*Street*Smart

How might we better urban mobility in metropolitan Atlanta?

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Problem Statement

Problem:

Our overarching question that we are trying to solve is, how might we better urban mobility in metropolitan Atlanta? Atlanta continues to sprawl outwards but remains dependent on cars for transportation. Atlanta is having difficulty working with communities to expand the MARTA rail system. As a result, people are having trouble with the first-mile and last-mile commute to the MARTA train and bus stations. Overall, Atlanta is ranked as one of the worst cities in the world for urban mobility and the worst in the United States.[1]One chief area of urban mobility is bicycle use, and our goal is to solve Atlanta's alarmingly prevalent problem by focusing on bicycle mobility. MARTA riders do not feel comfortable leaving their bikes locked up at stations while at work or running errands.[2] Public transportation hubs are a vulnerable area for bicycles, and having a threat of larceny deters citizens of Atlanta from traveling by bike.[3] In addition, commuters cannot risk arriving at a MARTA station with full bike racks. However, if there were a secure location that is available at MARTA rail stations where people could reserve spots and store their bikes, there would be an increase of commuter ridership on public transportation. There is an overall need for better bicycle infrastructure in metropolitan Atlanta for general commuting.

Significance:

Atlanta is improving bicycle infrastructure; Mayor Kasim Reed's billion-dollar "Walk, Bike, Thrive!" plan will expand bike lanes, sidewalks, and multi-use trails in metro Atlanta.[4] Bike paths already encompass over 150 miles in Atlanta. Nevertheless, the issue still exists that people do not find biking convenient or safe enough to make the most of this ambitious plan. Currently, only five percent of all trips taken in the city of Atlanta are pedestrian or bicycle trips. Eighty percent of all home to work trips are in single occupant vehicles. This is a big factor in rush hour traffic problems and parking availability issues. Safer bike routes and storage would encourage more commuters to use bicycles for their daily commutes, freeing up space on highways and making parking easier to find.

As mentioned earlier, MARTA's limited reach requires an innovative approach to the first-mile/last-mile issue.[5] We have identified biking as an eco-friendly and efficient way to tackle commuting issues by encouraging more people to use public transportation. However, fear of theft and lack of convenient bike space is a strong deterrent of bike-riding and storage in

cities, especially in public transportation hubs. In fact, about half of all regular bicyclists experience bike theft, often more than once.[1]

Stakeholders:

General Commuter

Having a deterrent towards bike theft, along with making biking more convenient, encourages the general population to utilize their bike. Furthermore, specifically to the first-mile/last-mile issue, the general commuter would greatly benefit. Commuters will be able to take their bikes to MARTA stations to save time and money, both of which are important to most consumers. If biking infrastructure is safe and convenient in all parts of the city, the general population will be even more encouraged to utilize their bikes.

An indirect impact of more bikers (who may or may not use public transportation) would be less auto-commuters on the road. For a city that ranks one of the worst in the Western Hemisphere for road traffic, it is extremely important to find ways to reduce traffic on major interstates and busy local roads.

Private Businesses

A 2012 study conducted by the Transportation Research Board showed that bikers actually spend more money in businesses than auto-commuters.[6] Contrary to what majority of business owners believe, "patrons who arrive by automobile do not necessarily convey greater monetary benefits to businesses than bicyclists, transit users, or pedestrians". This is not because bikers spend more per visit; rather, they are able to visit more often and spend more in a cumulative sum over time (the "window-shopper" effect). The figure on the right conveys this notion with a survey of over 1,700 individuals. Therefore, even private businesses who choose to invest

TABLE 1 Average Customer Expenditures by Mode of Travel and Type of Establishment

Mode	Establishment	Trips per Month	$ per Trip	$ per Month	*N*
Auto	Bar	1.6	25.55	40.21	88
	Convenience	9.9	7.98	79.37	543
	Restaurant	2.2	18.74	41.16	409
	Total	4.5	13.70	61.03	1,040
Bike	Bar	4.9	14.08	68.56	42
	Convenience	14.5	7.30	105.66	63
	Restaurant	3.5	12.08	42.52	48
	Total	7.1	10.66	75.66	153
Transit	Bar	1.8	19.54	35.35	13
	Convenience	10.9	6.91	75.62	53
	Restaurant	3.5	11.52	40.68	36
	Total	5.7	10.15	58.16	102
Walk	Bar	3.1	22.17	68.42	53
	Convenience	12.6	6.13	77.34	254
	Restaurant	2.6	16.74	43.77	131
	Total	5.9	11.25	66.22	438
Total	Bar	2.5	21.78	53.59	196
	Convenience	10.9	7.36	80.40	913
	Restaurant	2.4	17.39	41.78	624
	Total	5.0	12.60	63.46	1,733

NOTE: *N* = number of respondents.

in personal bike infrastructure can benefit from an increase in bike commuters.

