Final Project
K. G.

Use of RFID Technology for Providing Safe and Accessible Bicycling and Walking Opportunities in the Town of Watertown, Massachusetts, United States

1) Topic: Tell us again the topic that you are planning to explore.

For this project, I am exploring how Radio Frequency Identification (RFID) technology can be used at roadway intersections and bike trails to provide safe biking and walking opportunities for Watertown residents and visitors. I am also exploring how RFID technology can be used for improving bike and pedestrian accesses to the community paths and neighborhood areas.

RFID technology can help in reducing bike and pedestrian accidents. RFID technology can be used at traffic signals at major roadway intersections or at the intersections that have records of having high accidents. With the RFID technology, when a rider approaches an intersection, the RFID tag on his or her bike sends a signal to an RFID reader mounted at the intersection. An alert for the driver flashes right under the traffic light.[1] RFID can also be combined with GPS technology to send alerts directly to the GPS device inside a driver's car. Similarly, RFID technologies can also help in improving safety for pedestrians with the help of RFID tags attached to their bags or worn as wristbands. Pedestrians, especially elderly people can carry RFID tags with them, which will increase the pedestrian crossing time at an intersection allowing enough time for crossing the street.[2]

I am exploring this topic because my family loves walking and biking in our community. Like all Watertown residents, we are also concerned about safety issues. Watertown lacks bike lanes, well maintained sidewalks, and connectivity of existing bike trails and sidewalks in neighborhoods. There are no designated bike lanes on the streets therefore, bicyclists and cars have to share the roads. The existing bike trails (see Photo 2) are short and disconnected and the sidewalks are narrow. Traffic congestion on major streets creates another problem for pedestrians and bicyclists. Safety is a major concern for me and for everyone using a street. It would be nice to have a worry free moment whenever we are walking or riding and would be nice to have safe and continuous bike riding experience within the city all year round.

2) What: Tell us what you learned by exploring this topic.

By exploring this topic, I learned many things about Watertown's existing bike and pedestrian facilities, how citizens feel about biking and walking in Watertown and how badly Watertown is lacking on good bike lanes, well-maintained sidewalks and connectivity of sidewalks and bike trails/paths to the Charles River and residential neighborhoods. This topic also helped me understand how RFID technologies can be used for creating safe environment for both pedestrians and bicyclists at roadway intersections. Additionally, review of public forums conducted by Watertown and analysis of "Envision Watertown 2013 Comprehensive Plan" online forum in MindMixer, StreetSeen Survey, and analysis of accident and mode of transportation all helped me in understanding the topic in detail. These are further explained in later sections.

3) Where: What city is the student exploring this topic.

The community I am exploring is the Town of Watertown located in the State of Massachusetts in the United States. According to US Census 2010, population of Watertown in 2010 was 31,915. The area of Watertown is 4.2 sq. mi. (10.8 km^2).

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[1] EPCglobal Inc. discoverrfid. http://www.discoverrfid.org/what-is-possible/travelling-smart/by-bicycle.html

[2] EPCglobal Inc. discoverrfid. http://www.discoverrfid.org/what-is-possible/travelling-smart/on-foot.html?l=0

Photo 1: Town of Watertown, MA
Source of the map: SimpliCITY Mapping by PeopleGIS
http://www.mapsonline.net/watertownma/

Photo 2: Existing Rail Trail from Grove Street to School Street in Watertown. (Source: Fitchburg "Cut-off" path from Alewife to Belmont, http://www.pathfriends.org/fitchcut/)

Existing Rail Trail from Grove Street to School Street is the Watertown Branch of the Fitchburg "Cut-off" path from Alewife to Belmont (See Photo 2). The Fitchburg cutoff is an informal name given to the existing unimproved 0.8 mile multi-use path from the MBTA's Alewife Station in Cambridge along the Fitchburg commuter rail line to Brighton Avenue in Belmont. The Town of Belmont borders north side of Watertown and the City of Cambridge borders east side of Watertown.

Figures 1 and 2 provided below show that there are not many on-road bike lanes or path/trails in Watertown.

