Can We Reduce Parking at MIT: Design and development of a functional commuter dashboard

by

Corey L. Tucker

B.S. Civil and Environmental Engineering, Engineering and Public Policy
Carnegie Mellon University, 2009

Submitted to the Department of Civil and Environmental Engineering and the Institute for Data, Systems, and Society
in partial fulfillment of the requirements for the degree of

Master of Science in Transportation and Master of Science in Technology and Policy
at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June 2016

Author: .... Signature redacted
May 19, 2016

Certified by: .... Signature redacted
John P. Attanucci
Research Associate of Civil and Environmental Engineering

Certified by: Signature redacted ....
Frederick P. Salvucci
Senior Lecturer of Civil and Environmental Engineering

Accepted by: .... Signature redacted ....
Munther Dahleh
Acting Director, Technology and Policy Program

Signature redacted
Accepted by: ....
Heidi Nepf
Chair, Graduate Program Committee

Can We Reduce Parking at MIT: Design and development of a functional commuter dashboard for MIT

by

Corey L. Tucker

Submitted to the Institute for Data, Systems, and Society and the Department of Civil and Environmental Engineering on May 19, 2016, in partial fulfillment of the requirements for the degrees of Master of Science in Technology and Policy and Master of Science in Transportation at the Massachusetts Institute of Technology

Abstract

This thesis presents the design, development and initial implementation of a new commuter dashboard tool entitled AccessMyCommute for use by all MIT employees. This is the first in a series of new commuter benefit incentives that MIT will introduce during the 2015-2017 academic years to its employees in order to reduce parking demand and to increase campus sustainability. Previous research has suggested that both financial and non-monetary incentives can be effective at encouraging behavior change, and AccessMyCommute leverages that knowledge with the introduction of a number of non-monetary incentives including: real-time trip planning, carpool facilitation, and a leaderboard to exert social influence. The tool also provides a platform for introducing a variety of forms of financial incentives. Quality control and usability studies preceded implementation. Introduction of AccessMyCommute to the MIT community is documented, and a design for the first set of financial incentives is presented. The first set of financial incentives was conducted through the use of Point Programs in AccessMyCommute and all users were awarded points for their commutes based on levels of sustainability. Those points could then be redeemed for prizes including a small set-value or entries into lottery raffles for larger prizes.

Initial results from the introduction of AccessMyCommute as well as the first point program suggest that in the absence of other incentives, particularly any disincentive to driving, commuters are unlikely to alter their mode. Point programs are effective as an incentive for commuters to log on to AccessMyCommute, but the number of employees participating is small and future work should aim to increase the number of participants. Finally, participation in the initial point program confirmed previous research that suggests that individuals exhibit risk-seeking behavior in the face of uncertain gains. This information should be leveraged in future work with AccessMyCommute, particularly in conjunction with additional new commuter benefits and incentives to be offered by MIT in the next academic year.

Thesis Supervisor: John P. Attanucci
Title: Research Associate in Civil and Environmental Engineering
Thesis Supervisor: Frederick P. Salvucci
Title: Senior Lecturer in Civil and Environmental Engineering

Acknowledgments

John, Fred, and everyone else associated with MST and with the Transit Lab for taking a chance on me when I was looking for something I was actually interested in doing at MIT.

Matthew, I would not have made it through this without you and our somewhat sarcastic competition to see who could be further behind at all times.

Barb, Ed, and everyone that makes TPP tick. Thank you for dealing with my visits and need to talk to someone about all that is hard about grad school. And for the constant supply of chocolate...mostly for the chocolate.

Larry Brutti, and the rest of the Parking and Transportation Office. I could not have done this without you. Thank you for all of your help, all of the data, and for constantly telling me to chill out.

Olu Brown, Kevin Lyons, and Eugene Bubis in IS&T. AccessMyCommute would not be online without your help because I certainly could not have done the programming to get all of our data processed week to week. I promise someone will continue to try to fix all the data problems to make your lives easier.

The RideAmigos team. It was a pleasure to work with all of you. Thank you for responding to my constant requests and for going above and beyond to help me accomplish what I needed to in order to get this done.

MIT cycling real and honorary. I could not have asked for a better group of people to call my friends and to get to spend countless hours on bikes and in cars with.

Mom, Dad, Lisa, and the rest of my family for constant support and lack of judgment when I call to tell them any of my crazy ideas for what comes next.

Table of Contents

List of Figures

List of Tables

Chapter 1 - Introduction

This thesis describes the design and implementation of an interactive commuting tool as an incentive mechanism to encourage commuting mode shift away from single occupancy vehicle (SOV) commuting. This type of tool was proposed as a new employer benefit in Emily Gates' master's thesis (Gates, 2015). In this research, the tool was developed and implemented, and early results form its implementation are reviewed to assess employee reactions and early influence on modality.

1.1 Background/Motivation

American cities exhibit the most dependence on car use among major cities worldwide (Kenworthy & Laube, 1999). There are a number of reasons for this, starting with the widespread suburbanization of the mid 20^{th} century, which saw the migration of most white-collar workers from city centers to the suburbs (Baum-Snow, 2010). This shift in home locations of a large proportion of the workforce led to a series of patterns that have sustained even as employers and employees begin to move back to central business districts. In the United States, a large proportion of government funding for transportation related projects is spent on highway infrastructure, as opposed to public transit (US DOT, 2013). And employers often offer parking to their employees, either for free or at a heavily subsidized price. These policy choices and norms make sense in an environment where employees and employers are locating outside of core areas, and therefore not concerned about externalities associated with encouraging employees to drive to work everyday, such as congestion and greenhouse gas emissions.

This is no longer the situation being faced in the United States, and specifically, in Kendall Square, a neighborhood located in the city of Cambridge, MA. Large employers are increasingly moving to the Kendall Square area to take advantage of the young, well-educated workforce matriculating from local universities (Chesto, 2016). Property values in central business districts are significantly higher than those in the suburbs and so the costs of continuing to provide parking to all employees would be very high. Most employers rent parking spaces from real estate developers, who charge set monthly fees at slightly lower than market rate to employers for a guaranteed number of spaces. Employers may then pass some or all of this cost directly to its employees. By doing this, real estate developers are guaranteed a set amount of income; however, they may miss potential income from market rate parking that they could obtain from visitors coming to the area for purposes other than work. This is particularly true in Kendall Square, which is a growing social destination for Cambridge residents with shops, restaurants, and entertainment. Many employers offer parking at highly subsidized prices as an incentive to new hires (LAO, 2002). As a result, employees continue to drive their cars to work, creating excessive amounts of congestion in Kendall Square and similarly situated urban centers (Jaffe, 2016). Furthermore, the parking supply in Kendall Square is insufficient to meet increasing demand at present (S Pollack, 2012). Employers and property developers must consider either building additional parking at high cost or encouraging commutes using alternative modes. Even if additional parking is constructed, the Kendall Square area is geographically constrained by the Charles River, and there is a finite parking capacity that may eventually be reached at which point it will not only be advisable that individuals commute differently, it will be absolutely necessary.

Additionally, the target new hire for most of these companies are recent graduates who are increasingly choosing to live in the core city area, or proximate to it, and commute by means other than single occupancy vehicle (Dutzik & Baxandall, 2013). As such, businesses locating in Kendall Square, and more broadly in any similarly situated urban area have an opportunity to encourage their employees to commute by means other than personal vehicle in order to reduce costs for the company, reduce congestion in the area, and reduce contributions to global warming.

1.2 MIT as a case study

The Massachusetts Institute of Technology (MIT) is an example of a large employer located in Kendall Square. MIT employs just over 11,000 individuals at least half time or more, making them benefits eligible (MIT Facts, 2016). Of these, nearly half hold some form of parking permit indicating that they park some or all of the time in MIT parking garages or leased spaces (MIT Parking and Transit, 2015). MIT is an interesting case because it owns much of its parking supply (4000 spaces vs. 300 leased spaces) allowing them to set parking prices independently. MIT is, however, experiencing many of the same problems facing other Kendall Square employers, namely, parking space constraints. Currently, MIT has two parking garages that have reached the end of their useful life. Additionally, parking demand is growing. MIT has some options to address this issue: renovate the old parking structures, build new underground garages at a cost of nearly \$120,000 - \$150,000 per space, or try to reduce demand. Although spending money and increasing parking capacity to meet demand is a simple solution, MIT could use that money to fund other university projects such as new lab space or dorms.

As part of Emily Gates' master's thesis work, the utilization of MIT as a case study for improved employer transportation benefits was proposed to the Institute (Gates, 2015). The proposal consisted of three key aspects, that, when combined were anticipated to reduce parking demand at the Institute. The first was a recommended elimination of the annual parking permit and a subsequent shift to charging for parking at all Institute garages on a daily basis. This would reduce the "lock-in" effect of the annual parking permit as parkers would no longer have the sunk cost associated with the permit. Instead, the daily decision of how to get to and from work would become more salient for the commuter that would have to daily consider whether or not they wanted to pay for parking on campus. The second was the provision of a universal transit pass to all MIT employees. The pass would provide free transit to employees, and would be paid for on a pay per use basis by the Institute. In combination with the shift away from annual parking pricing, this would provide commuters with a zero marginal cost commuting option, while the marginal cost of parking increased to the new daily parking rate. Finally, it was recommended that the Institute provide employees with a commuter dashboard tool that would provide a trip planner, facilitate carpool matching, and include a platform for the introduction of challenges, games, and lotteries as financial incentives to mode-shift.

After a number of iterations, the decision was made to launch the commuter dashboard, titled "AccessMyCommute", in early 2016. This launch would be followed by introduction of daily parking and universal transit to all employees at the beginning of the 2016-2017 academic year.

1.3 Objectives and Methodology

Previous research in transportation, as well as in other fields such as healthcare and education suggest that both non-monetary and financial incentives can be used to nudge behavior. Non-monetary incentives such as provision of real-time information and trip planning, carpool facilitation and matching, and exerting social pressure and/or leveraging social norms have all been shown to have an influence on behavior. Financial incentives have been used effectively in healthcare to promote both wellness and weight loss (John et al., Gomes et al.). In the field of education, incentives have proven effective at raising student test scores (Levitt et al.). And in transportation, a number of studies from the U.S., India and the Netherlands, have used financial incentives to encourage drivers and public transit users to commute during off-peak hours, thus reducing congestion during the peak (Ettema et al., Pluntke & Prabakhar). Although financial incentives have been employed in all of these contexts with varying levels of success, financial incentives have as yet to be used in an attempt to reduce parking demand by changing commuter's choice of travel mode.

Although there has been work that employed incentives to change behavior in transportation, the majority of previous research has been focused on shifting travel away from peak periods. This research seeks to apply a similar method to mode shift. This thesis will review the design and implementation of AccessMyCommute at MIT to offer both non-monetary and financial incentives of varying types and degrees in an effort to reduce parking demand at MIT. In order to facilitate the program, the research team worked with a third party to customize and implement AccessMyCommute, an online platform to track commuting behavior and implement incentives. AccessMyCommute was populated with trip data obtained from the MIT Parking and Transportation office, the Massachusetts Bay Transit Authority (MBTA), and electively from the *Moves* trip tracking mobile application that users could download onto their smart phones. Additionally, self-reported modes were allowed for users for which data could not be obtained from the sources listed above. Financial incentive schemes were conducted through an AccessMyCommute feature called "Point Programs", where points were awarded at designated levels for preferred commute trips (generally non-SOV trips). Those points could then be exchanged for cash prizes or entries into a lottery drawing at the discretion of the user.

In depth study into behavioral economics suggests that individuals do not always behave as expected when making decisions. A number of effects exist that skew human behavior away from the rational (Kahneman et al, 1983). As a result of these effects, it is unclear how individuals will respond to different types of financial incentives (deterministic vs. lotteries with differentiated payouts and chances of winning), and in fact may differ from individual to individual based upon each individual's perception of risk. As a result of this, the team offered a variety of different financial incentives including both a set value exchange rate as well as lottery entries for a larger prize drawing. The intent was to develop a better understanding of user behavior and preferences so that MIT can implement the most effective incentive scheme moving forward.

The methodology for implementing incentives and analyzing the effectiveness of those incentives is as follows:

- **Web platform design and implementation**
  - **Design:** For the design of the web platform the team worked with a third party developer to modify and further develop their web platform for trip tracking. The customized design seeks to make the tool as user friendly as possible by eliminating the need for self reporting and automating trip record generation through the use of parking data from the MIT Parking and Transportation office, and public transit data from the MBTA. The tool also integrates the mobile phone app *Moves* so that users can track their walking and biking trips should they choose to download and use the app. The team designed and implemented an algorithm to create trip records from the data listed above. One trip record is created per user per day to reflect a round trip commute to and from MIT. The logic of the algorithm is discussed in more detail in Chapter 3 – Dashboard Design and Review.
  - **Quality Control:** In order to ensure that the data obtained from the MIT Parking and Transportation office and the MBTA is accurate, and that the algorithm is functioning as expected, quality control testing was conducted prior to making AccessMyCommute available to MIT employees. For this, the team developed a brief questionnaire that was distributed to a sub-group of MIT employees. The questionnaire asked those users to review AccessMyCommute and report on the accuracy of their trip data. Should this review reveal systematic errors, the team

then reviewed the triplog creation process to make edits accordingly. If the triplog creation process was altred in any way as a result of feedback from the questionnaire, an additional quality control check was conducted.

- **Usability Review:** In addition to quality control, a two level usability review was conducted to ensure that the platform is sufficiently user friendly. The first level was a heuristic review where a group of transit lab students spent an hour reviewing the dashboard against a set of 10 heuristics defined by Jakob Nielsen (Nielsen & Molich, 1990). These initial reviews informed the second, more formal, moderated usability review conducted with MIT employees. The moderated usability reviews asked a group of MIT employees to perform a series of tasks while "thinking out loud" with the moderator present to observe the user with the interface and note any issues that arise (Barnum, 2011). Based on these reviews, minor changes were made to the AccessMyCommute interface.

- **Implementation at MIT**
  - **Rollout email campaign:** An email announcing AccessMyCommute was sent by the MIT Parking and Transportation office to the parking coordinators for each MIT department. This was done over the course of approximately one week, with email distribution to a subset of departments each day. The rollout was conducted slowly so that the team could handle incoming questions and concerns slowly, and so that any initial issues could be identified prior to the dashboard being made available to all Institute employees in the hope that those issues could be remedied prior to launch to the entire community.
  - **Point program launch:** Approximately a month following rollout of AccessMyCommute, the team launched the first point program to offer financial incentives in an effort to encourage regular visits and use of the dashboard as well as mode shift away from drive alone commuting. Rewards were offered at three levels: (1) small deterministic cash out, (2) mid level lottery reward with higher probability of winning and smaller buy in, and (3) large lottery reward with small probability of winning and large buy-in. Lottery drawings were conducted once, at the end of the point program. Rewards were distributed following the lottery drawing.
- **Analysis**
  - **Survey:** A survey was conducted in conjunction with the point program to elicit feedback on reception of AccessMyCommute among MIT employees, effectiveness of rollout and materials, and attractiveness of the various features including use of the trip planner and point program prizes.
  - **Mode-shift analysis:** Mode share was monitored before, during, and after completion of the point program. That mode share was also compared to commuting history over previous years to account for variability associated with the time of the year (weather). Because there was not a true control group, past

years populations were used as a control group. To do this, it was assumed that previous years populations of MIT employees are sufficiently similar to the MIT population to which financial incentives were offered so that a time series analysis could be performed to identify any mode shift trends.

- **Evaluation of population perception of rewards:** By offering multiple rewards during each period including a deterministic prize as well as lottery options, risk aversion and risk seeking among participants was evaluated by analyzing participation levels in each of the rewards. This information was combined with survey responses to inform recommendations for point program prizes during the future of the program.

1.4 Research approach

This research focuses on the design and implementation of a commuter dashboard at MIT as a case study for utilization of this benefit elsewhere. Although this thesis will explore and analyze first impressions of the dashboard and reactions to the first point program, it will focus heavily on future experiments that should be conducted with the tool now that it is in place. Furthermore, as the Institute has accepted a proposal for transitioning from annual to daily parking pricing as well as provision of a universal transit pass to employees, this research will consider the future of AccessMyCommute in the broader context of a large-scale change in employee benefits.

1.5 Thesis Organization

This thesis is organized following the outline of objectives enumerated above. Preceding the chapter on experimental design, Chapter 2 will include a review of relevant research literature, including research in human computer interaction and web interface design, behavioral economics, and the use of incentives to induce behavior change. Following the literature review, Chapter 3 will be devoted to the design and review of AccessMyCommute. Chapter 4 will follow the design chapter, with a discussion of experimental implementation including a full description of the first point program conducted at MIT and the methods for analyzing its reception and success. Chapter 5 will be a full analysis of initial experimental results including user perception, usability of the dashboard, overall mode-shift statistics, and a review of the different financial prizes offered during the first months of the experiment and the reaction to those incentives. Finally, Chapter 6 will offer conclusions about the use of AccessMyCommute to encourage mode shift and will then provide a recommendation for the future of AccessMyCommute at MIT and it's goals for parking reduction, as well as presenting some key points that will be useful for any other Kendall Square or similarly situated employer considering using financial incentives to achieve parking demand reduction.

Chapter 2 - Literature Review

This chapter will review research relevant to this thesis beginning with a review of website design standards and usability for both the design and review of AccessMyCommute. It will then review some concepts of behavioral economics that will be critical to designing and implementing effective incentive schemes at MIT. The review will then turn to a look at the use of non-monetary incentives on behavior change, followed by the use of financial incentives on behavior change. The chapter will conclude with a discussion of some research on the effectiveness of lotteries specifically as behavioral modification tools.

2.1 Website Design and Usability

2.1.1 Design

Usability is a critical aspect of the design of any website and should be considered throughout the design process. The standard definition of usability provided by the International Organization for Standardization (ISO) is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO 9241-11, 1998). Further, a study performed by Consumer WebWatch in collaboration with researchers from Stanford University surveyed 2,684 people in an effort to identify the website features most likely to lend credibility to the site. Of the 16 identified features, the top two were "Design-look" and "Information Design/Structure" (Fogg et al., 2002). These two features can be mapped directly to the "effectiveness, efficiency, and satisfaction" descriptors of the ISO standard for usability. This finding further highlights the importance of usability in website design, and suggests that it is THE critical aspect of determining a website's credibility.

Having a working definition of usability is critical to being able to evaluate a website to ensure that it provides a good user experience. Although the ISO definition is concise and easily conceptualized, it does not necessarily lend itself to the development of easily measurable metrics for a usability review. Usability expert Whitney Quesenbery elaborates on the ISO definition to provide a straightforward framework for thinking about usability that she refers to as the 5 E's: effective, efficient, engaging, error tolerant, and easy to learn. Any website should be effective in that it provides users with the information and tools necessary to complete specified goals, those things for which the user would access the website, accurately. It should also be efficient, meaning, it should enable users to not only complete those goals accurately (effective), but it should enable them to complete those goals quickly. The website should be engaging for the user, they should enjoy using it and want to return. It should exhibit design intended to prevent errors caused by the user and be also able to help users recover from errors that do occur. And finally, a website should be easy to learn, not just at the time of initial launch, but anytime new features are added (Quesenbery, 2001).

2.1.2 Evaluation

Methods to evaluate a website's usability can generally be classified in two ways. The first, is based upon WHEN during the website development process the testing occurs. Testing that occurs during, and possibly ongoing throughout, the design process is referred to as "formative". Formative testing is also generally performed using smaller samples and feedback may be used to make changes to the product during development, before re-testing. In contrast, testing that occurs after the product is complete is referred to as "summative". Summative testing generally has a "goal of establishing a baseline of metrics or validating that the product meets requirements". It is generally performed with a larger sample, and feedback from summative testing may be archived for future product revisions (Barnum, 2011).

As noted, formative testing generally uses significantly smaller sample sizes than summative testing. Through research on the cost and benefit ratio of usability testing per participant, Jakob Nielsen and Tom Landauer determined that the maximum cost-benefit ratio occurred when testing with between three and five participants as shown in Figure 2-1.

Figure 2-1 Usability issues by number of testers

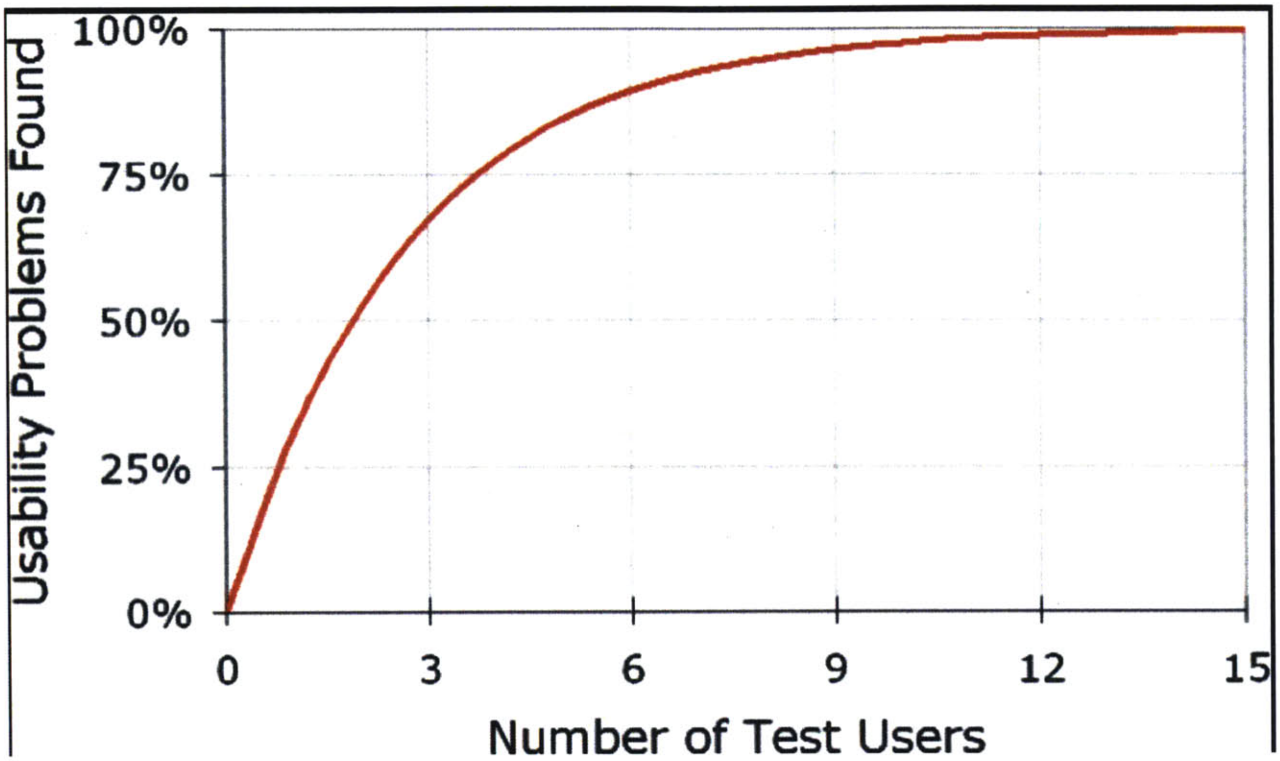


Image from the Nielsen-Norman Group (https://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/)

What their research suggested, as shown graphically in the Figure 2-1 above, is that approximately 80% of all usability problems are discoverable with five testers, and that above that number you learn relatively little with each new user (Nielsen, 2000)

The second classification of testing methods is based upon WHERE the testing is performed. Traditionally, usability testing has been conducted in a testing lab with specialized equipment and set-up. Available technology is changing this, however, by enabling remote testing through the use of web-cams, computer recording software, and online surveys. There are three main location possibilities for testing: (1) in a lab, (2) in the field - at the user site, and (3) remotely. In the field requires the moderator to travel to the user and perform the testing "in the field". This can be costly because of the potential of required travel, however, there are distinct benefits in that the moderator can see how the user interacts with the website in their environment, including prevalent distractions, etc. Remotely can be synchronous or moderated, with a person interacting with the user as they complete the test via the Internet, or it can be asynchronous or un-moderated, utilizing computer recording software to record the user's performance of tasks and online follow-up surveys. These methods obviate the costs associated with travel, however, eliminates the possibility of direct observation of the user with the website which may limit understanding of user interaction (Barnum, 2011).

Finally, usability testing can be classified by HOW the testing is performed, or the method of analysis employed. The U.S. Department of Health and Human Services highlights a number of usability evaluation methods including: usability testing (remote - moderated, remote – un-moderated, in a lab, informal), focus groups, surveys, and heuristic evaluation, among many others (usability.gov, 2016). Questions from the "Usability Professionals' Association Salary Survey 2009" regarding techniques, identified usability review and heuristic evaluation as the two most commonly used methods among usability professionals, with heuristic evaluation overtaking usability review for the top spot as compared to 2007 survey results (UPA 2009 Salary Survey, 2009).

A heuristic review is a "review or inspection of a product by experts" (Barnum, 2011). These reviews are based on a set of guidelines or "heuristics" against which a website's functionality and usability is assessed. Jakob Nielsen and Rolph Molich developed the initial set of heuristics to evaluate user interfaces and presented them in their paper, *Heuristic Evaluation of User Interfaces* (Nielsen & Molich, 1990). Jakob Nielsen further refined the list to a final 10 heuristics:

1. Visibility of system status;
2. Match between system and the real world;
3. User control and freedom;
4. Consistency and standards;
5. Error prevention;
6. Recognition rather than recall;
7. Flexibility and efficiency of use;
8. Aesthetic and minimalist design;
9. Help users recognize, diagnose, and recover from errors; and
10. Help and documentation.

