Preventing Texting While Driving: A Design Investigation

by

Daniel Isaul Meza

Submitted to the Department of Mechanical Engineering on May 22, 2015 in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science Mechanical Engineering

ABSTRACT

With the integration of the smartphone into society, people have become increasingly dependent on technology to remain connected to one another. One result of this techno-social integration is that people now have the choice to text while driving, an action that now accounts for nearly 25% of all vehicle accidents and results in at least 11 deaths per day.

Current methods of preventing texting while driving are either too new to be fully realized or are ineffective due to poor design or implementation methods. A methodical investigation into the design and merits of these methods, the environments that drivers interact with, and alternative driving experience systems will facilitate an informed design of a new system that may effectively prevent texting while driving.

A solution comprised of three separate but dependent strategies is proposed to effectively prevent texting while driving: a universally compatible hardware device for the vehicle setting, financial incentives supported by data acquisition, and a required education curriculum for new drivers.

Thesis Supervisor: David Robert Wallace
Title: Professor of Mechanical Engineering
ACKNOWLEDGEMENTS
The author wishes to thank several people. I would like to express my sincerest gratitude to Dr. David Robert Wallace for his inspiring lectures in 2.009 and his patience and mentorship as a thesis advisor. I would also like to thank Brandy Baker for constantly checking in with me as I progressed through my final years as an undergraduate. Finally, I would like to thank my friends, family, and my fraternity brothers of Theta Delta Chi for their unyielding support and for pushing me to strive forward both academically and as an individual.
Contents

ACKNOWLEDGEMENTS 4

LIST OF FIGURES 7

1. Introduction 8
   1.1 Emergence and Impact of the Smartphone 8
   1.2 The Dangers of Texting While Driving 8
   1.3 The Process of Texting 9
   1.4 Driving, Simplified 11
   1.5 Texting While Driving 11
   1.6 Texting While Driving with Hands-Free Devices 12
      1.6.1 Limitations of Hands-Free Devices 14

2. Design Investigation Methods 14

3. Design Investigation 15
   3.1 Current Methods and Technology 15
      3.1.1 Phone Applications 15
      3.1.2 In-Vehicle Systems 17
      3.1.3 Education 19
   3.2 Environment 21
      3.2.1 Prerequisites for Driving 21
      3.2.2 The Vehicular Environment 21
   3.3 Alternative Driving Experience Systems 22
      3.3.1 OnStar 22
      3.3.2 Active Park Assist 23
      3.3.3 Insurance Rewards and Incentives 23
      3.3.4 Ignition Interlock 23

4. Designing a Texting and Driving Prevention System 23
   4.1 Functional Requirements 26
   4.2 Proposed Solution 27
      4.2.1 Smartphone-Hardware Integration 27
      4.2.2 Smartphone Application and Safe Driving Monitoring and Incentive 29
      4.2.3 Required Driver Education 29
   4.3 Feasibility, Risks and Countermeasures 30
      4.3.1 Feasibility 30
      4.3.2 Risks and Countermeasures 31

5. Looking to the Future 33
5.1 Future Technology
   5.1.1 Self-Driving Cars 33
   5.1.2 Vehicle Communication Networks 35
   5.1.3 Artificial Intelligence 35
5.2 Future Work 35
6. Conclusion 36
7. Appendix 37
   Appendix A: Smartphone Applications Functionalities 37
   Appendix B: In-Vehicle System Functionalities 38
   Appendix C: Education Methods Characteristics 39
8. Bibliography 40
LIST OF FIGURES

Figure 1-1: The Texting Process 10

Figure 1-2: Introducing Driving to the Texting Process 12

Figure 1-3: Ford Sync® System Process 13

Table 3-1: Design Evaluation of Phone Applications 16

Table 3-2: Design Evaluation of In-Vehicle Systems 18

Table 3-3: Design Evaluation of Education Methods 19

Table 4-1: Merits, Disadvantages, and Solutions of Investigated Methods 24

Table 4-2: Unique Solution Considerations 25

Table 4-3: Key Functional Requirements with Explanation 26

Figure 4-1: Steering Wheel Sleeve and Ignition Interlock Systems 27

Figure 4-2: Smartphone Dock 28

Figure 4-3: Mapping of Proposed Solution 29

Table 4-4: Feasibility Considerations for Proposed Solutions 30

Table 4-5: Risks and Countermeasures for Proposed Solutions 31

Figure 5-1: Autonomous Vehicles Prototypes by Company 34
1. Introduction

1.1 Emergence and Impact of the Smartphone

In 2007, Apple Inc. introduced the first iPhone, the first smartphone of its kind to utilize a multi-touch interface. The original iPhone included a two megapixel camera, Bluetooth and WiFi connectivity, and GPS tracking capability; within a few months of its initial release users could download 3rd party applications [1]. Since the release of the first iPhone, Apple Inc. has sold more than 590 million new iPhone devices worldwide [2].

The emergence of smartphones running the Android mobile operating system, starting with the HTC Dream in 2008, has further widened accessibility of the smartphone, leading to global sales of all smartphones to over 967 million units as of 2013 [3].

With the integration of smartphones in modern society, many facets of daily life—including business, education, health, psychology, and social interactions—have been impacted both positively and negatively. The determining factor as to its effect is how each individual user utilizes their smartphone. That is, if they choose to use their smartphone smartly or not [4].

