U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

NHTSA
www.nhtsa.gov

DOT HS 811 863

December 2013

Cell Phone Filter/Blocker Technology Field Test

DISCLAIMER

Suggest APA Format Citation:

Funkhouser, D., & Sayer, J. R. (2013, December). Cell phone filter/blocker technology field test. (Report No. DOT HS 811 863). Washington, DC: National Highway Traffic Safety Administration.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 811 863		

4. Title and Subtitle	5. Report Date
Cell Phone Filter/Blocker Technology Field Test	December 2013
6. Author(s) Dillon Funkhouser, James R. Sayer	7. Performing Organization Code 8. Performing Organization Report No.
9. Performing Organization Name and Address University of Michigan Transportation Research Institute 2901 Baxter Road, Ann Arbor, Michigan, USA 48109-2150	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTNH22-08-D-00114/ Task Order 2
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration 1200 New Jersey Avenue SE. Washington, DC 20590	13. Type of Report and Period Covered Technical Report 14. Sponsoring Agency Code NHTSA/NVS-300

15. Supplementary Notes

16. Abstract

Forty-four participants each received a cell phone filtering/blocking application on their employer-provided cell phones for 9 weeks. During the first and last 3 weeks, cell phone activity including calling, text messaging and application use was simply recorded in the background. During the middle 3 weeks, the cell phone filtering/blocking software was active, meaning that anytime the application sensed that the phone was moving faster than the pre-set speed threshold, all phone activity was blocked. Two different custom applications were designed for this study, one a software-only solution, and one a combination of hardware and software.

Objective data on participants' phone use behavior and subjective data (from a questionnaire) on participants' acceptance were collected. Additionally, the impact on an organization attempting to implement a similar program employing cell phone filtering/blocking was examined.

During the blocking period, participants initiated a higher proportion of their calls when stopped than when the blocking software was inactive. Also, during the blocking period, participants answered a much smaller proportion of incoming calls while driving, and outgoing calls were placed at a lower mean speed. Participants were neutral in their opinions on whether they received a safety benefit from the cell phone blocking. While the costs for an organization attempting to implement a program like this are incurred throughout the life cycle, the largest costs will likely come from the monitoring and maintenance required and through any losses in productivity associated with blocking phone use while driving.

17. Key Words	18. Distribution Statement
Motor vehicle safety, mobile device, cell phone filter, cell phone blocker	Document is available to the public from the National Technical Information Service www.ntis.gov

19. Security Classify. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	90	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

LIST OF ACRONYMS

FCC	Federal Communications Commission
FTP	File Transfer Protocol
IIHS	Insurance Institute for Highway Safety
GLM	general linear model
GPS	global positioning system
MDOT	Michigan Department of Transportation
NHTSA	National Highway Traffic Safety Administration
OBDII	on-board diagnostic port
SMS	Short Message Service
UMTRI	University of Michigan Transportation Research Institute
UTC	Universal Time Code

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Executive Summary

A cell phone filtering/blocking application is a third-party application installed on a cell phone, which detects when the phone is moving and can then block any activities from being performed on the phone including answering or placing calls, sending or viewing text messages, and interacting with other applications. This report provides the results of a study on the impact of instituting cell phone filtering/blocking software applications across a medium-sized organization in order to evaluate the role of filtering/blocking software in reducing cell phone use while driving, and access the level of acceptance for these applications.

PURPOSE

- Examine the impacts of cell phone filtering/blocking on participants' *phone use behavior*.
- Examine *technical performance* of the technology and the level of *acceptance* among participants who received the cell phone filtering/blocking applications.
- Examine the *impacts on an organization* attempting to implement a cell phone filtering/blocking program.

This study sought to answer the following questions related to implementing a cell phone filtering/blocking program across an organization.

Phone Use Behavior

- What are the indicators of cell phone usage change during the blocking period?
- What were the override use patterns during the blocking period?
- What was the impact of cell phone filter/blockers on driving performance?
- Were there any lasting effects?

Technical Performance and Acceptance

- What was the technical effectiveness/reliability of the cell phone filter/blockers?
- How did drivers feel about the cell phone filter/blockers?
- Did drivers "game" the system, and if so, how?

Organizational Impacts

- What were the management opinions of the experience in implementing such a cell phone filter/blocker system?
- What is the effect of cell phone filter/blockers on work productivity?
- What are the costs of savings or losses due to cell phone filter/blocker implementation?