In order to perform a heuristic review, expert users would spend time with the website to familiarize themselves with the platform before analyzing the website against the ten heuristics listed above. Often this type of review is performed early in the development process, and ideally before a more traditional usability review, as a means of identifying catastrophic errors at a sufficiently early point to be able to remedy it, as well as to inform a future usability review (Barnum, 2011).

2.2 Behavioral Economics

Herbert Simon originated the concept of behavioral economics in his work *A Behavioral Model of Rational Choice* where he postulated that the prevalent economic assumption of a rational actor (economic man) was in need of revision to account for anomalies of human decision-making (Simon, 1955). His theory was further refined in the 1970s by Daniel Kahneman and

Amos Tversky who presented a collection of biases commonly displayed by individuals making decisions under uncertainty and further developed a set of heuristics of thinking under uncertainty (Kahneman & Tversky, 1974). Essentially, Kahneman and Tversky posited that making decisions in risky circumstances are difficult, and therefore humans use these heuristics to make the decisions easier. As a result, if we fully understand the heuristics, we can utilize them to encourage good decision-making.

Kahneman and Tversky went as far as to propose an alternative model to the traditional model of expected utility theory that they titled "Prospect Theory" (Kahneman & Tversky, 1979). Prospect theory highlights three departures from expected utility theory exhibited by individuals making decisions under uncertainty: (1) the certainty effect, (2) the reflection effect, and (3) the isolation effect. The certainty effect suggests that individuals tend to "overweight outcomes that appear certain, relative to outcomes that are merely probable". This suggests that individuals are risk averse when it comes to gains. That is, a person is more likely to take a sure gain of $5, than a 50 percent chance of winning $10. The expected value of both prospects are the same, however, individuals are more likely to opt for the certain $5. The reflection effect is characterized by a reversal of preferences around the break-even point. That is an individual that exhibits risk aversion in the case of sure gains, would exhibit risk seeking in the case of sure losses (i.e. would prefer a 50% chance of losing $10 to a sure loss of $5). Finally, the isolation effect suggests that individuals often disregard components that are shared between alternatives and focus on components that distinguish them. This sometimes distorts rational behavior because there are often numerous ways to decompose a risky choice and this effect ignores all but one (Kahneman & Tversky, 1979).

Robert Metcalf and Paul Dolan conducted a review of the application of these behavioral economic concepts to the field of transportation. Their research highlights a number of applications to transportation. They note that individuals are extremely sensitive to losses. This corresponds closely to the reflection effect described by Kahneman and Tversky where individuals would favor a chance of a loss over a sure loss, even when the expected value of the options is the same. They also point out that individuals overweigh small chances. In a study on the probability weighting function, Gonzalez and Wu point out that decision makers do not usually perceive changes in probability linearly. That is, a change from a five percent chance to a ten percent chance of winning seems more significant than a shift from a 30% to a 35% chance, even though the magnitude of the change is the same (Gonzalez & Wu, 1999). It is also explained that people value the present very highly and often practice hyperbolic discounting wherein they value the present very highly over later, and although they value later over later still, the relative magnitude of the value differential is less. This leads people to discount future events if sacrifices are necessary in the present. When connected to incentives, this suggests the importance of offering an incentive that is temporally proximate to the sacrifice that is required in order to garner the incentive. Finally, Metcalf and Dolan point to the context of the decision as being exceptionally important in the behavior of an individual faced with making a risky choice, and present a mnemonic device - MINDSPACE to summarize the impacts of context on human behavior. MINDSPACE stands for messenger, incentives, norms, defaults, salience, priming, affect, commitments and ego (Dolan & Metcalf, 2012). See figure Table 2-1 below for a more detailed explanation of MINDSPACE.

Table 2-1 Mindspace

Table 1
MINDSPACE – the role of context on behaviour.

Messenger	We are heavily influenced by who communicates information
Incentives	Our responses to incentives are shaped by mental shortcuts
Norms	We are strongly influenced by what others do
Defaults	We 'go with the flow' of pre-set options
Salience	Our attention is drawn to what is novel and seems relevant to us
Priming	Our acts are often influenced by unconscious cues
Affect	Our emotional associations can powerfully shape our actions
Commitments	We seek to be consistent with our public promises, and reciprocate acts
Ego	We act in ways that make us feel better about ourselves

Note: This is taken from Dolan et al. (2010) and Dolan et al. (2012).

Metcalf and Dolan demonstrate the importance of these contextual attributes by presenting a number of studies. With respect to norms, Metcalf and Dolan note "people often take their understanding of social norms from the behavior of others" (Metcalf & Dolan, 2012). They further point to a study conducted by Allcott, wherein OPower, a software company that provides data analytics to utilities and the customers, provided letters to its customers providing social comparisons of energy use between that customer and their neighbors. The outcome was to reduce energy consumption by about two percent compared to the baseline, suggesting that customer's perceptions of social norms for energy use from those letters led them to reduce their energy consumption (Allcott, 2011). Another study performed by Cialdini presented further evidence that social pressures can be incredibly important in eliciting behavior change. In that study, signs were placed in hotel rooms encouraging people to reuse towels for environmental reasons, which resulted in a 35% increase in towel reuse. When those signs were replaced with signs suggesting that most previous occupants of that room had reused their towels, the percentage jumped to 49%, further demonstrating the value of social norms on individual behavior (Cialdini, 2003). With respect to transportation, this could mean that people would more willingly consider taking transit if it were portrayed as the most socially acceptable option, or was the norm.

Saliency refers to the perception by the individual that something is relevant or irrelevant to them. This is usually reflected in the ease with which people can understand and can use or process information that is made available to them. Furthermore, this contextual attribute also "explains why unusual or extreme experiences are more prominent than constant experiences" (Metcalf & Dolan, 2012). That is, peak or extreme events, or events that are last in a chain of events, are more likely to recur in our memory and therefore will be representative of the event to us. This phenomenon is closely related to the availability heuristic explained by Kahneman and Tversky and described by the ease with which an event can be recalled (Kahneman & Tversky, 1974). Saliency may be critical in the application of an incentive structure as the reward may be the last in a chain of events, or even represent an extreme event, and therefore significantly impact an individual's perception of the event. An individual who made a minor sacrifice over the course of a month by taking transit rather than driving daily, may forget about that sacrifice if they are rewarded with a large prize at the end of the month, prompting them to continue the behavior in the future seeking a similar reward. Furthermore, the daily decision of whether or not to commute alone could be made more salient by making the costs of that choice more available to the commuter.

Priming describes the phenomenon where an individual's actions may be impacted by cues that we are unaware of impacting behavior. For example, individuals primed with words related to cooperation led people to give more during a public cooperation game (Drouvelis et al., 2010). In another study, individuals primed with words about the elderly were observed to walk slower and have a poorer memory of the room upon completion of the interview (Dijksterhuis & Bargh, 2001). Metcalf and Dolan are unable to present any studies of the priming effect related directly to transportation, but the evidence in other fields is substantial and could be extended to transport related behaviors. For example, even providing commuters with more robust information about their commute by offering suggestions for public transit or biking and walking routes could bring those modes to the forefront of their mind and lead to their consideration the next time a commuter has to make a choice about how to get to work.

The contextual impact of affect can be described as the impact of an individual's mood on the decisions and choices that the individual makes. A study by Xu and Schwarz suggests that an individual's feelings about driving their car are impacted by how they think about what they are doing (Xu & Schwarz, 2006). The suggestion is that a person who has a positive association with their car, or a negative association with taking transit (or other alternative modes) likely has positive feelings when driving and is more likely to drive. Alternatively, a person who often experiences frustration when driving, perhaps as a result of heavy congestion, might opt happily to use alternative modes if they are primed with information about those modes (Metcalf & Dolan, 2012).

2.3 Non-monetary Incentives

The theories behind behavioral economics have been utilized in a number of ways to encourage behavior change in the context of transportation. In addition to financial incentives that will be discussed further below, short-term initiatives, carpool facilitation and benefits, provision of real-time information, and leveraging of social norms, are methods frequently used in transportation in an attempt to influence mode choice or other transport related behaviors.

2.3.1 Short-term initiatives

Short-term initiatives may include bike to work days or climate or sustainability challenges, among others. A report from an annual bike to work day event conducted across the Australian state of Victoria reported that 27% of those that reported riding to work for the first time during the event, reported that they were still riding to work five months after the event (Rose & Marfurt, 2006). This study also asked participants to identify which aspect of the event was most significant in encouraging their participation. The two most prevalent responses were "being part of a big event that promotes cycling" and "seeing lots of people riding to work" (Rose & Marfurt, 2006). These outcomes suggest that providing a participatory experience that encourages new cyclists by putting a lot of cyclists on the road, perhaps making novices more comfortable by surrounding them with other cycling individuals, as well as fostering a sense of community is likely to solicit new riders, and the experience can contribute to their continued riding as a form of commuting. Further evidence for the effectiveness of ride to work days is provided by similar events held in Queensland, Australia and Washington, D.C. where 38% of first time riders reported continued bike commuting after the event (LDA Consulting, 2002).

Another common form of short term initiative are sustainability challenges such as the annual Utah Clear The Air Challenge, which is a month long challenge to encourage non-SOV commuting throughout the state. The majority of participants joined as a member of a corporate team, suggesting that competitions conducted between businesses may be an effective means for encouraging participation. The challenge was facilitated through a self-reporting online platform designed by RideAmigos, a third party providing a commuter tracking platform which not only tracks trips made via sustainable modes, but provides estimated statistics on CO_2 reduced, money saved, and calories burned (UDOT, 2015). RideAmigos will be discussed in more detail in Chapter 3 - Dashboard Design.

2.3.2 Carpool facilitation and benefits

A review of carpooling incentives conducted by Emily Gates in her master's thesis work suggests that "psychological barriers, attitudes and perceptions" have a significant impact on whether individuals choose to carpool. Further, that "people find employer or school affiliation a quick and comfortable way to decrease the 'stranger barrier' in organizing carpools" (Gates, 2015). As a result, utilizing an employer network to encourage carpooling as a sustainable mode may be effective as it eliminates some of the concerns of potential users.

Another key consideration and complaint of possible carpoolers is that carpooling does not offer the flexibility that they need before and after work, citing necessary stops (groceries, kids at daycare, the gym) as major hurdles in sharing a ride to and from work with other people (O'Brien, 2010). These concerns can be addressed and potentially mitigated by provision of information and the availability of good carpool matching that may enable individuals to find people that have similar commitments or to at least set up carpools on certain days of the week, perhaps when they have a more flexible schedule.

2.3.3 Real-time and trip planning information

With the progression of technology including cell-phone technology and automated data collection technologies on public transit, information is available more readily than ever before. Real-time information is critical, not only during travel, but for commuters as a part of their trip-planning to and from work. Mapping technologies such as Google Maps and Open Street maps enable individuals to plan trips and see not only the quickest route by car, but to compare those routes to possible public transit options. A study conducted in New York City suggests that the availability of this information via the web or a smartphone has increased bus ridership in New York by approximately two percent (Brakewood et al, 2015).

2.3.4 Social Norms

Finally, as discussed above, people demonstrably care what others think of them. This results in individuals tending to "follow the crowd" or have a tendency to abide by social norms. The impact of social norms on behavior can be seen in a study by Cialdini where signs requesting that hotel guests recycle their towels were placed in hotel bathrooms. The research demonstrated that the most effective signs were those that implied that recycling hotel towels was the normal behavior for individuals staying in that room (Cialdini, 2003). Furthermore, utility companies often include a comparison of a customer's energy use to their neighbors in order to exert social pressure on the customer to use less energy. A study by Alcott showed that this method resulted in a 2% reduction in energy use as compared to the baseline. This method could be used in the context of transportation by making sustainable commuting patterns the norm. If SOV commuting becomes an anomaly, rather than normal, a commuter may be more willing to consider alternative commuting habits.

2.4 Financial Incentives and Behavior Change

The use of financial incentives to encourage behavior change is well documented. Studies in health have used financial incentives to both encourage weight loss as well and to encourage people to follow prescribed drug intake (Volpp et al, 2008). In education, a study by Levitt et al. demonstrated that incentives could be an effective means of increasing student performance on standardized tests if rewards are offered immediately. The impact of the offered rewards diminishes if temporally separated from the test demonstrating the behavioral phenomenon highlighted by Metcalf and Dolan of the heightened value of the present (Levitt et. al, 2011). Furthermore, Hirshleifer demonstrated through a study with school children in India, that providing incentives to encourage behavior change is more effective if applied to behavior inputs rather than behavior outputs (Hishleifer, 2016). That is, rewarding students for better test scores without explaining how they might achieve better test scores may not be as effective as rewarding students for reading and/or studying more, which may then lead to better test scores.

Within the transportation field, incentives have been used in several instances to shift travel demand from peak to off-peak times. Researchers at Stanford University have conducted studies in Bangalore, India, Singapore, and on the Stanford University Campus to offer financial incentives to commuters willing to shift to off-peak commuting times. The project in Bangalore ran for six months from October 2008 to April of 2009, and was referred to as INSTANT (the Infosys-Stanford Traffic Project), and awarded credits to users daily based on their arrival time at the work site. Users were then qualified for a monetary reward at the end of every week. The rewards were offered in the form of a raffle, where the credits that had been accrued by the user qualified them for specified reward levels and win probabilities (higher rewards and better odds were possible for those with more points). The experiment in Bangalore resulted in an approximate doubling in the number of people commuting during off peak times and a 17-minute reduction in average commute times for all commuters (Merugu et al., 2010).

Following on the success of INSTANT, the same group of researchers conducted a similar study in Singapore entitled INSINC. INSINC relied on the belief that "commuters respond more to 'higher payout raffles' than to 'lower payouts' made with certainty". That is a reflection of the concept that decision makers overweight small probabilities. Furthermore, the researchers hoped to capitalize on social norms by leveraging social motivation to increase the impact of financial rewards. INSINC differs from INSTANT in that points earned through commuting during off-peak periods could be exchanged for a fixed exchange rate, or the opportunity to win larger prizes by playing a game. Approximately 88% of participants elected the raffle option over the fixed exchange rate, clearly demonstrating user's likelihood to overvalue small probabilities of winning. Researchers witnessed an approximate seven percent shift in peak to off-peak commuting times overall, with marked differences in groups based on whether individuals had friends participating, distance lived from the office, and whether or not the user chose the deterministic prize or the lottery prize (Pluntke & Prabhakar, 2013).

A similar incentive program was introduced at Stanford University. The program at Stanford, entitled Capri, offered prizes similar to those offered in INSINC. Points awarded for preferred off-peak commuting behavior were exchangeable for deterministic amounts of money or for participation in a self-directed lottery through the playing of a game. Similar to the findings of INSINC, researchers observed approximately 87% of participants choosing the raffle/game mechanism for prizes. Through this, among other TDM offerings, Stanford was able to reduce its peak commuting significantly (Zhu, et al., 2015).

Finally, in the Netherlands, a similar experiment entitled "Spitsmijden" or the peak avoidance project, attempted to offer commuters either set amounts of cash or points towards a smart phone at the end of the experiment in an effort to encourage off-peak commutes. The findings from the experiment suggest that incentives can be used to shift commute times (approximately 60% of commuters shifted their commute times), but that the behavior shift was not lasting and most commuters returned to peak hour commutes when rewards were removed (Ettema et al., 2010). In an effort to avoid this return shift, Ettema et al cite the work of Geller suggesting that smaller incentives are more effective than larger incentives at creating lasting behavior shift as the behavior change is more likely to be internalized and less directly connected to the financial incentive provided (Geller, 2001).

2.5 Use of Lotteries as Incentive Mechanisms

Many of the studies discussed in section 2.4 employ both deterministic financial incentives and a lottery or raffle for potential larger prizes. Absent behavioral economic theory, it would be expected that individuals would consider the expected value of the deterministic prize as compared to the expected value of a lottery and respond with behavior change dependent upon those expected values. Incorporating behavioral economics concepts, however, it may be expected that individuals would overweight their chances of winning a lottery, not value probabilities linearly and value the present very highly leading to a propensity for participation in a lottery even when the odds are apparently not in the participant's favor or the expected value of the lottery is significantly lower than the deterministic payout. In fact, in those studies presented that offered both a deterministic cash prize as well as a lottery option, participants strongly preferred the lottery option at a ratio of approximately four or five to one.

For a more thorough discussion of why lotteries tend to attract higher participation levels than set value prizes as well as recommendations for the use of lotteries as incentive mechanisms see Fangping Lu's master's thesis "Framework for a Lottery Based Incentive Scheme and its Influence on Commuting Behaviors - an MIT Case Study" (Lu, 2015). Lu uses a number of studies to demonstrate the attractiveness of lotteries as an incentive mechanism, and general preference of a lottery scheme to deterministic rewards. The reason for this, as Lu points out, is likely the propensity of individuals to believe that they are luckier than they are when presented with small odds of winning. Furthermore, the lottery scheme offers a significantly larger hedonic benefit to participants through the possibility of winning large amounts of money. She further presents insights and guidelines regarding the design of a lottery incentive scheme for encouraging commuter mode shift including: (1) ensuring that the desired behavior is also beneficial to the well-being of the participant in order to encourage participation and increase the likelihood of lasting shifts, (2) appealing to the hedonic tendencies of individuals, and (3) focusing on input behaviors as opposed to output behaviors (Lu, 2015).

2.6 Summary of Literature Review

This chapter presented a review of relevant literature on website design and usability, behavioral economics, and incentive mechanisms - non-monetary, financial, and lottery based. Some key takeaways from this chapter include:

- Usability is a critical part of perception and reception of a functional website;
- Understanding and use of contextual behavioral heuristics are critical to design of incentive scheme to encourage a behavior shift;
- Non-monetary and financial incentives can both be utilized effectively to shift individual behavior; and
- Individuals generally prefer lottery schemes to set-value cash rewards because of overweighting of chances of winning and hedonic benefit provided by lotteries.

Chapter 3: Dashboard Design and Review

3.1 Dashboard Design

The stated research objectives of this thesis, to encourage mode shift in commuting among MIT employees necessitated the development of an interface that would offer commuters tools to understand their commute, provide real time information for trip planning, and allow them to earn prizes for making better commutes. As a first step, the research team created a list of features that were desired in a dashboard. The initial list consisted of:

- High level summary of user's travel behavior, as well as accessibility of more detailed information;
- Ability to communicate, introduce, and conduct incentive schemes including a deterministic cash-out as well as gamification for lottery participation;
- Ability to assign points based on distance user lives from campus and ease of switch to alternative modes;
- Automated commute trip "tracking" - to create a user interface that is as easy to use as possible, the team wanted to automate trip tracking, rather than require self-reporting. This encourages participation by reducing activation energy;
- Editable user interface – the team wanted users to be able to adjust the interface to make it more relevant to their personal commuting habits;
- Preferential treatment of contributors or individuals that log-in to the application frequently; and
- A leaderboard or other method of comparing users to their peers or specified peer groups;

Based on research conducted by Emily Gates in support of her master's thesis regarding available platforms currently on the market, the research team narrowed the list and highlighted key features desired by the research team, and in some cases strongly desired by the parking and transportation committee at MIT (Gates, 2015). The consolidated list of key features were: (1) a trip planning tool, (2) carpool facilitation, (3) automated commuter tracking and trip information, and (4) a lottery and rewards platform.

3.1.1. Automated commute tracking and trip records

Perhaps the most common feature of a dashboard is recording and display of information pertinent to the user. This "commuting" dashboard needed to reflect commuting behavior by showing users details of their commutes including, at a minimum, the number of commutes made by mode. Additional desired information that could be provided was distance traveled, calories burned for alternative modes, and money spent or saved commuting by alternative modes. Beyond that, the team wanted the dashboard to offer small tokens or acknowledgement of preferred activities, such as congratulations for commutes taken by alternative modes, or badges for reaching a certain number of alternative commutes.

3.1.2. Trip planning tool

The trip-planning tool needed to provide door-to-door trip information for commuters for all possible modes that they could take for their commute. The trip information would include multiple route options (including multiple routes and mode combinations for multi-modal trips) and estimated time for each of those routes based on traffic and known traffic delays. Additional features identified by the research team as helpful were estimated costs of the trips and/or money saved by choosing certain modes, calories burned through active modes, CO2 saved or other sustainability metrics for sustainable modes. The goal of the trip planning tool was to offer a trip planner that is fully integrated into AccessMyCommute and further into ATLAS, MIT's online employee portal for its administrative systems, including benefits. The team hoped that incorporation of this feature into AccessMyCommute would encourage consideration of alternative modes by MIT employees that might not otherwise often reconsider their commute because of the energy required to visit additional websites and investigate their commuting options. Additionally, by integrating the tool into AccessMyCommute, it could be integrated with other dashboard features such as carpool facilitation and rewards to more accurately reflect the benefits of alternative modes that would not be factored in to other, external, trip planners.

3.1.3. Carpool facilitation

The team recognized carpooling as an underutilized, but sustainable commuting mode at MIT. Although there is currently a carpooling program at MIT that offers preferential as well as discounted parking to carpools that have registered with the Parking and Transportation office, there is little in the way of help forming a carpool offered by the Institute. As discussed in Chapter 2, carpooling is often not used for fear of sharing a ride to work with a stranger or even because of the difficulty in locating a suitable carpool to join. To overcome this, the team hoped to incorporate some form of carpool facilitation into the commuter dashboard. This should, at a minimum, locate and notify a user of available carpools based on geographic compatibility. Additional features that were desired by the research team were carpool matching by schedule or other additional information that would make joining a carpool less daunting for MIT employees.

3.1.4. Lottery and rewards platform

Finally, for research purposes, the team wanted to offer rewards for sustainable commutes in an effort to spur participation and encourage mode shift. Based on previous research using financial incentives to encourage behavior change, the team wanted not only to be able to offer prizes, but to offer various prizes at different reward levels and to have the ability to conduct a lottery or raffle. In order to do this, AccessMyCommute needed to be able to track how many of each type of commute was taken by each user during a specified period of time, and reward different commuting modes at different levels in order to distinguish those individuals that are commuting most sustainably. This required offering points or credits to users for exhibiting specific behaviors that could then be exchanged for their preferred reward. This feature would enable the research team to study risk preferences of users of the dashboard. It would also provide the most comprehensive means of using financial incentives to encourage mode-shift as different users may be encouraged to switch modes by set value prizes versus lottery prizes.

3.2 Dashboard development

To create a user interface, the research team needed to identify and work with a developer of computer and/or mobile applications. For a comprehensive list of developers investigated, see Appendix A of Emily Gates' master's thesis (Gates, 2015). After consideration of a multitude of developers, the research team concluded that third party contractor RideAmigos' platform matched most closely with the desired platform as described above and initiated talks with RideAmigos to discuss customization of their platform for use at MIT. During the same period, the team continued discussion of the alternative of in-house development of an MIT specific platform. The pros and cons of each alternative can be found in Table 3-1 below.

Table 3-1: Pros and cons of external dashboard development

	RideAmigos Platform	Internal Development
Pros	Platform already developed More quickly ready for roll-out Cheaper	Fully customizable
Cons	Less customizable	More time to roll-out Need to find developer More costly

The critical and limiting feature of this project was time to deploy as the team wanted to create and implement a fully functional commuter dashboard in as little time as reasonably possible. Additionally, the location of a developer internally was a difficult problem that would have required either identifying an additional student worker from a different department (likely computer science), or an attempt to use a full time employee from the MIT Information Systems and Technology (IS&T) department. As a result, and based on the pros and cons identified for each option, the team chose to contract with RideAmigos for use and customization of their Unity platform.

3.2.1. RideAmigos Unity platform and customization

The initial task for the partnership with RideAmigos was to identify which aspects of the initial design they would be able to accommodate in their platform. RideAmigos Unity platform required self-reporting of trips and included on it's home screen a summary of the user's trips including summary statistics and badges for commuting accomplishments. Additionally, the platform included a trip planner that enabled users to investigate their commuting options to and from work. Included in the home screen was also a leaderboard that provided the social pressure aspect that the team was looking for. Finally, the Unity platform offered a number of styles of incentive programs including: incentives, which provide rewards for users reaching certain targets; challenges, which pit users or networks of users against each other and rewards users or teams that outperform others in terms of defined criteria; and point programs which award points based on preferred commute types and allows users to exchange those points for prizes.

One additional attractive feature of the Unity platform is an easy process for starting and joining a carpool. As carpooling is a commuting method that is generally underused, and difficult to implement, this feature was particularly appealing. Research has suggested that two of the main impediments to carpool participation are the reluctance to carpool with unknown individuals and the lack of flexibility that users perceive a carpool offers. The carpool matching feature within the RideAmigos Unity platform provides in-network connections to those people that live along your chosen route, reducing the fear factor, and allows a user to specify to the extent desired their time limitations to perhaps facilitate matches as frequently as possible without locking into a commute mode daily.

By electing to employ a third party with an already developed platform, it was understood that a fully customized interface was unavailable. However, the RideAmigos Unity platform already contained many of the features that were desired in the MIT platform and RideAmigos was willing to work with the team to offer some customized features, including: (1) a certificate based log-in from the MIT ATLAS employee portal to ensure security and allay privacy concerns, (2) automated commute trip tracking and triplog creation, and (3) incorporation of the *Moves* mobile phone application for creation of biking and walking triplogs. Through discussions with RideAmigos, it was decided that triplogs for SOV and transit commutes would be created in house at MIT and passed in a batch to RideAmigos weekly. RideAmigos would work with the *Moves* application program interface (API) to incorporate use of the application with the custom MIT platform. As a result, detailed discussion of data collection and triplog creation for SOV and transit commuting are included below, and the *Moves* process is given a more cursory discussion.