1.2 The Dangers of Texting While Driving

One negative impact of smartphones is that users now have the choice to text while driving. Texting while driving causes 1,600,000 accidents per year—nearly 25% of all car accidents—and kills 11 teenagers every day. A driver who is texting is 23 times more likely to be in an accident than an undistracted driver, which is significantly more dangerous than driving with a BAC of 0.10, a risk factor of only 7. Perhaps the larger issue is that over half of all young adult drivers claim that it’s easy to text while driving, and three-quarters of young adults are very confident that they can safely text while driving. The dangers of texting while driving aren’t limited to only young adults, however; 48% of young drivers have seen their parents drive while using their smartphone, 27% of adults have actively texted while driving, and 48% of kids age 12-17 have been in the vehicle while the driver was texting [5] [6].
1.3 The Process of Texting

To understand the inherent dangers of texting while driving, it is first necessary to define the actions and cognitive processes in which a person receives, reacts, and responds to a text message. For the purpose of defining this process, the following assumptions will be made: the mobile device is a smartphone, the person’s mobile device is set to alert the user when a text message is received, the person is in an environment that does not require their undivided attention, and the mobile device is easily accessible. Given these assumptions, the following process ensues:

First, the mobile device receives a text message and consequently alerts its owner. This can occur in one of three ways: the mobile device will vibrate, emit an audial notification, or both vibrate and emit an audial notification.

Now alerted by an external stimulus, the person must now locate the mobile device and navigate to the texting application. This process will vary based on the location of the mobile device, whether or not the mobile device requires a passkey to access, and the last application used on the mobile device.

If the mobile device is not immediately accessible—for example, the mobile device may be in the person’s front pants pocket—then the person must move the device to a location where it can be physically manipulated. This may require flipping and turning of the mobile device. Once the phone is in a position to be manipulated and is ready to receive input from its owner, the phone may require the entry of a passkey if the phone is not already unlocked.

Passkey entry options include entering a numeric code, physically interfacing with the touch screen to replicate a pre-determined pattern, pressing on a fingerprint sensor located on the mobile device, or facial recognition, which requires the user to look directly at the mobile device’s camera. Entering a numeric code or a pattern to unlock the mobile device may also require the user to directly look at the screen to ensure that the passkey is correct.
With the mobile device now unlocked, the user must now navigate to the text messaging application. If the mobile device was last locked while another application was in use, then the screen will display that last application. In this case, the user must exit the application and navigate to the texting application via a series of swipes and inputs. Once the texting application has been opened, the user must then select the new message. The total number of required swipes and key entries will decrease if the mobile device was on the home screen or if the text messaging application was in use when the phone was last locked.

The text messaging application now displays the message content: a combination of words, pictures, and videos. The user must now cognitively process the information presented to them and, based on the context and content of the message, consider if and how to best respond.

Responding to the text message may require the user to type directly onto the mobile device’s screen or open a camera application to capture photographs or videos. In the case of the former, most users will read their response text to ensure that their spelling and grammar is correct; in the latter, users will look at the photographs and videos before sending the content. Both cases require the user to look directly at the mobile device’s display screen.

With the text message response now sent, the user will wait for the next response and the process repeats. Figure 1-1, below, depicts this process.
1.4 Driving, Simplified

In its most base functions, driving a vehicle can be modeled as having two main parts: drivers must physically control a moving object and attend to environmental cues such as stoplights, adjacent and oncoming vehicles, pedestrians, and other road hazards to reach a destination.

1.5 Texting While Driving

Texting, while harmless and seemingly simple in a safe environment, is a very complex and involved process.

When introduced to the process of driving, texting deviates the driver’s attention from the road to the mobile device. More specifically, texting while driving requires the driver to divert their attention from the road in all but one part of the texting process. When notified of a new text message, the driver’s attention is momentarily dedicated to the presence of a new text message; while locating the mobile device, the driver may need to remove their eyes from the road and, once the driver knows of the mobile device’s location, manipulate the device to be unlocked; as the driver unlocks the mobile device, navigates to the texting application, and opens the text message, one of both of their hands will need to be removed from the steering wheel to manipulate the device and their vision diverted from the road to mobile device’s screen; processing the message content and considering how to respond requires the driver’s eyes and mental attention; and finally sending a response will require the driver’s visual attention and removing at least one hand from the steering wheel. Actively text messaging—navigating to the texting application, opening the text message, processing content, considering a proper response, and actually responding to the text message—makes a crash up to 23 times more likely; talking or listening on the phone makes a crash 1.3 times more likely; reaching for the device makes a crash 1.4 times likely. Therefore, it can be said that the most dangerous part of texting while driving occurs when the driver is looking away from the road—at 55 mph, drivers whose eyes are off the road will travel the length of a football field in 5 seconds [5]. The only part of the texting while driving process that does
not deviate the driver's attention from the road is the period when the driver is between sending a message and receiving a response—that is, when the driver is not actively texting. **Figure 1-2** demonstrates this process.

![Diagram](image)

**Figure 1-2**: Introducing Driving to the Texting Process

### 1.6 Texting While Driving with Hands-Free Devices

The process for texting while driving with a hands-free device—any technology that allows for control of a mobile device without limited manual input, such as the Ford Sync®—greatly simplifies the texting process. In the case of the Sync®, the mobile device is connected to the vehicle via Bluetooth. Once connected, the driver can set the system to read and respond to texts through voice commands and manual controls located on the steering wheel. Sync® has a number of predetermined responses that can be customized as well [7]. **Figure 1-3** documents this process.
7 STEPS

Before you start
There are a few things you should do before starting step 1:

✓ Make sure that your phone is compatible with SYNC with MyFord Touch by checking our compatibility chart
✓ Pair and connect your phone with SYNC
✓ Familiarize yourself with the controls in your vehicle

1. A soft tone alerts you to an incoming text message and a notification displays on your 8-inch touchscreen.

2. Press or pull the Voice button and say, "Listen to text message."

SYNC will read the message aloud.

3. When you want to reply to a text message, press or pull the Voice button and say, "Reply to text message."

SYNC displays a list of 15 preset-messages on the touchscreen and will ask you to pick one to send.

4. Press the arrow buttons to scroll through a list of 15 preset-messages on the touchscreen.

1. I'll call you back in a few minutes.
2. OK.
3. I just left, I'll be there soon.
4. Yes.
5. Can you give me a call?
6. No.
7. I'm on my way.
8. Yes, run a few minutes late.
9. Stuck in traffic.
10. Ahead of schedule, so I'll be there early.
11. Call me later.
12. OK.
13. OK.
14. Fill call you when I get there.