METHODS

Two custom applications were designed to be installed on the employer-provided phones of 44 Michigan Department of Transportation employees who volunteered to participate in this study. The participants in the study all do work-related driving. This sample of licensed drivers include employees who regularly drive as part of their employment, and conduct regular business communications using cellular phones provided by their employer. The applications were designed to both block phone use while driving, and also to monitor and record phone use whether in the blocking state or not. One application, referred to as the Software-Only solution, used the phone's GPS to determine the speed at which the phone was moving. The other application, the Hardware/Software solution, wirelessly transmitted the speed of the vehicle to the phone from the on-board diagnostic portof the vehicle through Bluetooth. In either case, when the software loaded on the phone received information that the phone was traveling faster than the pre-set speed threshold, phone activity was blocked.

Data was collected for 9 weeks for each participant. During the first and last 3 weeks, the blocking application was inactive, and simply monitored phone use while running in the background (and not restricting any phone use). During the middle 3 weeks, the software became active, and if it received information that the phone was moving faster than the pre-set speed threshold, phone use was blocked. This included all calling, text messaging, and other interactions with the phone. During the blocking period, participants were allowed to override the blocking for work purposes by entering a short password. At the completion of the sixth week (after the blocking became inactive) each participants was asked to complete an online questionnaire regarding experience with the application.

RESULTS

Phone Use Behavior

- Participants answered fewer incoming calls at non-zero speeds during the blocking period.
- Participants placed outgoing calls at lower speeds during the blocking period.
- Participants placed more calls at zero speed during the blocking period.
- Participants overall were neutral in their responses when asked if they received safety benefits from the cell phone filtering/blocking applications.
- The only evidence of participants "gaming" the program was found in 2 participants responses in which they indicated that they gave out their personal phone numbers in order to receive incoming calls while driving when they knew that their work phones would be blocked.
- Very little was seen in the form of positive lasting effect after the applications went back into monitoring-only mode in the last 3 weeks, as no significant differences were found in their behaviors from the first monitoring period to the second monitoring period. Additionally, participants disagreed that they used the phones less in their personal vehicles after this experience.

Technical Performance and Acceptance

Because of the nature of the two different approaches, both applications had different issues in terms of reliability. While any dropouts in data were immediately identifiable for the Software-Only solution, it was more difficult to assess the reliability of the Hardware/Software solution as data was only generated when participants were in their assigned vehicles. The Software-Only solution worked as expected on 15 of 22 phones but generated inconsistent data for 7 phones, mostly related to the inability to consistently receive GPS signals. No participants reported inconsistencies with operation of the Hardware/Software solution.

Participants were not especially accepting of the cell phone filtering blocking applications. Part of this may be due to the adaptations to the applications necessary for their use as research tools. When asked what they liked most about the applications, 18 out of 44 participants responded "nothing" in some form, while 15 responded that they liked having no distractions while driving. Responses about what they liked least were most often related to the fact that the phones could not be used while driving. Additionally, through its adaptation for use as a research tool, the Software-Only solution substantially decreased the life of the participants' phone battery, and 11 out of 22 participants who received the Software-Only solution noted this.

Institutional Impacts

Management opinions of their experience with implementing a cell phone filter/blocker system were neutral, and were split among the managers who gave feedback, with 4 indicating that they felt the safety benefit outweighed the losses in productivity and three indicating the opposite.

While it is difficult to assess the exact effects on work productivity, during the overrides participants who received the Software-Only solution performed 685 activities with an average of 1.53 activities per override. Participants who received the Hardware/Software solution performed 843 activities during overrides with an average of 2.38 activities per override. Individually, the cost of delaying these activities until the vehicle was stopped would have generally been small (in the case of simple e-mail checks), but for more important activities, a delay in a response could have led to longer delays in construction and maintenance projects or emergency responses.

The cost incurred through implementing a cell phone filtering/blocking program would mostly be associated with the monitoring and maintenance of the software and the devices. The cost of the software itself is relatively small, and the installation, while potentially time consuming, is a one-time cost that could be mitigated through different methods. An additional cost, although difficult to assess across different organizations, would likely be the losses in productivity across the organization due to the elimination of cell phone related work activities while driving. Some believe these losses in productivity would be offset by gains in productivity as a result of the reduction in time lost due to crashes (which may be reduced due to the implementation of the filtering/blocking software).

1. Introduction

In recent years driver distraction has become a very high-profile topic in the realm of transportation safety. This is especially true in terms of mobile devices like cell phones. Not only are cell phones used to make and receive calls but also to send and receive text messages ("Short Message Service" or SMS) and e-mail, and to interact with a variety of applications that can be installed on today's "smart" phones. With drivers able to bring cell phones with them into vehicles, all these functions are now available while driving.