Single sign-on

MIT's ATLAS platform is its online gateway to all administrative systems at MIT and includes, specifically for employees, access to personal information such as paystubs, healthcare benefits enrollment, and commuter benefits enrollment. As a result, the team felt that ATLAS would be the most appropriate location for linking to or embedding AccessMyCommute. Additionally, as the dashboard would contain personal information about a user's commuting behavior that only that specific user should have access to, AccessMyCommute should be appropriately located with and secured in the same manner as other Institute benefits.

MIT employs a single sign-on (SSO) system for all of its web applications, including ATLAS. SSO allows a user to log-in with a single user ID and password and gain access to multiple connected systems. This means that once a user has signed into ATLAS, they are able to access all of the systems contained therein, including health care benefits, access to paystubs, and sign-up for commuting benefits, without having to sign-in to each system independently. As RideAmigos is an outside party, access to their system would traditionally require each user to set up an account user ID and password to login. In order to streamline the incorporation of AccessMyCommute as thoroughly as possible, the team worked with RideAmigos to enable SSO on the RideAmigos platform through a link available on ATLAS. This would enable any user that had already accessed and signed-on to ATLAS to connect to their dashboard automatically, without an additional log-in step. It would also enable the use of MIT certificates, which all MIT employees and students have loaded onto their computers, to login, without having to manually enter log-in details.

This feature had an additional benefit in that it extended the security and privacy safeguards inherent to the MIT SSO system, including the use of certificates to verify who was logging in, to the RideAmigos platform. This ensured that the person logging in to AccessMyCommute and gaining access to the personal data contained was the owner of that data.

Automated trip tracking and triplog creation

In order to create automated triplogs for users, the necessary data were identified and a method for regularly procuring it needed to be designed and implemented. For a full description of the data necessary for triplog creation, see Chapter 6 of Emily Gates' master's thesis. Based on this work, the primary data needs are parking facility data from the MIT Parking and Transportation office to create triplogs for those individuals who have driven alone or carpooled to work and fare card data from the MBTA to create triplogs for individuals who use public transit to get to work (Gates, 2015). The most critical, and often most challenging aspect of this data collection is ensuring that each individual user could be connected accurately to their parking and transit records by relating the MIT ID number, a unique, nine-digit number that identifies individuals to the university, and the relevant identifier in the parking and transit systems. For parking, this is the "prox number" that is associated with the proximity chip in an individual's MIT ID card that grants them access to gated MIT parking facilities. For transit, the number of concern is the CharlieChip number, which is the unique identifier used in the MBTA system and is associated with the smart card chip that enables access to the MBTA system.

Obtaining parking records was fairly straightforward as all parkers are provided with a prox chip, necessary to tap into an MIT controlled parking garage, in their MIT ID card. The Parking and Transportation office, through collaboration with off-site contractors Amano-McGann and EDC Corporation, has access to all parking records with the prox number connected to the MIT ID number. Parking records were obtained weekly by the Parking and Transportation office at MIT and were then transferred to MIT's Information Systems and Technology division (IS&T).

Public transit records present a significantly larger challenge. Data for CharlieCard transactions associated with MIT employee cards were obtained from the MBTA. In order to do this, the data request to the MBTA required a list of the CharlieCard numbers specific to MIT employees. To assemble the list of CharlieCard numbers to pass to the MBTA, the numbers must be related to MIT ID numbers. MIT employees can use a number of different fare media on public transit and each distinct fare media may have different identification numbers and those numbers are often stored in different forms and in different locations:

- Monthly Bus and Linkpass - MBTA Corporate Pass Program;
- Mobility Pass/CharlieChip in MIT ID;
- Commuter rail month pass;
- Pass purchased outside of MIT.

Presently the MIT ID number can be related to the CharlieCard number in the case of the monthly Bus and Linkpass - Corporate Pass Program, the Mobility Pass, and those individuals that have a CharlieChip in their MIT ID. In order to obtain the list of MIT IDs and monthly bus and Linkpass holders, the MBTA Corporate Portal, the MBTA online interface that allows companies participating in the MBTA Corporate Pass Program to manage their particiption and enrollment in the program, is accessed weekly and the current list of CharlieCard numbers and MIT ID numbers is downloaded. This is performed weekly as a user may obtain a new CharlieCard at any time as a result of a lost card and their CharlieCard number will change. Downloading the list weekly ensures that the most up to date list of CharlieCard numbers is used to query the MBTA transit records and therefore trips are not missed. The list of MIT ID numbers related to the mobility pass and MIT ID embedded CharlieChips are maintained on-site in spreadsheets maintained by the MIT Parking and Transportation Office. Weekly, a spreadsheet containing these relationships as well as those for the monthly bus and Linkpasses obtained from the Corporate Portal are securely passed to the MBTA to request usage transaction records.

Although sufficient data is obtainable for the majority of MIT employees to create parking triplogs, MIT still has a number of MIT owned lots that are un-gated and therefore do not produce any records of auto commuters tapping in for access. In addition, MIT leases some parking from other property managers in the area, and MIT does not have access to parking records for parkers in those facilities. Those individuals that are assigned to un-gated or off-campus lots are only those parkers holding annual parking permits. Additionally, although there are records for carpoolers tapping into MIT garages, tracking those individuals and ensuring that they are in fact sharing a vehicle to MIT with another employee is virtually impossible today, as only the driver of the car is required to tap-in to a lot.

With respect to transit data from the MBTA, commuter rail pass holders are currently difficult to track, as well as those individuals who purchased their transit passes outside of MIT. Commuter rail pass holders present difficulty because they currently use a fare media that differs from a traditional CharlieCard or LinkPass type of fare media and is tracked by a different set of numbers. In the future, the CharlieChip number corresponding to commuter rail passes should be obtained upon distribution, and combined with those CharlieChip numbers sent to the MBTA for trip records as discussed above. However, the card numbers are only captured for subway or bus trips that commuter rail users also tap onto, and not all commuter rail users utilize the subway or bus system when commuting. For those individuals that purchase their transit passes outside of MIT, MIT does not have access to the CharlieCard number or the ability to connect that number to an MIT ID number, and therefore cannot obtain those usage records from the MBTA.

The team recognized that although there was not data available to automatically generate triplogs for the individuals that park in un-gated lots, or that use fare media for which data is not currently available, some form of trip generation was necessary to ensure that all MIT employees are given the opportunity to participate in the program. As a result, the team elected to utilize the carpool facilitation feature of AccessMyCommute in an attempt to verify carpools, and allowed self-reporting of trips for individuals that were not trackable via automated data collection methods. The incorporation of these methods into the triplog generation algorithm is discussed in more detail in section 3.2.2 below.

Moves for biking and walking

One of the main goals that the team had for the dashboard was to automate all trip tracking and to eliminate the need for any manual trip entry. This would make use of the dashboard as simple as possible as previous research suggested that the less effort required of the user, the more likely any individual is to use a tool such as AccessMyCommute. In order to accomplish this, it was necessary to identify a method for automatically tracking biking and walking commute trips. The team chose to use the *Moves* mobile phone application for this purpose as other researchers at the Institute were already using it and would also be able to use any data collected from AccessMyCommute. Furthermore, based on the other research project ongoing using *Moves*, the team was comfortable with the application's accuracy with respect to differentiating between walking, biking, and transit. Finally, *Moves* has an open application program interface (API), meaning that the team would easily be able to obtain trip data from users of the application as long as the users agreed to grant access to that data.

As noted above, RideAmigos incorporated *Moves* into the MIT customized platform, and therefore data for biking and walking trips did not need to be collected. Discussion of how biking and walking trips were created within the structure of triplog creation is included in section 3.2.2.

3.2.2 Trip generation logic

After a thorough investigation of the amount and type of data available through each outlet, it was necessary to determine the most effective way to create triplogs from the data. Ideally, generated triplogs would be exact and ensure that the trips made are in fact from home to work or vice versa. However, triplogs that exacting would require a very complicated algorithm and use of a technique called Origin-Destination Inference (ODX), which may not produce reliable destination inferences for every trip taken. Additionally, it would likely require more information than is currently available for drivers, where there were only records of drivers tapping into and/or out of gated MIT parking garages. Therefore, some assumptions were made in order to present a functional and useful tool to commuters.

To simplify the process, one trip per day per individual is recorded. That trip is considered to be a round trip, and the mode is assigned in the following order of data precedence: (1) Moves bike/walk commute, (2) SOV commutes based on parking records, (3) transit commutes based on MBTA records, (4) carpool commutes based on participation in a registered carpool, and (5) a self-reported mode. These modes are assigned based on the logic described below and graphically described in Figure 3-1.

Moves bike and walk commutes

The triplog generation algorithm first determines if there was a biking or walking record from mobile phone tracking data (using the *Moves* app) if it is voluntarily downloaded and made available by the commuter. If there is a *Moves* record on the day for either biking or walking that originates from either home or work, AccessMyCommute will record a walking or biking commute for that day. *Moves* is able to spatially locate trip origin and destination points, and therefore, biking and/or walking trips recorded from *Moves* accurately reflect trips made from home to work or vice versa. This makes *Moves* data the most accurate, and should in no cases need to be over-written by other data sources, therefore the team chose to prioritize it in the triplog generation algorithm.

SOV commutes based on MIT parking records

If the user did not have a walking or biking record from *Moves* on the day in question, the triplog generation algorithm then turns to MIT parking data to determine if there was a parking record on the day in question by searching all of the parking "tap-ins" for the user by prox number. If there was a record of the user "tapping in" to an MIT parking facility on the day, an SOV commute is assumed and recorded for the user.

Transit commutes based on MBTA data

In the absence of any *Moves* record or a parking tap at an MIT parking facility, the algorithm turns to MBTA transit records. Similar to parking records, the algorithm searches all tap-ins to the MBTA system for the user by CharlieCard number. If a record is located, a transit trip is assigned to that user for the day. As noted above, ensuring that a trip on public transit originated at home or at work and ended at work or at home would require a number of complicating assumptions and the use of several different search and matching algorithms. As a result, and in order to simplify the process of trip creation, an assumption is made that if there is a tap on to the MBTA system on a work day when no *Moves* or parking record exists, the user is taking public transit to work and the trip creation algorithm records a transit trip for that user for the day.

Carpool/Vanpool commutes

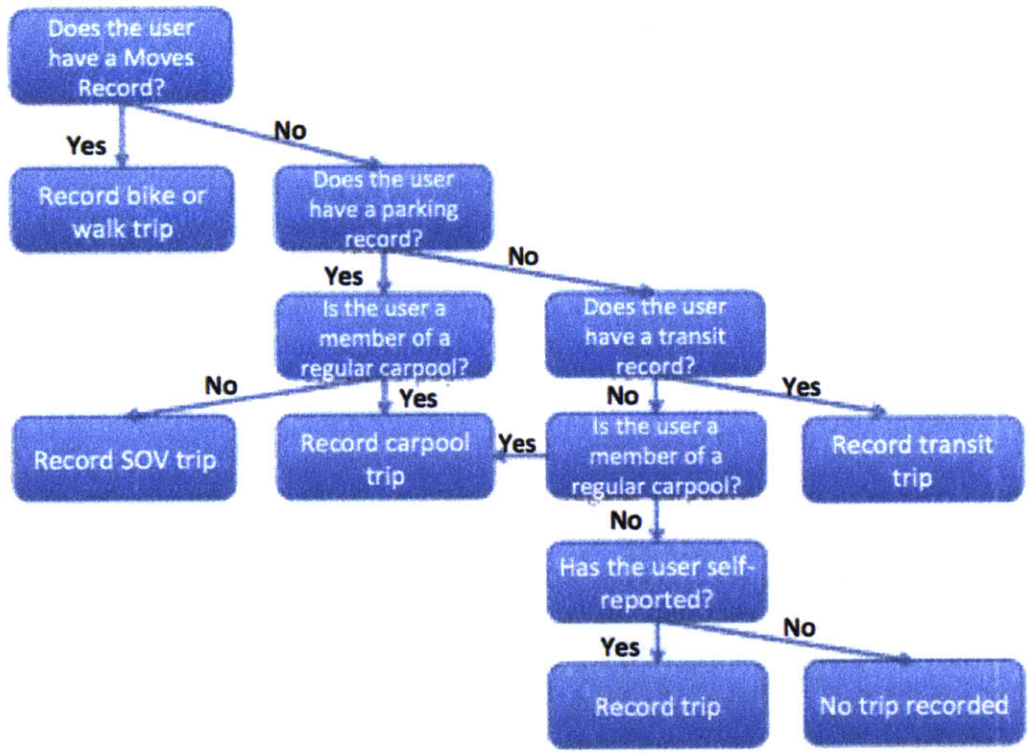
The creation of carpool and vanpool commutes is the final automated trip that can be created in the triplog creation algorithm and, additionally, they are the only modes that can overwrite SOV commutes. Once all other modes have been assigned for the day, AccessMyCommute searches through all users that have been assigned an SOV commute for the day to determine if any user is associated with a registered carpool. Through this search, a list of carpool IDs is compiled that correspond to the carpools for which a driver arrived at work on the day in question. AccessMyCommute then searches through all users that are also associated with those carpool IDs. If any of those users did not have a recorded trip for the day, that is, no parking, transit, or *Moves* record, that user is assigned a carpool trip, and the corresponding driver's SOV record is overwritten as a carpool record.

Modes recorded through self-reporting

In the case that no triplog can be generated automatically through the methods outlined above, AccessMyCommute users will be prompted to manually enter their trips. The manual trip entry will allow a user to select from a list of modes including: drive-alone, transit, carpool, vanpool, bike, walk, telework, Uber/Lyft/taxi, etc., and dropped-off. Should the input of any data from an automated source lag, and later become available, triplogs are automatically generated through that automated data will then over-write any trips that have been self-reported.

The inclusion of this self-reporting feature was to ensure that individuals that cannot currently be tracked through automatic data collection, are still able to record trips and therefore be eligible for rewards. Making self-reporting available only to those individuals that do not have automatically generated trips also minimizes the risk that users could substantially "game the system" by falsifying their mode in order to accrue more points. Finally, an added benefit of this feature is that it requires action by the user should they desire their trips to be recorded or to earn points as it requires that they log-in to AccessMyCommute to enter those points. This provides an additional incentive for those users who may have otherwise not yet visited AccessMyCommute to log-in and be exposed to all of the features that the tool has to offer, and potentially give some further thought to their chosen commute mode.

Figure 3-1 Triplog creation algorithm



In the future, the triplog generation algorithm may be made more sophisticated and able to more accurately identify trips between home and work or vice versa, with further development of the ODX transit trip inference method and use of a potential new mobile trip tracking app under development by RideAmigos.

3.3 Dashboard Review

In order for AccessMyCommute to be well received and widely used by the MIT employee community, it needed to contain and reflect data that was accurate of users commuting behavior, and be easy and welcoming to use. To ensure that AccessMyCommute meets these two criteria, two phases of review were conducted: (1) quality control to ensure that the data were accurate and were being processed as desired, and (2) a usability review to ensure that the user interface was clear and easy to use.

3.3.1. Quality Control

To facilitate the quality control process, a cohort of individuals from the Information Systems and Technology (IS&T) office at MIT were recruited. The IS&T office was chosen because of ease of implementation and IS&T's involvement in the process. Utilizing individuals from the

IS&T office allowed for quicker and more direct feedback to individuals working on the data uploads so that they could easily update and make changes to the data feeds.

MIT has nearly 11,000 employees using the dashboard. A week's worth of trip log data constitutes approximately 50,000 trip instances. According to the Acceptance Quality Limit (AQL), a quality control standard employed by various standard-setting organizations including ASTM International, the American National Standards Institute (ANSI), and the International Organization for Standardization (ISO), this lot size requires a default sample size of 200. As noted below, testers were asked to review approximately three weeks of their own data, at least fifteen instances a piece, therefore, a sample of 40 individuals could review 600 instances. AccessMyCommute reflects six distinct trip types: drive alone, transit, walking, biking, carpool and vanpool and because the process for creating a triplog is slightly different for each, different issues were possible with each distinct trip type. As a result of this, the most important aspect of subject recruiting for quality control is to ensure that all trip types are well represented by the sample.

Once a representative sample was selected, each individual was asked to examine their trip data in the dashboard during the previous month and to note any inconsistencies. In particular they were asked to note any inconsistent/incorrect trip logs (a trip log on a particular day that does not match the mode they took) and missing trip logs. Furthermore, any additional notes were solicited. The team collected these reports and reviewed them with the technical team from IS&T. Any errors that were systemic, appeared more than ten times in the sample population of 600 instances, triggered an IS&T or RideAmigos review of the triplog creation method. Errors that appeared less than ten times out of the sample population of 600 instances were considered acceptable according to the sampling method and were noted for future QC checks.

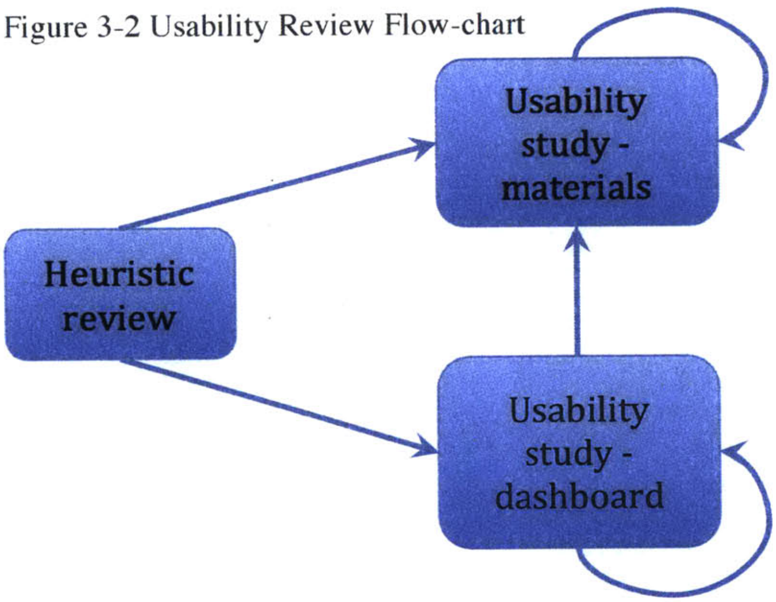
The team received responses from 24 individuals. Generally, the feedback suggested that the data processing was valid and was operating as expected. Several of the users suggested: (1) that they were missing trip data as transit users, or (2) that they were missing trip data as parkers. As noted above, there are some data holes that the team is continuing to try to resolve that could potentially lead to these issues. For example, if a transit user is a commuter rail pass holder or purchases fare media outside of MIT, AccessMyCommute is unable to track those trips at present and therefore they will not appear in the dashboard. Furthermore, if a parker is assigned to an ungated parking lot, SOV trips will not appear in AccessMyCommute. The research team followed up with individuals that reported these issues to ensure that the missing data was the result of known data limitations and not the result of unforeseen issues.

After following up with these users, no changes were deemed necessary to the data collection mechanisms, and the team moved on to the usability review.

3.3.2 Dashboard Usability Review

The usability evaluation was conducted in two phases: (1) a heuristic review conducted by a cohort of student reviewers, and (2) a usability study conducted with three MIT employees. The heuristic review was conducted first and information gained was used to develop instructional materials to accompany AccessMyCommute. Those materials were then presented along with the website during the usability study to ensure usability of the entire system. Figure 3-2 below is a flowchart of the usability review process indicating that the heuristic review informed both the usability study with respect to the materials as well as the dashboard interface, and further, that updates to the dashboard instructional materials were further updated based on results of the usability study.

Figure 3-2 Usability Review Flow-chart



Heuristic Review

The heuristic study is a basic method of usability review that employs an identified list of heuristics to evaluate the usability of a website. The most commonly used set of heuristics are ten guidelines presented by Jakob Nielsen (Nielsen, 1995).

Figure 3-3 Nielsen's Usability Heuristics

1. Visibility of system status	The system should always keep users informed about what is going on through appropriate feedback within reasonable time.
2. Match between system and the real world	The system should speak the users language, with words, phrases, and concepts familiar to the user rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
3. User control and freedom	Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
4. Consistency and standards	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
5. Error prevention	Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
6. Recognition rather than recall	Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
7. Flexibility and efficiency of use	Accelerators—unseen by the novice user—may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
8. Aesthetic and minimalist design	Dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
9. Help users recognize, diagnose, and recover from errors	Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
10. Help and documentation	Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

In order to conduct an effective heuristic evaluation nine evaluators were employed as recommended by Nielsen. These individuals were recruited from the transit lab and they were non-employees so that they did not have any relationship to the dashboard or to the data in the dashboard and were able to study the interface objectively. Each evaluator met with research team members and was provided with a description of a typical user and asked to assume that role. They were then asked to evaluate the dashboard twice. The first evaluation was to become familiar with the dashboard and how it works. During the second evaluation the evaluators reviewed the dashboard against the set of heuristics defined above. Following these reviews, the research team compiled and reviewed the feedback to identify issues that should be addressed with immediate changes to AccessMyCommute or the instructional materials as well as those that should be cataloged for future improvements to the website.

Based on the review, immediate changes were made to how the *Moves* application is advertised and located within the dashboard, adding a prominent banner at the top of the homepage. Additionally, although Point Programs are structured as a subset of incentives on the dashboard, it was sometimes difficult for reviewers to locate the open program, therefore an automatic re-direct to point programs from the incentives tab was added. The search radius on the trip-planner tool was expanded to include the entirety of New England rather than just Massachusetts recognizing that some commuters may regularly commute from southern New Hampshire, Rhode Island or further. Finally, some small bugs with redirect buttons were identified and fixed, and some language that seemed confusing to reviewers was changed.

Additionally, feedback from the heuristic review was used to inform the development of "Getting Started with AccessMyCommute" and "AccessMyCommute FAQ" documents. This included instructions about how carpools are matched, how to post one, and how to link the *Moves* account a user has on their phone to AccessMyCommute to record biking and walking trips. Getting Started with AccessMyCommute can be found in Appendix B, and the AccessMyCommute FAQ in Appendix C.

Usability Review

The team followed the heuristic evaluation with a usability review. While the heuristic evaluation focused on the usability of the AccessMyCommute interface without instructional materials, the usability review included the instructional materials as well as the AccessMyCommute interface. The intention was to assess the entire package of website and help materials because the team recognized that some changes that may be recommended for the website would be time consuming and may have to wait until the next round of large updates, but that appropriate documentation and guidance may obviate issues created by those needed changes.

To conduct the usability study, three users were recruited from MIT faculty and staff. It has been demonstrated that for usability, a sample size of 3-5 individuals captures 85% of usability problems (Nielsen, 2000). The team visited each user in their office and employed a moderated study method that is described in the book Usability testing essentials: ready, set...test! by Carol

Barnum. The method employs four key steps: (1) define the user profile, (2) create task based scenarios, (3) use a think aloud process, and (4) make changes and test again.

Defining the user profile was accomplished by employing actual users or future users of AccessMyCommute as the cohort. The users varied in their commuting patterns with one using transit almost exclusively, one exclusively cycling, and one holding an annual parking permit.

The team first asked each reviewer a series of basic questions intended to develop a better understanding of the user as a commuter, and then presented each reviewer with a series of task based scenarios. The scenarios were presented in the order outlined below, one by one, and the reviewer was asked to inform the moderator when they felt that they had completed the task. This was done to assess whether user perception of completion matched actual completion. Additionally, the scenarios were targeted at features of AccessMyCommute that would be important to its being used as the research team intended. The scenarios were as follows:

- You are a person that values your privacy and you do not want others to see your name on the leaderboard. See if you can change your name so that what appears on the leaderboard is a pseudonym rather than your real name.
- Although in the winter months you commute to work via car or transit, once the weather gets nice, you like to ride a bike into the office and you'd like for those trips to be recorded in the dashboard. See if there is information on the dashboard about recording those trips and if so, if the instructions for doing so are clear.
- Although you drive to work most days, you are considering alternative options including transit and carpooling to reduce costs and be more environmentally minded. Use the dashboard to gather as much information as possible about your commuting options to MIT.
- You drive to work every day, but you are thinking about starting a carpool to reduce costs. You don't know if there would be any interest from others that live near you and you're not sure how to find out. Use the dashboard to create a new carpool with you as a driver. Share as much or as little information as you are comfortable with others knowing about your carpool and/or you feel necessary to match with a reasonable carpool colleague.
- You've heard from your friends that they have been getting cash prizes from MIT for commuting by public transit and you want to find out if you can get in on the action. See if you can find out if the commutes that you've made recently are eligible for prizes and cash in!

Reviewers were asked to think aloud as they worked through the scenario and the session was recorded for further study by the research team. At the end of the session, each reviewer was asked to complete the Computer System Usability Questionnaire (CSUQ), a computer usability satisfaction questionnaire originally developed by IBM that provides a quantitative score based on subjective usability measurements (Lewis, 1995). The CSUQ consists of 19 questions that ask the user to rank different aspects of the website on a scale of 1 (strongly disagree) to 7 (strongly agree). The user's answers were then aggregated into an overall average CSUQ score. The average CSUQ score for the three MIT reviewers was a 6 out of 7, indicating a high degree of usability.

Following the usability review, minor changes were made to the FAQ and Getting Started documents including adding additional information pertaining to carpools that was requested by one of the reviewers. Apart from these changes, the results of the reviews indicated to the team that AccessMyCommute and the related materials were ready for rollout to MIT employees.