SYNC will ask you to confirm your selection. Reply, "Yes," "No," or "Cancel."

Figure 1-3: Ford Sync ® System Process. © 2015 Ford Motor Company
1.6.1 Limitations of Hands-Free Devices

While technology such as Sync® and its competitors may prove effective in the future, it is only in recent years that this particular technology has become available in vehicles; vehicles equipped with Sync® have only been available since 2014 [8]. In 2010, Ward’s Auto determined the number of vehicles sold globally to be 1.015 billion with 291 million of those units registered in North America; U.S. vehicle sales alone are estimated to be in the vicinity of 20.8 million units since 2014 [9] [10]. Even under the assumption that all vehicles sold after 2014 have hands-free technology and not accounting for the number of vehicles sold between 2010 and 2013, this amounts to less than 10% market penetration of vehicles with hands-free technology in North America alone.

The technology is rendered ineffective if the driver chooses to not register their smartphone with the in-vehicle system, turn off the smartphone’s Bluetooth capabilities, or simply chooses not to use the hands-free device.

No full-proof method currently exists for effectively preventing texting while driving. The market is lacking in vehicles with the appropriate technological capabilities that could effectively mitigate the issue and it is too easy for drivers to choose to be unsafe. What may be needed instead is an effective system that enforces drivers to consider their actions before driving themselves and others into danger.

2. Design Investigation Methods

In order propose an effective method of preventing texting while driving, it is first necessary to set a baseline system for evaluating various methods and technologies. To standardize this, each method and technology will be subject to the following evaluation:

1. Characterization of features: What makes the system unique and what sets it apart from other systems?

2. Effectiveness: Which features are effective in preventing texting while driving?
3. Ineffectiveness: What features of the system fail to make the system the dominant method preventing texting while driving?

4. Design-Motivation: What were the possible decisions that each designer, engineer, or educator made when designing their system?

5. Human-Interactions: Why would a driver select to use or not use the system?

This initial evaluation will investigate current methods of preventing texting while driving, the environment that drivers are subject to, and alternative driving experience systems—that is, any systems that may not directly combat texting while driving, but whose design and functions could inspire other facets of design.

Drawing upon the results of the initial evaluation, a list of functional requirements will be determined and applied to propose a system or set of complementary systems to prevent texting while driving. Furthermore, proposed solutions will be analyzed for feasibility as well as possible risks and countermeasures.

A brief look into future technologies and advancements will also be investigated but, as they are not yet current technologies, they cannot be considered as realistic solutions for this design investigation.

3. Design Investigation

Many different methods and technologies for preventing texting while driving exist. For ease of evaluation and analysis, iterations of similar approaches will be defined, grouped together, and categorized as a single entity.

3.1 Current Methods and Technology

Current methods and technology consist of any established means whose purpose is to prevent or mitigate texting while driving.

3.1.1 Phone Applications

Phone applications are any program that can be accessed and downloaded to a smartphone. Research into the Google Play App Store, an online depository of applications available to smartphone owners, yields two different types of phone
applications designed to prevent texting while driving. These applications can be categorized as “Automatic” and “Manual”—the “Automatic” phone applications use global positioning to detect when the smartphone is above a certain speed and automatically turn on; “Manual” phone applications require users to turn the program on before driving. Both types share many of the same features—preset automated replies, text to speech and speech to text, silencing of alerts—but the distinguishing method is how they initialize. Appendix A shows a comprehensive list of applications found within the Google Play App Store geared to prevent texting while driving with their defining characteristics. Table 3-1 summarizes the evaluation as outlined in 2. Design Investigation Methods.

Table 3-1: Design Evaluation of Phone Applications

<table>
<thead>
<tr>
<th>Phone Applications</th>
<th>Automatic</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Features</td>
<td>Automated replies, text to speech, speech to text, silencing of alerts.</td>
<td>Automated replies, text to speech, speech to text, silencing of alerts.</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>Automatically initializes based on the smartphone’s speed.</td>
<td>Various features allow for safer driving.</td>
</tr>
<tr>
<td>Ineffectiveness</td>
<td>Drain of battery life, requirement to have smartphone’s GPS on at all times.</td>
<td>Requires direct input from driver to initialize.</td>
</tr>
<tr>
<td>Design-Motivation</td>
<td>When driving, vehicles are above a pre-determined threshold speed. Given the GPS capabilities of smartphones, taking advantage of this technology can make for safer driving.</td>
<td>Requiring constant use of GPS will drain battery life and users may not like the idea of being monitored. Give users the element of choice as to when the application will be used.</td>
</tr>
<tr>
<td>Human-Interactions</td>
<td>Drivers would select this type of phone application for</td>
<td>Drivers would select this type of phone application for its</td>
</tr>
</tbody>
</table>
initialization convenience and features. However, issues arise when the smartphone owner is not driving but is over the threshold speed, such as when the owner is in a train or is the passenger in a vehicle. Additionally, the application may turn off when the driver is at a standstill but still driving, such as at stoplights or in traffic jams. features and the element of choice to use the application or not. However, given the element of choice, drivers can simply choose to not use the application.

### 3.1.2 In-Vehicle Systems

In-vehicle systems include any system that comes pre-installed when a vehicle is manufactured and any independent systems that can be and installed after the vehicle is purchased. In-vehicle systems can be categorized by their interface with smartphones: Bluetooth or physical pairing, where the former relies on a Bluetooth connection to be utilized and the latter requires the smartphone to be physically inserted onto the device. The two types of systems are fairly uniform throughout; Bluetooth pairing systems allow for hands-free functionality, come pre-installed in the vehicle, cannot be physically moved within the vehicle environment, and are universally compatible with Bluetooth-capable smartphones. Physical pairing systems, on the other hand, must be purchased and installed separately, physically lock the phone in place, are fluid in both location within the vehicle and the viewing angle. Physical pairing systems—when not connected to Bluetooth pairing systems—require direct manipulation to use the smartphone’s features. Not all physical pairing systems are universally compatible with all smartphones. One feature lacking in most of the in-vehicle systems is the ability to charge the smartphone’s battery; while this is not a necessity for preventing texting while driving, this feature may increase the likelihood that a driver will select one system over another. Appendix B documents researched in-
vehicle systems with their functionalities. **Table 3-2** summarizes the design evaluation results for in-vehicle systems.