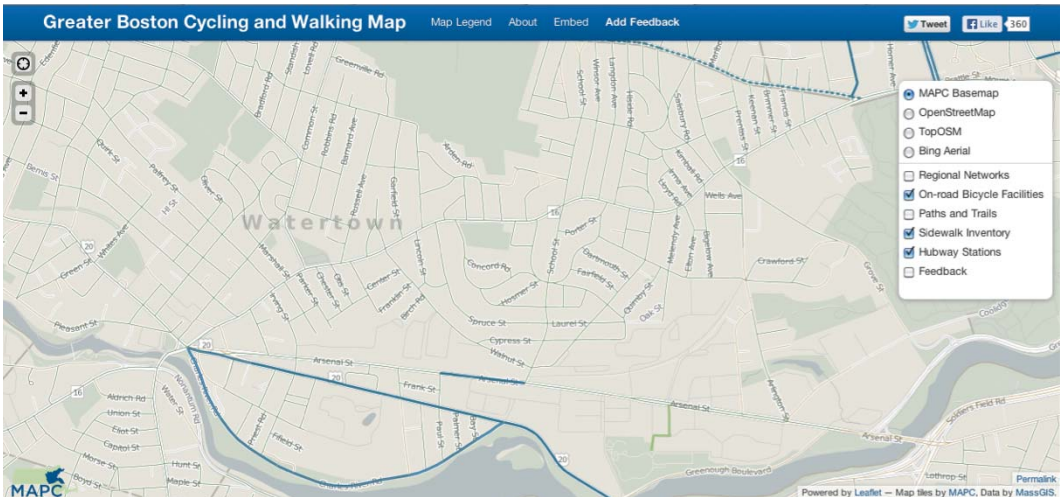


Figure 1: Map of Watertown showing on-road bike lanes. Solid blue line shows existing on-road bike lanes and the dashed blue line shows proposed on-road bike lanes.

(Source: Greater Boston Cycling and Walking Map. Metropolitan Area Planning Council (MAPC). http://trailmap.mapc.org/)

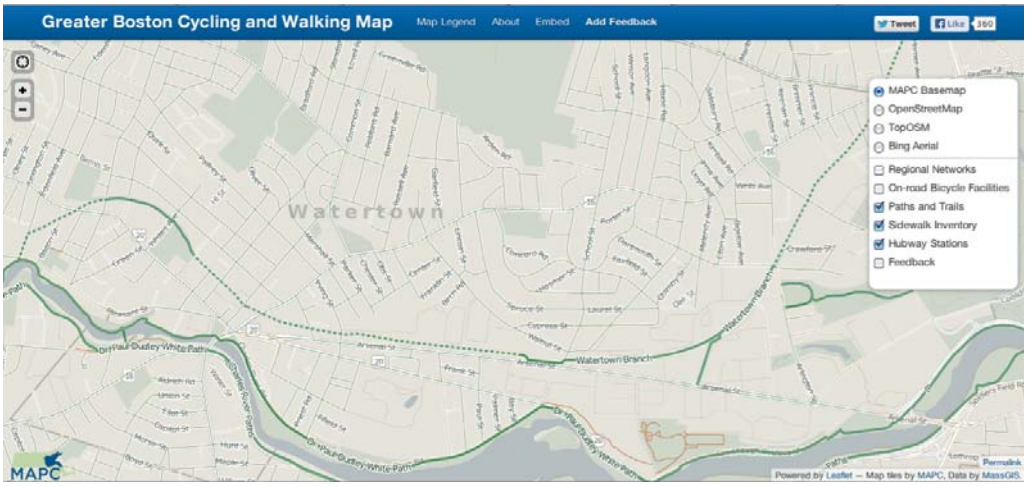


Figure 2: Map of Watertown showing paths and trails. Solid green line shows existing improved path and trails and dashed green line shows proposed improved path and trails.

(Source: Greater Boston Cycling and Walking Map. Metropolitan Area Planning Council (MAPC). http://trailmap.mapc.org/)

4) Who: Tell us who you engaged through this project and how you engaged them. Explain what you learned from the people you engaged with.

This project benefits all the people living in and visiting to Watertown, including little children, adults and senior citizens of the community. As part of the public engagement process for my project, I reviewed the most recent public forums conducted by the Town of Watertown in March of 2013, I did content analysis of "Envision Watertown 2013 Comprehensive Plan" online forum in MindMixer and conducted a survey about biking and walking experience. Additionally, I also conducted StreetSeen survey that showed photos of various streets from Watertown and Cambridge. These photos focused on sidewalks, crosswalks, bike paths and bike lanes, which were used in identifying the bike and pedestrian friendly streets. The public engagement process is explained below:

Public Forums of Watertown 2013 Comprehensive Plan Process:

The Town of Watertown is in the process of updating its Comprehensive Plan, which is expected to be completed in 2013. As part of the public participation process, Watertown and the project team have conducted a number of public forums and community meetings in the past few months. Since these public forums are the most recent public engagement processes initiated by the town, they provide the most relevant information about the citizens' perspectives and help in identifying the key issues about biking and walking. Therefore, I have included the review of March 21, 2013 public forum (uploaded in the Town website) that was participated by 200 people as one of my secondary resources for public engagement.[3]

During the March 21, 2013 public forum, a community survey was also conducted. Turning Point techniques were used for the survey that allowed the public to see the results of each survey questions instantly. Participants were asked a total of seven questions. One of the survey questions asked the public to identify the two most pressing transportation needs in Watertown. Public identified "Increase bicycle/pedestrian access and safety" (29% votes) and "Reduce congestion" (25% votes) as the two most pressing transportation needs. The other needs such as "Improve conditions of roadways" and "Build and/or repair sidewalks" each received 16% votes. This survey shows that people are certainly concerned about biking and walking in Watertown.