3.4 Summary

This chapter presented the initial design and subsequent development of AccessMyCommute by describing what the research team was initially seeking in a dashboard followed by how key parts of that design were implemented during development and collaboration with RideAmigos. Detail was provided on how AccessMyCommute was customized for MIT including enabling SSO, automatically generating triplogs for commutes made by all commuter types to MIT, and integration of the *Moves* application for tracking biking and walking trips. The chapter concluded by presenting the methodology that was used to review AccessMyCommute for both data quality and usability prior to its launch to MIT employees. The next chapter will discuss how AccessMyCommute, once launched, was used to implement a number of incentives and how the impact of those incentives on MIT employees was assessed.

Chapter 4 - Incentive Design, Implementation, and Assessment

For this research, AccessMyCommute, the interactive commuter dashboard interface that was described in detail in the previous chapter will be used to implement a number of incentives to reduce Single Occupant Vehicle (SOV) commuting to MIT. Previous research suggests that both financial as well as non-monetary incentives can be effective catalysts for behavior change, largely based on the behavioral economics phenomena described initially by Herbert Simon (Simon, 1955), and expanded upon by Kahneman and Tversky (Kahneman & Tversky, 1974). Non-monetary incentives including provision of real-time commuting information and trip planning, facilitating carpool matching, and exerting social pressure and/or leveraging social norms have all been demonstrated to have an impact on behavior, and in some cases, on commuting behavior specifically. Financial incentives including lotteries can be powerful motivators, and previous research in the field of transportation demonstrated their effectiveness in encouraging commuters to travel during off-peak, rather than peak hours (Merugu et al., 2010; Pluntke & Prabhakar, 2013). This chapter will describe how each of these incentive mechanisms was implemented at MIT through AccessMyCommute, and how data from AccessMyCommute as well as surveys conducted within AccessMyCommute and the 2014 MIT commuter survey were analyzed to assess the effectiveness of each one of these incentives.

4.1 Non-monetary incentives

Non-monetary incentives can be a powerful mechanism for reducing SOV commuting. AccessMyCommute provides a platform to: (1) provide trip planning based on real time traffic and public transit information, (2) match individuals looking for a carpool or vanpool to others with a similar commute, and (3) exert social pressure on individuals regarding their commuting modes.

4.1.1. Trip planning with real time information

As automatic vehicle tracking and smartphone technologies become more sophisticated, real-time information for commute times across modes has never been more accurate. Commuters are using real-time information to determine how and when to make their commute like never before. Trip planners can now tell a user how heavy the traffic is on all of the driving paths into work and suggest one of those routes based on estimated commute times as a result. They can also tell users when the next bus or train is coming, and predict how long a commute will take by multiple modes (bus, train, walking) from door to door. This functionality enables users to make decisions on a moment's notice, which means that individuals with flexible commuting choices can choose what mode to take to work daily based on traffic that day, or delays on the trains that morning. While this kind of information is important now to those individuals that already have flexible commuting choices including occasional parkers that also hold some form of transit pass, or transit pass holders that live close enough to MIT to bike or walk to work, providing this type of information will become incredibly important as the Institute introduces daily parking pricing and universal transit accessibility during the upcoming academic year. Those new policies are designed to increase the commuting flexibility of all employees, and with that increased flexibility, employees can make commuting decisions on the fly, without being fiscally tied to any particular mode.

Real-time trip planning is incorporated into AccessMyCommute through its trip-planning tool. The tool uses Open Street Maps, which is a collaborative, free data source that is often used to replace Google maps in applications. To use the trip planner, a user simply enters a start and finish destination and the tool searches for matching commute options. Where available, the trip planner will show results including: transit, driving, carpooling (available carpool matches), vanpooling (available vanpool matches), biking, and walking routes. It also provides some relevant information including the details of the trip (directions, or segments if its a multi segment transit trip), estimated commute time (based on traffic for driving, or bus and/or train schedules for transit), calories burned, CO2 saved, and money saved. The commuter then has all the information he or she needs to choose a mode to get to work, or to find a new carpool or vanpool.

4.1.2. Carpool/Vanpool Facilitation

Carpooling and vanpooling are effective, but often underutilized commuting modes. Individuals may be hesitant to join a carpool because of a fear of the unknown or social awkwardness at sharing a ride to work with someone that they perhaps don't know very well. Research also suggests that the perception of carpooling as an inflexible means of getting to work keeps people from exploring it as an option (O'Brien, 2010). In order to encourage the use of carpooling, AccessMyCommute facilitates introduction and safe interaction between potential carpool/vanpool mates, and attempts to reduce barriers to inflexible commutes.

In order to overcome the stranger barrier to carpooling, AccessMyCommute provides comprehensive carpool matching within the MIT community. The selection of the MIT population is important because even before trying to match individuals in a more detailed manner, the pool of individuals has been restricted to the MIT community. Although large, the MIT employee population is likely to feel safer to a user than the broader population of Cambridge employees. Beyond that, carpool matching is more than simply matching individual users based upon geographical compatibility. The biggest fear of users is not that they will be slightly inconvenienced by not living immediately next door to their carpool mate, but that they will spend an hour per day in a car with someone that they dislike, or that they do not feel comfortable with. As a result, most individuals choose to drive alone rather than share a ride. AccessMyCommute addresses these concerns by offering a platform through which individuals can connect and set up a carpool once they are comfortable doing so.

Carpool matching occurs in one of two ways: (1) through the trip planner, or (2) through entry of a carpool ID number. When a user inputs a home and work address into the trip planner, the results will include any potential geographically compatible carpools and will allow the user to contact the individual within the app. At this point, the user can reach out to the driver and exchange some information regarding carpool needs and preferences (days of the week, timing, relative flexibility, non-smoking) within the confines of the platform. This provides a safe space for having a conversation prior to starting a carpool, without having to provide any private or semi-private information such as name, e-mail address or home address, before a user is comfortable enough with the other person to do so. If a user does not see an available carpool in the planner results, they may also post their own carpool preference with information such as days of the week, time of day, whether they can be a driver, and car etiquette, among others. Other users may then contact the user that posted the carpool as described above. The other method of carpool matching is more direct, and requires obtaining a carpool ID from the person that started the carpool within AccessMyCommute. When a carpool is posted, it is assigned a carpool ID number to identify the carpool and to connect those users that are affiliated with it, to each other. If a user already shares a ride, but wants to be recognized as a carpooler in AccessMyCommute, or meets someone on campus that he or she decides they would like to share a ride with, they may provide that other user their carpool ID, which can be directly entered into AccessMyCommute to find and then join that carpool.

In addition to the fear of stranger danger when joining a carpool, individuals are often hesitant to join because of the perception that commuting by carpool does not offer flexibility to the commuter. While this is true to a certain extent, it is also likely that individuals can structure their commutes to take advantage of days when their schedules perhaps don't require quite as much flexibility. AccessMyCommute carpool matching allows users to specify which days of the week they can share a ride, while leaving some other days for driving alone so that they may drop the kids off at school on the way in, or hit the gym in the morning.

These features of AccessMyCommute are intended to help users get over some of the hurdles commonly associated with joining a carpool. Still, it is important to advertise and strongly encourage carpooling. Although the issues identified and addressed within AccessMyCommute are often hang-ups on the road to carpooling, the initial hurdle is often even considering carpooling as an option in the first place. In order to encourage users to consider carpooling, the structure of financial incentives will address the necessity of providing additional incentives to move past initial carpooling hurdles. The incentive and its implementation will be discussed further later in this chapter.

4.1.3. Social Pressure

Research suggests that individuals care significantly about other's perceptions of them. Furthermore, individuals tend toward competitiveness with their peers. It is for these reasons that social networks now exert such a powerful influence on society. Commonly, utility companies have employed energy use comparisons (neighbor to neighbor, or against the average of the neighborhood) to encourage a downward trend in power usage. Results from one study indicate an average two percent decline in energy use in households that receive bills that compare them to their neighbors (Allcott, 2011).

To leverage social pressure to influence mode-choice at MIT, AccessMyCommute includes a feature called a "leaderboard". The leaderboard shows the highest ranked commuters based on selected criteria including total trips, non-SOV trips, or points earned, among others. Through this feature a user can assess how he or she compares to their peers. The basis for comparison can be customized by the administrator by changing the metric of comparison, the comparison group(s), or by making the leaderboard relevant to an ongoing incentive program including incentives, challenges, or point programs.

The default metric for comparison on the leaderboard is total trips and it is truncated to a specified date range. That is, the administrator may set the leaderboard to display trips that have taken place in the last month. This would not be an effective setting for encouraging mode shift away from single occupancy vehicle commuting as it compares individuals to their peers based on the total number of trips recorded regardless of commuting mode, and appears to reward individuals that have recorded a lot of trips, which would be counter to the goal of AccessMyCommute. To encourage mode shift the administrator may prefer to display number of non-SOV trips, for example, or the percentage non-SOV trips of their total trips. This would provide a comparison based on more desired trip types and would encourage individuals who see that they are commuting by car much more often than their peers, to increase their number or percentage of non-SOV trips in order to meet social norms and expectations.

For comparison groups, the default setting in AccessMyCommute compares users to all other users in the system. Users, however, may be grouped into networks so that comparisons occur within more representative cohorts of individuals. Networks are created within AccessMyCommute and can be based upon any information that is in the system, including MIT affiliation (department) and address, among others. Although currently not available in AccessMyCommute, it is possible that with an update to the interface, users could be grouped based on geographical areas such as neighborhoods, census tracts, or zip codes. Should this be done, networks could be created to allow individuals to be grouped with and compared to others with similar access to campus or access to transit options. A peer comparison based on those criteria may be more salient to the user. Comparison of individuals that have little or no access to transit to those that do, for example, may actually discourage those individuals that have little access to public transit as keeping up with those that do, in terms of non-SOV commutes, may seem like an impossible task. If the challenge is not achievable, or is perceived to be unachievable, users are unlikely to try to make that change.

Finally, the leaderboard can also be directly related to any ongoing incentives within AccessMyCommute. Incentive structures offered by AccessMyCommute include incentives, which encourage users to reach a specified goal to earn a reward; challenges, which have users (or networks) compete against each other for a prize; and point programs where points are awarded for preferred behaviors, and those points can be redeemed for various prizes. Incentives have goals that can be quantified, for example, the number of bike trips made to work during a bike to work month challenge. In this example, the leaderboard could be aligned with that challenge to display total trips made by bicycle. A user competing, or thinking of competing, in the challenge may be encouraged to take more commutes by bike when they see how many commutes have been made by their peers.

Although use of the leaderboard could be a very powerful incentive tool, the feature was hidden on AccessMyCommute during the early introduction of the tool to the MIT community due to privacy concerns. As a result, this thesis does not provide a detailed description of its implementation in the context of MIT in this chapter. More detailed suggestions for how the tool may be effectively introduced and used to encourage further mode-shift at MIT are presented in Chapter 6 - Conclusions and Next Steps.

4.2. Financial Incentives

In addition to non-monetary incentives, provision of financial incentives can have a very strong impact on mode-choice. There are multiple methods of deploying financial incentives including set value payouts or prizes for achievements and lottery or raffle prizes that offer a chance of winning, and usually involve a larger prize than a set value payout. The effectiveness of either method depends highly on the composition of the group to whom the incentive is being offered. While research suggests that most individuals would exhibit risk seeking behavior, and would respond more favorably to a lottery incentive that appeals to an individual's seeking of hedonic pleasure, there is a subset of individuals that would respond more favorably to a set value reward. As a result, this research employed both a set value reward as well as a lottery scheme in an attempt to encourage participation by the largest subset of MIT employees possible by offering rewards that are attractive to diverse audiences. Additionally, a two level lottery was employed offering both a smaller lottery value with more chances of winning (5 prizes offered) as well as a larger lottery prize with a single chance of winning. This structure was used to assess not only a preference for a lottery over a sure thing, but also to more thoroughly understand the cohort's perception of risk and winning probabilities. AccessMyCommute features several mechanisms for financial rewards including challenges, incentives, and point programs. The point program feature was used for the purpose of this research, but future work with AccessMyCommute may employ either challenges or incentives depending on the desired outcome, participation, and reaction of users.

The first set of financial incentives was launched in the middle of March 2016 and run through the end of April 2016. This section will describe the initial point program that was conducted at MIT. Financial incentives were facilitated through the use of point programs in AccessMyCommute. Point programs for this thesis consist of three key parts: (1) eligible commutes, (2) the structure of points awarded for those commutes, and (3) the rewards available for those points. The structure of points awarded for each commute will impact the probability of a commuter winning a prize.

4.2.1 Eligible Commutes

AccessMyCommute provides nine distinct mode choices: (1) Bike, (2) Carpool, (3) Drive Alone, (4) Dropped off, (5) Lyft/Uber etc., (6) Telework, (7) Transit, (8) Vanpool, and (9) Walk. Triplogs that were developed based on automated data were mapped into one of the modes based on the logic described in Chapter 3 (i.e. drive alone, carpool/vanpool, transit, bike or walk). Any individuals that could not be tracked through automated data feeds were able to self-report their commute mode into any of the above nine modes. Each commute mode was eligible for points during the initial point program.

In order to be eligible, commutes had to be made during the time period defined by the program. Although the program was launched on March 24th, trips made anytime from the first of March through the end of the program on April 29th, were eligible for points. The first of March was chosen to account for the slow rollout that took place for AccessMyCommute during the month of February, and is assumed to be the date by which all members of the MIT employee community should have received information about AccessMyCommute.

During the first point program, points awarded for commutes taken during the program had to be redeemed during the program or were lost. This is the result of present limitations within AccessMyCommute software. Future updates to AccessMyCommute would allow users that do not win prizes during a point program to retain some fraction of their points to be used in future lotteries. This approach should be considered in future incentive promotions with AccessMyCommute.

4.2.2. Points Structure

Similar to the approaches of INSTANT and INSINC, this research attempts to offer increased points for the most preferred types of commutes (Merugu et al., 2010; Pluntke & Prabhakar, 2013). As this research targets mode-shift and not shifting commute times away from peak periods, modes were judged based on their differentiation from SOV commuting, that is, the ease with which the shift could be made, and overall sustainability. Table 4-1 below contains the point levels that were awarded during the initial point program.

Table 4-1 Point Structure

Commute Mode	**Points Awarded**
Drive-Alone	1
Lyft/Uber/Taxi etc.	1
Carpool/Vanpool	2
Transit	2
Telework	2
Dropped off	2
Bike and walk	3

Points were awarded at the lowest level to those individuals that drive-alone in order to foster participation and inclusion in the program. This was an attempt to both mitigate any Institute concerns regarding equity, and to provide encouragement to those individuals to participate in the hope that by logging on to AccessMyCommute, exposure to commuting information would encourage those individuals to consider a commuting change. The same number of points was awarded to individuals that use Lyft or Uber, or a similar taxi-like mode, to get to work as research has suggested that those modes generally do not reduce vehicle miles travelled as compared to an SOV trip.

Twice as many points were given to carpoolers, vanpoolers, transit users, teleworkers and individuals that were dropped off as these modes are preferred to SOV commuting in terms of sustainability and the effort required to shift from SOV commuting to these modes is substantial. In order to receive credit for a carpool trip, a carpooler must belong to a carpool that is recognized through a carpool ID in AccessMyCommute. AccessMyCommute will categorize a commute as a carpool commute if it can corroborate that multiple members of a carpool have arrived at work in a shared vehicle.

Finally, biking and walking were rewarded with the most points as they are the most sustainable commuting modes and often require the most effort to switch to if one is a current SOV commuter.

The structure is designed to reward those people that bike or walk more than those that take transit, carpool/vanpool, telework, or are dropped off, and further than those that commute alone by car or use a taxi-like service. As will be discussed in the next sub-section, the higher point levels for individuals that take more sustainable modes produce a higher likelihood of winning large rewards should they opt into the lottery scheme that was used during the first point program.

Additionally, individuals that were willing to download *Moves*, even if they did not walk or bike to work, were awarded an additional one time sum of twenty points to reflect the additional effort required to download and use *Moves* as well as to encourage people to take this step. Twenty points was chosen as it is substantial enough to redeem additional funds and/or to raise a user's chances of winning a lottery; however, is not significant enough to equal the points that coule be earned by a user in the next higher sustainability category of commuters. For example, 20 points added to an SOV commuter's point total would not result in that commuter earning as much as a transit user over the course of the program. As noted above, the additional commuting information that can be gleaned from additional *Moves* data may inform upgrades to AccessMyCommute in the future to include modes that are not included at present. Furthermore, additional information about how individuals that cannot currently be tracked will provide the team with a more accurate picture of the mode share of MIT employees. There is also other research projects ongoing at the Institute that utilize *Moves* data to understand how public transit agencies can use trip tracking data as well as fare collection data to better understand their customers travel patterns. That research team will also use this additional *Moves* data to bolster their data set. For all of these reasons the team wanted to incentivize participants to download the app.

4.2.3 Rewards

Rewards offered during the initial point program were determined based upon estimated participation, estimated selection of the lottery over a deterministic payout, as well as the budget for the first six months of the program.

Rewards offered during the first program were:

- $0.10 set value cash payment, to be distributed in TechCash in exchange for **one point**; or
- One entry into a lottery drawing for $100 in TechCash in exchange for **one point**; or

- One entry into a lottery drawing for a $500 American Express gift card in exchange for **five points**.

The $0.10 prizes were available in an unlimited quantity. There were five $100 TechCash prizes available, and one $500 American Express gift card available.

As every member of the MIT employee community eligible for this program could earn at least two points per day, this means that every individual making the choice to commute by transit, carpool, or walking/biking could accrue either $1.00 in TechCash, ten entries into the $100 dollar lottery drawing, or two entries into the $500 lottery drawing per week. The structure was designed to determine how individuals in this group would approach risky or uncertain choices. The small set-value prize is targeted at individuals that are risk averse and would prefer a sure payout. The exchange value of one point was elected in order to provide users with the most flexibility to use their points to obtain various and different prizes. The $100 lottery prize will appeal to users that are less risk averse/more risk seeking, however, presents a greater chance of winning than the $500 prize and therefore may be more attractive than the larger prize because of the higher perceived value of the prize. Again, a one-point exchange value was chosen to provide the most flexibility to users to choose various reward combinations and to make the most of their earned points. Finally, the $500 reward is the riskiest choice, however, the payout is large and therefore may appeal to those individuals that inflate their own chances of winning.

Based on previous research, including the INSTANT and INSINC studies, it was expected that users would choose a lottery prize approximately 80% of the time, and a set value payout the other 20% (Merugu et al., 2010; Pluntke & Prabhakar, 2013). Additionally, prospect theory would suggest that of those 80%, the majority would choose to enter the $100 lottery over the $500 lottery because of the higher probability of winning, even if the expected values of the lotteries are the same (Kahneman & Tversky, 1974).

Probability of winning and expected values

The lottery winners were drawn at random from the pool of entrants at the end of the point program. As a result, the more lottery entries that had been exchanged with points earned, gave the user a greater opportunity to win the lottery. Furthermore, those individuals that made the most sustainable commutes earned the largest number of points, and could therefore have the best chance of winning a lottery drawing depending on how they chose to utilize their earned points.

Actual winning probabilities for both lotteries depended upon both the number of entrants as well as the number of entries each entrant redeems from their accumulated points. Additionally, the probability of winning depends upon the choice of the smaller lottery prize drawing or the larger. Considering previous research into lottery schemes and prospect theory, some initial predictions of the winning probability could be calculated. Below is an example of how winning probabilities were calculated given:

- 10% participation rate among MIT employees;
- 80% of participants choose to participate in a lottery, 20% take the set value payout;
- 80% of lottery entrants choose the smaller, more probable lottery;

First, it was necessary to estimate the eligible population mode share in order to estimate how many points will be awarded and will be available for rewards. To estimate mode share, the team mapped the nine categories of commute mode from the 2014 MIT commuter survey that had positive responses into four modes: (1) drive and park, (2) transit, (3) carpool/vanpool, and (4) bike/walk. These four were chosen because they most closely matched any 94% of respondent's chosen modes. Estimates for the number of commuters using each of those modes were generated by multiplying the corresponding percentages of the staff results given by the commuter survey by 11,000 (representing the number of total MIT employees). The remaining 5% of commuters that reported "other" were split evenly among the additional modes: Lyft/Uber/Taxi, dropped off, and telework as the commuter survey did not indicate any differentiation among those modes.

Table 4-2 Estimated Mode Share

Commute Mode	Estimated Population
Drive and park	3080
Transit	4620
Carpool/vanpool	660
Bike/walk	1980
Lyft/Uber/Taxi	220
Dropped Off	220
Telework	220

The probability of any entrant winning the lottery is equal to the number of entries that entrant redeemed, divided by the total number of entries that were purchased into the lottery. As an example, a transit user that has a preference for the $100 lottery in a situation where 10% of MIT employees chose to participate would have a .74% chance of winning that lottery, calculated as follows:

The transit commuter is awarded two points per transit commute and commutes 40 days during the approximately two-month program. This assumes that the transit user commutes using their primary commuting mode every day of the 40-day program period. Additionally, assuming 10% of users opt to download *Moves*, an additional 2 points was awarded to each commuter on average over the course of the program. Based on this, the average transit commuter earns:

2 points/day x 40 days/point program + 2 points = 82 points during the initial program

Assuming that this person strongly prefers the $100 lottery and exchanges all earned points for entries into that lottery at one point per entry, this means that the commuter has:

82 points during the initial program/1 point per entry = 82 entries into the $100 lottery during the initial program

Next, the total entries into the lottery were based on the total estimated number of commuters, the number of points awarded for each specific commuting mode, the participation rate of those commuters (in this example, 10%) and the percentage of them anticipated to enter the $100 lottery. As noted above, it is expected that approximately 80% of the 11,000 commuters would prefer a lottery to a set value payout. Additionally, from prospect theory, it is assumed that users will strongly prefer the smaller lottery with a higher chance of winning to the larger lottery, assumed 80% to 20%. To calculate the total number of lottery entries, the following calculation for a transit commuter is provided as an example. The same calculation was performed for all commute modes eligible.

Of the 4620 expected transit commuters, 10% were expected to participate in the program. Of those 10%, 80% are expected to prefer a lottery to a set value payout. Finally, 80% of those individuals were initially expected to choose the $100 lottery entry over the $500 entry. The total number of expected transit commuters participating in the lottery and choosing the $100 entry is:

4620 transit commuters x 0.10 participation x 0.80 lottery preference x 0.80 $100 lottery preference = 296 transit commuters

If each of these commuters earned two points per commute over the course of the program, each point was assumed used to enter the $100 lottery. Therefore, the total number of lottery entries for transit commuters was:

296 transit commuters x 2 points per commute x 40 commutes during the program + 2 points / 1 point per lottery entry = 24,246 total lottery entries

The above calculations, performed for the entire employee population, with an expected participation rate of 10%, and 64% opting into the $100 lottery, result in a total of 54,349 lottery entries. As a result, any single participating user that commutes by public transit and has therefore earned 82 points during the program has a winning percentage of:

*82 entries/54,349 entries = .145% * 5 chances to win = 0.74%*

The calculations outlined above were performed for each different type of commuter for both chances of winning a $100 prize as well as chances of winning the $500 prize at various levels of participation. The estimates are included in Table 4-3 below.

Table 4-3 Winning probabilities per commuter type at varying participation levels

Commute Mode	**10% Participation Rate**		**25% Participation Rate**		**50% Participation Rate**	
	Probability of Winning Grand Prize	Probability of Winning $100	Probability of Winning Grand Prize	Probability of Winning $100	Probability of Winning Grand Prize	Probability of Winning $100
Drive and park	0.29%	0.37%	0.12%	0.15%	0.06%	0.07%
Transit	0.59%	0.74%	0.24%	0.29%	0.12%	0.15%
Carpool	0.59%	0.74%	0.24%	0.29%	0.12%	0.15%
Bike/walk	0.88%	1.10%	0.35%	0.44%	0.18%	0.22%
Lyft/Uber	0.29%	0.37%	0.12%	0.15%	0.06%	0.07%
Dropped Off	0.59%	0.74%	0.24%	0.29%	0.12%	0.15%
Telework	0.59%	0.74%	0.24%	0.29%	0.12%	0.15%

Additionally, "the expected value" (EV) for the program of the set value payout for commuters was the number of points per commute multiplied by the 40 days of the program, and again by $0.10 per point redeemed. For example, for a transit commuter:

2 points per commute x 40 commutes x $0.10 per point = $8.00

There would be an additional $2.00 (20 points x $0.10 per point) for users that also choose to download *Moves*.

Table 4-4 Expected values for set value payout by mode

Commute Mode	**EV Set Value**
Drive and park	$4.00
Transit	$8.00
Carpool	$8.00
Bike/walk	$12.00
Lyft/Uber	$4.00
Dropped Off	$8.00
Telework	$8.00

These can be contrasted with the expected values (EV) for each of the above lottery participation scenarios displayed in Table 4-5 below. Prospect theory suggests that a large portion of the population would choose either of the lottery options, even though the set value payout has a significantly higher expected value as most individuals inflate the probability that they will win a lottery drawing.