**Table 3-2**: Design Evaluation of In-Vehicle Systems

<table>
<thead>
<tr>
<th>In-Vehicle Systems</th>
<th>Bluetooth Pairing</th>
<th>Physical Pairing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Features</strong></td>
<td>Hands-free functionality, direct vehicle integration, universal compatibility.</td>
<td>Physically locks phone in place, location- and orientation- adjustable.</td>
</tr>
<tr>
<td><strong>Effectiveness</strong></td>
<td>Hands-free functionality minimizes required physical manipulation and attention diverted from the road.</td>
<td>Locking the phone in place limits the amount of direct manipulation from the driver.</td>
</tr>
<tr>
<td><strong>Ineffectiveness</strong></td>
<td>Relatively new technology; lack of market penetration. See 1.6.1 <em>Limitation of Hands-Free Devices</em>.</td>
<td>Interfacing with the phone still requires direct input from the driver. Driver can choose to not use system.</td>
</tr>
<tr>
<td><strong>Design-Motivation</strong></td>
<td>Most drivers will have Bluetooth-capable smartphones and will want to remain connected socially regardless of their environment. Instead of removing the ability to text while driving, introduce a system that will make texting while driving safer.</td>
<td>Drivers want to easily view and access their phones. Drivers will want the placement of their smartphone to be adjustable to their own liking, especially if the vehicle is shared between multiple drivers.</td>
</tr>
<tr>
<td><strong>Human-Interactions</strong></td>
<td>Drivers who are purchasing or leasing a new vehicle would select a Bluetooth pairing system for the ease at which they can continue their social</td>
<td>Physical pairing devices are inexpensive, easy to install, and do not require the purchase or lease of a new vehicle. There is no software</td>
</tr>
</tbody>
</table>
functions. This type of system is still relatively new, however, so many drivers may consider this functionality to be available in only luxury vehicles. to download or calibration process required for use. Physical pairing devices do limit the degree to which drivers can manipulate their smartphones, however, and some drivers may not find that preferable.

3.1.3 Education
Solutions in the realm of education aim to prevent texting while driving by presenting drivers with information, statistics, and appeals to ethos, pathos, and logos. The ultimate aim for education-based methods is to instill a lasting memory in drivers such that they remember the risks associated with texting while driving and make the choice to be safe rather than impart danger on themselves and others. The two main methods of educating drivers about the dangers of texting while driving were found to be through information sites and documentaries. The former primarily present facts and statistics from reputable sources; the latter utilize case studies and user interviews to appeal to driver's emotions and empathy. Both methods make recommendations for safer driving and back their claims through reputable sources. Appendix C lists the characteristics that education-based strategies employ to convince drivers to not text while driving. Table 3-3 summarizes the results of the design evaluation for education methods.

Table 3-3: Design Evaluation of Education Methods

<table>
<thead>
<tr>
<th>Education</th>
<th>Information Sites</th>
<th>Documentaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Features</td>
<td>Facts and statistics from reputable sources. Recommendations and resources for being a safer driver.</td>
<td>Appeals to emotions and empathy. Utilization of case studies and interviews from those directly affected by texting while driving.</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>Knowledge of facts and statistics education drivers of risk.</td>
<td>Emotion and empathy appeals; seeing how texting while driving can negatively impact others leaves lasting impressions on drivers.</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ineffectiveness</td>
<td>Drivers are unaware of this information unless they look for it. Information may not be internalized due to a lack of emotional impact.</td>
<td>Drivers may be deterred from watching due to the graphic nature and emotional impact of these documentaries.</td>
</tr>
<tr>
<td>Design-Motivation</td>
<td>An organized and well-presented depiction of potentially life-saving information will teach drivers of the dangers they put themselves and others in when they text while driving. Backing this information with well-established sources will increase credibility and drivers will be more likely to accept the facts and change their driving habits.</td>
<td>Presenting only facts and statistics to drivers will not yield lasting results. Instead, make the impact of texting while driving personal; show drivers how individuals and families are affected by texting while driving. Allow social responsibility—that is, not letting one’s choices bring harm to others—to influence the individual driver’s decisions.</td>
</tr>
<tr>
<td>Human-Interactions</td>
<td>Drivers may use information sites for research purposes, if another person shares it with them, or if they or someone they know has been directly</td>
<td>Drivers may view documentaries for research purposes, if another person shares it with them, or if they or someone they know has</td>
</tr>
</tbody>
</table>
affected by texting while driving. Otherwise, there is little motivation to use these resources.

been directly affected by texting while driving. Otherwise, there is little motivation to use these resources.

3.2 Environment

The environment includes any prerequisites for legally driving and parts of the vehicle that all drivers must and interact with regardless of make and model.

3.2.1 Prerequisites for Driving

All drivers must meet three base requirements in order to drive legally: drivers must have a valid driver’s license, the driver must have valid automobile insurance, and the vehicle must be registered in the driver’s state of residence [12].

The requirements for a new teen driver to obtain a license will vary from state-to-state but most all require the new driver to complete a new driver’s education program, apply for a learner’s permit, obtain a provisional license and, once the driver has passed both the DMV written and driving tests, upgrade their learner’s permit to an unrestricted driver’s license. In order to obtain the unrestricted driver’s license, the new driver must also take a photo at the DMV and present multiple forms of identification [12].

Purchasing automobile insurance requires drivers to answer questions about their driving habits, their purpose for driving, the number of vehicles that need to be covered, and a number of other driver-specific questions [12].

In order to obtain a vehicle registration, drivers must possess the title of the vehicle in the driver’s name, the vehicle must pass an emissions or smog test, pass a vehicle safety inspection, and be covered by automobile insurance [12].