Driver distraction is a major cause of crashes in the United States, accounting for almost 3,092 fatalities and approximately 416,000 injuries in 2010, according to National Highway Traffic Safety Administration data (NHTSA, 2011). Many states have chosen to target cell phones specifically as a source of distraction, with 10 states (plus Washington D.C.) banning hand-held cell phone use for all drivers (Distraction.gov, n.d.). Previous studies have shown that tasks associated with high eyes-off-forward-road times, such as texting, are also associated with increased risk of a safety critical event (Olson, Hanowski, Hickman, & Bocanegra, 2009) and therefore 39 states (plus Washington D.C.) now prohibit text messaging for all drivers. Thirty-two states (plus Washington, DC) ban cell phone use completely for novice drivers, and in almost every state with a ban in place, a violation constitutes a primary offense (Distraction.gov, n.d.). Additionally, an executive order has been issued banning cell phone use while driving for federal employees.

Despite these initiatives, crashes do not appear to be decreasing in frequency. In 2010 the Insurance Institute for Highway Safety examined four geographic areas where texting while driving had been banned. They found no associated decrease in crashes for these areas after the ban was enacted. The report states "Noncompliance is likely a reason texting bans aren't reducing crashes," and notes that in these areas the percentage of young drivers (18 to 24 years old) who continue texting despite the ban is very similar to the percentages in areas with no ban in place (45% versus 48% of young drivers) (Highway Loss Data Institute, 2010). With texting bans alone potentially proving ineffective at reducing texting while driving and the associated crashes, other approaches to reducing cell phone use while driving need to be considered. One method that has seen success is the combination of a cell phone ban along with high-visibility enforcement. This method of combining a widespread educational campaign with stepped-up enforcement has shown the potential to reduce actual cell phone use in some communities (Cosgrove, Chaudhary, & Reagan, 2011). The passage of Federal, State, and corporate texting bans, increased public awareness of the problem, and police enforcement of state laws all have a role in preventing distracted driving. A more recent approach to the issue of cell phone related driver distraction is the use of cell phone filter technologies.

Cell phone filters/blockers are software applications that can be installed on cell phones and through various methods can restrict the use of the cell phones' features based on inputs indicating that the cell phone users may be driving. These applications, being developed by a number of manufactures, can restrict calling, text messaging, e-mail, and application use. The two primary methods of detecting driving to activate the blocking software use either GPS information or information directly from the vehicle's on-board diagnostic port. A list of applications available at the time of this reporting is included in Appendix A. Both methods have their benefits and limitations, and both methods were investigated in this study.

Under its stated goal to “save lives, prevent injuries, and reduce economic costs due to road traffic crashes,” NHTSA has developed a distraction plan in an effort to eliminate crashes due to driver distraction. The plan has four initiatives:

- Improve the understanding of the problem;
- Reduce workload from interfaces;
- Keep distracted drivers safe; and
- Recognize the risks and consequences.

This study falls under the third initiative, and specifically seeks to “assess the effectiveness (technical and behavioral) of cell phone filters” (NHTSA, 2010).

The goal of this study was to evaluate current technologies available to prevent cell phone use while driving. There were three main objectives for this study:

- Examine the impacts of cell phone filtering/blocking on participants’ phone use *behavior*.
- Examine *technical performance* of the technology and the level of *acceptance* among participants who received the cell phone filtering/blocking applications.
- Examine the *impacts on an organization* attempting to implement a cell phone filtering/blocking program.

This report provides the results of a study on the impact of instituting cell phone filtering/blocking software applications across a medium-sized organization in order to evaluate the role of filtering/blocking software in reducing cell phone use while driving, and assess the level of acceptance for these applications. In this study, 44 participants used one of two modified, smart phone applications for 9 weeks. One test relied only on the installation of software, and the other used a hardware device which interfaced with the vehicle in conjunction with the software installed on the phone. Both applications were commercially available cell phone filtering/blocking products that received considerable modification by, and with the full support of, their manufacturers in order to be used as research tools in this study.

During the first 3 weeks and the last 3 weeks of the study, the software applications simply ran in the background on participants’ employer-provided cell phones, recording phone activity as well as the speed at which the phone, or vehicle, was moving. For the 3 weeks in the middle of the study, the blocking function of the custom applications was enabled, and participants experienced filtering/blocking of cell phone use while they were driving/in motion. Emergency 911 calls were always allowed regardless of the state of the software. During the blocking period, each participants was allowed to override the blocking for work purposes by entering a short password. This was allowed to prevent participants from resorting to using their personal phones to initiate or receive time critical work-related calls or e-mails, in which case researchers would have no record of the cell phone use for analysis. Additionally, the software applications could not distinguish between a user driving or riding as a passenger in a moving vehicle, and therefore in order to allow passengers to conduct business while being driven the override was provided as an option. As overrides by participants were allowed, of interest was the frequency of overrides and the activities performed during the overrides. This is used as a surrogate for productivity losses that would be associated with implementing a filtering/blocking program in which overrides were not allowed.