Table 4-5 Expected values for lottery entries at various participation levels

Commute Mode	**Participation Rate 10%**		**Participation Rate 25%**		**Participation Rate 50%**	
	EV Grand Prize	EV $100	EV Grand Prize	EV $100	EV Grand Prize	EV $100
Drive and park	$1.47	$0.37	$0.59	$0.15	$0.29	$0.07
Transit	$2.94	$0.74	$1.18	$0.29	$0.59	$0.15
Carpool	$2.94	$0.74	$1.18	$0.29	$0.59	$0.15
Bike/walk	$4.42	$1.10	$1.77	$0.44	$0.88	$0.22
Lyft/Uber	$1.47	$0.37	$0.59	$0.15	$0.29	$0.07
Dropped Off	$2.94	$0.74	$1.18	$0.29	$0.59	$0.15
Telework	$2.94	$0.74	$1.18	$0.29	$0.59	$0.15

Estimated budget

In order to estimate the budget for the first program, it was necessary to add the known lottery values to the estimated cost of the set-value payout. The total amount of the set value payout depended upon the number of users that participated in the program as well as the percentage that opted into the payout over the lottery. Estimated mode-share is outlined in Table 4-2 above. Again, assuming a similar percentage of users chose the lottery as chose the lottery in the INSINC and INSTANT experiments, approximately 20% of those commuters were expected to choose a set value payout. For example, the number of commuters choosing a set value payout in the event of 10% overall participation is given in Table 4-6 below.

Table 4-6 Participants choosing a set-value payout (10% overall participation)

Commute Mode	**Set value population**
Drive and park	62
Transit	92
Carpool	13
Bike/walk	40
Lyft/Uber	4
Dropped Off	4
Telework	4

With the point structure given in Table 4-1 above, the number of points available to spend on a set value payout in the case of 10% participation would be the set value population shown in Table 4-6 multiplied by the corresponding points awarded for each commute type multiplied by the duration of the program (40 days) plus an average of 2 points per transit commuter awarded over the course of the program for downloading *Moves*. For example, for transit users:

92 transit commuters/day x 2 points/commute x 40 days/program + 92 transit commuters x 2 points/commuter = 7544 points per program for transit commuters

Performing this calculation for all commute modes results in 16,918 points expected to be exchanged for the set value payout as shown in table 4-7.

Table 4-7 Points exchanged for set-value payout

Commute Mode	**Set Value Points**
Drive and park	2604
Transit	7544
Carpool	1066
Bike/walk	4880
Lyft/Uber	168
Dropped Off	328
Telework	328
Total	16918

As the set value exchange rate is one point for $0.10, the expected budget for the set value payout at a 10% participation rate is:

16,918 points x $0.10 per point = $1,692

In order to determine the total budget for the first program at a 10% participation rate, this number must be added to the cost of the lottery prizes:

$1,692 + $500 + (5x$100) = $2,692

These calculations can be performed for various participation levels. Table 4-8 provides estimated budget values for the first program at participation rates of 10, 25, and 50 percent. More than 50% seems unlikely, and it is anticipated that the participation rate will be somewhere closer to 10-15%.

Table 4-8 Budget projections at varying participation levels

Participation Rate	Estimated Budget
10%	$2,692
25%	$5,246
50%	$9,492

The projected budget for the first six months of the program is approximately $50,000, meaning approximately $8,300 per month (20 work days). The first program ran for 40 days, or close to two months. This suggests that should participation approach 50%, it can be sustained for the first six months of the program. These levels also enable administrators of the program the flexibility to increase rewards should levels remain low in order to possibly attract more participants. The initial thinking was that reward levels should not be lowered from these levels during the first several months so as not to discourage participation in the program. Budgeting for room to raise rewards was deemed to be strategically critical to sustain interest in the commuter dashboard.

4.2.4. Payment of Rewards

Lottery drawings are being conducted periodically, every month or two, at the end of each point program. All prizes are awarded subsequently. Prizes are awarded in the form of "TechCash" for the smaller prizes, the set value payout as well as the $100 lottery drawing. TechCash is a convenient debit card method by which to award financial benefits at MIT as prize amounts can be automatically loaded onto employee IDs without any action required on the part of the user. Each employee and student's ID card can be used as a cash debit card at many on campus and a number of nearby campus vendors.

Although TechCash is convenient, and desirable in smaller increments, the research team felt that the provision of a large value of TechCash would provide less of an incentive than a gift card that could be used away from campus. For this reason, the grand prize for the initial point program was awarded in the form of an American Express gift card. The winner of the gift card was informed by e-mail that they had won the grand prize, and was directed to pick up the gift card at their convenience from the MIT Parking and Transportation office.

4.4 Assessment of the Initial Dashboard Rollout

This initial experiment with the commuter dashboard was conducted during the months of March and April, 2016 at MIT, during which time, the team collected both subjective and objective data in order to better understand the impact of these tools on commuting behavior at MIT. Surveys were used to obtain qualitative information regarding users perceptions and opinions of AccessMyCommute. Additionally, during the course of the point program, quantitative data was collected on usage, mode shift and commuting trends, and participation in point programs. By combining these data, the team was able to quantitatively identify trends and highlight mode-shift changes and behavioral patterns, and was also able to use survey data to make recommendations that could lead to improvements in the program in the future.

4.4.1 Surveys

A survey was introduced at the beginning of April through a survey tool contained within AccessMyCommute. The goal of the survey was to collect information on three broad topics: (1) user perception and reaction to the tool, (2) AccessMyCommute use and usability, and (3) the appeal of the point program.

In an effort to understand how AccessMyCommute was received by the MIT employee community, questions were directed at assessing how AccessMyCommute was introduced to the community and whether or not the roll-out method was effective and user perception of the tool as a benefit provided by the university, among others. To assess use and usability, questions were asked regarding how often individuals log-on to AccessMyCommute, whether there were any features that might encourage logging in more often, and what features are used most often at present. To learn about users perceptions of the point program as an incentive tool, questions were asked regarding the size of the prizes and the perception of the likelihood to win. Questions included on the survey were:

- How did you first learn about AccessMyCommute?
- Did you log-in immediately when you learned about AccessMyCommute?
- If not, please describe anything that may have led you to log-in immediately.
- Do you think AccessMyCommute is a valuable addition to your commuting benefits offered by MIT?
- How often do you use AccessMyCommute?
- If not, are there features that could be added that would make you more likely to use AccessMyCommute?
- Which tool in AccessMyCommute is most useful?
- Have you visited the help/FAQ section of AccessMyCommute?
- If so, did you find the information you were looking for there?
- If not, please let us know what you would like to see explained better.
- Have you redeemed any points you've earned through your commute for prizes?
- If yes, did the offer of prizes play a significant role in your decision to log-on to AccessMyCommute?
- Did the offer of prizes lead you to consider altering your commuting mode?
- If you have not redeemed points for prizes, why not?

4.4.2. Data Analysis

Generally, three types of data were collected during the first point program: (1) AccessMyCommute usage data, (2) mode-shift and trend data, and (3) point program participation data. These data were combined with survey data to analyze and identify trends, as well as to provide recommendations for the future of the program.

Usage Data

Upon introduction of AccessMyCommute, the team established a Google Analytics account to monitor usage data for AccessMyCommute. Google Analytics is a free function provided by Google that tracks and reports website traffic. It is important to observe traffic on AccessMyCommute in order to assess the effectiveness of the rollout approach as well as ongoing engagement activities. Furthermore, any impact attributed to AccessMyCommute must be accompanied by demonstrable use of the tool.

In order to assess the effectiveness of the rollout strategy, the team compared the number of new sessions observed on the day(s) of the rollout, to those observed prior to the rollout. Based on this, an approximation of the influence of those initial e-mail announcements was made. Rollout of AccessMyCommute, however, took place over the course of two weeks with email distribution to a subset of departments at MIT occurring daily. This was done in order to allow the team to absorb any initial feedback in a moderated manner, and to realize any immediate issues prior to full rollout. This led to some delays in the relay of information from the MIT Parking and Transportation office to MIT employees. As a result, this thesis provides a somewhat qualitative assessment of whether the e-mail announcements were an effective means of promoting this new tool to the MIT community. It is expected that new sessions would spike immediately following an e-mail announcement, however, the spike may be less pronounced due to inconsistencies in turnaround time on emails.

Assessing the impact of subsequent announcements such as the announcement of the point program, included observed sessions, both new and returning users. The launch of a point program, and the advertising information associated would be expected to cause a spike in sessions for both new users, perhaps people who were not incentivized to access the site immediately but for whom rewards provide such an incentive, as well as users who may have previously logged on, or may log on regularly. Additionally, the increased activity would be expected specifically to include the point program page. To assess the effectiveness of these types of announcements, these numbers were observed on the day of the announcement as well as in days immediately subsequent. Additionally, a time series of sessions were observed during the duration of the program to assess whether the point program increased average engagement with AccessMyCommute.

In addition, data regarding pageviews - the number of pages viewed per session and the bounce rate - percentage of sessions that are terminated from the initial homepage allowed the team to make general observations regarding the usability of the AccessMyCommute interface. A high bounce rate would be observed if the interface does not engage users upon logging in, and encourage them to explore other pages. A high pageview, on the other hand, would indicate an engaging interface that users want to explore.

Mode shift and trend data

There are a number of data sources that were compiled to understand the impact of AccessMyCommute on mode-shift, including usage figures noted above, mode-share statistics extracted from AccessMyCommute, transit and parking records from previous years, parking facility utilization rates, and MIT commuter surveys, which are conducted every two years and ask MIT commuters to provide information on their primary commuting modes, among other commuting information.

First, the team observed the usage of AccessMyCommute. In order to assess the impact of the tool, it was necessary to establish that the tool is being used. If mode-shift can be observed during the time period after AccessMyCommute was made available, but usage is low or zero, it is unlikely that the shift can be attributed in any way to the introduction of AccessMyCommute.

As AccessMyCommute was designed to track almost every MIT employee automatically, mode share statistics that were extracted from AccessMyCommute provided the baseline for mode-share that was determined during the early months of the program. AccessMyCommute is only able to automatically track parkers in gated MIT parking lots, transit users with specific MIT provided fare media, and walkers and bikers that download and use the *Moves* mobile application. Self-reporting was allowed for individuals that could not be automatically tracked at present, however, self-reporting required users to log-in to the system and manually enter their trips. As a result, it is unlikely that mode share data taken from AccessMyCommute will reflect the entire MIT employee population, therefore the mode-shares that were initially determined from AccessMyCommute were augmented by parking facility usage in un-gated lots that were determined through parking counts performed during weekdays at various points during the program as well as by adding the number of commuter rail pass holders obtained from the parking and transportation office to the number of transit users. Additional users that are not accounted for through the above process will be assigned to a mode based on responses to the 2014 commuter survey.

In order to assess mode-shift associated with the tool as well as with the introduction of incentives, the above process was performed immediately prior to the introduction of the first point program, once during the program, and immediately subsequent to the program end date. This was done in an effort to determine the impact of the point program as an incentive to mode-shift and to provide an initial assessment of whether mode-shift resulting from a point program is likely to persist beyond the end of the program.

To assess mode-shift that was the result of the introduction of the tool itself, an estimate of mode-share in previous academic years was constructed using reported mode-choice statistics from the 2014 MIT Commuter Survey. In his thesis work, Matthew Hartnett developed a method for using commuter surveys to estimate mode share. The MIT commuter survey allows users to select 14 possible commuting mode options. These 14 modes were then mapped to five aggregate modes: drive-alone, public transit, biking or walking, shared ride, and unknown. Although there are nine distinct modes used in AccessMyCommute, many of those modes, such as carpool and vanpool would be combined to match to the aggregate modes from the MIT commuter survey.

These mode share numbers at different time points represent the longitudinal data used to compare mode-share over time, that is, to determine the existence of any mode-shift. These offer some insight into the impact that the introduction of AccessMyCommute prior to financial incentives, as well as the introduction of financial incentives had on the commuting patterns of MIT employees.

Point program participation

To assess whether the point program appealed to a broad swath of MIT employees, participation statistics from AccessMyCommute was combined with the newly implemented dashboard survey data. Survey questions regarding the program provide qualitative information about the perceived attractiveness of the prizes and whether the point structure made users feel like they had a chance to win, or was a deterrent to participation. Recommendations for future programs point structure are based upon this information as well as the values corresponding to the participation rate of the different commuter types in an effort to push participation rates towards a closer correlation with mode-share.

Finally, point program participation data was used to assess behavior of MIT employees in the face of risk. Previous research suggests that users are very likely to prefer the lottery option presented during the first point program to the set value payout. This is true even in the case where the expected value of the set value payout is larger than the expected value of the lottery. Using statistics on participation in the point program, whether this cohort exhibits the expected risk seeking behavior was determined. This behavioral information will be important for the design of financial incentives in the future for AccessMyCommute.

4.5. Summary

This chapter presented the design and implementation of incentives within AccessMyCommute. First, non-monetary incentives were discussed in the context of this experiment. Next, financial incentives were introduced, and their implementation in AccessMyCommute was explained with an in depth description of the implementation of the initial point program at MIT. Finally, the different types of analysis that were performed based on the introduction of AccessMyCommute as well as the first point program were explained with an emphasis on the different data sources that will be combined to draw conclusions and form the basis of recommendations to the Institute. In the next chapter, the results of the data analysis will be presented.

Chapter 5 - Initial Results

This chapter will present findings from the initial rollout of AccessMyCommute to the MIT employee community. First, the chapter will explore the qualitative results from the initial rollout by discussing the results of a survey conducted through AccessMyCommute in combination with some usability data. Second, quantitative data analysis will be performed on AccessMyCommute usage, mode shift and trend data, and participation in the point program. Finally, based on participation in the first point program, some discussion of behavior and exhibited preferences will be discussed.

5.1 Assessment of user interaction and perception

In order to gather information on qualitative measures including the effectiveness of the communications and rollout, user satisfaction with the tool, as well as the usability of the tool, a survey was conducted at the end of the first point program. Furthermore, to assess the effectiveness of the rollout method as well as the email messaging and the impact of point programs on usage, Google Analytics was used to obtain usage numbers over the dates of the program. These data were combined to understand how users received, perceived, and interacted with the tool, and to enable the team to make suggestions for future work with AccessMyCommute.

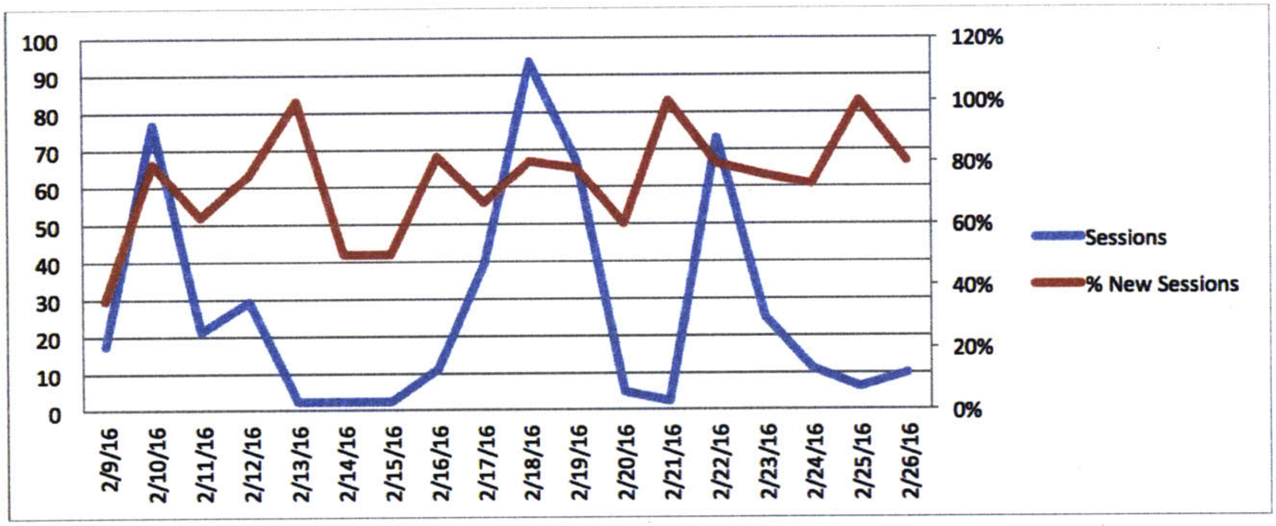
5.1.1 Effectiveness of communications and rollout

Two data sources were combined to assess the effectiveness of the communications plan including the initial rollout and announcement of the first point program: a Google analytics account and a survey conducted through AccessMyCommute. The Google analytics account provided the team with usage statistics over time so that the impact of email communications on usage could be observed. Adding feedback from the survey enhanced these observations. Survey questions were targeted at how users first heard of AccessMyCommute and whether or not users found those communications to be effective.

Rollout

Rollout of AccessMyCommute was initiated on February 10th, 2016 with an email sent to parking coordinators for approximately 10 departments at MIT. The email campaign for the rollout was conducted over the course of nearly two weeks in order to mitigate any concerns that would arise during rollout. Observing the number of sessions during the two-week period in Figure 5-1 below, it appears that there were approximately three spikes on February 10th, February 18th, and February 22nd. E-mails from the MIT Parking and Transportation office were sent daily from February 10th through February 16th, which may explain some of the dispersal of spikes, however, the spikes that occurred significantly after the last set of emails from the MIT Parking and Transportation office are likely the result of a lag in dispersal within each department. Additionally, Figure 5-1 also shows the percentage of sessions that were made by new visitors to AccessMyCommute. Based on this, consistently more than 50 percent of the visits made to AccessMyCommute during the rollout period were by new users.

Figure 5-1 Total observed sessions and percent new users during rollout period (February 9 - 26th)



This suggests that the email messaging was effective in notifying and eliciting a response from users. The slow rollout also clearly played a role in the speed with which the tool began to be used by the community. First, the announcement email was sent out to the individual parking coordinators in a controlled manner, which may explain the clear spikes. Second, it became clear that those parking coordinators did not immediately forward emails to their respective employees, which may explain the trend. The percentage of new sessions, indicating new visitors to AccessMyCommute, is lower than expected during the rollout period. As the tool is being introduced to the community for the first time, it would be expected that the percentage of new sessions would approach 100 percent. Again, this may be the result of the slow rollout, leading to users that already knew or received the announcement email earlier revisiting the site even as new users were learning about and visiting it for the first time, thus reducing the percentage of new users visiting daily.

Survey questions were also asked regarding the effectiveness of the rollout. Questions asked that pertained to the rollout specifically included:

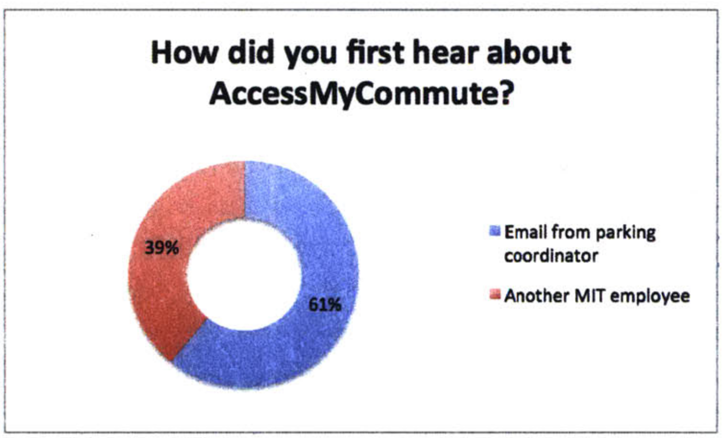
- How did you first learn about AccessMyCommute?
- Did you log-in immediately upon learning about it?

• If not, why?

The goal of these questions was to develop an even more thorough understanding of the effectiveness of the rollout strategy and whether it could have been even more effective had it been performed differently. That is, there were noticeable spikes in site visits immediately following email messaging; however, could those spikes have been larger? Was there a reason that individuals chose not to log-in immediately that was consistent across a broad swath of users and that could be obviated in the future?

Survey results indicate that while most people did hear about AccessMyCommute from their parking coordinator, through an email distributed from the MIT Parking and Transportation Office, a large proportion also heard about AccessMyCommute through other MIT employees. While information spreading by word of mouth is a desirable characteristic for a tool such as AccessMyCommute, had the email messaging been distributed more quickly, the percentage of individuals learning about the tool for the first time from another MIT employee would likely have been smaller. Figure 5-2 below displays the survey results for how users were most likely to first learn of AccessMyCommute.

Figure 5-2 How individuals first learned of AccessMyCommute

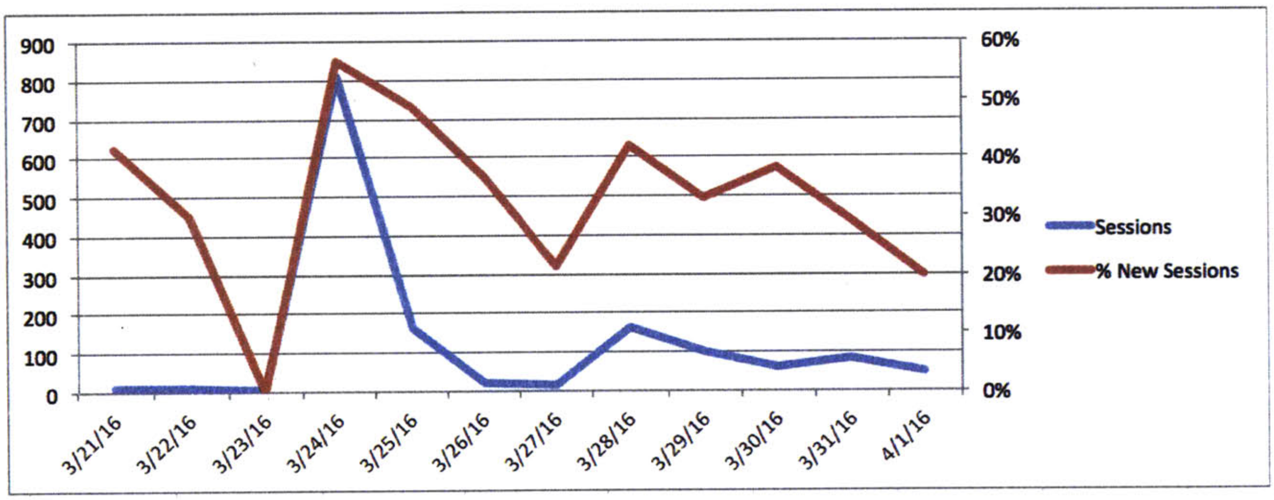


Additionally, users were asked whether they logged on immediately upon learning about AccessMyCommute to which 83 percent of survey respondents answered yes. The 17 percent that responded no generally indicated that they were busy at the time that they first heard about AccessMyCommute and therefore did not log on immediately. This value may be slightly biased, however, because the individuals that willingly take the time to fill out a survey about AccessMyCommute are also likely those that are interested in the tool and therefore will log on immediately.

Point Incentive Program

Approximately one month subsequent to the initial launch of AccessMyCommute, a second email blast announced the start of the first point incentive program. The emails were sent from the MIT Parking and Transportation office to an expanded list including parking coordinators and some additional MIT administrative staff on March 24th, 2016, with an immediate program launch. Figure 5-3 below shows the total sessions observed as well as the percentage of new sessions (users) during the two-week period surrounding the March 24th email. As expected, there was a large spike in the number of sessions on March 24th, 57 percent of which were new sessions.

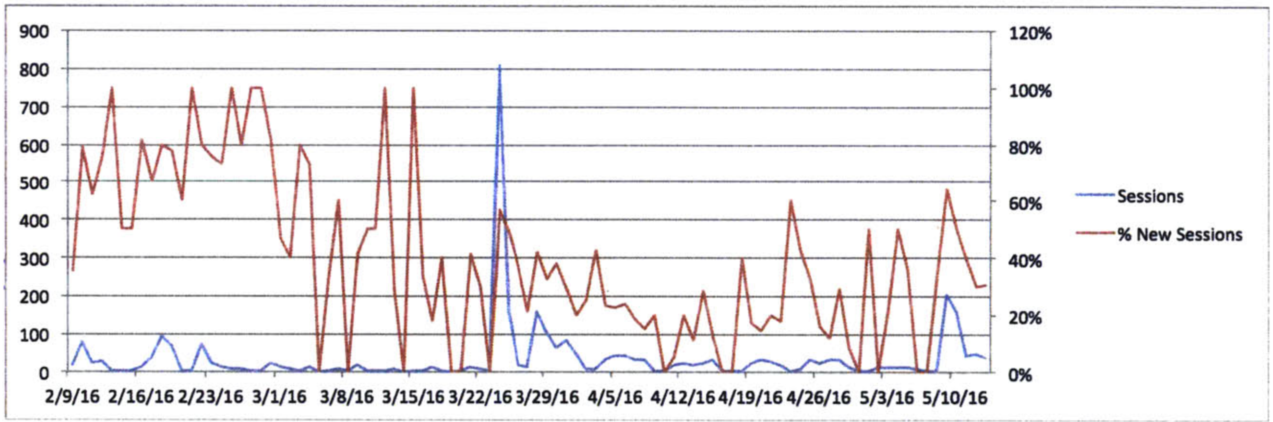
Figure 5-3 Total observed sessions and percent new users during point program announcement (March 21st - April 1st)



It appears clear from this spike, which was noticeably larger than any increase in site visits that were observed subsequent to the initial announcements of the tool, that the point program elicited a strong user response. This suggests that the availability of rewards was a strong incentive to logging in and using the tool. Additionally, while new users made a majority of the visits, returning users made 43 percent of the new site visits. Of the 810 site visits that were observed on March 24th, returning users made approximately 350. Prior to March 24th, 475 unique users had visited AccessMyCommute, meaning that 83 percent (350 out of 475) of AccessMyCommute users re-visited the site as soon as the point incentive program was announced, demonstrating the effectiveness of incentives to get users to log in to AccessMyCommute.