3.2.2 The Vehicular Environment

Drivers perform the following tasks as they prepare to drive:

1. Unlock and enter the vehicle via a physical or proximity key.
2. Sit, turn the vehicle on, and engage seatbelt.
3. Adjust mirrors, lights, and audio systems.

Once these tasks have been completed and the driver is ready to begin their trip, the driver must now perform the following:

4. Check surroundings for road hazards and pedestrians.
5. With the clutch pedal engaged:
   a. Automatic transmission: change gears from Park to Drive or Reverse.
   b. Manual transmission: switch gears from Park to Neutral, then to First gear or Reverse.
6. Navigate to the road by manipulating the gas and clutch pedals, turning the steering wheel, and changing gears as necessary.

Now on the road, the driver will continue to physically control the vehicle and attend to environmental cues.

3.3 Alternative Driving Experience Systems

Alternative driving experience systems are any products or services that do not directly prevent texting while driving but whose functions and design may inspire alternative facets of design that may have otherwise been overlooked.

3.3.1 OnStar

OnStar is a subscription-based service that offers a number of features to enhance the driving experience. Features include emergency response services, security measures to prevent thefts, GPS-enabled navigation, WiFi® hotspot hosting, and monthly vehicle diagnostic reports [13]. Despite the features that the OnStar system offers, the monthly subscription fees coupled with poor customer service has resulted in many negative customer satisfaction reviews [14]. Perhaps with more reliable services, lower costs, and better customer service, the OnStar system would be received favorably.
3.3.2 Active Park Assist
Active Park Assist is a feature on select Ford vehicles that utilizes an “ultrasonic-based sensing system and electric power-assisted steering...to position the vehicle for parallel parking, calculate the optimal steering angle and quickly steer the vehicle into a parking spot” [15]. The system itself requires minimal input from the driver and outperforms the Advanced Parking Guidance System offered by Toyota [16].

3.3.3 Insurance Rewards and Incentives
Automobile insurance companies may offer rewards and incentives for being a safe and responsible driver. Insurance companies may offer discounts for being a good driver—that is, not being responsible for accidents and maintaining a clean driving record—for extended periods of time. If drivers agree to be monitored, a telematics device can be installed in the vehicle and it will record and relay information to the insurance company. This information can then be used to determine if a driver’s habits are risky and, based on the results of the data, premiums are adjusted accordingly [17].

3.3.4 Ignition Interlock
Ignition Interlock is a court-mandated technology used to monitor and prevent intoxicated driving by drivers who have been caught driving under the influence. The physical manifestation of the device is a circuit that directly connects to the ignition and requires the driver to blow into a blood alcohol level sensor. If the driver’s blood alcohol content is below a certain threshold, then the vehicle’s ignition will be allowed to turn and the driver has the freedom to drive; if the driver’s blood alcohol content is above the threshold, then the vehicle will not turn on. The device can be installed by a licensed mechanic in as little as 45 minutes to 2 hours [18].

4. Designing a Texting and Driving Prevention System
In order to design a better system that prevents texting while driving, it is necessary to identify the merits, disadvantages, and propose possible solutions for each of the investigated methods and technologies. This is analysis is summarized in Table 4-1.
<table>
<thead>
<tr>
<th>Current Methods</th>
<th>Merits</th>
<th>Disadvantages</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Apps</td>
<td>Automatic initialization</td>
<td>Speed-based functionality</td>
<td>Consider different requirement for use</td>
</tr>
<tr>
<td>Manual Apps</td>
<td>Element of choice</td>
<td>Element of choice</td>
<td>Enforce use of application</td>
</tr>
<tr>
<td>Bluetooth Pairing</td>
<td>Pre-installed in vehicle, hands-free</td>
<td>Can still handle phone, requires</td>
<td>Consider physical pairing to system that maintains hands-free functionality</td>
</tr>
<tr>
<td></td>
<td>functionality</td>
<td>Bluetooth connectivity</td>
<td></td>
</tr>
<tr>
<td>Physical Pairing</td>
<td>Easy installation, placement of system</td>
<td>Use of smartphone still requires direct</td>
<td>Consider physical pairing to system that maintains hands-free functionality</td>
</tr>
<tr>
<td></td>
<td>variable, limited manipulation of smartphone</td>
<td>manipulation</td>
<td></td>
</tr>
<tr>
<td>Information Sites</td>
<td>Valuable facts and statistics of the</td>
<td>Little motivation for use</td>
<td>Consider a solution where drivers must be exposed to this information</td>
</tr>
<tr>
<td></td>
<td>dangers of texting while driving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentaries</td>
<td>Presentation of material has emotional</td>
<td>Little motivation for use</td>
<td>Consider a solution where drivers must be exposed to this information</td>
</tr>
<tr>
<td></td>
<td>impact and forces drivers to consider their actions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The prerequisites and environments drivers are required meet and interact with can be taken advantage of when proposing a solution for preventing texting while driving. By
considering these environmental requirements with alternative driving experience systems, a number of unique solutions can be considered for implementation. A summary of these considerations can be found in Table 4-2.

**Table 4-2: Unique Solution Considerations**

<table>
<thead>
<tr>
<th>Environmental Factor(s)</th>
<th>Alternative Driving Experience System(s)</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity Key, Ignition</td>
<td>Ignition Interlock</td>
<td>Introduce a system that uses the smartphone as a proximity key and as an ignition switch; ignition interlock will prevent movement of vehicle until smartphone is in specified area, such as a physical pairing mechanism</td>
</tr>
<tr>
<td>Insurance Requirement</td>
<td>Telematics Devices, Insurance Premium Adjustments</td>
<td>Introduce an incentive system that rewards drivers who use hands-free devices that can be monitored by insurance companies</td>
</tr>
<tr>
<td>Driver's Education Program Requirement</td>
<td>Insurance Premium Adjustments</td>
<td>Introduce an education program and incentive that effectively informs drivers of the dangers of texting while driving</td>
</tr>
</tbody>
</table>
4.1 Functional Requirements

Drawing from the analysis of current methods and technologies as well as considerations for unique solutions developed from environmental factors and alternative driving experience systems, seven key functional requirements should be met.