Government

Since this is an infrastructure-related project, one of the biggest stakeholders will be local governments and college-campuses within the metropolitan Atlanta area. Infrastructure is highly regulated by policy and bureaucracy, and ensuring a smooth transition with these organizations is key for the success of this project. Furthermore, if MARTA is our main target, we have to work with the official transportation board of Atlanta. Overall, the city of Atlanta would greatly benefit from investing in bicycle infrastructure. Studies show there can be up to a 20x return-on-investment (qualitatively and quantitatively).[7]

Bicycle Groups and Coalitions

Bike-sharing organizations (such as Relay Atlanta) may lose their market share if there are more accessible places for people to store their personal bikes around the city. However, since Atlanta itself may have the potential to be recognized as a top-10 bicycle city in the United States, any biking organization (such as the Atlanta Bicycle Coalition) stands to benefit from better biking infrastructure.

Context and Existing Solutions:

Currently, a few of the most common ways bikes are secured to stationary racks are chain/wire locks and U-locks. These low-level locks are fairly easy to break through and thus provide a false sense of security for the bike owner.[8] Moreover, when people do not find convenient bike racks, they often resort to locking their bikes to signs and street posts where they can be easily stolen or damaged. Some cities are beginning to build parking garages for bikes, but these systems are expensive for cities to actually implement, and it takes a long time to secure and retrieve bicycles. Commuters need a quicker solution.

In regards to the market of smart bike-racks, most of these specialized racks are only seen in the bike-sharing industry rather than for bike owners. Recently, Atlanta has been working with a company called Relay, which uses mechanized bike-racks to store their shareable bikes.[9] We want to create a system that is accessible to all users, not just those who prefer to use shared bikes.

There is an Estonian-based startup called Bikeep specializing in bike storage systems. Bikeep has implemented smart commercial bike racks in over 1,000 locations in Eastern Europe and is now beginning to work in California.[10] Our team was able to talk to Bikeep's Head of

Business Development for inspiration. We would attempt to bring similar technology to the Atlanta region but work to create a design that is more space-efficient and more secure.

Why this problem still exists:

One of the main reasons bike theft remains a prevalent issue is that it tends to be a low risk crime for thieves. Most of the time, they will not be caught, as the police tend to consider bike theft low priority. Even if they are found, they will often be released because many bike owners have not registered their bikes and thus can not prove ownership. Also, existing locks and GPS trackers for bikes tend to be ineffective due to the practice of stealing parts of bikes. One study found that in about 20% of bike theft incidents, the thief left only the locked part and stole the rest of the bike.[2] Overall, bike lock technology desperately needs an update to keep up with the times and often is an overlooked aspect of bike infrastructure.

Proposed Work

Goal:

In regards to our goal/solution, we are looking to design and implement a smarter bike rack that securely locks all parts of the bicycle, is space-efficient, and can provide valuable analytics about bicycle usage and storage.

Objectives:

Objective 1. Develop Prototype(s) for our bike rack :

Background

To implement this solution, we must create the bike rack. The majority of the work towards accomplishing this task is completing the research and development phase. During this phase, we want to develop various prototypes so multiple designs can be tested.

Methods

We will make 3D models of the rack and use these to plan out our actual prototypes.We will secure the necessary materials as shown in the 3D models and use these to create and establish a proof of concept for the bike rack system. Using the Invention Studio, we can create the bike-rack(s) for little-to-no cost, as the Studio has all the necessary tools. This will allow us to model and experiment with our design.

Outcomes

We will consider this objective to be met if we can develop at-least one prototype bike rack that can successfully prevent bike theft. Ideally, we will have multiple prototyped designs, but that is limited by the amount of resources we are able to secure.

Anticipated Problems

As mentioned earlier, the ability to acquire resources to develop multiple designs is difficult but extremely crucial for the success of our research and development phase. Furthermore, we will have to learn the app development skills to create an RFID scanner necessary for our project that is compatible with BuzzCards.