[3] Town of Watertown, Massachusetts 2013 Comprehensive Plan. Public Forum. March 21, 2013. http://www.vhb.com/watertowncompplan/pdf/Watertown%20Public%20Forum%20presentation_03-21-13_update.pdf

A snapshot of this survey question is provided below:

3. What are the two most pressing transportation needs?

a. Improve condition of roadways (16%)
b. Build and/or repair sidewalks (16%)
c. Reduce congestion (25%)
d. Provide more public transit options (15%)
e. Increase bicycle/pedestrian access and safety (29%)
f. Not sure/other (0%)

Source: Watertown 2013 Comprehensive Plan. March 21, 2013 Public Forum Summary Report.
http://www.vhb.com/watertowncompplan/pdf/3-21-13%20Watertown%20Public%20Forum%20Summary%20Report_draft_042613.pdf

The March 21, 2013 Public Forum also included breakout sessions. The following key issues related to my project were identified:

- Poor condition of roads and lack of trees and sidewalk in some neighborhoods
- Lack of pedestrian and bicycle connections,
- Need paths, lightings and better crosswalks,
- Traffic congestion, traffic signals difficult for bikes and pedestrians, need traffic calming,
- Need to improve walkability and bike safety

Content Analysis of "Envision Watertown 2013 Comprehensive Plan" on MindMixer

The *Watertown 2013 Comprehensive Plan* project team has opened an online, interactive community engagement forum called "Envision Watertown 2013 Comprehensive Plan" in MindMixer. The website for the online forum is: http://www.envisionwatertowncompplan.com/. I reviewed this online forum because this provides the most up-to-date ideas of the community citizen. As of May 25, 2013, 424 interactions and 150 comments were made by the users.

The engagement forum had a poll asking people to identify the two biggest obstacles to improving quality of life in Watertown to which people voted "traffic congestion" and "lack of quality open spaces and neighborhood" as the two biggest obstacles.

People were asked to provide suggestions for improving Watertown's transportation system. 34 comments were made and they included providing transit connections from Watertown Square to West Watertown, Waverly Square and other areas to the north and south of the Watertown Square. Comments were also made for increasing number of buses; reducing traffic congestion; providing bike lanes, pedestrian bridges, and safe crossings; and improving road conditions.

Finally, I sorted the most popular ideas based on the number of stars each topic received. There were a total of 56 ideas submitted, 18% of which (10 ideas) were directly related to making biking and walking safe and accessible in the community. The list of ideas related to biking and walking is provided below in the order of its popularity.

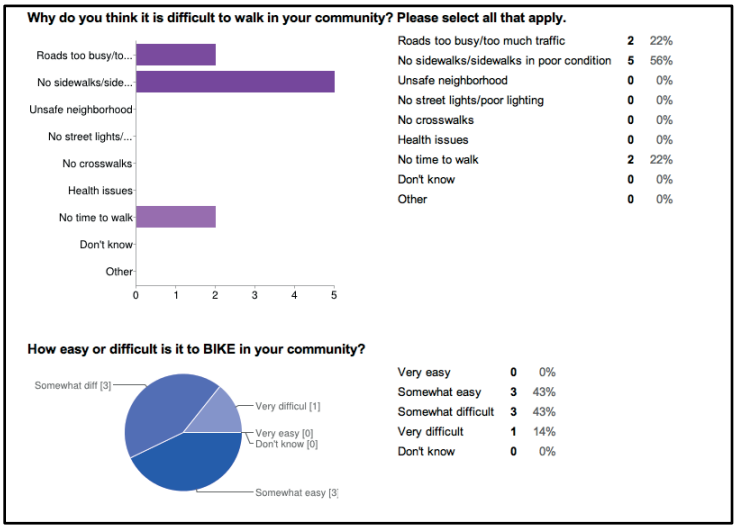
Most popular ideas from MindMixer (biking and walking related)
1. Continuous, uninterrupted walkability along commercial corridors
2. Better pedestrian access from Watertown Square (to Charles River)
3. More bumpouts for safe crossing
4. Develop centers of pedestrian/out activity and business
5. A walking culture (areas where people spend time outside in public spaces)
6. Prioritize pedestrian and bicycle traffic over vehicle traffic (reduce traffic lanes and provide bike lanes)
7. Kids are safe enough to walk or ride their bikes anywhere (need safe crossings and sidewalks)
8. Upgrade existing access point and promote obscure connections (provide ADA compliant access points)
9. Develop new connection along Pleasant Street West of Bridge St
10. Think of entire sidewalk network as a public greenway network

Source: MindMixer. http://www.envisionwatertowncompplan.com/.