Table 4-3: Key Functional Requirements with Explanation

<table>
<thead>
<tr>
<th>Functional Requirement</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Hands-free functionality</td>
<td>Drivers must keep their eyes on the road and their hands on the wheel but granted the option to remain socially active.</td>
</tr>
<tr>
<td>(2) Physical docking of smartphone</td>
<td>When combined with hands-free functionality, there is no need for the driver to handle their smartphone other than to dock and remove the smartphone.</td>
</tr>
<tr>
<td>(3) Automatic detection of smartphone docking</td>
<td>The vehicle must be able to detect when the driver’s phone is docked before allowing the vehicle’s ignition to turn.</td>
</tr>
<tr>
<td>(4) Installation after vehicle purchase and universal compatibility</td>
<td>In order to maximize the number of drivers who use this technology and ease market penetration, the solution must be compatible with a multitude of different vehicles and smartphones.</td>
</tr>
<tr>
<td>(5) Smartphone docking incentive</td>
<td>Drivers will want to benefit from this system past mitigated risk.</td>
</tr>
<tr>
<td>(6) Smartphone docking enforcement</td>
<td>Drivers need to use the system regardless of their preferences to ensure the safety of the driver and others on the road.</td>
</tr>
<tr>
<td>(7) Driver education requirement</td>
<td>The most critical component to the success is</td>
</tr>
</tbody>
</table>
ensuring that every driver knows the dangers associated with texting while driving and can make informed decisions.

4.2 Proposed Solution

Given the functional requirements outlined above, a three-part solution is necessary to meet the requirements.

4.2.1 Smartphone-Hardware Integration

The first part of the solution is the smartphone-hardware integration into the vehicle that would require installation by a licensed mechanic for safety, connectivity, and power requirements. An iteration of this solution is detailed and visualized below.

4.2.1.1 Steering Wheel Controls and Ignition Interlock

In order to meet functional requirements one and six, an attachable sleeve can be secured to the steering wheel. To provide a hands-free functionality, the sleeve would have an integrated microphone for voice commands and selection keys that allow the to respond to texts and calls when prompted. Within the steering column, an Ignition Interlock system is installed; the vehicle will not start until the driver's smartphone is placed within the dock. Figure 4-1 gives a visualization of the system.

![Steering Wheel Sleeve and Ignition Interlock Systems](image)

Figure 4-1: Steering Wheel Sleeve and Ignition Interlock Systems
4.2.1.2 Smartphone Dock

The smartphone dock meets functional requirements two through four: once the smartphone is in its dock, drivers cannot handle their smartphone. Smartphones are then connected to an interchangeable USB tether that facilitates smartphone detection via a wireless connection to the Ignition Interlock system and also allows the driver to charge their phone. Once the smartphone has been detected, the Ignition Interlock system is disengaged and the driver is allowed to drive their car. To facilitate universal compatibility, the interchangeable USB tether allows any phone to be connected and the slotted lateral grips—in conjunction with an automatic tensioner and a compliant contact material—allows for smartphones of all thicknesses and widths to be placed securely within the dock. The dock is affixed to the interior of the vehicle via a suction- or clip-based mechanism, allowing for convenient placement of the dock. The dock is visualized in Figure 4-2.

![Figure 4-2: Smartphone Dock](image)

4.2.1.3 Audio System Integration

To complete the hands-free functionality requirement, the steering wheel sleeve needs to communicate to the vehicle’s audio system. This can be accomplished by installing a Bluetooth communication network to the audio system that pairs directly with the steering wheel sleeve. Additionally, the USB tether needs to be hardwired into the audio system to allow the notification of incoming calls and texts.
4.2.2 Smartphone Application and Safe Driving Monitoring and Incentive

The second part of the solution focuses on incentivizing the driver to purchase and use the proposed hardware, as some drivers may feel limited and deterred by a solution that enforces compliance to safety. To amend this, the smartphone application will collect compliance data and confirm that the proposed hardware is being used correctly to the driver's insurance company. The insurance company, which may already be offering other incentives and premiums for safe driving, would add then adjust the driver's monthly payments accordingly.

4.2.3 Required Driver Education

The third and final part of the solution is to work with individual state governments to incorporate a texting while driving curriculum as part of the standard driver's education course. The curriculum would include facts, statistics, and at least one documentary outlining how dangerous texting while driving is and the impact that an individual's decisions can have on others. In addition to the standard education curriculum, driver's knowledge of the dangers of texting while driving would be tested as part of the DMV written exam in order to obtain an unrestricted driver's license. Figure 4-3 maps the entirety of the proposed solution.

Figure 4-3: Mapping of Proposed Solution
4.3 Feasibility, Risks and Countermeasures

With any set of proposed solutions there are always drawbacks as to what is realistically feasible, new risks that a solution may introduce, and possible situations that may nullify or impede the success of a solution. These concerns are addressed below.

4.3.1 Feasibility

Feasibility considerations for the three levels of proposed solutions are addressed in Table 4-4.

Table 4-4: Feasibility Considerations for Proposed Solutions

<table>
<thead>
<tr>
<th>Solution Medium</th>
<th>Feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone-Hardware Integration</td>
<td>The technologies required for the development and implementation of this solution already exist and many are currently in use. Primary concerns arise with the installation of the technology, as each vehicle has a different configurations, parts, and electrical systems. In-depth development of this technology would need to account for the majority of all vehicles without in-vehicle hands-free functionality and be compatible with each system. A completely universal solution is unrealistic; different iterations may be necessary based on the transmission type, the manufacturer, and the model of vehicles.</td>
</tr>
<tr>
<td>Smartphone Application and Insurance Incentive</td>
<td>Development of a smartphone application to track and transmit data is an easy process—this can be accomplished across platforms and operating systems. The difficult part to this solution will be to convince automobile insurance companies to trust that the data is true and that the associated technology does, in fact, facilitate safer driving. Studies may need to be conducted in order to prove to the insurance companies the validity</td>
</tr>
</tbody>
</table>
of this solution. Once approved, however, the premiums may be widely adopted, as many insurance companies already offer safe driver incentives.