In addition to the data collected on cell phone use before, during, and after experiencing the cell phone filtering/blocking application, participants completed online questionnaires regarding their experience with, and general acceptance of, the cell phone filtering/blocking software applications. The results of the subjective data collected from participants and the objective data collected on participants' cell phone usage through all three periods that cell phone use was monitored is reported.

2. Methods

2.1 Participants

2.1.1 Recruitment

Participants were recruited through e-mail by the research contact in the Michigan Department of Transportation, based on the following characteristics:

- They currently had an MDOT-supplied BlackBerry phone version 8350i, 9630, or 9650; and
- They worked in one of the five southern Michigan MDOT regions (Southwest, Metro, University, Grand, Bay).

Potential participants were then contacted to meet with an UMTRI researcher at their Regional Offices. Participant meetings were generally held in a one-on-one setting however three of these meetings were held with multiple potential participants.

This recruitment of human participants was approved by the Institutional Review Board at the University of Michigan. No information regarding who was participating and who was opting out was shared with anyone at MDOT including the supervisors or the other participants, and this was made clear to each potential participant so as not to induce their participation. Additionally, no identifiable data on any of the participants is reported in this document.

Participants with dedicated MDOT vehicles received the Hardware/Software application, as the required hardware module would otherwise need to be moved from vehicle-to-vehicle with the participant if they used a variety of vehicles. Other participants without dedicated MDOT vehicles received the Software-Only application.

Because of the MDOT vehicle assignments, the two participant pools (Software-Only and Hardware/Software) were fairly different in terms of their day-to-day driving and phone use activity. Participants who had dedicated MDOT vehicles generally were involved directly in maintenance or construction in the field, and would need to be traveling in their MDOT vehicles as a large part of their jobs. They rarely rode as passengers with other drivers and tended to stay within their home regions. Because the participants who received the Hardware/Software application spent considerably more time traveling, they had considerably more opportunity for calling activity while driving. In fact, participants receiving the Hardware/Software application, on average, placed more calls per day while driving than participants receiving the Software-Only application placed in an entire day - regardless of whether they were driving or stationary.

Upon meeting with each potential participant, the recruitment information was presented orally. A script of this information is presented in Appendix B.

Individuals willing to participate were then asked to complete the informed consent document, and the custom application was installed on their phone by the UMTRI researcher. The application was installed through a hyperlink e-mailed to participants' phones that would initiate the application download from the specified application provider. In the process of downloading and installing the application, some specific permission also needed to be set on the phones. For the custom Software-Only application it was necessary to check and often enable the GPS tracking and for the custom Hardware/Software application it was necessary to enable Bluetooth communication. If they were receiving the Hardware/Software application, the UMTRI researcher would then accompany them to their vehicles, where the hardware module would be installed.

Generally, after each installation the UMTRI researcher performing the install would check in with the application providers to ensure that they were seeing the newly installed phone show up on their servers and that data was being collected properly.

2.1.2 Demographics

Throughout the entire project, UMTRI researchers met with 81 potential participants (MDOT employees) and at least attempted to install one of the two custom applications on 75 MDOT BlackBerries. The final dataset used in the analyses is much smaller however. Participants were lost for a number of reasons, specifically:

- Three had phones incompatible with the custom application (Verizon BlackBerry 8330).
- Eleven withdrew from the study as a result of the reduction in battery life, specifically. Two withdrew because they had suspicions that the application was interfering with the operation of their phone.
- Five changed jobs and gave up their dedicated vehicles, making them unable to use the custom Hardware/Software application.
- One received a new phone that was incompatible with the custom Software-Only application.
- Six were ultimately not included in the dataset because the custom application worked very inconsistently on their phone.
- Three withdrew from the study because they felt they could not do their jobs with the blocking-aspect of the custom application enabled.
- Six declined to participate after hearing the introduction to the program.

Demographic data on the final dataset is presented below in Table 1 and Table 2. The sample population of 44 participants used in the final dataset was largely male and over 35 years old.

Table 1: Gender breakdown of participants in the final dataset

	Male	Female
Software-Only	17	5
Hardware/Software	20	2
Total	37	7

Table 2: Age group breakdown of participants in the final dataset

	20-34	35-49	50-70
Software-Only	4	11	7
Hardware/Software	1	15	6
Total	5	26	13

Participants were selected from one of five MDOT regions in southern Michigan. These regions are defined below, and presented visually on the map in Figure 1. The two northernmost regions were excluded based on their distance from UMTRI (located in the lower Red region).