Survey Analysis

I also conducted a quick survey with my friends living in and around Watertown about their biking and walking experiences and how they would think of application of the RFID technologies. The link to the survey is provided here:
https://docs.google.com/forms/d/1EzwYBG1HDisOA1F9C9_ECQxE52tRxBCDtui_2sKYnck/viewform

The survey analysis shows that participants were mostly in the 31-40 age group, enjoyed walking and biking, used cars as major mode of transportation and were very supportive of the adoption of RFID technologies for safe biking and walking opportunities. Most of the participants selected "no sidewalks/sidewalks in poor condition" as a reason for walking difficulties and "no bike lanes" as a reason for biking difficulty. Below is a snapshot of the survey result.



StreetSeen Survey

Please see sub-section "**c. Challenge**" under Section 5 of this report for more information about the StreetSeen survey analysis.

5) How: Explain how you completed the project. Include a discussion of how this project would improve your city.

a. Data Analysis: What data did you analyze for this project and what did you find?

I collected pedestrian and bike crash data to identify major problem locations in Watertown and mode of transportation data to understand how workers commute in Watertown compared to the state and major cities in Massachusetts. Identification of problem areas helps the city to prioritize the application of RFID technology. I also did online review about use of RFID technologies on improving biking and walking experiences. Data analysis discussion is provided below.

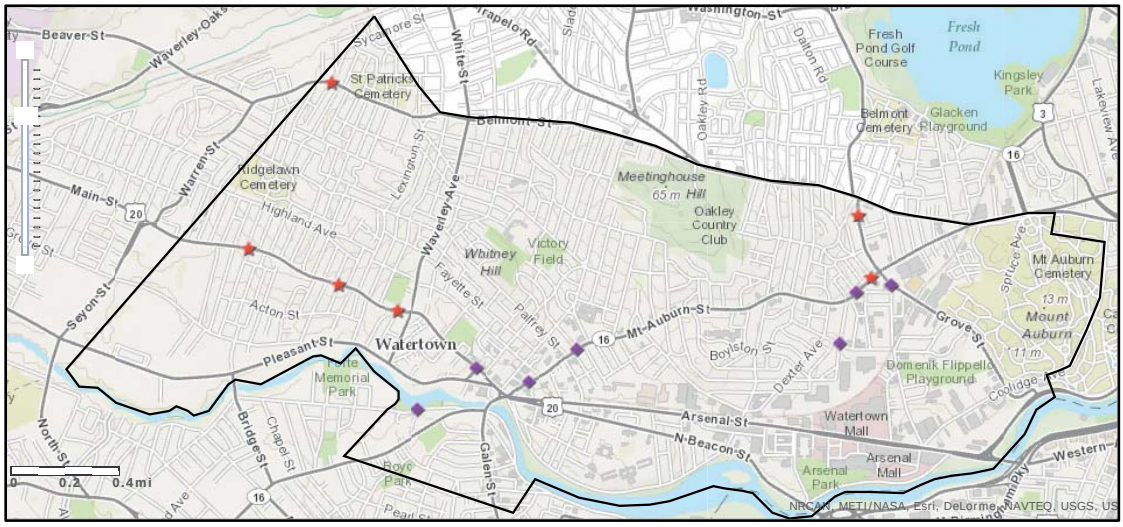
Pedestrian and Bike Crash Data

Pedestrian and Bike crash data for Watertown was collected from Massachusetts Department of Transportation (MassDOT) Accident data for Watertown. MassDOT provided a huge list of accident locations in Watertown however since my focus was only on pedestrian and bike crashes, I sorted out the list to separate the accidents that involved only pedestrian and bikes. The key points are highlighted below and listed in Table 1. Figure 3 illustrates the intersections where pedestrian and bike crashes occurred.

- A total of twenty (20) pedestrian accidents and ten (10) bike accidents were reported in Watertown at various locations in 2010. Seven of the pedestrian accidents and six of the bike accident were reported to be at roadway intersections. Other accidents were along roadways.

- As shown in Figure 3 and Table 1, majority of the pedestrian accidents occurred along the main corridor of Watertown: Main Street and Mount Auburn Street. All of these accidents were non-fatal type and involved collision with motor vehicles.

- Majority of pedestrian and bike crashes occurred during off-peak period, during daylight time and when the road surface condition was dry and weather condition was clear.



Legend

Bike Accident Location

Pedestrian Accident Location

Figure 3: Map showing bike and pedestrian accident intersections

(Source: Massachusetts Department of Transportation (MassDOT) 2010 Watertown Accident Data and http://www.arcgis.com/home/webmap/viewer.html?webmap=5d977f5b5cb04b30b6f5a7ce228c9400)