Required Driver’s Education

Of the three solution mediums, enacting a required driver’s education in each individual state will take the most time and effort. Each state’s department of motor vehicles has a unique process to updating their rules and regulations. Working with each state’s bureaucracy will take time and, unless there is a large enough population that supports the proposed education requirement such that politicians take notice and act, implementation will fail. However, if a different approach is taken—proposing curriculum additions directly to independent driving schools—then new drivers may at least have the opportunity to be educated on the dangers of texting while driving.

4.3.2 Risks and Countermeasures

Risks and countermeasures for the three levels of proposed solutions are addressed in Table 4-5.

Table 4-5: Risks and Countermeasures for Proposed Solutions

<table>
<thead>
<tr>
<th>Solution Medium</th>
<th>Risk</th>
<th>Countermeasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone-Hardware</td>
<td>Vehicle is in an accident; phone is locked in dock.</td>
<td>Install an accelerometer on the dock to detect sudden impulses; in such a case, the dock can release the tensioner to allow the driver to call for help. Alternatively, add emergency call system to smart</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Driver has more than one smartphone.</td>
<td>Consider docks that allow for multiple smartphones. However, drivers will most likely carry only one smartphone at any given time.</td>
<td></td>
</tr>
<tr>
<td>Driver does not have a smartphone or the smartphone doesn’t have any charge.</td>
<td>Consider installing a capacitive sensor in the driver’s seat area that could detect the presence of a battery. If none is detected, override the ignition interlock system.</td>
<td></td>
</tr>
<tr>
<td>Driver is handed a phone of another party in the vehicle and is now distracted.</td>
<td>It is up to the parties in the vehicle to be responsible and safe while driving. The system cannot account for this, but the capacitive sensor mentioned above can take note of the presence of another smartphone and relay that information to the driver’s insurance company.</td>
<td></td>
</tr>
<tr>
<td>Airbag deployment is obstructed due to the presence of the steering wheel sleeve.</td>
<td>Consider moving the system to the rims of the steering wheel where the airbag would not be obstructed.</td>
<td></td>
</tr>
<tr>
<td>Technology malfunctions and is cause of vehicle accident.</td>
<td>Perform robustness testing and run simulation analysis; address issues with the technological systems as</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Necessary</td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Smartphone Application</td>
<td>Application is hacked and data, falsified.</td>
<td></td>
</tr>
<tr>
<td>and Insurance Incentive</td>
<td>Consider installation of GPS unit into dock to periodically detect when the vehicle is in motion. Hire hacker to improve application security.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technology fails to increase driver safety.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Perform studies and experiments to test results.</td>
<td></td>
</tr>
<tr>
<td>Required Driver’s</td>
<td>Curriculum fails to educate drivers.</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Bring in education experts to develop curriculum.</td>
<td></td>
</tr>
</tbody>
</table>

5. Looking to the Future
As technology continues to advance, the driving environment will steadily become safer. The following technologies have yet to be realized but are in development. It is the duty of those who are professionally trained and properly educated to ensure that roads are safe for all.

5.1 Future Technology
As the world continues to advance technologically, many works of science fiction may become reality. These technologies may help prevent texting while driving by removing the human element to driving—that is, by removing the necessity for humans to dedicate their attention to the road, humans can continue to text while not posing a threat to themselves and their surroundings.

5.1.1 Self-Driving Cars
Google Inc. has been developing autonomous, self-driving cars since 2012 but will not release the vehicles to the general public until 2020 [19]. The vehicles themselves are equipped with a multitude of sensors that monitor their surroundings, positions, and react to unexpected hazards [20]. In a user-test video, a legally blind man was able to complete his daily errands without so much as touching the wheel [21]. Further testing has logged over 1.7 million miles where vehicles were in accidents only a total of 11
times—each time the accident was caused by the driver of another vehicle [22]. These autonomous vehicles are also being developed by a number of other automobile manufacturers such as Ford, GM, Toyota, Nissan, Volvo, and Audi, but still require the supervision of its drivers, as autonomous vehicles still have limited detection and reaction capabilities [23]. Figure 5-1 shows a number of the current autonomous vehicles prototypes under development.

![Traffic Ahead](image)

**Figure 5-1:** Autonomous Vehicle Prototypes by Company. © 2013, MIT Technology Review

One issue with self-driving vehicles is the requirement of the Light Detection and Ranging (LIDAR) system or an equivalent—these systems can cost up to $70,000 USD but newer, less accurate models will cost $8000 USD per unit [24] [25]. Additionally, ethical questions arise as to who will be liable in the event of an accident, there are concerns over security from hackers, displacement of workers such as taxi cab drivers, and what entities are to determine the rules that all autonomous vehicles must abide by [26]. These costs and questions must be addressed at a global level before the autonomous vehicle can be integrated into society.
5.1.2 Vehicle Communication Networks

Vehicle to Vehicle (V2V) technology allows vehicles to communicate with one another, calculate risks, and subsequently alert the driver to take action or, in the case that the vehicle has the capability, act on its own to avoid collision [27]. The National Highway Traffic Safety Administration (NHTSA) conducted an extensive assessment of V2V communications and found that V2V technologies have been “proven effective in mitigating or preventing potential crashes” and could annually “potentially prevent 25,000 to 592,000 crashes, save 49 to 1,083 lives...by the time V2V technology has spread throughout the [vehicle market]”. However, the NHTSA expresses concerns with the communication frequency—5.8 to 5.9 GHz—that V2V technology would operate at as other devices could interfere with communications and possibly pose a threat to security. Additionally, there is concern from automobile manufacturers that they would be held liable for any accidents resulting in miscommunications from V2V technologies. Finally, there is concern that consumers will not accept V2V technologies, rendering the safety benefits null [28].