MDOT Regions:

- Metro (Green) - Oakland, Wayne and Macomb counties
- Southwest (Orange) - Kalamazoo, Marshall, Coloma
- Grand (Purple) - Grand Rapids, Muskegon
- Bay (Light Blue) - Mt. Pleasant, Saginaw, Bay City
- University (Red) - Lansing, Jackson, Brighton

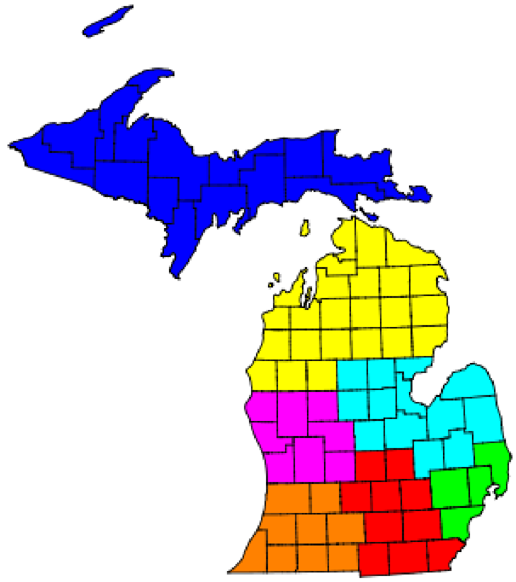

Figure 1: Map of Michigan Department of Transportation Regions

2.2 Experimental Design

This field test was designed as a 9-week, A-B-A experiment in which the first and last 3 weeks functioned as first monitoring period and the second monitoring period. Data from the first 3 weeks would serve as baseline data on driving and phone use activity. The middle 3 weeks functioned as the blocking period. Data from this period was used to estimate the safety and productivity impacts of implementing cell phone filtering/blocking applications across the MDOT organization. The final 3 weeks of monitoring were used to determine any residual effects of the blocking application on participants' phone use while driving.

The data collection process was the same for both the Software-Only and the Hardware/Software applications. Participants had the custom application installed on their phones for the entire 9 weeks (or more in some instances as a result of technical difficulties). During the monitoring periods, no blocking occurred. The custom application simply ran in the background, recording phone use, and transmitting the data back to the application providers' servers (who passed it on to UMTRI researchers). At the onset of the blocking period, the cell phone filtering/blocking technologies were remotely activated by the application providers at the request of UMTRI researchers, and the phone blocking began occurring during the prescribed situations. Instructions regarding the functionality of the blocking and override procedure were resupplied to each participant when the blocking became enabled.

During the blocking period participants were provided with the password ("aaaaaa" for all participants) to override the blocking from the custom applications, which could be used on roughly a trip-by-trip basis, although its use was discouraged and was specifically only to be used when participants deemed it necessary for either their safety or the completion of their job. Participants were told they may also use the password override on their phone in instances when their phone was being blocked while they rode as a passenger in someone else's vehicle.

At the completion of the blocking period, (after week 6), participants were sent, and completed, an on-line questionnaire regarding their opinions of the custom application they received on their phone, their phone use patterns, and their override behavior.

2.3 Commercial Products Used as the Framework for the Custom Applications

Two cell phone application providers were selected to design a custom cell phone-based research application that could block phone use while driving. These two providers were selected based on multiple factors, but most importantly because of their custom software's ability to store phone use data remotely from the phone handset and to allow for data to be monitored when their application was not actively blocking calls (monitoring periods). Two selected application providers each designed a custom research application based on the framework of their commercially available cell phone filtering/blocking products. One custom software-only application (designed by Illume Software, Inc.) and one custom combined hardware/software application (designed by obdEdge, LLC) were developed to be used by the fleet of MDOT employees for the 9-week study.

2.3.1 *iZup* from Illume

IZup is a software-only, third-party application designed to be installed on a "smart" cell phone. It tracks the movement of the phone through the phone's built-in GPS. When the application detects the phone is moving faster than a pre-set speed threshold, a "locked" screen appears and cannot be removed from the phone. The locked screen clearly displays the "Blocked" message over the home screen of the phone.

Incoming calls and text messages are blocked when the screen is locked. The phone still receives these, reporting the calls as "missed calls," but the user cannot answer or view them. The phone still gives a tone when a call or message is being blocked. Another feature of this product is the potential to include a "white list" of numbers. A white list is a list of numbers permitted to be called even while the phone is blocked. Numbers on this list can be called and incoming calls from these numbers are allowed even when the application is blocking other phone use. Emergency (911) calls are always permitted.

