

DASH

Team

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Problem & Solution Overview

Texting a friend, navigating on GPS, admiring the scenery along a road--these are all common distractions that lead to motor accidents. Distracted driving is a major issue, and many states have enacted laws in response to the alarming correlation between driver recognition error and vehicle accidents. Unfortunately, many people continue to engage in distracting behavior, even though they are aware of the dangers of unfocused driving.

We are designing a mobile application, DASH, that allows users to visualize and share data on driving behavior. Our design is supplemented with movement-tracking hardware, but we will assume that the hardware is already available so that we can focus on designing the app itself. By providing users with information on how they spend their time driving, we can motivate them to be more conscious about road safety. The goal of our project is to prevent potential accidents, encourage safe driving habits, and transform the mundane task of driving into a social activity.

Design Research Goals, Stakeholders, & Participants

We pursued four participants for our design research. When selecting our participants, we aimed to diversify levels of driving experience and reasons why they drive. We targeted two general demographics of drivers. The first demographic consists of *casual drivers*--people who drive for personal errands and common commutes (e.g. to work or school). The second demographic consists of *professional drivers*--people who make driving their career. We primarily conducted interviews and fly-on-the-wall studies, since contextual inquiry posed a safety risk to our drivers. In addition, fly-on-the-wall method will minimize the Hawthorne effect--a tendency for people to change their behavior when they know they are being watched.

Lynn, our first participant, is a soil scientist with the U.S. Forest Service. She owns a 2016 Subaru Impreza that she drives for work and leisure. She also checks out cars from a government-provided fleet, and she has driven a variety of vehicles. We first conducted a fly-on-the-wall study of Lynn's driving behavior on a short drive. While she was driving, she would glance at her phone every time she received a message. She also used Siri and Bluetooth controls to avoid physical interaction with her phone. Following this observation, we did an interview. She shared that her cell phone is the most distracting element of her daily commutes. We also discovered that Lynn is fully aware of potential distractions, and she seriously considers consequences of risky driving habits.

Stephanie, our second participant, is a casual driver with 36 years of driving experience. She primarily drives herself and her family in a 2016 Toyota Prius for her daily work commute, errands, and leisure. As a computer engineer at the Department of Defense, she is aware of privacy and security issues associated with data collection and the internet-of-things. With this expertise, she suggested that we store driving statistics locally rather than on the cloud. As we interviewed Stephanie in her car, we noticed that there seemed to be a generational difference with our previous casual driver, Lynn. The distractions that she faces on the road are further removed from interacting with her phone (e.g. checking messages or social media) and closer to external distractions (e.g. passengers and views). She shared that she rarely touches her phone when driving.

Jim, our third participant, is a retired law enforcement officer and a drive instructor from the 911 Driving School. Jim has been driving since the 1970s, which amounts to 40+ years of driving experience, and has been an instructor for 8 months. He believes that anything that can take people's eyes off the road is distracting, such as views/accidents on the road, as well as the use of cell phones. When we asked him to identify common mistakes of new drivers, he pointed out primarily mechanical behaviors; for example, new drivers often fail to signal, check their mirrors, or glance at blind spots. Although students don't check their phone during lessons due to the nature of the situation, Jim has noticed that students' attention span varies depending on the time of the day. Students in early morning lessons who are tired tend to make more mistakes than those who are more energetic and focused in later lessons.

A **bus driver** on Route 67, our fourth participant, was the subject of a fly-on-the-wall study. We got on bus 67 from UW and sat on the seats closest to and across from the driver (the disabled seating area). We did not tell him that we were observing him because we wanted to see how he genuinely drives. We observed that the driver was usually very attentive to everything around him. He would look into his rearview mirror to keep an eye on passengers, check his side mirrors when changing lanes and turning, and looked around often. There was an instant when a passenger was talking to the driver and he almost missed a stop. This was clearly dangerous behavior, but it was not the driver's fault. However, this shows that even professional drivers can become distracted even if it isn't from phone usage or exhaustion.