Further supporting this conclusion, looking at the number of sessions observed during the entire time since the launch of AccessMyCommute, it appears that the number of sessions increased substantially following the announcement of the point program. Furthermore, relative to prior to the announcement of the point program, the sessions observed continued at an elevated level after the announcement of the program. Figure 5-4 below shows the number of sessions observed from February 8th through the end of the point program, including the redemption period, on May 13th. This suggests that the impact of rewards on overall program participation is large.

Figure 5-4 Total AccessMyCommute Sessions and percent new users



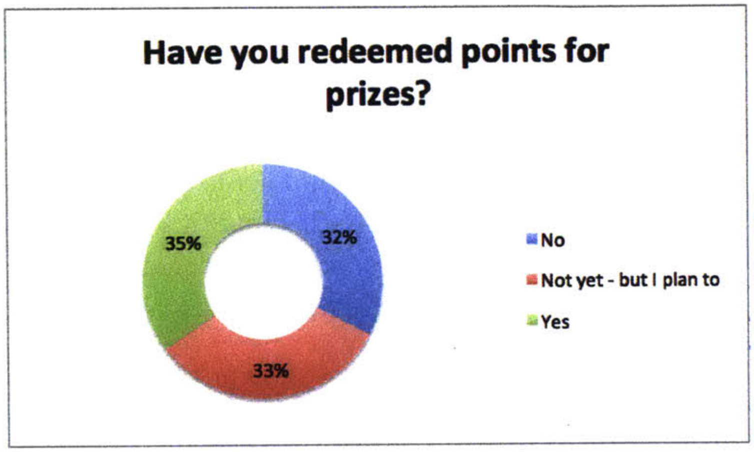
Again, survey questions were asked to complement these usage statistics regarding how strong the incentive of rewards was as an impetus for users to log-in and explore the website. The questions asked specifically pertaining to the perception of the point program were:

- Have you redeemed any points for prizes?
- If yes, did prizes play a significant role in your decision to log-on to AccessMyCommute?

Additionally, the survey also asked the user to identify their favorite feature of AccessMyCommute with point programs as one of the options. While the question is less directly related to whether or not prizes were the biggest factor in a user logging on, identification of point programs as a common favorite feature would indicate the importance of point programs and prizes to user's continuing to use the tool.

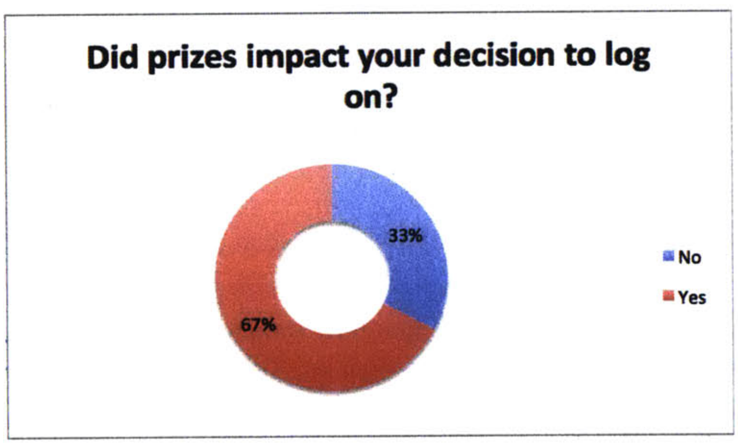
The survey results confirm that prizes are a significant incentive to getting users to log on and use AccessMyCommute. As shown in Figure 5-5 below, approximately two-thirds of respondents indicate that they have redeemed points for prizes or intend to.

Figure 5-5 Percentage of users that have redeemed points for prizes



This corresponds exactly with the number of survey respondents that indicated that the offer of prizes was a major factor in their decision to log on to AccessMyCommute as shown in Figure 5-6 below.

Figure 5-6 Percentage of users identifying prizes as a major contributor to their decision to log on to AccessMyCommute.



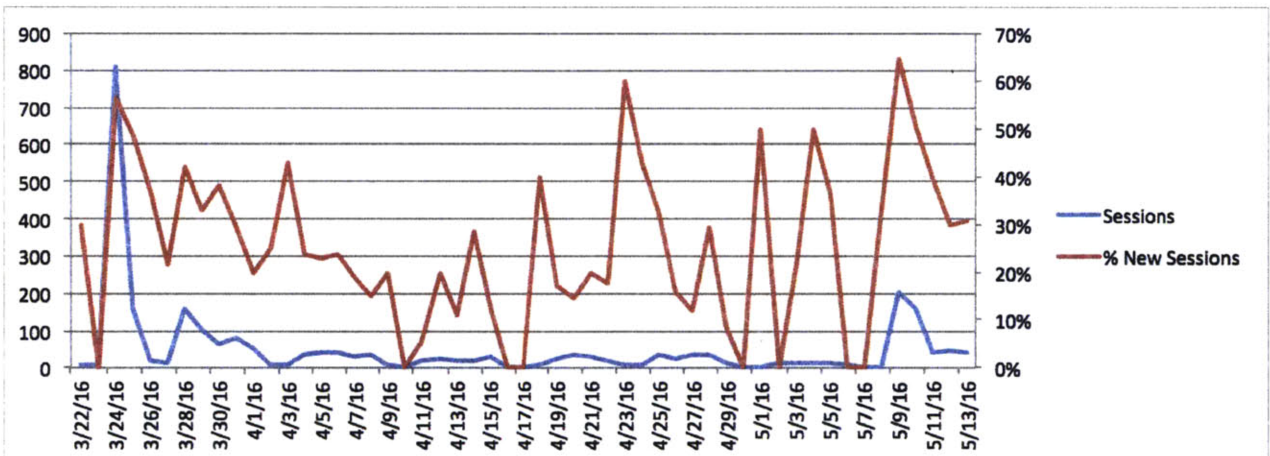
Finally, of the 46 survey respondents, 20 identified point programs as their favorite feature of AccessMyCommute. While not an overwhelming majority, point programs were the most favored feature of those currently offered in AccessMyCommute.

This survey response, combined with the clear spike in user sessions surrounding the introduction of the first point program, as well as the continued increased usage during the point program period, clearly indicate that rewards in the form of cash prizes are a strong incentive for people to use AccessMyCommute.

Introduction of new features

In order to allow all users to earn points for commutes, self-reporting was added towards the end of the first point program. This was done with the intention of incentivizing all MIT employees to log on to AccessMyCommute and explore its features. This additional feature was announced via an email during the last week of the point program and served as a reminder to users to redeem their points for prizes by the end of the week and to log on and self-report if their trips were not already being tracked automatically. This resulted in another noticeable spike in site visits relative to the duration of the point program as can be seen in Figure 5-7 below. The figure also shows a spike in new users.

Figure 5-7 AccessMyCommute sessions from the introduction of the point program



This again confirms that email messaging is an effective mechanism to disperse information and engage users, but that offering incentives are the most effective way to get users to log on. Considering the offer of new features that should appeal to users that may have previously refrained from using AccessMyCommute because rewards were not yet available to them, the spike to just over 200 sessions was smaller than anticipated. Considering earlier experience with delays in email delivery, this could have had a significant impact in this case as the email announcement went out only four days prior to the end of the point incentive program, it is possible that only a small subset of MIT employees received the email notification prior to having to finalize redemptions.

Additionally, the addition of self-reporting was the first time that user were able to report the modes: Commuter Rail, Dropped Off, Uber/Lyft etc., and Telework. Following this announcement there were a small number of trips that fall into one of these categories that were recorded in AccessMyCommute, indicating that users received the email and began using the new feature. Presently, it is estimated that approximately 90 users self-reported trips.

Considering the small number of trips reported taken with the newly introduced modes, it is likely that there are some transit, drive and active mode trips that were reported through the new self-reporting feature, however, it is impossible to differentiate those trips from the trips automatically recorded.

5.1.2 User Perception

Beyond the communication strategy, user perception of the tool may also play a significant role in initial dashboard use. User perception is a qualitative assessment that is difficult to capture through any quantitative data methods, therefore a survey was employed to ask a series of questions regarding user perception of the tool as a benefit offered by MIT. The questions that were asked pertaining to user perception of the tool were:

- Do you think AccessMyCommute is a valuable addition to your commuting benefits offered by MIT?
- How often do you use AccessMyCommute?

Of the 46 survey responses, 28 indicated that they thought that AccessMyCommute was a valuable addition to their commuting benefits offered by MIT. Most respondents, however, indicate that they use the tool only rarely. Although there was an overall positive response regarding the value of a tool such as AccessMyCommute, the infrequent use, coupled with write-in comments on the survey suggesting improvements to the tool that would make it more user friendly, suggest changes that should be made in the future to encourage more use. For a full list of write-in comments broken down by category, please see Appendix D. Regardless of user's perceiving AccessMyCommute as a worthwhile tool, if it is not being used, the benefits of the additional information and carpooling facilitation are not being realized. Suggested updates to the tool to encourage increased use are discussed in Chapter 6 - Conclusions and Next Steps.

5.1.3 Usability

Another critical aspect of the introduction of any new website or online tool as well as its subsequent improvement, is to solicit feedback on usability. As discussed in Chapter 3 - Dashboard Design and Review, AccessMyCommute went through an initial usability and quality control review prior to rollout. This review was intended to ensure that there were no major usability issues that would create a roadblock to the tool's use. With a larger sample size, however, any usability feedback can begin to inform small changes to future versions of AccessMyCommute to not only make the tool usable at the minimum, but enjoyable to use so that users come back often. This data was taken from the survey conducted through AccessMyCommute that asked questions about the usability of the tool, including:

- How often do you use AccessMyCommute?
- Which feature of AccessMyCommute do you find most useful?

- Have you visited the help/FAQ section of AccessMyCommute?
- If so, did you find the information you were looking for there?
- If not, please let us know what you would like to have explained more clearly in the FAQs.

Usability results from the survey are more difficult to quantify than other survey questions. As indicated above, survey respondents generally indicated that they used the tool only rarely and write-in comments suggest that improvements could be made for general usability. Additionally, though some respondents indicated that they liked the trip tracking and carpool facilitation features of AccessMyCommute, respondents generally indicated that their favorite feature of AccessMyCommute were the point programs. While cash prize incentives are a good feature to incentivize users logging on and interacting with the site, the automatic trip logging does not require users to log in frequently. In fact, users only need to log in once in order to redeem points for prizes before the end of each point program. Future changes to AccessMyCommute to make it more user friendly may increase user traffic on the site. Suggested changes will be discussed in detail in Chapter 6.

Regarding the help and FAQ sections of AccessMyCommute, about half of the survey respondents indicated that they had visited the sections to look for information and the majority indicated that they found what they were looking for in those sections. Those respondents that indicated otherwise provided information that will be used to update the help/FAQ sections in the future.

Additionally, some quantitative data can augment this survey data to ensure that the feedback received accurately reflects reality. Since the initial launch of AccessMyCommute, there has been an observed bounce rate of approximately 2.5%, indicating that 2.5% of users that login to AccessMyCommute proceed to close the page immediately. This is a relatively low number, indicating that the website interface is interesting enough to elicit some form of interaction prior to log off. Additionally, the average number of pages per session was approximately 7.8. This indicates that users visited nearly eight pages during each of their sessions, which is high for this tool.

5.2 Data Analysis

The survey was a good method for collecting necessary qualitative data to draw conclusions about MIT employee's reception of the tool, as well as its usability. In order to develop an expanded understanding of usage, mode shift, and point program participation, the available quantitative data was analyzed in addition to the survey data.

5.2.1 Usage

When drawing any conclusions about the effectiveness of AccessMyCommute as a tool to influence mode shift, it must first be demonstrated that the tool is being used. If there is demonstrable mode shift in the absence of use of AccessMyCommute, it is unlikely that AccessMyCommute was a contributor to that mode shift. Discussed in detail above, usage of AccessMyCommute exhibited small spikes around the announcement of the tool, however, larger spikes were observed in conjunction with the introduction of point programs. Furthermore, from the survey responses, users indicate that they use the tool only rarely. This suggests that usage of the tool is not as high as desired, but that users can be incentivized to log on through the offer of prizes that require interaction with the tool to obtain.

5.2.2 Mode Share Trends

One goal of AccessMyCommute, along with the other new transit benefits that will be introduced in the next academic year, is to affect mode shift among MIT employees in order to reduce parking demand and increase campus sustainability. While the introduction of daily parking pricing and provision of universal transit to all employees is likely to have a large impact on mode shift, AccessMyCommute was introduced early. Therefore, this thesis looks at mode shift that may be the result of the provision of new and additional commuting information as well as the introduction of prizes for sustainable commutes. A comparison of mode share estimates from MIT commuting surveys from previous years to mode share estimates from AccessMyCommute provides some intuition into how the provision of new information may have impacted mode share. Furthermore, AccessMyCommute was introduced at the beginning of February and followed approximately a month later with the introduction of prizes for more sustainable commuting. This allows for a direct comparison of the same population, before and after the introduction of prizes to better understand the impact of prizes on the MIT employee population's commuting choices.

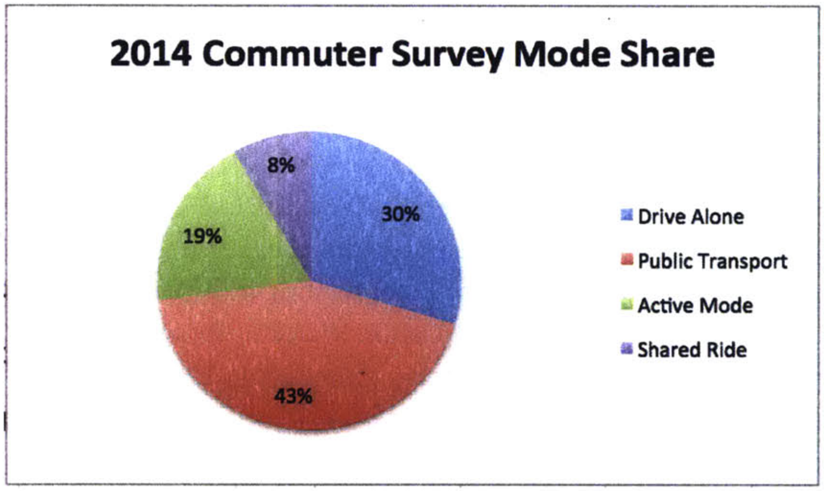
Mode share trends from introduction of AccessMyCommute

Prior to the introduction of AccessMyCommute, mode share is estimated using the 2014 MIT Commuter Survey (MIT Commuter Survey, 2014). Only the 2014 survey was used as it most closely represents mode share in the time immediately before the introduction of the tool. For a more thorough analysis of mode share trends during the period from 2004-2014 and their contributing factors, see Matthew Hartnett's master's thesis (Hartnett, 2016).

As described in Hartnett's thesis, mode share was estimated from the 2014 MT Commuter Survey primarily using the reported primary mode, augmented with data from the travel diary where respondents are asked to report their method of travel to and from MIT for a sample week.

Based on these data, individuals are then grouped into the following categories: SOV, public transportation, active mode, and shared ride (including carpool, vanpool, and private shuttle). Where the primary mode indicated closely matches with those modes indicated in the travel diary, the user is classified into the reported primary mode category. In the instance that a user's travel diary indicates a difference with the primary mode reported, they are considered multi-modal and are fractionalized into one of the modal categories. Based on this, Figure 5-8 below shows the mode share breakdown indicated by the 2014 MIT Commuter Survey. Based on these data, nearly half of the MIT employee population uses public transportation to get to work, about a third drive, and the rest are split between active modes and shared rides. Notably, active modes are well represented in this breakdown of the 2014 MIT Commuter Survey results.

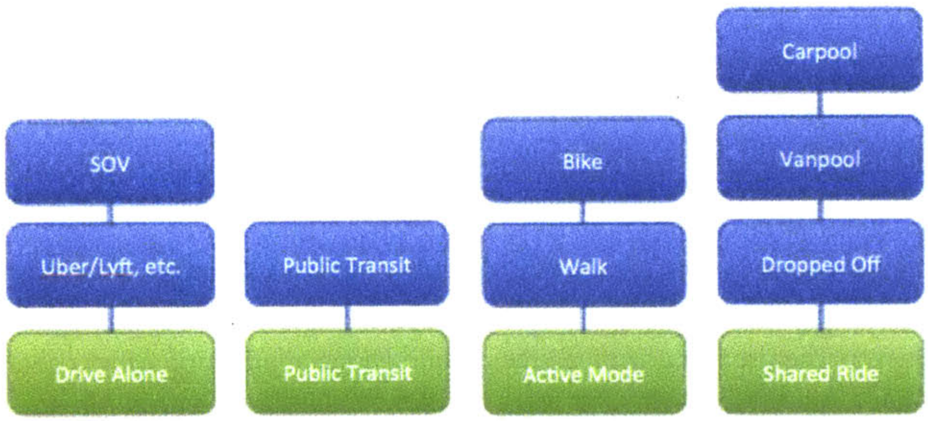
Figure 5-8 Mode share from 2014 MIT Commuter Survey



As discussed in detail in Chapter 3, AccessMyCommute automatically tracks most users that commute by transit and private automobile. Additionally, an automatic tracking feature is offered for those users that commute via an active mode and download a mobile phone application to track those commutes. Finally, all other commuters are able to self-report their commutes. As a result, and dependent on AccessMyCommute usage, the tool is able to track all MIT employees commuting modes.

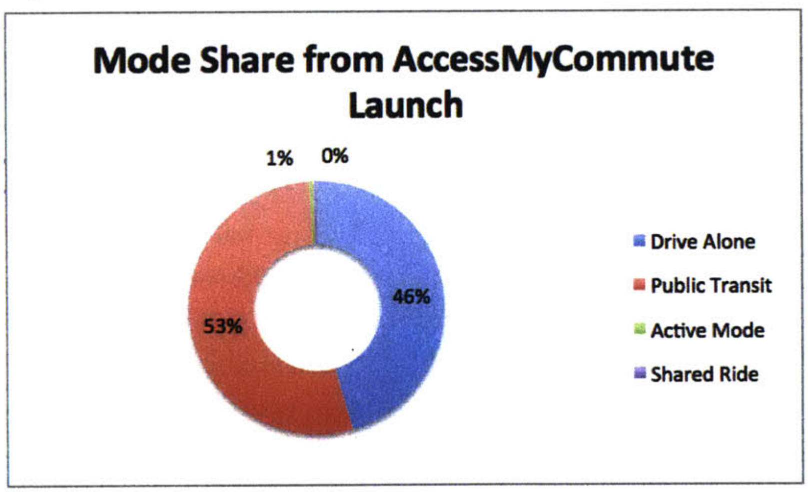
As noted above, AccessMyCommute provides automatic tracking for four distinct modes: SOV, public transit, walk, and bike. For users of the self-reporting feature, AccessMyCommute offers nine distinct modes: SOV, public transit, carpool, vanpool, walk, bike, dropped off, Uber/Lyft etc, and telework. In order to provide a more direct comparison to the categories observed in the commuter survey, those nine categories were combined into: Drive Alone, Public Transport, Active Mode, and Shared Ride as described in Figure 5-9 below. Reported teleworkers represented an exceedingly small percentage of total commutes and were therefore discarded.

Figure 5-9 AccessMyCommute mode categorizations



Once these modes were combined, mode share could be estimated during the period since the rollout of AccessMyCommute, from February 9th through the end of April. Figure 5-10 below shows the estimated mode share since the introduction of AccessMyCommute.

Figure 5-10 Estimated mode share from introduction of AccessMyCommute



These numbers are markedly different from mode share numbers that are estimated from the 2014 commuter survey. Notably, the percent of both transit and SOV users is much higher than the survey indicated and the ratio of transit riders to drivers is lower as indicated by AccessMyCommute when compared to the commuting survey. There are a number of reasons that this may be the case. First, there are public transit modes that cannot be automatically tracked via AccessMyCommute. Although a self-reporting feature was introduced to AccessMyCommute, its introduction happened significantly after the initial rollout of AccessMyCommute, and therefore it is most likely that users that do not have trips automatically tracked have not taken the opportunity to self-report trips for the past several months. Furthermore, although self-reporting is allowed, it requires a significant action by users and therefore one would not expect the results to date to fully reflect the commuting patterns of all MIT employees. Finally, parking data is fairly reliable and most garages are gated, thus providing a steady and reliable source of parking data. As a result, these numbers are likely to overestimate mode share for drive alone individuals.

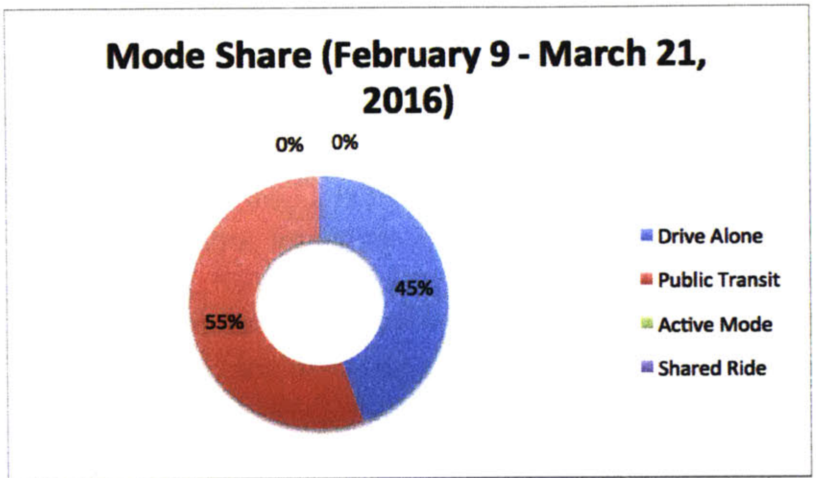
Additionally, the percentage of active mode users is substantially lower in the AccessMyCommute data as compared to survey data. Once again, this is probably the result of the time and effort required of active mode users. For automatic tracking to occur for users that bike or walk to work, users were required to download the mobile phone application *Moves* and sync it to AccessMyCommute. As of May 14th, 280 users had downloaded and synced *Moves*. Out of a current total of 8,241 unique users, that is approximately 3.3 percent, significantly lower than the estimated 19 percent of employees using an active mode according to the 2014 commuter survey. Again, the self-reporting feature was also made available for these individuals, however, because self-reporting was made available nearly two months after the initial launch of AccessMyCommute, it is unlikely that users entered trips going back to the beginning of February, but some users likely started using the self-reporting feature moving forward. As a result of this, the estimated mode share from AccessMyCommute clearly underestimates the number of active mode users relative to transit users and drivers.

Mode share trends from the introduction of Point Programs

A mode share comparison for before and during the initial point program that was run during the months of March and April, 2016 is likely to be more representative of mode share change as it compares the same population, using the same tools for comparison. This means that any discrepancies that were noted above as a result of the difficulty of inputting trip data, or a desire not to download the *Moves* application to a user's phone, are accounted for. As it is the same population, with the same limitations, any mode share changes that are observed between the time prior to the point program introduction and the period of the point program were at least somewhat impacted by the introduction of the program.

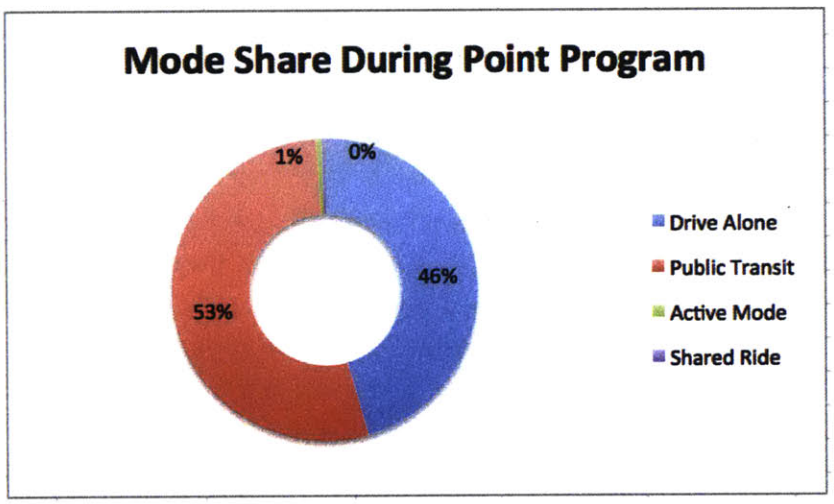
Figure 5-11 below shows the estimated mode share prior to the introduction of the point program from the rollout of AccessMyCommute until the announcement of the program

Figure 5-11 Mode share from February 9 to March 21st, 2016



This can be compared to the mode share estimated during the point program from March 21st through April 29th, 2016, shown in Figure 5-12 below.

Figure 5-12 Mode share from March 21 to April 29th, 2016



Though there is not a striking difference in mode share, there is a very small increase in active mode commuters after the introduction of the point program. This may be the result of bikers and walkers wanting to take advantage of elevated point levels for active modes, and logging on more frequently to AccessMyCommute. This suggests that the introduction of prizes has an impact either on mode share, or on individuals logging on to AccessMyCommute and reporting trips taken in order to be eligible for prizes.

There are some conflating factors that should be considered, and perhaps tested in future work. One possibility is that the point program was introduced in conjunction with the arrival of spring in Cambridge, so it is also possible that the increase in active modes is the result of better weather.