Objective 2. Test proof-of-concept with prototype on Georgia Tech's campus :

Background

College campuses generally have a high amount of bikers proportionally to the general population, and Georgia Tech is just the same. To test the proof-of-concept of our bike-rack, we will work with Georgia Tech, since they have a ready population to test and gather results with. Furthermore, many Georgia Tech students have been victim to bike theft (especially in the west campus area) despite the best efforts of GTPD because the current bike racks are insecure.

Methods

After we have developed a prototype, we would like to use Georgia Tech campus as a testing ground. We would deploy the bike racks around campus and configure them to be accessible via Buzz Cards. We would gather data about usage via the Buzzcard tracking system and our mobile application as well as survey students to learn about their preferences. This stage is important, as it allows us to gather field-data, test our prototype in realistic conditions, and give our team information to make any necessary changes to the design.

Outcomes

For this stage, we would consider it a success if we deployed the bike racks on campus in various location that students could used with BuzzCards or a mobile application.

Anticipated Problems

This objective hinges on the fact that Georgia Tech will be willing to work with us during our proof-of-concept phase, so we may face problems if they choose not too. Furthermore, we have to configure the bike racks with BuzzCard usage, and thus even if we are able to gain permission from Georgia Tech to deploy our bike-racks, we will need to work with the BuzzCard Office to get the necessary information and technology. Last but not least, we want to gain meaningful data about data usage, so our data analytics skills must be exemplary (a stage we are not necessarily at yet).

Objective 3. Expand solution to off-campus locations (MARTA, businesses, etc.) :

Background

After making necessary changes, we would look to expand our bike rack locations to public transportation hubs (MARTA train stations and high-traffic bus stations) and possibly other other college campuses and/or private businesses. Since our initial goal is working to solve the first-mile/last-mile, a clear objective to work with MARTA after our proof-of-concept phase is inherent.

Methods

Our first step will be to use the data gathered from the trial run to promote the efficacy and convenience of our new system. From there, marketing and communicating to MARTA (and eventually other organizations) the strengths and impacts of our system will be our next step. This second step can take a lot of time, so we must be diligent and methodical in how we communicate.

Outcomes

A key measure of success for this objective is the number of users and locations, especially those at MARTA hubs. Supplementary success can be provided by the usage of these bike-racks at colleges and private businesses.

Anticipated Problems

This stage will probably the most problematic, as at this point we are establishing ourselves as an actual "business." With that comes legal work, but also time-consuming bureaucratic hindrances. Furthermore, for MARTA station and general public installments, we would need the approval and funding from the officials of MARTA and the City of Atlanta to actually buy into the process. Overall, capital is going to be a significant limiting factor, so we will have to find different ways to find funding. This could from the government, private investors, or even organizations here at Georgia Tech.

Project Team:

Mechanical Engineers

We will need a total of six people to complete our project. We will need at least two people to design the prototype for our bike rack. These engineers will require 3D-modeling and mechanical engineering skills. After building the 3D model they will then need to physically build a bike rack prototypes.

Electrical/Computer Engineer

In addition, we will need another person to code the RFID scanner on the rack and get it to work with Breeze Cards or smartphones. They will also need electrical engineering skills to wire up the required hardware for the bike rack.

Computer Scientist

We will also need a computer scientist to create a backend web framework with an API for the bike racks to access and a mobile user interface. The computer scientist will be working closely with the electrical engineer.

Project Managers

Another one or two people would be in charge of project management and outreach. They will get feedback on our designs and manage the other group members. In addition, they will contact MARTA officials and obtain approval for the implementation of our prototype. Ideally these people will have communication and design skills to create pitches for our idea.

Potential Mentors

Catherine Ross

Not only does Catherine Ross have experience in transportation infrastructure at a national level, but she also has very detailed projects specifically in Atlanta. Furthermore, many of her projects and published research revolves around the synthesis between transportation accessibility and urban mobility, which is exactly what we are trying to tackle as well. And, as comes with being a leading expert, she can refer us to contacts that can come in very handy for us. We have already interviewed her about our project, and she showed a lot of interest.