Design Research Results & Themes

Concerns surrounding privacy were common amongst the participants we interviewed. We first discovered this theme when asking our participants: "If we provide a device to track your driving behavior, what types of functionality do you expect it to have?" Most responded with a sort of eye or body movement tracker, and further questioning reveal minor concerns regarding security. Lynn shared, "I don't like the idea of having a camera watching me." On the other hand, Jim and Stephanie were extremely open to allowing data collection *only* in the case that their information was not being shared publicly (i.e. via the internet). This shows that there are different levels of information that can be collected and different people draw the line for what they are comfortable sharing at different places. Privacy is a legitimate concern, especially since adversaries can obtain and manipulate data for illegal use.

We have discovered plenty of common distracting behaviors that people have while driving. The one mentioned the most was the use of cell phones, especially texting and calling while driving. Switching radio stations, looking at GPS navigation, tuning AC controls, and other interactions with car technology may also be a cause for concern. Some people also revealed that they drink, eat, and put on makeup while driving. Other than distractions from the car and themselves, drivers can also be distracted by having conversations with passengers, as well as accidents or scenery along the road. In other words, anything that takes one's eyes off the road is a distraction, which poses a serious threat to both the driver and everyone on the road. Finally, people tend to be more easily distracted when they are tired.

Clearly, people are concerned with road safety. Nobody goes out to drive with the goal of getting distracted and possibly hurting someone. However, people still do things like use the audio assistant (e.g. Apple's Siri) on their phone, talk on the phone through Bluetooth, change radio stations, listen to music, and use their phone to play music. These activities do not seem like distracting behavior to our participants. One of our participants said that she listens to music while driving and that the only distracting part is if she has to switch songs or change channels. Another one uses her car audio and Bluetooth to chat on the phone. The conclusion to draw here is that people generally know the things that distract them and the things that do not distract them, even if they may be wrong about some of them.

We discovered that the presence of a passenger or a supervisor has a big influence on whether our participant will engage in distracting activities while driving. In both Stephanie's and Lynn's interview, when asked what stops them from doing distracting behaviors, they said that warnings from passengers reminds them to keep their eyes on the road. In our interview with Jim, we learned from his professional experiences that students rarely engage in distracting activities when they know they are being watched. The presence of a supervisor reminds drivers that they are being held accountable for their actions, thus preventing them from engaging in distracting actions.

Answers to Task Analysis Questions

1. *Who is going to use the design?*
People who drive will use our design. In addition to benefiting individual drivers, our design will also work well when two or more parties are involved and data needs to be shared. For example, our design may benefit parents and their children, drive instructors and students, and taxi/Uber/truck companies and their contractor drivers.
2. *What tasks do they now perform?*
People can purchase tracking devices to collect data about their car, braking frequency, and turning speed. People can also purchase signal blocking devices which block phone signals when the car is moving. Also, many newer versions of cars come with preinstalled programs that discourage drivers from engaging in very distracting activities such as typing in addresses into the GPS and adding new Bluetooth devices. In addition, people avoid taking their eyes off the road and hands off the wheel by utilizing voice recognition to perform tasks on their phone and car.
3. *What tasks are desired?*
People want to be reminded to stay safe on the road. They want good driving behaviors to be reinforced and rewarded. People want to cultivate good driving habits, which may require data collection on eye movements, head positions, and body positions, but they also want to ensure their privacy is maintained.
4. *How are the tasks learned?*
Tasks can be learned through intuitive tutorials or instructional videos that will demonstrate our design's features. The user can be periodically reminded of the consequences of distracted driving through various statistics.
5. *Where are the tasks performed?*
Tasks are primarily performed in the car. They can also be performed later at home to review stats and to compare driving habits with friends. The tasks can also be done in a company setting, where employers or insurance companies track their employees and customers, respectively.
6. *What is the relationship between the person and data?*
Data will be collected on driving behavior, which includes records of face, head, and body positions of the driver. It will be completely personalized to the user.
7. *What other tools does the person have?*
Native phone apps can track the usage of phones directly. There is existing technology that can block the phone signals (e.g. airplane mode), which might keep drivers from

interacting with their phones. There are also some devices that are currently used by insurance companies that tracks the states of cars.

