into place
7/24	9:24 AM	RE	N	Yes, RE (2)	Empty	N	N	Lifts bike into place
7/26	8:55 AM	RE	N	N	Half	N	N	Locks back wheel and frame, definitely not first time user
7/26	9:04 AM	RE	N	Yes, RE (1)	Half	N	N	Locks back wheel and frame, checks that bike is secure and stable, it is!
7/26	9:43 AM	RE	N	Yes, RE (2)	Full mostly	N	N	
7/26	9:52 AM	RE	N	Yes, RE (3)	Full mostly	P (1)	N	
7/27	7:32 AM	RE	N	N	Empty	N	N	

Original videos can be viewed in the Google Drive folder [Green Garage Flycycle Video Footage](#).

9. Zoning Appendix

[from City of Cambridge Zoning Ordinance Article 6]

6.105 Design and Layout of Bicycle Parking. Required bicycle parking shall be provided in some combination of Bicycle Racks or Bicycle Lockers according to the standards set forth below. Other design options may be allowed pursuant to Section 6.108 further below.

6.105.1 Bicycle Racks. Long-Term Bicycle Parking or Short-Term Bicycle Parking requirements may be satisfied by the installation of Bicycle Racks which meet the design and layout standards set forth in this Subsection. Installers of Bicycle Racks may consult the *City of Cambridge Bicycle Parking Guide*, 2008 or later version, for illustrations of acceptable Bicycle Rack design and layout.

a. A Bicycle Rack shall mean a fixed-in-place stand, solidly anchored to the ground or other fixed object, which allows a bicycle to lean against it in an upright position with both wheels on a level surface. A bicycle shall make contact with the stand at two (2) points along the length of the bicycle and shall allow one or both wheels to be locked to the stand by way of a cable, chain, U-lock or shackle. Types of permissible Bicycle Racks include, but are not necessarily limited to, those commonly known as “Inverted U-shape,” “Swerve” and “Post-and-Ring” racks. Stands commonly known as “Wave Racks” do not meet the standards for Bicycle Racks set forth herein.

b. Each Bicycle Rack, if designed to the spacing requirements set forth herein, may provide up to two Bicycle Parking Spaces, with one Bicycle Parking Space provided on each side of the Bicycle Rack. If a Bicycle Rack meets the spacing requirements on one side of the stand but not the other (as may be the case where a Bicycle Rack is attached to a wall), then it may provide one Bicycle Parking Space.

c. A single interconnected structure may provide parking for more than two bicycles, in which case the term Bicycle Rack as applied in this Ordinance shall refer to any vertical element of the structure upon which one or two bicycles may be secured and which otherwise meets the layout standards set forth herein.

d. To provide adequate space to store and remove a standard bicycle, there shall be at least three feet (3') clear horizontal distance from the center point of the Bicycle Rack in a direction perpendicular to the length of the bicycle, and at least four feet (4') clear horizontal distance from the center point of

the Bicycle Rack in each direction parallel to the length of the bicycle.

e. Where twenty (20) or more Bicycle Parking Spaces are required, at least five percent (5%) of the required spaces must provide an additional two feet (2') of space parallel to the length of the bicycle to accommodate tandem bicycles or bicycles with trailers.

f. Bicycle Racks shall generally be arranged either in rows (where bicycles are parked side-to-side) or in alignment (where bicycles are parked end-to-end). Where Bicycle Racks are arranged in rows, they shall be spaced at least three feet (3') apart on-center. Where Bicycle Racks are arranged in alignment, they shall be spaced at least eight feet (8') on-center.

g. In addition to the requirements set forth herein, all Bicycle Racks shall conform to any applicable federal, state or local requirements for accessibility by disabled persons.

6.105.3 Unacceptable Bicycle Parking Designs. Bicycle Parking Spaces shall not be deemed to meet the requirements of this Section 6.100 if any of the following are true:

- a. Bicycles must be stored lying down or require a kickstand to remain upright.
- b. Bicycles must be "hung" with one or both wheels suspended in the air.
- c. Bicycles must be lifted off of the ground or floor without any physical assistance provided.

Otherwise, flexibility in the design of bicycle parking shall be allowed pursuant to the provisions for modification by special permit as set forth in Section 6.108 below. Such modifications shall allow for consideration of new or innovative technologies that provide equal or greater convenience and accessibility to bicyclists when compared to facilities designed according to the *Bicycle Parking Guide* standards.

6.108 Modification of Requirements by Special Permit

6.108.1 Any requirement set forth in this Section 6.100 may be modified upon the granting of a special permit by the Planning Board. Given that community standards for bicycle use and bicycle parking have evolved and may continue to evolve in the future, the intent of this provision is to provide a mechanism for the review and approval of alternative technologies and methods for providing bicycle parking that may provide equal or greater benefits to bicycle users but may not conform to the exact requirements set forth in this Section.

6.108.2 Bicycle Parking Plan Requirements. When seeking a special permit pursuant to this Section 6.108, the Applicant shall provide a Bicycle Parking Plan as part of the Special Permit Application. Such plan shall include the proposed quantities and locations of bicycle parking facilities as well as exact details and specifications of the design and layout of proposed Bicycle Parking Spaces. The Bicycle Parking Plan shall include a narrative listing the requirements that are proposed to be modified and explaining how the Bicycle Parking Plan would benefit from such modifications. The Bicycle Parking Plan may also include quantitative analyses of expected bicycle usage for the proposed land uses.

6.108.3 Findings and Approval. Upon granting a special permit to modify any requirements of this Section 6.100, the Planning Board shall make a general determination that the proposal is consistent with the purpose of this Section 6.100 and that the Bicycle Parking Plan proposes a quantity, design and arrangement of bicycle parking that will serve bicycle users in a way that is sufficiently comparable, given the circumstances of the specific project, to the bicycle parking that would be required under the regulations of this Section 6.100. The Planning Board shall also make specific determinations applicable to the modifications being sought as set forth below:

- a. Where an alternative design or layout of Bicycle Parking Spaces is proposed, the Planning Board shall determine that such design or layout shall be durable and convenient for the users whom it is intended to serve. Where new technologies are proposed, the Board may require that the Applicant demonstrate such technologies for review by City staff.
- b. Where modifications to the location or quantity of bicycle parking is proposed, the Planning Board shall determine that the Bicycle Parking Plan will satisfactorily serve the needs of all expected users, based on quantitative and/or qualitative evidence provided by the Applicant. Such a modification may be appropriate for a campus master plan or other large development site within which bicycle parking is planned comprehensively across an area instead of on a specific site-by-site basis.