Table 1: Pedestrian and Bike Accident Location

S. No	Location	Intersection/ Non-intersection	Crash Period	Road Surface Condition	Ambient Light	Weather Condition
Pedestrian Accident Locations						
1	Marshall St/Mount Auburn St	At Intersection	Weekend	Dry	Dark - roadway not lighted	Clear
2	Main St/Cross St	At Intersection	Weekend	Dry	Daylight	Clear
3	Grove St/Arlington St	At Intersection	Off Peak Period	Dry	Daylight	Clear
4	Mount Auburn St Rte 16 / Taylor St	At Intersection	Off Peak Period	Dry	Daylight	Cloudy/ Unknown
5	Mount Auburn St / Irma Ave	At Intersection	Off Peak Period	Dry	Daylight	Clear
6	Melemdy Ave/ Nichols Ave	At Intersection	Off Peak Period	Dry	Daylight	Cloudy
7	California St / Fifth Ave	At Intersection	PM Peak Period	Dry	Daylight	Clear
8	Olney St	On a roadway	Weekend	Snow	Daylight	Clear
9	50 feet S from Intersection Galen St/Watertown St	On a roadway	PM Peak Period	Wet	Dark - lighted roadway	Rain
10	Lexington St	On a roadway	Off Peak Period	Dry	Daylight	Clear
11	Main St	On a roadway	Off Peak Period	Wet	Dark - lighted roadway	Clear
12	Orchard St	On a roadway	Off Peak Period	Dry	Daylight	Clear

13	Pleasant St	On a roadway	Off Peak Period	Dry	Daylight	Clear
14	Arsenal St	On a roadway	Off Peak Period	Wet	Daylight	Clear
15	Mount Auburn St	On a roadway	Off Peak Period	Dry	Daylight	Cloudy
16	Access Road next to Best Buy (off of Arsenal St.)	On a roadway	AM Peak Period	Dry	Daylight	Clear/Other
17	Arsenal St.	On a roadway	PM Peak Period	Wet	Daylight	Rain
18	50 feet E from Intersection Orchard ST/249 Panteline Terrace	On a roadway	Off Peak Period	Dry	Dark - roadway not lighted	Clear
19	783 Mount Auburn St Rte 16 W / Saint Mary Street	On a roadway	PM Peak Period	Wet	Dark - lighted roadway	Rain/ Unknown
20	Mount Auburn St	On a roadway	Off Peak Period	Dry	Daylight	Clear
Bike Accident Location						
1	Main St/Morton ST	At Intersection	Off Peak Period	Dry	Daylight	Clear
2	Belmont St/ Sycamore St	At Intersection	Weekend	Dry	Daylight	Clear
3	Main St/Evans St	At Intersection	PM Peak Period	Dry	Daylight	Clear/ Unknown
4	Arlington St/Ashland St	At Intersection	PM Peak Period	Dry	Daylight	Clear/Other
5	Main St/French St	At Intersection	Off Peak Period	Dry	Dusk	Clear
6	Mount Auburn St / Templeton Pkwy	At Intersection	PM Peak Period	Dry	Daylight	Clear
7	Main St	On a roadway	PM Peak Period	Dry	Daylight	Clear
8	Main St	On a roadway	Off Peak Period	Dry	Daylight	Clear
9	Mount Auburn St	On a roadway	Off Peak Period	Dry	Daylight	Clear/Other
10	Arsenal St/Watertown Mall	On a roadway	Weekend	Dry	Daylight	Clear

(Source: Massachusetts Department of Transportation (MassDOT) 2010 Watertown Accident Data)

Modes of Transportation in Watertown

United States Census Bureau, 2007-2011 American Community Survey provides the most recent data on the modes of transportation for workers 16 years and over in communities, which have more than 5,000 population. Mode of Transportation data is important to understand how workers in a community commute to their work, whether they depend mostly on private automobiles, carpools or public transportations to commute to their work or whether they bike or walk to their work.

Raw data of mode of transportation used by workers in Watertown, Massachusetts, Boston and Cambridge was collected and summarized as shown in Figure 4. I compared the data of Watertown with Massachusetts because it is important to know whether Watertown is doing better or worse in terms of walking compared to the state level. And, I compared it with Boston and Cambridge because these are two major cities of Massachusetts and are located next to Watertown. Additionally, both Boston and Cambridge have very good bike and pedestrian facilities such as bike lanes, sidewalks in good condition, hub stations for bikes etc. As shown in Figure 4, percentage of workers who walked (green bars) in Watertown is only 3%, which is below the state level (5%) and below both Boston (15%) and Cambridge (22%) walking levels. It shows that only few people are walking in Watertown compared to the state and the two cities. This could be due to lack of good sidewalks and proper bike lanes on the streets, which create unsafe environment for riders and walkers. By investing on technologies such as RFID system, the Town could encourage more people to walk and bike.