8. *How do people communicate with each other?*
A potential design can track and analyze people's driving behavior. Hence, parents and driving instructors can track the driving performance of their children and students, respectively. Users can also share safety scores graded by the system with families and friends. Passengers of ride-sharing services, such as Uber, can potentially learn about their driver's safety score before hopping on a car.
9. *How often are the tasks performed?*
Tasks will start every time one drives. It will record and analyze in real time. The data will be stored and ready to be shown the user.
10. *What are the time constraints on the tasks?*
One of the time constraints is providing drivers real time processing and feedback. It is important to give live updates and reminders when the driver is engaged in dangerous activities. We also want to provide cumulative data to drivers so they can track their driving habits over an extended period.
11. *What happens when things go wrong?*
This design should discourage unsafe driving behaviors, so we do not want the tool itself to be a distraction. Since a device will give warnings when it detects a potential distraction, a possible error is to misjudge people's behaviors and warn them even if they are not distracted. We also intend to secure our users' information, but personal data can be leaked if there is a security loophole; if things go wrong, we need to make ensure that the data is not incriminating or personally identifiable information.

Proposed Design Sketches | DESIGN #1

The first design is a mobile app that aims to track distracting phone usage while the user is driving. It automatically detects driving using the phone's internal speedometer and gyroscope. Whenever the user texts, navigates using GPS, or answers a phone call, the mobile app will record and visualize the activity (Figures 1, 2). To motivate safe driving behavior, the app also maintains a leaderboard for the current user and their contacts (Figure 3). Finally, the app contains a settings view that allows the user to adjust their profile, alert style, and friends list (Figures 4, 5). This design is targeted to users who may not be interested in tracking finer-grained details such as their eye and body movements.