5.2.3 Point Program Participation

The final piece of data that will be analyzed in this thesis will be the participation in the initial point program. General participation numbers as compared to the entire user population, combined with feedback from the survey will help the team to understand how important prizes are to user's mode choices and to their decision to log on to AccessMyCommute and log their commutes. This will also add to the mode share trend analysis presented in brief above. Additionally, a breakdown of participation based on the primary mode of the individuals that participated in the program will allow the team to determine if the point program as structured appealed to all users, or only to particular groups, thus suggesting that a different program structure should be considered in the future. Finally, analysis of the choices made by the users in terms of which prize was chosen most often, or by the largest number of individual users, as well as whether or not users exhibited diversification behavior or consistently purchased the same reward will help the team make recommendations for point programs that should be conducted in the future.

Participation and perception

Only a total of 240 users participated in the initial point incentive program where "participated" is defined as redeeming some points for prizes. This is approximately 3 percent of the 8,240 registered users in AccessMyCommute. Since any user that is automatically tracked is also registered automatically, it is easily seen that there are not 8,240 true dashboard users. From Google Analytics, the number of distinct individuals that have logged into AccessMyCommute is approximately 1,574, significantly lower than 8,240. From this base, point program participation rises to approximately 15% of AccessMyCommute users, where a "user" is defined as an individual that has actively logged into AccessMyCommute at least once. This is clearly somewhat disappointing and indicates that the third email blast on May 9th, either wasn't fully carried out or did not have its intended consequences.

Survey questions were asked to augment these numbers. The questions that were asked to help identify the impact that the point program had on user's interaction with AccessMyCommute and with their decisions on their commute mode were:

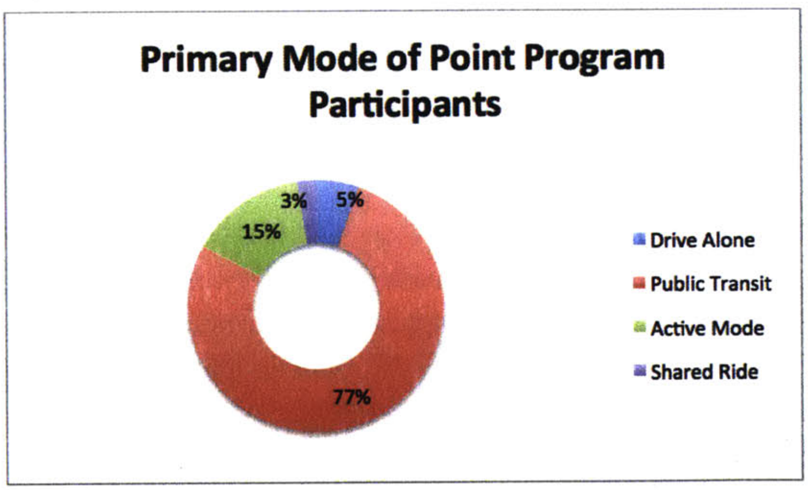
- Did prizes play a significant role in your decision to log on to AccessMyCommute?
- Did the offer of prizes lead you to consider your commuting mode?

As discussed above, prizes did play a significant role in getting users to log on to AccessMyCommute with nearly two thirds of survey respondents indicating that it played a role in their decision to log on. Additionally, while approximately one-third of respondents indicated that prizes did lead them to consider changing their commuting mode, most continued to commute as they had, and the other two-thirds did not consider a change. These data suggest that, thus far, prizes incentivize people to log-on to AccessMyCommute, but not to change their commuting mode. This may be because the prizes are too small relative to the difficulty a change in commuting mode entails. With the upcoming introduction of daily parking pricing and universal transit access, however, it could be important to best determine how the tools offered through AccessMyCommute can be more useful. In general, it is likely that continuing to offer small cash incentives may encourage users to log on and explore their options.

Point Program Appeal

The initial point program was designed specifically to appeal to the entire MIT employee population by offering points for every type of commute, even less sustainable modes such as single occupancy vehicle commuting. This was an effort to encourage use from all MIT employees in the hope that some of the new benefits would incentivize users to consider their commuting choices. As such, it was important to gather information about the participation in the program to assess whether all types of MIT employee commuters used it. To do this, the primary mode for each individual that participated in the point program was determined, where participation was defined as redeeming points at least one time. The primary mode breakdown of the participants in the initial program is shown in Figure 5-13 below.

Figure 5-13 Primary Mode of 240 Point Program Participants



Based on this, and compared to the estimated mode shares discussed in the previous section, transit users and active mode commuters participated in the point program at a high rate when compared to their estimated total mode share. There are a number of likely causes for this. First, when the point program was launched initially, points were only awarded for public transit users and active mode commuters. As a result, it is likely that these groups were made aware earlier, and therefore had more time, to use AccessMyCommute and exchange points for prizes. Self-reporting was added at the very end of the initial point incentive program period in order to be able to offer points to all commuter groups. While the period of eligibility for trips was the same, it is most likely that those individuals that were not being automatically tracked did not log in and update their trips when that became available. Additionally, usage data suggests that the final email blast that announced the availability of this new feature was not effective. The reasons for this may be that the email was not fully distributed to all AccessMyCommute users, or that the email itself was ineffective.

Additionally, transit users and active mode commuters earned more points for every commute made, potentially making the program and the prizes more attractive. Furthermore, individuals that drive alone are less likely to choose to consider changing their mode, or to want to explore options for a change of mode. They may be locked into the annual parking permit currently, or feel that their schedule does not allow for use of alternative modes. Individuals that do not feel that they have a choice for commuting are less likely to log on to AccessMyCommute and explore its features, including the point program. This may suggest that the offer of prizes or the point total available was not attractive enough for most SOV commuters to want to log on and see what AccessMyCommute had to offer.

Purchasing Behavior

Users were offered three different prize options during the initial point program:

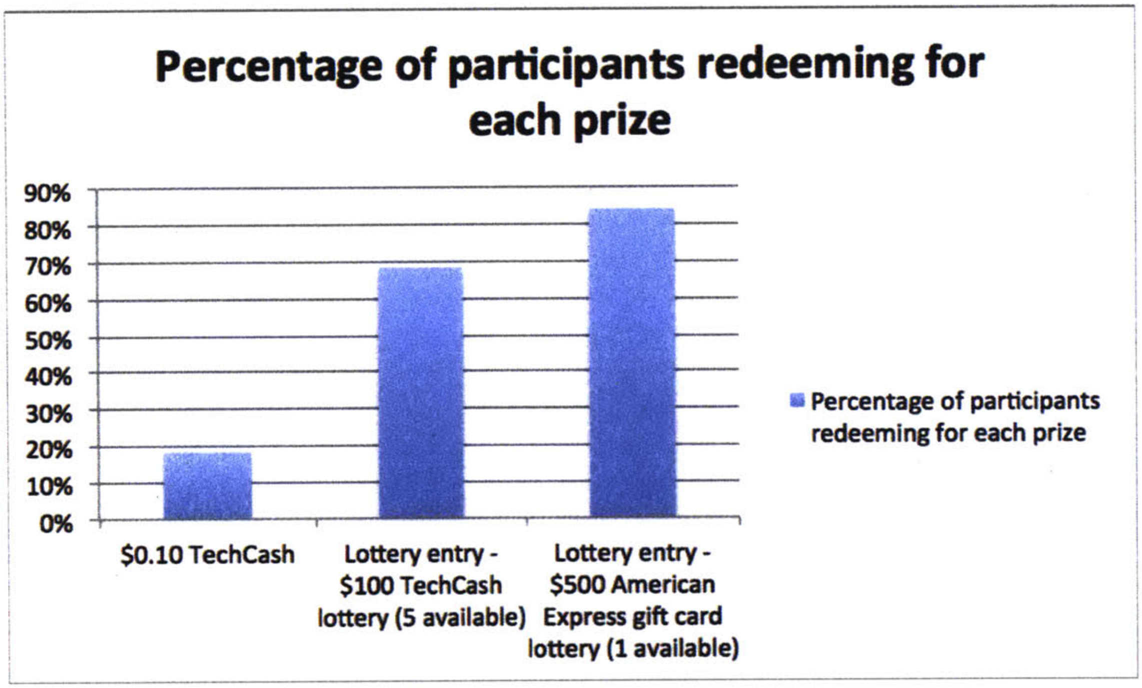
- $0.10 in TechCash in exchange for 1 point
- Lottery entry for $100 in TechCash for 1 point
- Lottery entry for a $500 American Express giftcard for 5 points

The set TechCash value was available with an unlimited supply. There were five $100 TechCash prizes, and a single $500 American Express giftcard.

Based on previous research in behavioral economics, it would be expected that users would favor the lottery entries over the set value of TechCash because most individuals overweigh their chances of winning prizes, and because the lottery has hedonic appeal. Furthermore, it may be expected that the entry for the $500 American Express giftcard would be favorable to the entry for $100 in TechCash for the same reason. Most research does not indicate whether users have a tendency to diversify when given the chance.

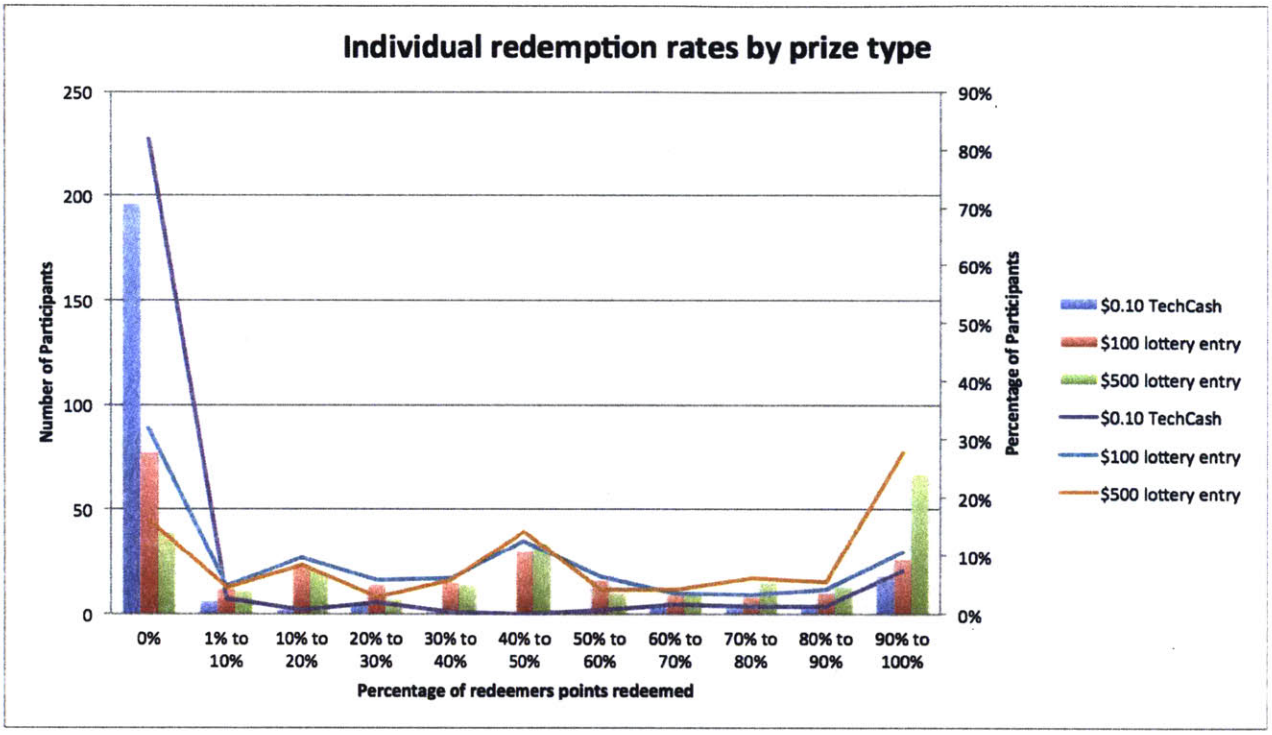
As expected, during the initial point program nearly 85 percent of participants purchased at least one $500 lottery entry as shown in Figure 5-14 below. Sixty-eight percent of users chose to purchase at least one entry into the $100 lottery, and nearly 20 percent of participants chose to redeem for $0.10 in TechCash at least once.

Figure 5-14 Point Program Prize Selection



This suggests that users do tend to diversify their redemptions, primarily between the two lottery prize options. This may be a result of a desire to take chances on both lotteries, or for a much smaller number of users, to take a chance while also earning some guaranteed money with the set-value TechCash. It could also be the result of the large lottery redemption requiring five points. Users were unlikely to have points in even multiples of five, meaning that they would have to spend the remainder on something other than the $500 lottery. This can be broken down by looking at the redemption rates for each prize in Figures 5-15 below. The figure shows how each participant chose to redeem their points by breaking down individual redemptions by the percentage of each individual's total points that they chose to redeem for each prize type. The columns represent the total number of redeeming participants that chose to redeem a specified percentage of their earned points on each individual prize. For example, the first blue bar indicates that nearly 200 out of the 240 redeeming individuals chose to NOT redeem any points for $0.10 in TechCash. The lines on the chart indicate the percentage of redeeming users that chose to redeem a specified percentage of their earned points on each prize type. For example, nearly 40% of users redeemed nearly all of their points (90-100%) on the $500 lottery.

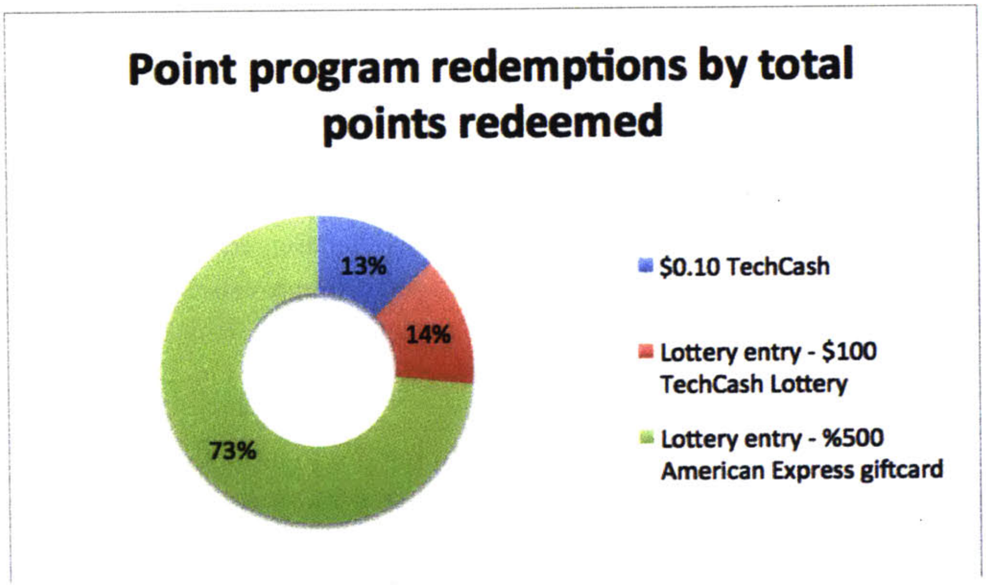
Figure 5-15 Individual redemption rates by prize type



Based on these redemption rates, it would appear that most users chose to redeem for very little set-value TechCash, with the vast majority of users redeeming less than 10% of their points for TechCash. Another interesting note is that there were extremely few users that redeemed anywhere from 10 to 90% of their points for TechCash, and the users that did choose TechCash used the majority of their points for it (90-100%) suggesting that some users are exceptionally risk averse and will always take the set value prize. Similarly, 37% of participants redeemed less than 10% of their points for entries into the $100 lottery. By contrast, a large number of participants (35%) chose to redeem the vast majority of their points for the largest lottery prize. This, in combination with the redemption rates for the $100 lottery prize may suggest that participants used as many of their points as possible on the $500 lottery, and used any remainder that was less than five points, to purchase entries to the $100 lottery. Again, this corresponds closely with what would be expected based on prior research, with greater than 80% of participants favoring a lottery entry to the small set-value payout.

The number of redemptions of each type can also be broken down by total points, as shown in Figure 5-16 below.

Figure 5-16 Point Program redemptions by total points redeemed



Eighty-seven percent of points earned were redeemed for lottery entries. This is slightly higher than expected; previous research suggests that between 75 and 80 percent of participants will choose to redeem for a lottery entry over a small set value payout. From that, it would be expected that a further 75 to 80 percent of lottery participants would be expected to choose the larger lottery over the smaller lottery. Again, more points were spent on the larger lottery prize than may be expected, 73% in this case, compared to a maximum of 64% expected.

This behavior is even more interesting when considering both the probabilities of winning either of the lotteries as well as the expected values from each prize. As discussed in Chapter 4, individuals tend to exhibit risk-seeking behavior even in the face of expected values for set values that are larger than lotteries. Based on the data from this initial program, for the $100 TechCash lottery, 1053 total points were redeemed, with individuals redeeming for as few as one and as many as 54 entries. This corresponds to a probability of winning that ranged between 0.5% and 25%, and an expected value of between $0.5 and $25. For the $500 American Express giftcard, a total of 1134 5-point entries were redeemed, with individuals redeeming as few as one and as many as 22 entries. This corresponds to a probability of winning that ranged between .09% and 2%, with expected values of between $0.5 and $10. This can be compared to the expected value for the set value payout, which ranged between $4 and $12 depending on the primary commuting mode of the individual. Clearly, depending on the points that they expected would be redeemed for each prize, some users likely chose to redeem for lottery entries in the face of a smaller expected value than they would expect if they only redeemed for TechCash.

5.3 Summary

This chapter reviewed initial results from a survey conducted through AccessMyCommute as well as an initial data analysis based on early use and the first point program run at MIT. Survey results generally indicate favorable user perception of AccessMyCommute with room for improvement in messaging and usability. Most users identify point programs as their favorite feature of AccessMyCommute as well as one of the key reasons that they logged on initially and have continued to use AccessMyCommute. This indicates that point programs should continue to be leveraged as a tool to encourage people to log on to AccessMyCommute. Improvements in usability should make those sessions more productive for users.

The data analysis does not show a marked shift in mode share from prior to introduction of AccessMyCommute; however, data from the tool likely over estimates transit riders and drivers as compared to MIT commuting survey responses. The data does indicate minor shifts in behavior after the introduction of, and during the extent of the point program. Finally, the point program appealed most to public transit commuters, with nearly 80 percent of all point program participants using public transit as their primary commuting mode. This may be because the majority of public transit users have their commutes tracked automatically and therefore do not have to do a lot in order to redeem points for prizes. Furthermore, these users tended to diversify when redeeming points by choosing a variety of different prizes for redemption, and each prize was selected in nearly equal quantities. Based on total points redeemed, however, the $500 American Express giftcard was the most preferred prize, as was expected.

Finally, while email messaging was somewhat effective, and resulted in some usage spikes, inconsistencies in email distribution appear to have caused issues with users not learning about features or tools in time to take advantage of them. In particular, new features were added near the end of the point incentive program to provide all MIT employees with the opportunity to earn and redeem points for prizes, but that email blast appears to have been ineffective. Based on previous experience with other email blasts, it is most likely that the email was not distributed fully in enough time for users to take advantage of these new features.

Chapter 6 - Conclusions and Next Steps

The goal of this research was to design and implement a new commuter dashboard tool to incentivize MIT employees to consider their commuting modes and make more sustainable choices. For the Institute, this would serve the dual purpose of decreasing parking demand, which is necessary as the Institute is losing some parking capacity in the next few years, and increase campus sustainability.

6.1 Summary

Dashboard Design and Review

This research focused initially on the design of a new commuter tool for MIT employees titled AccessMyCommute. To do this, the team worked with a third party contractor, RideAmigos, Inc. to modify and improve upon their existing dashboard platform. Key modifications included:

- Enabling single sign-on through the employee only ATLAS portal at MIT;
- Automated trip tracking with data from the MIT Parking and Transportation Office and the MBTA; and
- Integration with the *Moves* mobile phone application for automatic tracking of bike and walk commutes.

Though the team worked with RideAmigos to automate as much trip generation as possible, data was not available to automatically generate trips for every MIT user. As a result, the existing self-reporting feature was retained as a way to augment automated trip tracking and account for all MIT users to ensure equity across MIT employees. Specialized logic was put in place to allow employees to self-report where there were no automatically generated trips.

The design of AccessMyCommute was conducted with four intended goals: (1) provide MIT employees with automatic trip tracking so that they can track their own commuting behavior, (2) offer an integrated trip planning tool that would provide commuters with information about all possible modes so that they were able to make fully informed commuting decisions, (3) provide an improved platform for carpool matching and facilitation, and (4) provide a platform for administering financial incentives through cash prizes and lottery schemes.

The design and development of AccessMyCommute was followed by a series of reviews that were completed prior to rollout to the MIT employee community. A quality check was performed to ensure that the data that was being handed to RideAmigos from various data sources was accurate, and that trips were being generated correctly. Concurrently, a two step usability review was conducted, beginning with a heuristic review where a small group of individuals was asked to review AccessMyCommute against a set of usability heuristics. The heuristic review informed and was followed by a moderated usability review with a set of three MIT employees. There, the employees were asked to perform a number of situation based tasks and comment on the ease or difficulty of completing the tasks. Initial reviews revealed only a small handful of issues with AccessMyCommute which were addressed, and the tool was considered ready for rollout to the community.

Incentive Design and Implementation

Previous research has indicated that both financial, and non-monetary incentives can be effective incentive mechanisms to change individual behavior. The design of AccessMyCommute allowed for the provision of a combination of both financial and non-monetary incentives, including:

- Trip planning with real-time information;
- Carpool/vanpool facilitation;
- Social pressure through the use of leaderboards; and
- Financial incentives in the form incentives, point programs, and challenges.

The initial incentive scheme was launched in early March using the point program feature of AccessMyCommute. Point programs allow users to collect points for sustainable commuting modes and exchange those points for prizes. In this initial program, all commuters were eligible for points and points were scaled based on the sustainability of the mode, with individuals that drive alone to work earning the fewest points and those commuting through an active mode earning the most. The goal of offering points to SOV drivers was to encourage drivers to log on to AccessMyCommute and explore the other benefits that the tool had to offer and possibly consider modifying their commuting modes, at least some of the time.

Three different rewards were offered during the first point program in exchange for different point values. The prizes were:

- $0.10 in TechCash in exchange for 1 point;
- Lottery entry for $100 in TechCash in exchange for 1 point; and
- Lottery entry for $500 American Express giftcard in exchange for 5 points.

Based on previous research in behavioral economics, it was expected that users would prefer the lottery entries to the set value of TechCash.

The probability of winning one of the lotteries depended upon the number of entries purchased by all participants as well as the number of points redeemed by the participant in question. For the $100 TechCash lottery, 1053 total points were redeemed, with individuals redeeming for as few as one and as many as 54 entries. This corresponds to a probability of winning that ranged between 0.5% and 25%, and an expected value of between $0.5 and $25. For the $500 American

Express giftcard, a total of 1134 5-point entries were redeemed, with individuals redeeming as few as one and as many as 22 entries. This corresponds to a probability of winning that ranged between .09% and 2%, with expected values of between $0.5 and $10. This can be compared to the expected value for the set value payout, which ranged between $4 and $12 depending on the primary commuting mode of the individual.

Initial Results

A survey was conducted through AccessMyCommute in order to gather feedback on the effectiveness of the email messaging, and user opinions about the new tool. Generally, the survey suggested that the email messaging was effective when it was received, but that the slow rollout and failure of some parking coordinators to pass the email along to employees promptly may have blunted the impact of the initial rollout as well as the last program reminder and introduction of new features. Additionally, feedback about the value of the tool was generally positive, but comments suggested that improvements could be made to the usability of the tool that would make its value even more substantial.

Early data analysis indicates little to no mode shift as a result of the introduction of the tool. Some data limitations and discrepancies may lead to an over-representation of certain commuter groups in the early data from AccessMyCommute that may need to be addressed moving forward. Given the introduction of self-reporting to AccessMyCommute, all commuters can at present be accounted for in AccessMyCommute. A key aspect of future work will be encouraging users to log-in and take the time to self-report. This may be accomplished with challenges or incentive programs that offer incentives for logging in and self-reporting or introduce a competitive aspect that may encourage users to log-in and self-report with social pressure.

Within AccessMyCommute, the introduction of the point program appears to have resulted in a slight mode shift to more use of active modes, but exogenous factors (e.g. better weather) may be the real cause. Furthermore, the introduction of the point program was a strong incentive for users to log on to AccessMyCommute. This corresponds closely with survey data, as well, that indicated that most respondents were incentivized to log in to AccessMyCommute by the offer of prizes, and some did consider changing their commutes. The additional flexibility that will result from the introduction of daily parking pricing and universal transit should help those individuals take the next step of actually making a change.

While the introduction of the point program was clearly an incentive to people to log in to AccessMyCommute, the number of people that logged in after the program was introduced was significantly higher than the number that ultimately ended up redeeming points for prizes, nearly 1000 as compared with 240 that redeemed. There are several possible explanations for this, including the prizes not being attractive enough, difficulty in understanding and using the interface, or the lack of points for certain modes initially. When the point program was first introduced, points were only awarded for users taking public transit or biking or walking. Any user that logged on that did not use one of those modes would likely notice that the program did not apply to them and perhaps not log back on. This may be yet another indication that the last email blast was unsuccessful as that email announced points availability for all commuters and would've been expected to increase redemption rates.

6.2 Next Steps

Introduction of AccessMyCommute prior the introduction of additional commuter benefits has proven to be a valuable means of identifying areas for improvement prior to introduction of daily parking pricing and universal transit that will help make those benefits more effective.