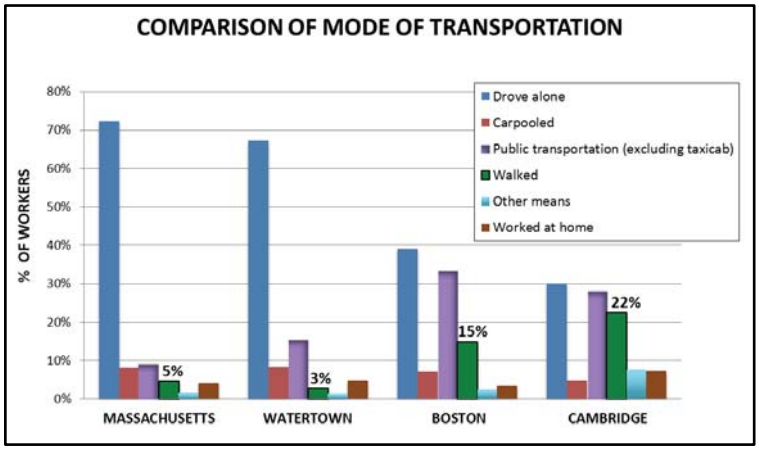


Figure 4: Comparison of Mode of Transportation
Source: US Census Bureau, 2007-2011 American Community Survey

Online Review of RFID Technologies

Some of the best practices to increase bike safety include design techniques that can be applied at traffic signals. *Bikeway Facility Design: Survey of Best Practices* dated 2010 and prepared by the City of Portland Bureau of Transportation provides two examples. One example includes traffic signal operations for bicycles designed to include advance signal detection in the bike lane, shorten delay for bike boulevard crossings and increasing bicycle interval. The second example includes design of traffic signal crossings for bicycles to full traffic signals with detection/actuation for bikes, pedestrian hybrid signals (also known as Hawk), midblock signals for trails and pedestrian crossings.[4]

Both of the above best practices can be further improved with the use of RFID technologies. I did online review of RFID technology use and researches conducted by various industries. These are summarized below:

RFID Technology at Roadway Intersections:

An article "Safer Roads for Bicyclists" written by Beth Bacheldor and published in RFID journal discusses how See-mi's RFID system, could reduce bicycle accidents. See-mi is a startup in Grenå, Denmark that focuses on road safety. In See-mi's RFID system, the "cyclist warning" display, which is mounted on traffic lights, flashes to alert drivers that there are riders in their path. The system consists of RFID interrogators installed on traffic lights and RFID-enabled reflectors affixed to the front of bikes. The reflectors contain semi-active UHF tags operating at 2.4 GHz. When a tag comes within 10 to 25 meters (32 to 83 feet) of an intersection, it sends a signal to the interrogator that, in turn, activates a "cyclist warning" display, which begins flashing to alert drivers. The display is placed strategically in the line of sight of the driver and encourages him to take extra precautions to avoid any accidents when turning his heavy vehicle.

This system was tested in Grenå to improve bicycle safety. Seven most dangerous intersections for cyclists and heavily used by school children were RFID-enabled, and 275 volunteers (both students and adults) were given RFID reflectors to affix to their bikes. See-mi also experimented with other technologies, but RFID proved the most effective and reliable technology. The journal further mentions that because of the unique ID associated with each tag, municipalities could use the system to track riding patterns, and adjust traffic lights to better accommodate bicyclists at certain times of day. The cost to install See-mi system at each intersection is about $38,000 (based on 2008 dollars). RFID-enabled reflectors could be sold to businesses, such as insurance companies, supermarkets and bicycle stores. Additionally, municipalities and schools could also purchase the reflectors for their citizens.[5]

RFID Technology at Parks:

RFID technology with locating system is being used at amusement parks to track kids. This technology could be useful in managing safety and accessibility of bike paths/trails in Watertown. Dolly's Splash Country is a water park in Tennessee that uses RFID locating system to help parents keep track of kids during a visit. This system was developed by "SafeTzone", a company that uses RFID to track people in large parks. The SafeTzone Child Locating System uses a wristband with an active, or battery-powered, transponder that sends a signal at 303 MHz to one of 22 readers located around the park. The band also has a passive RFID tag that operates at either 134 KHz or 13.56 MHz. The readers and active transponders are provided by RF Code, a Mesa, Arizona, provider of RFID systems and the passive tags are from Texas Instruments.

The system is fairly simple, but very effective. Wristbands strapped onto each person's wrist with a tamper-proof strap (it has to be cut off at the end of the day). Each party is registered together,

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[4] City of Portland Bureau of Transportation, "Bikeway Facility Design: Survey of Best Practices," 2010. http://www.portlandonline.com/transportation/index.cfm?c=44674&a=266116.

[5] RFID Journal. Safer Roads for Bicyclists. Beth Bacheldor. April 15, 2008. https://www.rfidjournal.com/purchase-access?type=Article&id=4023&r=%2Farticles%2Fview%3F4023

so during the day, anyone in the party can walk up to one of two kiosks strategically located at footbridges in the park, and swipe the low-frequency tag. A reader in the kiosk identifies the person and displays the location of the other members of the party on a cartoon map of the park.