A password can be used to suspend the active blocking application via the handset. This will allow the phone to function normally even when above the speed threshold. When the blocking is suspended through the phone, the length of the suspension is adjustable.

If in the middle of a call when the suspension time limit is reached, the call is cut off by the blocking application. Also, if in the middle of a call when a drive starts (and the speed threshold is exceeded), the call is cut off. After the car has stopped (speed at 0), some latency occurs during which the phone is still blocked to ensure the phone is not simply stopped at a stop light. When the application determines that the driver is no longer driving, which is generally after 90 to 120 seconds, the application returns to its background state. The algorithm in the application attempts to determine whether the driver is fully stopped versus at a traffic light using a number of methods, but ultimately the application returns to the rest state when it stops seeing motion.

The application is relatively easy to uninstall from a cell phone. If a user uninstalls the software from the phone, the server will continue waiting for reports from the handset for 2 days. If no reports are received from the handset, a violation is recorded, and an e-mail is sent to the administrator.

2.3.2 *Cellcontrol* from obdEdge, LLC

Cellcontrol is a hardware/software application designed to be installed on a “smart” cell phone that works in conjunction with a hardware device referred to as the Bluetooth module, or simply the “Module.” The module is installed in a vehicle in the OBDII port near the steering column of a vehicle, and takes no tools to install. When the module receives a signal from the vehicle that it is moving faster than the preset speed threshold, a signal is sent via Bluetooth to the phone causing a “locked” screen to appear that cannot be removed from the phone. The locked screen clearly displays the “Blocked” message over the home screen of the phone.

Incoming calls and text messages are blocked when the screen is locked. The phone still gives a tone when a call or message is being blocked. White listed numbers can be set. Emergency 911 calls are always permitted.

A password can be used to suspend the application via the phone. The suspension lasts for the duration of the current trip. If in the middle of a call when a drive starts (and the speed threshold is exceeded), the call is cut off. After the car has stopped (speed at 0), very little latency occurs (around 10 seconds) during which the phone is still blocked to ensure the phone is not simply stopped at a stop light. If the car ignition is shut off, blocking latency is around 5 seconds.

If the module is removed from the OBDII port while the vehicle is off, for the next trip, the blocking never initiates and the phone functions as if the application is not present on the phone. When the module is reconnected however, a signal is sent back to the software provider and a “Violation” is recorded. This is conveyed through an e-mail sent to an administrator.

If the module is removed from the ODBII port while the vehicle is in motion (and the blocking is activated) the blocking will stop. When the module is replaced in the OBDII port, a violation will be recorded and sent to the administrator. Additionally, if a module does not report to the software provider’s server for 3 consecutive days, a violation will be recorded and sent to the administrator.

2.4 Adaptation as Research Tool

While both application providers involved in this study have commercial products available similar to those tested in this study, the custom applications used for this data collection required considerable modification for use here as a research tool, not simply as a cell phone filter/blocker application. From a user’s perspective, the interfaces looked just like those presented by the respective, commercially available applications, but unknown to the users; more back-end features were included in the research versions. In addition to simply monitoring handset speed and locking out the phones’ inputs (dialing, texting, application use) when under the blocking state, both software applications were custom designed specifically for this study to collect and report back to central servers all phone activity and speed data. This data was then formatted and provided to UMTRI researchers for analysis. No white list numbers were allowed by the custom software applications during the field test, however 911 emergency calls were always permitted.

In terms of functionality it is likely that the modifications made to the commercial applications by the application providers to support the use of their applications as a research tool may have adversely affected the battery life on phones receiving the custom Software-Only application. While the commercial application experiences a 3-percent reduction in battery life participants in this field test experienced much larger reductions from the custom application.

It is difficult to estimate how much the reduction in battery life was specifically due to the additional research-driven requirements of the cell phone filtering/blocking applications (i.e., trying to use a commercial application that has been modified into a custom research tool). While bench testing could provide some insight in a direct comparison of battery life, for example, between the commercial product and the research tool version of the application, the actual battery life (and blocking latency) is a function of many factors—including the types of activities performed on the phone and the environments in which it is used (and even the environments in which the phone is not used, but still required to search for GPS signals and transmit information on phone use activity). These discrepancies in performance should be taken into account when reviewing comments and subjective feedback from the participants regarding the custom application used in this study as they likely would not apply to the commercially available products' performance.

2.5 Overrides

Participants were given the option of overriding the blocking function of the cell phone filtering/blocking application by entering a password (and a username for the Hardware/Software application). Once the application was overridden, the phone would function as normal even if the phone was traveling above the speed threshold and the participant was in the blocking period of the data collection. For the custom Software-Only application this override was set at a default duration of 10 minutes, however participants could extend this with three additional button presses to whatever amount of time they input (in minutes). For the custom Hardware/Software application, once an override was entered, the blocking function of the cell phone filtering/blocking application would be disabled for the duration of the ignition cycle.