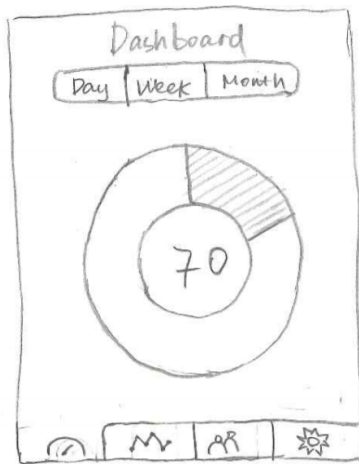


Figure 1

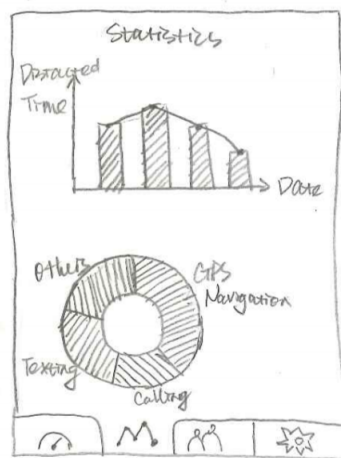


Figure 2

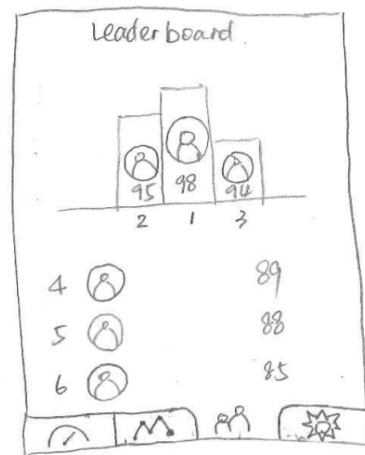


Figure 3

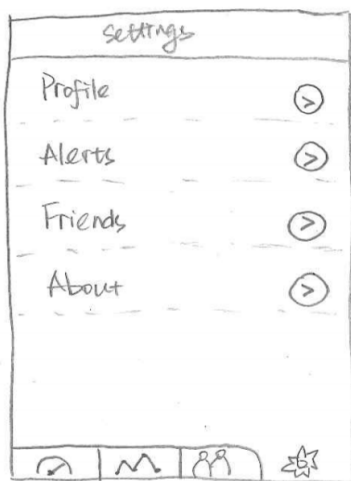


Figure 4

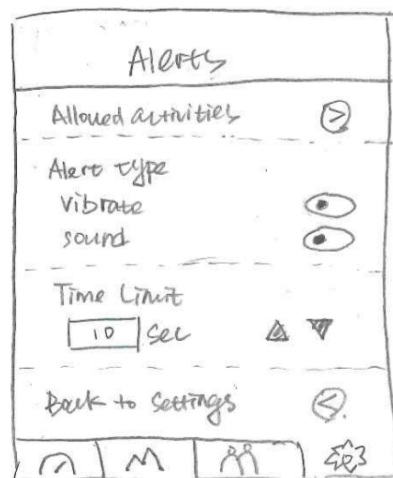


Figure 5

Proposed Design Sketches | DESIGN #2

The second design involves two components: hardware to track eye and body movements (Figure 6) and a webapp that visualizes driving behavior (Figure 7). This design is targeted to users who are concerned about their safety on the road as well as employers/guardians who would like to monitor driving behavior of their employees/children. The hardware will be a Kinect-like device that can record and analyze movements, which can then be translated into different activities such as "eyes closed," "checking rearview/side mirrors," "changing car/radio controls," and more. When the system detects potentially distracting behaviors--like a driver falling asleep or taking eyes off the road--it can alert the driver with a friendly noise. These activities are visualized in a webapp that may be used to calculate a Safety Score.

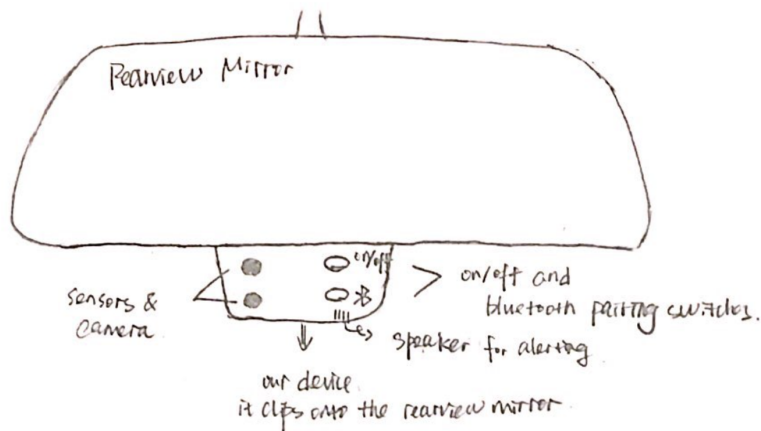


Figure 6

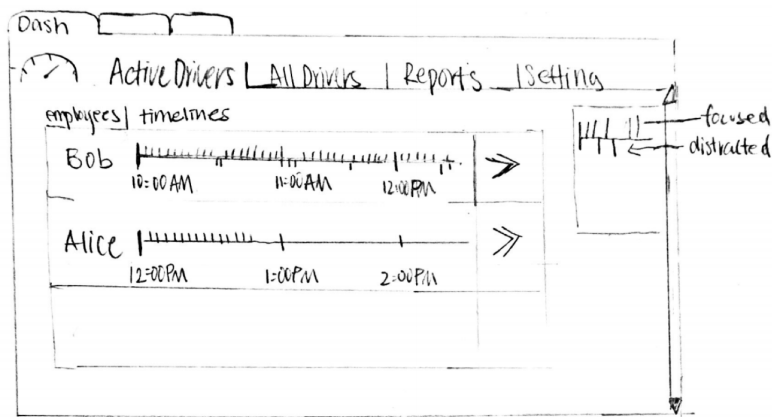


Figure 7

Proposed Design Sketches | DESIGN #3

The third design includes a mobile app (Figures 10-13) and a hardware tracking device for eye and body movements (Figure 9). Unlike the previous design, this design targets individuals who are interested in mobile informatics. The hardware will have the same functionalities as the one used for monitoring, but its interface is more friendly and less invasive. The device will be a Kinect-like device that can record and analyze movements, which can then be translated into different activities such as "eyes closed," "checking rearview/side mirrors," "changing car/radio controls," and more. When the system detects potentially distracting behaviors--like a driver falling asleep or taking eyes off the road--it can alert the driver with a friendly noise. The mobile app will analyze the data collected by the hardware and present visualizations to the user.