RFID readers communicate wirelessly, so aside from power lines, there are no cables to install. The readers are strategically located around the park, but they blend in with the country theme, so they aren't noticeable to visitors. SafeTzone installs all of the equipment, including servers that gather the data and provide location information. SafeTzone monitors the system remotely via a dialup modem.[6]

RFID Technology for Alerting Car and Truck Drivers:

RFID technology is being used by several companies to make streets and bike lanes safer for cyclists. A company based in Denmark has developed and tested a system that alerts drivers of cars and trucks. When a rider approaches an intersection, the RFID tag on his or her bike sends a signal to an RFID reader mounted at the intersection. An alert for the driver flashes right under the traffic light. Researchers have tested a similar system that combines RFID with GPS technology. It would send alerts directly to the GPS device inside a driver's car. RFID is making more bikes available for citizens and tourists in cities across Europe and the United States. Various companies offer systems that use RFID to operate unattended bike rental stations. Cyclists use an RFID-based smartcard or chip to check out bikes from racks that carry RFID readers. Since each bike carries an RFID tag, the system knows which bikes are available or rented and can calculate when bikes were returned for billing purposes.[7]

RFID Technology for Helping Pedestrians Navigate Streets:

Another use of RFID technology includes helping pedestrians navigate streets. RFID can provide guidance in places where GPS doesn't work (for example inside buildings or in pedestrian tunnels). A test in Japan used this technology to provide information for visitors to Tokyo's busiest shopping district – Ginza. Visitors used specially enabled cell phones or borrowed devices to obtain detailed electronic information from posters that contained RFID tags or other forms of automatic identification. The posters were located throughout the shopping district and in pedestrian tunnels. By reading the RFID tag, pedestrians were able to obtain directions to key tourist sites, find historical information, get route information for wheelchair access or learn the location of the closest emergency to the pedestrian tunnel. [8]

RFID Technology for the Elderly:

RFID was also tested for helping elderly people cross busy intersections. Singapore's Land Transport Authority mounted RFID readers at an intersection and gave 30 residents in the area who were over 65 special RFID tags to use while walking. If a pedestrian needed more time to cross an intersection, he could wave his RFID tag at the reader. The traffic light would then reset to allow more time for crossing.[9]

RFID Technology for Guiding the Visually Impaired People:

A research project is being conducted in Italy to develop RFID-enabled pathways for the blind. In this project, three pathways are being tested. It involves use of specially designed canes to navigate the paths. The readers inside the canes then identify the RFID tags embedded in the ground along the length of the path, which is used for calculating the location of the pedestrian. This information is turned into an audio signal that the user hears in a wireless earpiece – a beep for the right and a bop for the left. The audio clues help the user continue along the centre of the path.

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[6] RFID Makes a Splash at Water Park. March 02, 2003. http://www.rfidjournal.com/articles/view?326
[7] EPCglobal Inc. discoverrfid. http://www.discoverrfid.org/what-is-possible/travelling-smart/by-bicycle.html
[8] EPCglobal Inc. discoverrfid. http://www.discoverrfid.org/what-is-possible/travelling-smart/on-foot.html?l=0
[9] EPCglobal Inc. discoverrfid. http://www.discoverrfid.org/what-is-possible/travelling-smart/on-foot.html?l=0

A similar system can be used at intersections to activate the crosswalk signal to indicate that the blind person wants to move to the other side of the street. The application helps blind people orient themselves in unfamiliar areas, and it could also be adapted as a commercial application to provide travelers with a virtual audio tour guide in cities around the world. [10]

b. Design: Describe the key design elements of your project.

The data analysis of StreetSeen survey, pedestrian and bike accidents and mode of transportation, review of public forum, online forum in Mindmixer show that existing condition of walking and biking in Watertown is not very good and that Watertown residents are concerned about safety issues for both bicyclists and pedestrians. Watertown residents (and visitors to the town) would definitely benefit from any improvements made to the bike lanes, sidewalks, traffic signals, and pedestrian crossing time with the use of RFID technologies. I have included information about RFID system from "Office of Privacy Commissioner of Canada" website below for better understanding of how RFID system functions.

> *According to the "Office of Privacy Commissioner of Canada", RFID technology is a subset of a group of technologies, often referred to as automatic identification, that are used to help machines identify objects, and which include bar codes and smart cards. RFID refers to the subset of automatic identification that uses radio waves to automatically identify bulk or individual items. The components of RFID technology are briefly discussed below and the source is cited in the footnote[11]:*
>
> *An RFID system consists of three components: a tag (or multiple tags), a reader or interrogator and the necessary supporting infrastructure (both hardware and software). An RFID reader or interrogator is a device to communicate with the RFID tag. It broadcasts a radio signal, which is received by the tag. The tag then transmits its information back to the reader. Readers can either be portable handheld terminals or fixed devices that can be positioned in strategic places.*
>
> *RFID tags, also known as transponders, are usually small pieces of material, typically comprising three components: an antenna, a microchip unit containing memory storage and an encapsulating material. Tags can be either read-only or read-write tags based on whether or not the information stored on the tag can be changed or erased.*
>
> *RFID technology also includes software and hardware that help in translating the raw data from the tag into information about the goods that are represented by the tags. .*
>
> *It should be noted that because of unique identification of the objects associated with each tag, people are concerned about privacy associated with RFID technologies.*