Participants were provided this option for two reasons: First, had the override not been available, it would have been difficult to convince individuals to participate, and second, had the override not been provided, UMTRI researchers were concerned that individual participants may resort to using their personal phone for important work functions in instances when their phone was blocked – but they nonetheless were driving. All MDOT employees participating in this study had a personal phone that they carried with them in addition to the BlackBerry provided by MDOT for official use. If participants began using their personal phone during the blocking period, UMTRI researchers would have no way of knowing.

2.6 Objective and Subjective Data

Both objective and subjective data was collected as part of this study. Subjective data was collected through an on-line questionnaire given to participants after they had completed their blocking period in the data collection. The questionnaire can be seen in Appendix C. MDOT managers who were involved in this study also received a short questionnaire asking for management opinions of the project (Appendix D).

Objective data was obtained through the monitoring functions of the custom designed software applications added specifically for the purposes of this study. Objective data included time-stamped calling, SMS and application activity as well as overrides of the blocking. The objective data also included speed information around these events, and data collected by the custom Software-Only application also included GPS information. A full description of the data files in presented in the next section.

All statistical analysis was done in SAS 9.2 using “Proc GLM” (general linear model).

2.7 Data Analysis

2.7.1 Dataset

Data was combined within each study group to give more statistical power to comparisons between the three periods (monitor1, blocking, and monitor2). As the deployment of the software was initially delayed, not all participants experienced the full 9 weeks of data collection, and in some cases had little or no time spend in the monitor2 period. Additionally, as data was only collected from participants using the Hardware/Software application on days in which they drove in their MDOT vehicle, combining the data across participants in each software group allowed more participants to be included in the analysis even if they drove relatively infrequently. Finally, despite the confidentiality of the employees’ participation and of the data collected, before enrolling participants were given assurances that they would not be singled out in any reporting of phone use. This is a potentially sensitive subject in an organization that discourages cell phone use and driving, and highlighting any specific individual’s behavior, even anonymously, would have compromised the level of participation achieved.

Software-Only Application

The final dataset consists of 22 participants who received the custom Software-Only application, and 1,164 days of cell phone monitoring data. More data was collected (1,878 total days of data on 32 phones) but could not be used in this data set because it was collected from:

- A participant who withdrew.
- An individual who participated but had extensive problems with the custom application and not enough data was collected to include them in the final data set.
- A participant with extra data for a given period (if a participant had 23 good days of blocking data for example, only the first 21 days are included in the final data set.
- Data files that were incomplete.

Additionally subjective data regarding the participants' experience with the filter/blocking application was collected from 22 participants who completed the study using the Software-Only application.

Hardware/Software Application

The final dataset consists of 22 participants who received the custom Hardware/Software application, and 845 days of cell phone monitoring data. All data collected includes 1,875 total days of data on 28 different phones during the research study. Data was only considered part of the dataset if driving occurred on the given day. If no driving occurred, no data was generated for that day. This differs from the Software-Only data that should have a data file generated for each phone each day. Subjective data was also collected from 22 participants who received the Hardware/Software application.

2.7.2 Data files

The data files from the application providers captured the same basic information, but were organized and delivered to UMTRI differently.

2.7.2.1 Software-Only Application

Each data file came from one phone, and comprised one day from midnight to midnight. The data file was built of sequential rows, with each row being time stamped. Generally, each row contained speed data, GPS location data, or phone use data. A normal, complete data file had a GPS line about every 15 seconds with three speed lines between each GPS line, and ran the full 24 hours. Additionally, phone use (calls, e-mails, SMS) rows were intermixed based on their temporal location in the daily data file.

The size and content of each data file varied widely based on the availability and consistency of the GPS signal for each handset. One common scenario was for data to be generated on one phone from midnight until maybe 8 a.m. At some point the GPS drops out and only phone use data is included in the data file (no speed or GPS), until about 5 p.m. when GPS data is again available. This is a result of the GPS being unavailable while the participant is in their office throughout the day. Data on phone calling is still collected however no speed or location data is collected while the GPS is unavailable.

A data file generated from the Software-Only application was considered usable and included in the data analysis if:

- Calling data was available from at least 9 a.m. until 4 p.m.
- At least 20 percent of the rows in the data file were GPS location data rows.