5.1.3 Artificial Intelligence

If both V2V technologies and autonomous vehicles were to be fully realized and accepted into society, then it would be hypothetically possible that vehicles could develop an intelligence of their own. Autonomy gives vehicles the ability to sense and react to their surroundings, whereas V2V technologies allows vehicles to directly communicate with their neighboring vehicles to make decisions, plan routes, and determine the most efficient route to travel. This is not so different from what humans do in their daily lives; humans are able to directly control their own actions and influence the actions of others via communication.

5.2 Future Work

The proposed solution has yet to be tested and has not yet received feedback from possible users. It would be recommended to investigate which features are important to drivers and which are not, as well as to begin prototyping the different components for...
the in-vehicle system. Further development of the technology would require working closely with automobile manufacturers to ensure compatibility with vehicles. Working with automobile insurance companies will require further investigation into what data is required to offer a monthly premium as well as meeting base standards for component safety and compliance. The education curriculum will require further development of lectures, videos, and appropriate testing procedures. Employees of each state's department of motor vehicles will require further training to be knowledgeable to the material and testing methods.

6. Conclusion

Texting while driving is a very real danger to all drivers on the road. While there are currently methods of preventing this danger, the most effective ones have yet to be fully realized due to their recent introduction to the population. Once these systems are standard in most vehicles and as technology continues to advance and remove the error of human judgment, the dangers associated with texting while driving will be greatly reduced and may even be removed entirely. This design investigation identified seven key functional requirements for a better texting while driving prevention system: hands-free functionality, physical docking of the smartphone, automatic detection of smartphone docking, installation after vehicle purchase and universal compatibility, smartphone docking incentive and enforcement, and a required driver education program. To meet these requirements, a three-part strategy consisting of a smartphone-hardware integration device, data acquisition and financial incentives, and required driver education is proposed and evaluated for feasibility as well as risks and countermeasures.
7. Appendix

Appendix A: Smartphone Applications Functionalities

List of smartphone applications meant to prevent texting while driving and their features found in the Google Play App Store.

<table>
<thead>
<tr>
<th>App Name</th>
<th>Number of Users (USD)</th>
<th>Price (USD)</th>
<th>Start Mode</th>
<th>TTS (Text to Speech)</th>
<th>TTS (Talk to Text)</th>
<th>Manual Duration</th>
<th>GPS Motion Detection</th>
<th>Silence Alerts (Call/Text)</th>
<th>Emergency Laws</th>
<th>Manual Data</th>
<th>External Incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speak Text - Safe Driving App</td>
<td>100,000 to 500,000</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Groupon like deals</td>
</tr>
<tr>
<td>Texting While Driving</td>
<td>1,000 to 5,000</td>
<td>Free</td>
<td>Automatic</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe Drive</td>
<td>5,000 to 10,000</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hands Free Texting - Visual</td>
<td>5,000 to 10,000</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JARVIS - Texting Robot Machine</td>
<td>1,000 to 5,000</td>
<td>Free</td>
<td>Automatic</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti Texting Safe Driving App</td>
<td>1,000 to 5,000</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFT (Hands Free Texting)</td>
<td>500 to 1,000</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Texting While Driving</td>
<td>500 to 1,000</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive Safe Texting</td>
<td>500 to 1,000</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unihandy No Texting Driver</td>
<td>500 to 1,000</td>
<td>Free</td>
<td>Automatic</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Texting and Drive</td>
<td>2 to 30</td>
<td>3.99</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valery Texting</td>
<td>10 to 30</td>
<td>Free</td>
<td>Automatic</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop Texting While Driving</td>
<td>10 to 30</td>
<td>0.99</td>
<td>Automatic</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US Texting and Driving Laws</td>
<td>1 to 5</td>
<td>Free</td>
<td>Manual</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: In-Vehicle System Functionalities

List of in-vehicle systems organized by pairing type with listed functionalities.

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Pairing Type</th>
<th>Hands-free Functionality</th>
<th>Pre-Installed</th>
<th>Universal Compatibility</th>
<th>Physical Lock</th>
<th>Fixed Location</th>
<th>Adjustable Capability</th>
<th>Charging Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford Sync®</td>
<td>Bluetooth</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>GM MyLink® &amp; Intellilink®</td>
<td>Bluetooth</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Insignia™ Vehicle Mount</td>
<td>Physical</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bracketron Mi-T Grip</td>
<td>Physical</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Desk/Dash Mount</td>
<td>Physical</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>iOttie One Touch Vehicle Mount for Select Apple®</td>
<td>Physical</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>iPhone® Models</td>
<td>Physical</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Anymode Magnet Charging</td>
<td>Physical</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Car Mount</td>
<td>Physical</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: Education Methods Characteristics

Characteristics of education-based strategies to prevent texting while driving organized by medium.

<table>
<thead>
<tr>
<th>Method Name</th>
<th>Medium</th>
<th>Shock Value</th>
<th>Visual Impact</th>
<th>Emotional Appeal</th>
<th>Facts or Statistics</th>
<th>Case Studies</th>
<th>Interviews</th>
<th>Reputable Sources</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textinganddrivingsafety.com</td>
<td>Information</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Federal Communications Commission</td>
<td>Information</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Governors Highway Safety Association</td>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stoptextstopwrecks.org</td>
<td>Site</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car and Driver Texting While Driving: How Dangerous is it?</td>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSA Texting while Driving UK Ad Is It Worth It? Texting While Driving</td>
<td>Documentary</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liz Marks Texting &amp; Driving Story</td>
<td>Documentary</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From One Second To The Next - Texting While Driving</td>
<td>Documentary</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentary - Werner Herzog AT&amp;T Don't Text While Driving</td>
<td>Documentary</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

39
8. Bibliography


40


Readiness of V2V technology for application. (Report No. DOT HS 812 014).