My project involves the following key design elements:

- <u>RFID technology at traffic signals to create safe crossing environment for both bicyclists and pedestrians and people with disability</u>

  One of the major safety issues that people had mentioned in the online forum in MindMixer included providing safe crosswalks or increasing pedestrian crossing time in Watertown. This technology can be first applied at major problem areas (intersections with high accident history, high traffic volume, speeding vehicles and poor visibility). With the help of RFID technology, traffic signal operations can help in reducing bike and pedestrian accidents. Every time a biker approaches an intersection, the RFID tag on his or her bike sends a signal

[10] EPCglobal Inc. discoverrfid. http://www.discoverrfid.org/what-is-possible/travelling-smart/guiding-the-blind.html
[11] RFID Technology. "Office of the Privacy Commissioner of Canada" website. *http://www.priv.gc.ca/resource/fs-fi/02_05_d_28_e.asp*

to an RFID reader mounted at the traffic signal. A separate flashing light provided at the traffic signal will flash sending an alert to the driver about the approaching biker.

Similarly, pedestrians can use RFID tags or wristbands to alert the drivers while approaching a crosswalk. People with disability who have to depend on wheelchairs can also benefit by RFID system. Some of the sidewalks and crossings in Watertown are not safe and easy for people with disability. So, RFID tags attached to wheelchairs can help in alerting drivers at intersections and providing pleasant crossing experience for them.

- Adopt RFID technologies on sidewalks at major intersections and sidewalks:

  RFID technologies on sidewalks at major intersections (especially at Watertown Square, Mount Auburn Street/Grove Street intersection etc.), along the main corridor of Watertown (Main Street and Mount Auburn Street) and/or along sidewalks of the streets, which are more prone to pedestrian accidents. As shown in the pedestrian and bike accident data analysis in earlier section, most of these accidents occurred along the main corridor of Watertown (Main Street and Mount Auburn Street) that runs linearly through the town. The MindMixer forum also showed that many people were concerned about how streets in Watertown are being used as community highways by people trying to get to other communities thus making it unsafe for bikers and pedestrians.

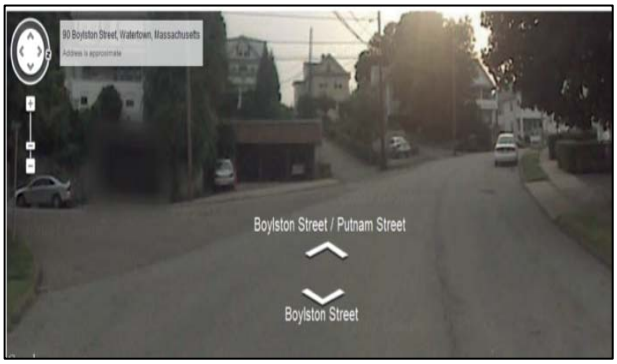
  Both of these designs would involve installing RFID reader at the traffic signal and installing RFID tag on bikes and wheelchairs or wearing RFID enabled wristbands or tags by pedestrians.

c. Challenge: If you have participated in challenge assignments that are related to your project, feel free to document the parts that are relevant to your final project.

As part of StreetSeen assignment, I had done the survey of bike and pedestrian friendly streets in Watertown and Cambridge. The survey result showed higher percentage of voters favored for Cambridge than Watertown because Cambridge has streets with bike lanes and well maintained sidewalks. Here is the link to my StreetSeen survey:
http://streetseen.osu.edu/studies/bike-and-pedestrian-friendly-streets/vote

The following key conclusions were drawn for bike and pedestrians friendly streets from the StreetSeen survey:

- People seemed to favour streets that have both designated bike lanes and nicely paved sidewalks, lots of trees along sidewalks, fewer cars, few travel lanes, and boulevards with trees separating traffic going in opposite directions.
- Aesthetics play great role when it comes to walking. People do not like streets or sidewalks that are in poor condition.
- People are concerned about their safety and do not like to use streets without sidewalks, trees, bike lanes or pavement markings. Traffic calming measures such as median islands were favoured.
- People are more willing to bike or walk in busy city centres (with more automobiles) if proper bike lanes and sidewalks are provided.
- One of the surprising results I found was that people were less likely to favour a street that has some construction activities going on even though that particular street has a bike lane Delay and safety issues due to construction activities could be the reasons.



Highest favoured photo on left and least favored photo on right. Source: StreetSeen Visual Survey.

6) Final Product:

Please see the link for the final product:
https://docs.google.com/file/d/0B7DSmJtuQkbuaWw0Q0V0ZFJQZk0/edit?usp=sharing

7) Who did you work with?

I worked on this project myself.