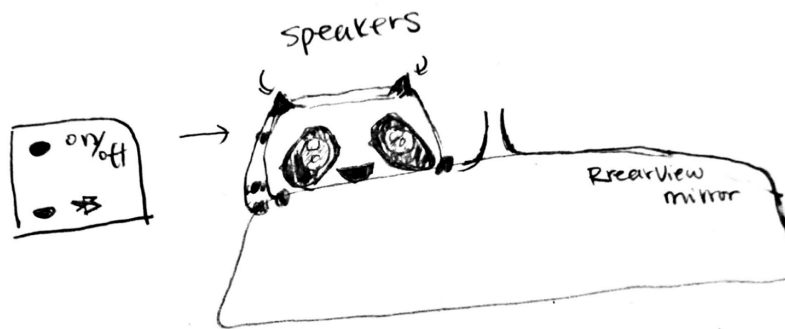


Figure 9

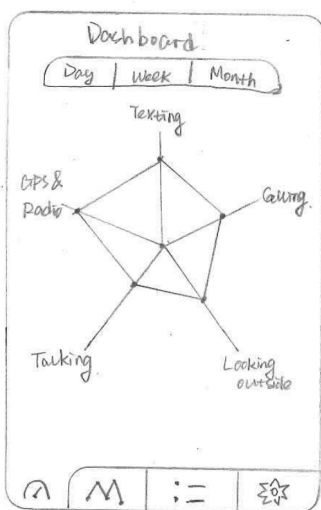


Figure 10

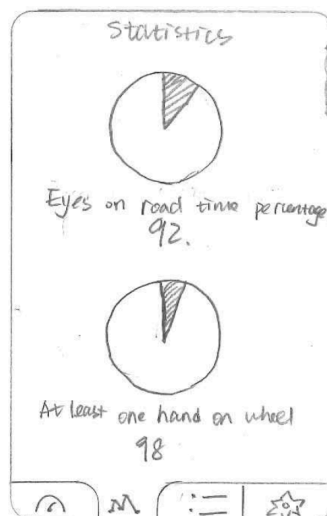


Figure 11

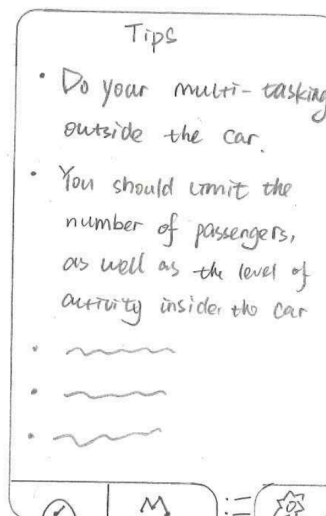


Figure 12

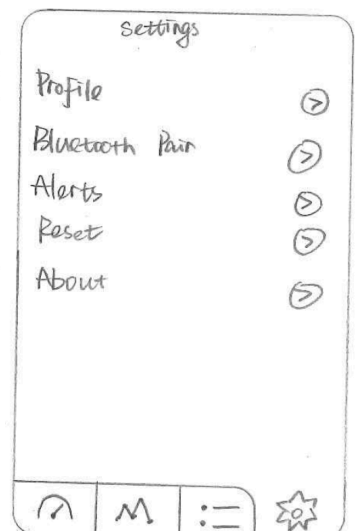


Figure 13

Proposed Design Sketches | SELECTED DESIGN & TASKS

Our final design synthesizes ideas from the proposed designs above, mainly focusing on two tasks: (1) processing and visualizing information about driving behavior and (2) sharing and comparing driving habits with friends. In our design research, we found that all our interview subjects were aware of when they were distracted while driving, but were unsure of the amount of time they were distracted. A design that reports and visualizes important statistics on driving behavior will be potentially helpful in motivating safe driving habits. In addition, having the feature of sharing and comparing driving safety with contacts is like having a passenger sitting in the car reminding the drivers not to get distracted. These tasks are more foundational than the other tasks and we believe that they provide the most opportunity to reward safe driving habits.

Written Scenarios

Scenario 1: Processing and Visualizing Information about Driving Behavior (Figure A)

Nicole is going to drive from Seattle to Los Angeles on her own. She chats with her friend, Nick, before she leaves. She mentions that she did not sleep well last night. Nick gets worried about her getting tired on the road, but Nicole is confident in herself since she has always been a good driver. She drives her own 2016 Jeep Cherokee and she feels excited about this road trip. However, before she even reaches Portland, the DashMoblle (the device installed on her car that tracks her driving behaviors) starts beeping like every five minutes, which prompts her to take the nearest freeway exit. She stops at a gas station and looks at DASH (the phone app that shows information about her driving behavior). According to DASH, she was distracted for about 20% of the time she was driving. Nicole realizes that she was falling asleep and it is not safe to continue driving. As a result, she decides to make an extra stop at Portland, where she finds a hotel to rest.