6.2.1 Improvements to AccessMyCommute Interface

A number of improvements were suggested by survey respondents and will be implemented prior to the introduction of the new transportation benefits at MIT. These include additions to the Help/FAQ section to ensure that all pertinent information is available there and reduce the number of support requests that are being handled by MIT support staff. A more streamlined version of the point program redemption process that allows users to redeem multiple points for prizes at one time should be implemented. Currently each user must redeem points individually, which requires a significant number of clicks. Other suggested changes to point programs include the ability for users to retain all or part of their point balance at the end of a point program and carry it over to the next program in the case that they did not win a lottery or had not redeemed all points earned.

Additional suggestions from the survey include syncing with additional applications or devices such as a Fitbit or Garmin wearable activity tracker. This may encourage more use by not requiring users to download an additional application, but leverage existing behavior. On the other hand, these devices may not reliably distinguish between active modes and vehicular travel.

Finally, survey respondents noted some data discrepancies and/or lagging data as a major concern. Although the self-reporting feature was added in an attempt to obviate this issue, self-reporting requires action from the user, and automated trip tracking is generally preferable. Future work should focus on streamlining the data process to ensure that the data is as reliable as possible and that as many trips are automatically tracked as possible. Additionally, work with RideAmigos on a mobile application version of AccessMyCommute may provide a more sophisticated level of trip-tracking.

6.2.2 Incorporate social influence as an incentive mechanism

The early rollout of AccessMyCommute was without a social influence component as the leaderboard feature was hidden. This was done in order to avoid any privacy concerns that may arise as a result of displaying user names on the leaderboard. Research suggests that social influence can play a major role in individual's behavior. In the future, researchers and the Institute should leverage the leaderboard as a mechanism to influence commuter mode choice at MIT. This can be done in a private manner by instructing users that do not want their names appearing on the leaderboard to choose an anonymous username to display.

Furthermore, work should continue with RideAmigos to improve the functionality of the leaderboard feature. For example, the platform could allow for grouping users by home address geofences, so that users are compared to others that have similar commuting options to and from work. This would make the comparisons more salient, and therefore, may have a larger impact on user's mode choices.

6.2.3 Community engagement

Although survey results and usage data indicate that the email messaging was moderately effective, and led to a spike in AccessMyCommute sessions, it was also clear that the introduction of prizes was the most effective means of getting people to log in. This suggests that users do not just need to be made aware of the tool, but also need to be incentivized to log on. In the future, the Institute should consider running challenges in order to engage users and get them to interact with the dashboard more frequently. Challenges could include bike to work weeks/months, or team or network based challenges where groups could compete against other groups to maximize the number of sustainable commutes taken for a specific period. These challenges could be run much like MIT's annual fitness challenge, getFit, which pits teams against each other in the amount of exercise performed weekly, with prizes given out weekly and at the end of the program.

Additionally, survey respondents indicated that email messaging could be more thorough. Suggestions included additional email reminders of rewards periods and key dates as a reminder to log in and take action. Other respondents also indicated that more email communication about the program as a whole and about new features that are introduced would be helpful.

6.2.4 Point programs and prizes

The survey and usage data show that the introduction of prizes was a strong incentive to get people to log on to the dashboard. Again, with the new benefits that will be introduced next year, individuals will have more flexibility in choosing their commuting mode, and tools such as the trip planner and carpool facilitation will become even more useful. Their use, however, depends on people logging into AccessMyCommute and actively using the tools provided. The Institute, then, should continue to use financial incentive programs as a way to encourage users to log in, at least in the early period of introduction of the new benefits.

Behavior associated with the point program prizes corresponded closely with what was expected. The majority of users chose lottery entries over the set value payout, however, more users redeemed for the set value than expected. The expected values of prizes were comparable depending on the type of commute and the number of lottery entries redeemed in any individual lottery. In the future, researchers should decrease the set-value payout while maintaining the lottery prize levels to determine if the value has an impact on user choice. Additionally, researchers may consider increasing the value of the large lottery prize to assess risk behavior when the perceived value increases.

Additionally, it was clear from usage data that while email messaging did increase the number of sessions, the initial introduction of prizes was the most effective method for getting people to log on to AccessMyCommute but that the incentives were less effective in eliciting mode shift. During the first point program, all commuter types were included in order to encourage more people to log in. As one key finding here is that cash prizes are a good incentive to log on, it is important to continue to offer prizes to all commuters in order to encourage participation.However, future work should consider rewarding sustainable modes even more so that drivers still log in to redeem small prizes, but perhaps also consider changing their commute because of a more significant difference in expected prize payouts associated with commute types. This, combined with the introduction of daily parking pricing and the provision of universal transit, may provide more encouragement to drivers to consider their mode rather than just logging in to redeem points that they've earned from continuing to commute via the same mode.

6.3 Implications for other employers

This research preliminarily suggests that in the absence of other commuting benefits such as daily parking pricing and universal transit, commuters are unlikely to change their commuting patterns based solely on the provision of new tools such as better planning information and trip tracking. Introduction of incentives for commuting has some impact, but likely not as much as it would have when coupled with daily parking pricing and universal transit. Employers considering changes in commuting benefits, or looking for ways to reducing parking demand, should consider these three benefits as a package, as any one benefit is likely to be less effective without the others. Work conducted in this research to design, review, and update a usable commuter tracking tool could be useful to employers looking to introduce a similar dashboard tool to their employees, as significant improvements have been made throughout this research to the platform that should make it more attractive to employers in the future.

Appendix A: Getting Started with AccessMyCommute

Getting Started with AccessMyCommute

Welcome to AccessMyCommute, a new interactive tool that will help you better manage your commute to and from MIT. AccessMyCommute will allow you to track and plan your commutes, match you to other MIT employees interested in carpooling in your area, and win cash prizes for more sustainable commutes (coming spring 2016).

This document will introduce you to some of the key features of the tool. For a more detailed description of the AccessMyCommute features, as well as instructional videos, please visit the "Help" section of AccessMyCommute. Also, make sure to read the FAQs if you have further questions.

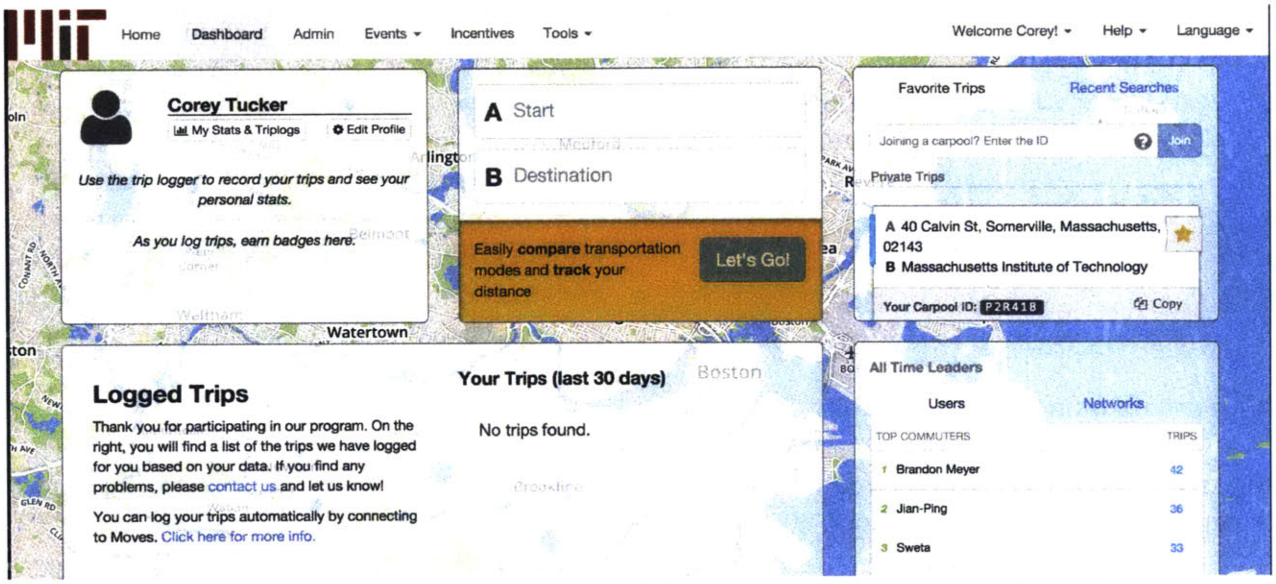
The AccessMyCommute tool is comprised of four sections, which appear in the top navigational menu when you log in. The banner indicates which page you are on by shading the page title in darker grey.

Make AccessMyCommute Yours

Before you start using AccessMyCommute, visit your profile by clicking on "Welcome [Your Name]! > Edit Profile" to view and update your personal information. You can also connect the *Moves*[1] app on your phone to AccessMyCommute to track your walking and biking commutes automatically by clicking on "Connected Apps" and following the instructions to connect.

The Dashboard is your default log-in screen and is your platform for most of the AccessMyCommute tools. Upon logging in, you will see four widgets on the dashboard screen: personal statistics, a trip-planner, favorite and recently searched trips, and a trip log.

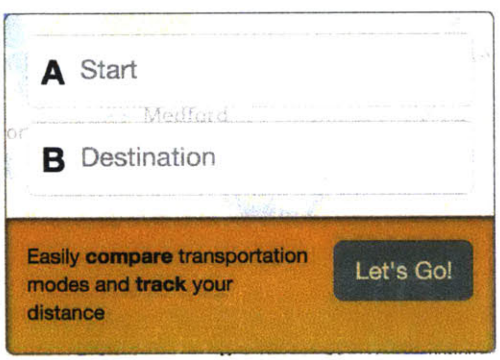
[1] Moves is a free application on your smart phone that will create an automatic travel diary using data from your smartphone. It is available on both iOS and Android devices. Once downloaded, you will open Moves and select 'Start From Scratch' to allow the app to access your location and start data collection. Then you will follow the instructions found through 'Welcome! [Your Name]' > 'Edit my profile' > 'Connected Apps' to authorize AccessMyCommute to access and display your Moves trips.



The Dashboard page, clockwise from top left: personal statistics, trip-planner, favorite trips/recent searches, trip-log, leaderboard

The personal statistics widget displays a high-level snapshot of your personal commuting statistics including the number of trips that you've taken and the distance travelled. It will also display badges that can be earned for various types of commutes and commuting milestones.

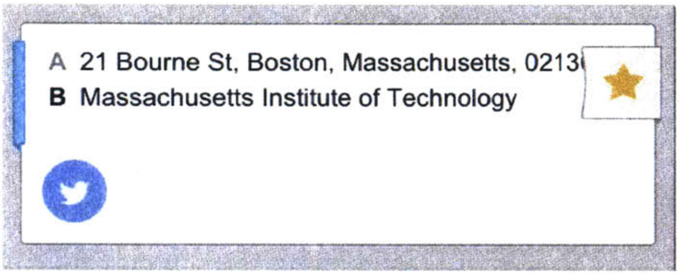
Planning your Trip to MIT



The trip-planner widget is a tool to help you plan your trip to and from MIT.

Simply enter your home address in the "Start" box and your address at MIT in the "Destination" box and click "Let's Go!" AccessMyCommute will show your commuting options (including potential carpools) along with some decision-making information including cost, CO2 saved, calories burned, etc.

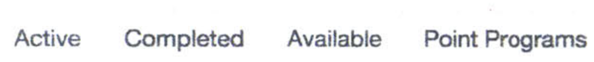
If you are interested in carpooling, but don't see an available carpool near you, you may choose to start your own. By clicking "Manage Your Carpool" you can decide what information to share (such as days of the week, time, carpooling preferences) and with whom (everyone, no one, or just those in your network). You will be given a carpool ID that you can share with your friends. Depending on who you choose to share your carpool status with, other people at MIT will see your carpool when they use the trip-planner tool. If others want to carpool with you, they can enter the carpool ID directly under "Favorite Trips," or select your carpool from their commute options and send you a message. This will allow you to e-mail potential car mates and get to know them and/or set up a meeting before you decide to carpool to work together.



The Favorite Trips widget can make the use of your dashboard much more efficient. When using the trip-planner above, you can "favorite" a trip by clicking on the star at the top of the results. Favorite trips will appear listed in the favorite trips widget and if you want to know what the commute time on transit is right now, all you have to do is click on the favorite trip to see commute options.

Win prizes using Commute MIT!

Coming soon in spring 2016, you will also be able to earn rewards through AccessMyCommute when you make smart commuting choices. Making your commutes through more active, sustainable modes will earn you points that can be redeemed for cash prizes. To investigate available prizes and exchange points for cash, simply navigate to "Incentives" > "Point Programs."



We hope that this information helps you to get started with AccessMyCommute and enables you to use all the resources to make informed commuting decisions. Additional functionality is described in the Help section of AccessMyCommute.

Appendix B: AccessMyCommute FAQ

Frequently Asked Questions

Q: Should I be concerned about the privacy of my information displayed on this dashboard?

A: Not at all! All personal data is processed within MIT before being passed to the dashboard, and once there, any data is only available to you through securely logging on with your personal certificate.

Q: How does AccessMyCommute calculate my trip distance as displayed in my "Logged Trips"?

A: AccessMyCommute assumes that you are commuting daily from your home to MIT, and calculates your trip distance as the shortest possible driving distance between your home and MIT.

Q: I take public transit to work, but I only see some of my trips?

A: Don't worry, your trips will appear in the dashboard. AccessMyCommute retrieves public transit data directly from the MBTA, and while some MBTA transit is linked to an automatic data upload system, some transit systems must manually update their data. As a result, AccessMyCommute will only receive this data when vehicles are brought in for service and data is manually uploaded from the farebox. Unfortunately, this means that there will sometimes be a slight delay in trips appearing on AccessMyCommute for certain transit lines such as the MBTA's Green Line, as well as some buses. Be patient, those trips will make it to your dashboard eventually.

Q: I take the commuter rail for all or part of my commute to MIT, but I don't see those trips?

A: The MBTA uses a different type of fare media for the commuter rail and commuter rail link passes. At present, AccessMyCommute cannot access data from those fare media. We are working to obtain commuter rail ticket trip data and hope to have those trips available in the dashboard very soon.

Q: I drove to work, but took public transit home. Why do I only see my driving trip?

A: AccessMyCommute defines a trip as a round-trip and determines the mode taken in descending order of preference: Driving > public transit > walking and biking. As the AccessMyCommute tool is targeted at increasing the overall sustainability of commuting practices at MIT and at reducing parking on campus, any day that you parked on campus is considered a driving day.

Q: How does AccessMyCommute match you to an available carpool?

A: When you search for a commute trip, AccessMyCommute will match you to potential carpools by searching for shared trips (eligible for carpool) that pass within a one-mile radius of your starting location.

Q: I bike or walk to work everyday and my dashboard looks empty? Why?

A: AccessMyCommute does not automatically track your walk commutes until you link it to the Moves app on your mobile phone. You can connect the Moves app on your phone to AccessMyCommute by going to "My Profile" and clicking on "Connected Apps."

Q: How do I connect AccessMyCommute to the Moves mobile app to track my biking and walking commutes?

A: In order to connect AccessMyCommute to the Moves app to track your biking and walking commutes, simply go to: "Welcome, [Your Name]!" > Edit Profile > Connected Apps. Under the Moves app, click "Connect" and follow the instructions provided to connect Moves to AccessMyCommute. (This isn't up yet, is that correct? I didn't see it on my profile)

Q: How do I earn points?

A: Points will be awarded automatically for commute trips that are eligible for points. Whether or not a commute trip is eligible for points will be determined based on the rules of available point programs. To determine if your trips are points eligible, please visit Incentives > Point Programs to learn about active point programs. Over the coming months, MIT will be introducing a variety of point programs.

Appendix C – Survey write-in comments

Comment Category	Comment
Communications	I would love better instructions and emails reminding us of any important dates
	More advertising of the platform before more features are added.
	No one has answered either of my customer service requests. Why is there an option to access customer service if no one will answer?
Community	I would like to see it made available to all members of the MIT community. I know a lot of other fellows who would like to use this.
External apps	I would like to see real time data or it adaptable to other trackers I have like my fitbit.
	I find that the Move app really drains my phone battery.
	better connection between moves and accessmycommute
	Align with my iphone app map my run
	Maybe it would be good as a mobile app, which would alert me to points earned. Thanks!
	easier interface on the moves app that doesn't require me to indicate home and work, and clearly shows points.
	Sync with fitbit or other apps we are currently using, rather than downloading an additional app
Point Program	better interface for redeeming multiple points
Trip Planner	which route to and from work was the fastest
	Location saving
Trip Tracking	Would be happy to work with someone there on getting this going for mass transit travelers!
	automatic transit log via charliecard
	I would like to be able to log in my trips
	Easier to log commuting using the t and commuter rail
	If it worked correctly that would really be GREAT!! I walk and take public transport but NONE f that has shown up on my dashboard. According to the dashboard I'm carpooling- which I do not do. The miles are wrong too. The program is a total mess but it is a great idea.
	Faster integration of info from Moves App / T Pass
	my commute is walk and transit but I did not see an option for both modes

	To accurately and reguarly record trips.
	track more locations instead of just work/home. Ex., I commute from my boyfriend's sometimes.
	website is not intuitive
Usability	make the site more user friendly

Chapter 7 - References

"A Better Way to Travel in Utah." *TravelWise*, 2008. http://www.travelwise.utah.gov/about_what.php.'

Allcott, Hunt. "Social Norms and Energy Conservation." MIT Center for Energy and Environmental Policy Research, October 2009.

Barnum, Carol M. *Usability Testing Essentials: Ready, Set...Test!*. Morgan Kaufmann Publishers, 2010.

Baum-Snow, Nathaniel. "Changes in Transportation Infrastructure and Commuting Patterns in U.S. Metropolitan Areas, 1960-2000," n.d.

Brakewood, Candace, Gregory Macfarlane, and Kari Watkins. "The Impact of Real-Time Information on Bus Ridership in New York City." *Transportation Research Part C* 53 (March 4, 2015): 59–75.

"Budget Highlights Fiscal Year 2013." U.S. Department of Transportation, n.d. https://www.transportation.gov/sites/dot.dev/files/docs/dot_budget_highlights_fy_2013_smaller.pdf.

"Capital Bikeshare 2011 Member Survey Report." Washington, DC: LDA Consulting, 2012.

Chesto, Jon. "Companies' Shift from Suburbs to Cities Part of National Trend: Firms Now Seek out Office Areas That Attract Young Talent." *Boston Globe*, January 19, 2016. https://www.bostonglobe.com/business/2016/01/19/move-reflects-headquarters-trend-choosing-cities-over-suburbs/Sebvk8lb7D6qxDr0IUR03N/story.html.

Cialdini, R. "Crafting Normative Messages to Protect the Environment." *Current Directions in Psychological Science* 12 (2003): 105–9.

Dijksterhuis, and J Bargh. "The Perception-Behaviour Expressway: Automatic Effects of Social Perception on Social Behavior." *Advances in Experimental Social Psychology* 33 (2001): 1–40.

Drouvelis, M, R Metcalfe, and N Powdthavee. "Priming Cooperation in Social Dilemma Games." In *IZA Discussion Paper*, 2010.

Dutzik, Tony, and Phineas Baxandall. "A New Direction: Our Changing Relationship with Driving and the Implications for America's Future." U.S. PIRG Education Fund, Spring 2013.

Ettema, Dick, Jasper Knockaert, and Erik Verhoef. "Using Incentives as Traffic Management Tool: Empirical Results of the 'Peak Avoidance' Experiment." *Transportation Letters: The International Journal of Transportation Research* 2 (2010): 39–51.

Fogg, B.J., Cathy Soohoo, David Danielsen, Leslie Marable, Julianne Stanford, and Ellen R Tauber. "How Do People Evaluate a Web Site's Credibility? Results from a Large Study." Stanford Univeristy, Consumer WebWatch, Sliced Bread Design, LLC, October 29, 2002.

Gates, Emily. "New Incentives to Change Modes: An Experimental Design to Reduce Single-Occupant Vehicle Commuting in Kendall Square," 2015.

Golden, Mark. "Stanford Study to Try Cold Cash and Social Game to Relieve Rush Hour Traffic." *Stanford Report*, April 2, 2012.

Gomes, N, D Merugu, G O'Brien, C Mandayam, J.S. Yue, B Atikoglu, and D Wischik. "Steptacular: An Incentive Mechanism for Promoting Wellness." In *Communications Systems and Networks*, 2012.

Gonzalez, Richard, and George Wu. "On the Shape of the Probability Weighting Function." *Cognitive Psychology* 38 (1999): 129–66.

Hartnett, Matthew. "Understanding the Evolution of Transportation Pricing and Commuting at MIT: A Study of Historical Commuting Data." Massachusetts Institute of Technology, 2016.

Hirshleifer, Saroiini. "Incentives for Effort or Outputs? A Field Experiment to Improve Student Performance." University of California, San Diego, January 28, 2016.

International Organization for Standardization. "ISO 9241-11: Ergonomic Requirements for Office Work with Visual Display Terminals - Part 11: Guidance on Usability," n.d.

Jaffe, Eric. "Commuters Don't Stop Driving to Work Unless You Take Away Free Parking." *The Atlantic - CityLab*, February 16, 2016.

John, L.K., G Loewenstein, A.B. Troxel, L Norton, J.E. Fassbeder, and K Volpp. "Financial Incentives for Extended Weight Loss: A Randomized, Controlled Trial." *Journal of General Internal Medicine* 26, no. 6 (n.d.): 621–26.

Kahneman, Daniel, and Amos Tversky. "Prospect Theory: An Analysis of Decision Under Risk." *Econometrica* 47, no. 2 (March 1979): 263.

Kenworthy, Jeffrey R, and Felix B Laube. "Patterns of Automobile Dependence in Cities: An International Overview of Key Physical and Economic Dimensions with Some Implications for Urban Policy." *Transportation Research Part A* 33 (1999): 691–723.

Levitt, Steven D, John A List, Susanne Neckermann, and Sally Sadoff. "The Impact of Short-Term Incentives on Student Performance," September 2011.

Lewis, J.R. "IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use." *International Journal of Human-Computer Interaction* 7, no. 1 (1995): 57–78.

Long, Rebecca. "A Commuter's Dilemma: Extra Cash or Free Parking?" Legislative Analyst's Office, March 19, 2002.

Lu, Fangping. "Framework for a Lottery-Based Incentive Scheme and Its Influence on Commuting Behaviors - an MIT Case Study." Massachusetts Institute of Technology, 2015.

McKenzie, Brian. "Who Drives to Work? Commuting by Automobile in the United States: 2013." American Community Survey Reports. U.S. Department of Commerce, August 2015.

Merugu, Deepak, Balaji S Prabhakar, and N.S. Rama. "An Incentive Mechanism for Decongesting the Roads: A Pilot Program in Bangalore." Stanford University, n.d.

Metcalfe, Robert, and Paul Dolan. "Behavioural Economics and Its Implications for Transport." *Journal of Transport Geography* 24 (2012): 503–11.

"MIT FACTS," January 2016. http://web.mit.edu/facts/.

MIT Office of the Provost. "MIT 2014 Commuting Survey by Respondent Type." MIT, 2014.

Nielsen, Jakob, and Rolf Molich. "Heuristic Evaluation of User Interfaces." In *CHI '90 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 249–56, 1990.

Nielsen, J, and R Molich. "Enhancing the Explanatory Power of Usability Heuristics." In *Proceedings of Association for Computing Machinery*, 1990.

O'Brien, Tim. "Why Don't We Carpool?" *Timesunion*, June 27, 2010. http://www.timesunion.com/news/article/Why-don-t-we-carpool-562503.php.

Pluntke, Christopher, and Balaji S Prabhakar. "INSINC: A Platform for Managing Peak Demand in Public Transit." *Journeys*, September 2013.

Pollack, Stephanie. "Hub and Spoke: Core Transit Congestion and the Future of Transit and Development in Greater Boston." Northeastern University, June 2012.

Quesenbery, Whitney. "Using the 5Es to Understand Users." *WQusability*, 2011. http://www.wqusability.com/articles/getting-started.html.

Rose, Geoff, and Heidi Marfurt. "Travel Behaviour Change Impacts of a Major Ride to Work Day Event." *Transportation Research Part A* 41 (2007): 351–64.

Simon, Herbert. "A Behavioral Model of Rational Choice." *The Quarterly Journal of Economics* 69, no. 1 (February 1955): 99–118.

"Sustaining Participation in a Safety Process: 10 Relevant Principles from Behavioral Science." *Professional Safety*, September 2001, 24–29.

Tversky, Amos, and Daniel Kahneman. "Extensional Versus Intuitive Reasoning: The Conjunction Fallacy in Probability Judgment." *Psychological Review* 90, no. 4 (October 1983).

———. "Judgment under Uncertainty: Heuristics and Biases." *Science* 185, no. 4157 (September 27, 1974): 1124–31.

"Usability.gov Improving the User Experience," May 17, 2016. http://www.usability.gov/.

Usability Professionals Association. "UPA 2009 Salary Survey." August 18, 2009.

Volpp, John, Norton Troxel, and J Fassbender. "Financial Incentive-Based Approaches for Weight Loss: A Randomized Trial." *Journal of the American Medical Association* 300 (2008): 2631–37.

Xu, J, and N Schwarz. "How Do You Feel While Driving Your Car? Depends on How You Think about It." University of Michigan, 2006.

Zhu, Chenguang, Jia Shuo Yue, Chinmoy V Mandayam, Deepak Merugu, Hossein Karkeh Abadi, and Balaji S Prabhakar. "Reducing Road Congestion Through Incentives: A Case Study," November 15, 2014.