Kari Watkins

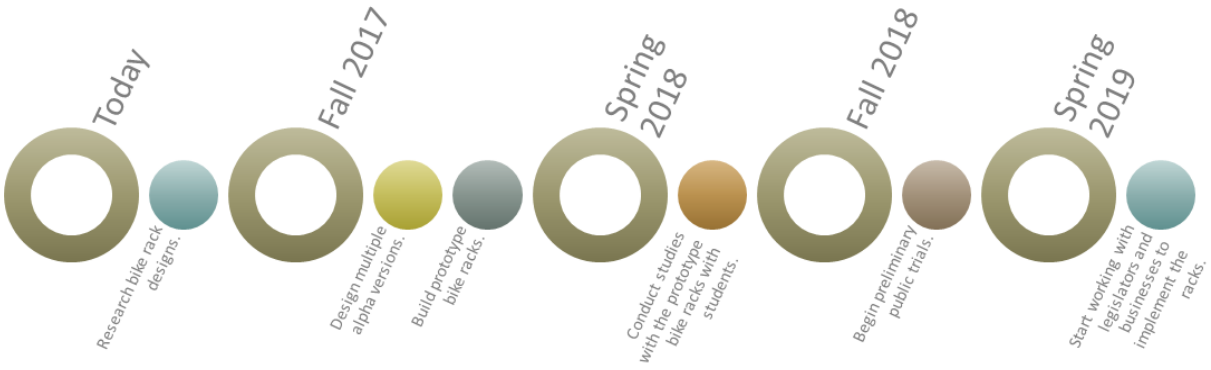
Kari Watkins is an Assistant Professor at the School of Civil and Environmental Engineering. Her research involves city planning for multiple modes of transportation. Recently, she has been focusing her research on cycling infrastructure presence in Atlanta. As an advisor, Dr. Watkins would understand the problem space and give great direction to the solution.

Ross Beppler

Ross Beppler has seen our group develop over the course of the year. He understands our problem space and our group dynamic. As an advisor, Ross will give guidance on what the group should work on and tell us how we can overcome obstacles.

Timeline:

We would like to design an alpha version of the improved safety bike rack before the end of the fall semester so that there would be time for getting a patent and preliminary testing before we install the bike racks in the fall at Georgia Tech. We would like to do testing on the effectiveness and ease of use for students for the spring 2018/fall 2018 semester, and then move on to preliminary trials for the general public at select locations by Spring 2019. We would then have to work with communities, legislators, and businesses to implement the bike racks on a



citywide level by Fall 2020.

Budget:

Expected Costs	
Price	Description
Materials Costs (per bike rack)	
~$300	Metal for the construction of the base of the rack.
~$10	Microcontrollers to enable the control of bike input and release.
~$30	RFID receivers and tags for user identification.
~	Web servers to keep track and manage users and bike racks.
~$50	Electric motors/servos for bike lock and release mechanism.
Equipment Costs	
~	The Invention Studio has suitable equipment to build the bike rack.
Service Costs (one time cost)	
~$3,000	If we decide to patent our solution, there will very likely be a significant legal charge for filing and processing the patent.
Travel Costs	
~$100	There is very little travel associated with our proposed project because all of our possible sites are accessible by public transportation or by car.
~$3,500	**TOTAL COST**

Expected Outcomes & Future Directions

We expect to create a smart and secure bike-rack that is accessible through a mobile-application, RFID, or personal codes. By the end of our second year, we hope to have a tested proof-of-concept on the Georgia Tech campus and would like to begin talks for implementation at MARTA train stations. Furthermore, at this point we would need to apply for funding from MARTA, the City of Atlanta, and/or the Georgia Institute of Technology. Eventually, we would start implementing our bike-racks at MARTA train and major bus stations. Finally, we would sell our bike racks to businesses around Atlanta so that they could encourage customers (as well as employees) to ride their bikes there. Overall, improved bike safety at public transportation hubs as well as businesses in Atlanta would promote biking all over Atlanta. Bike safety along with an important biking convenience factor would encourage more people to get out and explore the city. This would be beneficial to Atlanta tourism and transportation systems around the city and greatly reduce the strain on Atlanta's auto-infrastructure. We would also like to collaborate with biking organizations and local police, as that would help us gain support for our project and would get residents excited about improvements in bike safety.

In addition, we may decide to change the direction of our project to focus on some of our other ideas in the infrastructure space but still with the overarching goal of bettering urban mobility. One idea for improving transportation in Atlanta was to improve the general MARTA bus stop in Atlanta. Currently, bus stops have poor lighting and are very dangerous, and thus become a hotbed for illicit activity. Our idea includes equipping bus stations with electronic maps, emergency buttons, and improved lighting to make bus stops safer. Another possible route for pivot is to focus on improving package delivery. In our research, we found that package delivery has taken up increasing space on the roads, especially as companies try to speed up delivery, and we think there may be ways to improve this situation.

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