Scenario 2: Sharing and Comparing Driving Habits (Figure B)

Ashley and Adam are two senior students at University of Washington. Ashley lives in Bellevue and Adam lives at Northgate, so they both drive to school every day. After they finish their last class for the day, they walk to Central Parking Garage where they say goodbye and drive home. When Ashley gets home, her phone displays a push notification that says "Your ranking has been updated!". She unlocks her phone and checks out the leaderboard in DASH. She has been paying extra attention to not get distracted while driving recently and now she finally ranks the first among all her friends, with a Safety Score of 98! On the contrary, Adam did not receive any notifications when he gets home. Many of his friends are on DASH competing scores, so he checks out the leaderboard constantly. Then, he moves to the national leaderboard, where he finds out that his driving safety score is below the current national average. Adam realizes that he needs to be more focused while driving, for the sake of his own safety!

Storyboards of Selected Design | BOARD #1

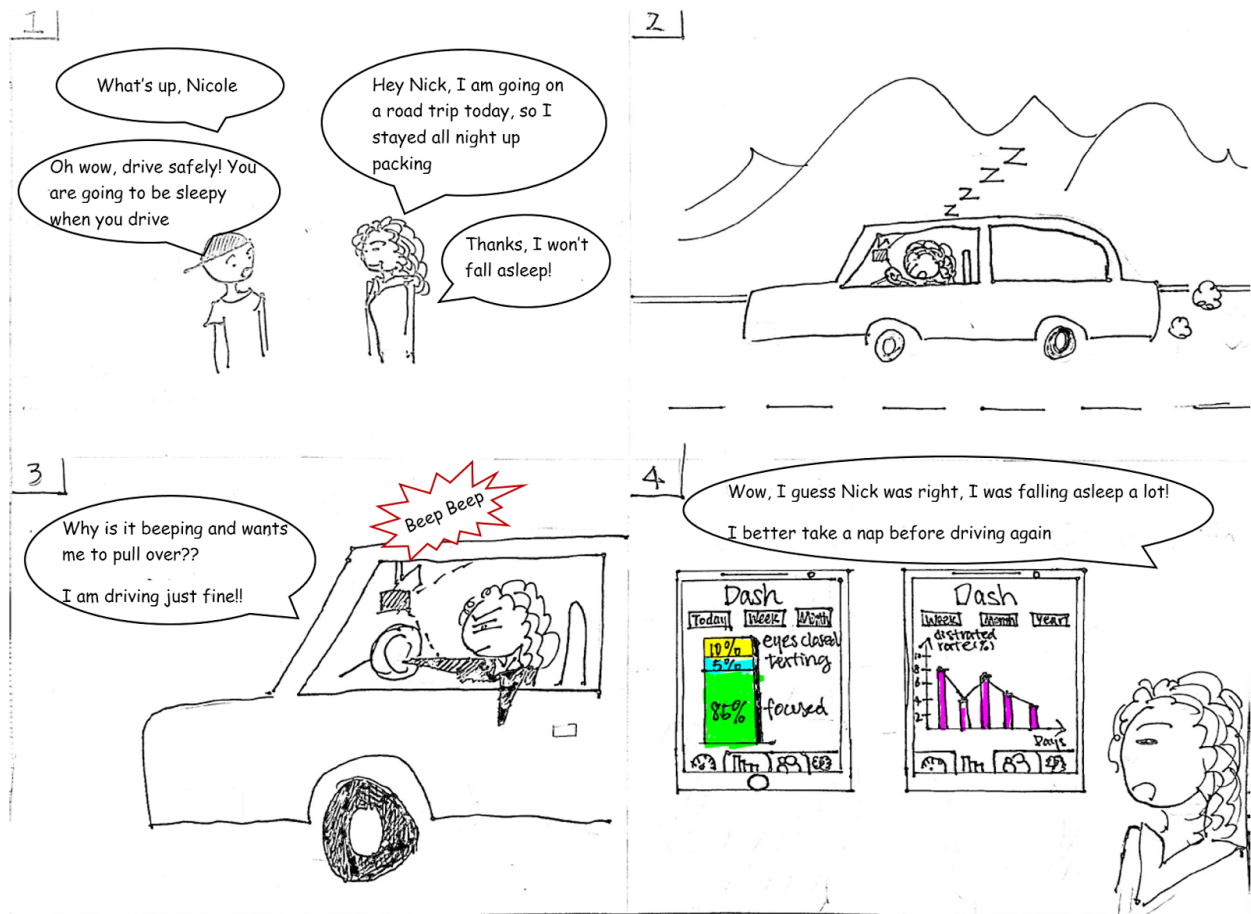


Figure A: Processing and Visualizing Driving Behavior

Storyboards of Selected Design | BOARD #2

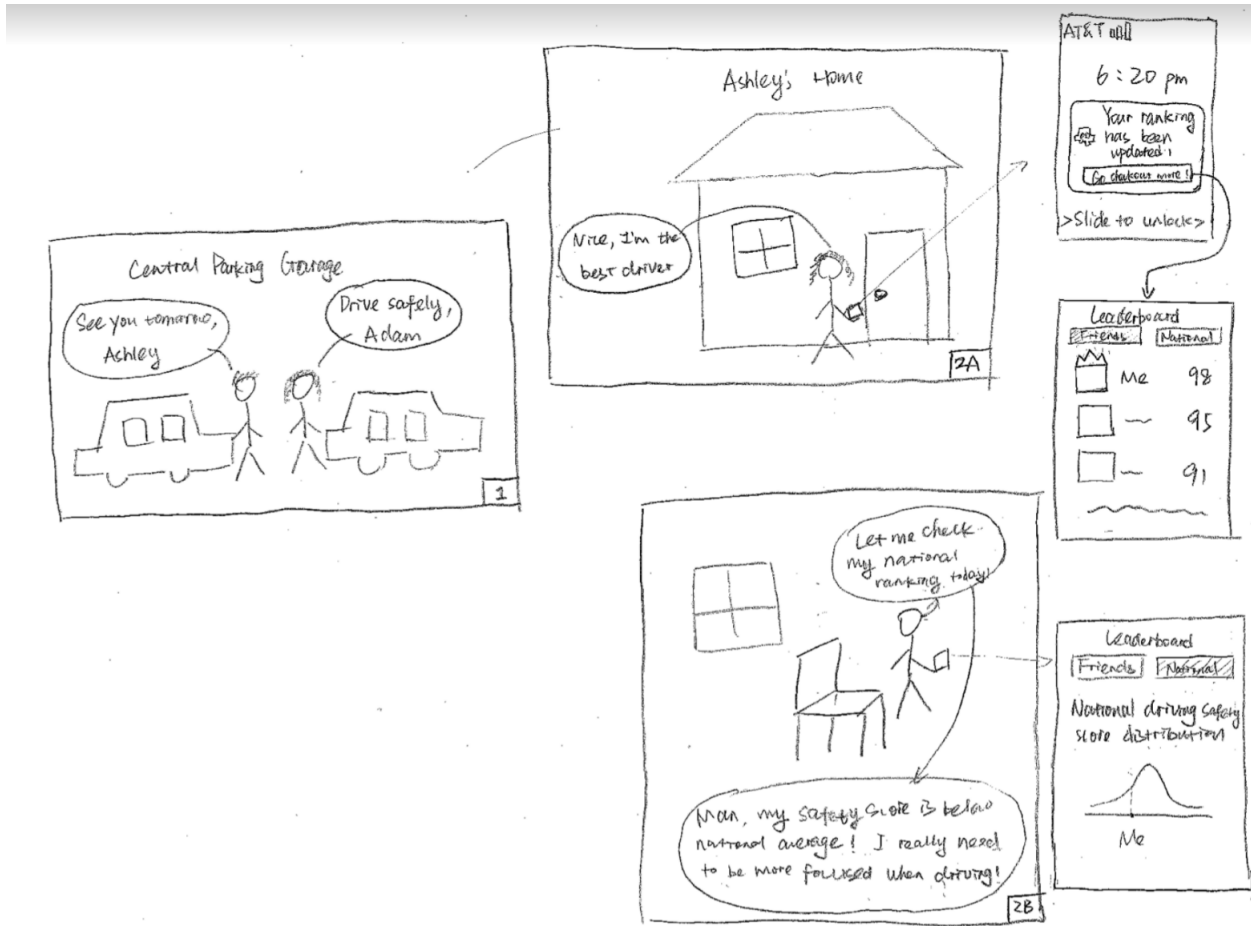


Figure B: Sharing and Comparing Driving Habits