Nearly all data files had some missing data when the GPS signal could not reach the handset, however generally these holes were small. In order to determine which files would be part of the data set, and that had too many holes to include, the above criteria were used. These criteria were established to be reasonably certain that accurate data was collected and reflected in the data files. If a file was too small, or if not enough GPS data was collected, it was possible that the software may have failed and data may be missing for that day with no explicit indication other than the missing data. Additionally, to perform the analyses, at least some speed data (from the GPS) had to be present around the calls and phone activities.

This data was placed on a secure File Transfer Protocol server where UMTRI researchers could download it at their convenience. Data was generally downloaded every 4 or 5 days, and a download would consist of a file for each phone for each day the application was functioning.

2.7.2.2 Hardware/Software Application

Data from the custom Hardware/Software application was aggregated over all phones receiving this custom application and then into separate files for each type of phone use activity. For example, a single data file would have all calling for the given time period for all phones on which the application is loaded. Each row in the file has a phone ID, a start time, an end time, the speed at which the activity was initiated, and a code to identify whether it was outgoing or incoming. The data files for the other phone use types were structured similarly.

These files were then placed on a secure FTP server where UMTRI researchers could download them at their convenience. A download of data from the Hardware/Software application would consist of six data files, one for each of the following functions.

- Blocking/Driving
- Calling
- Overrides
- SMS
- E-mail
- Applications

The blocking/driving data file was the most complete and was used to determine if participants were driving or not. Each individual trip was given a line in this data file, making it easy to track day-to-day use by each participant.

2.7.2.3 Zero-speed and non-zero speed calls

Based on the nature of the Software-Only application, data was collected continuously, whether the participants were driving a vehicle, riding in a vehicle, or sitting at their desk. Therefore, all calls made over the course of the research study on the participating MDOT BlackBerries were collected in the Software-Only application data files. Because of this, a distinction is made between “all calls,” “zero-speed calls” and “non-zero-speed calls.” Zero-speed calls were calls initiated or answered by the participant when the application data files reported that the phone was not moving (“zero-speed”). Non-zero-speed calls were initiated or answered by the participant when the data files reported that the speed of the phone upon the initiation was greater than zero. This same assumption is used for the Hardware/Software application, however based on the nature of the Hardware/Software application there were very few zero-speed calls in the data files (as data is generally only collected by the Hardware/Software application when the vehicle is moving, the exception is the period during the post-drive latency.) This distinction is used often to separate likely driving events from non-driving or stationary events, with zero-speed events classified as “non-driving events,” while non-zero speed events will be classified as “driving events.”

However, this is an assumption, particularly for the Software-Only application data, because from the data it is difficult to tell whether:

- A participant phone at zero-speed is at a desk, or in a vehicle at a stoplight; or
- A participant phone at non-zero-speed is in the hand of a participant who is actively driving, or in the hand of a passenger in a car, bus, or train.

2.7.2.4 Unanswered calls

One method of assessing the impact of the cell phone filter/blocker technologies is to examine the frequency with which incoming calls go unanswered. While there was no specific flag in the data files distinguishing an unanswered call from an answered call, based on an analysis of the call durations, it was determined that incoming calls under 3 seconds would be regarded as “unanswered.” This was based on the large frequency of calls with duration of 0, 1 or 2 seconds relative to the frequency of calls at slightly longer durations. Therefore an assumption has been made that calls of these very short durations (less than 3 seconds) in the data files represent unanswered calls.

3. Results

3.1 Phone use Behavior

In order to examine changes in cell phone usage as a function of the state of the cell phone filtering/blocking software the following indicators were examined:

- Speed at which participants placed outgoing calls;
- Fraction of incoming calls that are answered;
- Speed at which participants sent SMS;
- Call duration; and
- Override use patterns.

3.1.1 Speed at which participants placed outgoing calls

3.1.1.1 Software-Only Application

All outgoing calls from the final dataset for the Software-Only application were grouped for all 22 participants. A total of 2,527 outgoing calls with known speeds were collected from the participants receiving the Software-Only application. Information on these calls is presented in Table 3 below.

Table 3: All outgoing calls for participants who received the Software-Only application

	Software-Only
Total outgoing calls, known speed	2,527
Zero-speed outgoing calls	1,892
Percent of calls at zero-speed	74.3%

From Table 3 above, it is clear that the majority of outgoing calls initiated by participants who received the Software-Only application were initiated at zero-speed. This is not surprising as participants receiving the Software-Only application were less likely to be driving as part of their normal work responsibilities than those participants receiving the Hardware/Software application. Most of the zero-speed calls were therefore likely initiated from the Software-Only participants' offices, where they spent a significant portion of their workday.

Figure 2 below breaks down the frequency of all calls by the data collection period, each being 3 weeks in duration, in which calls were initiated.

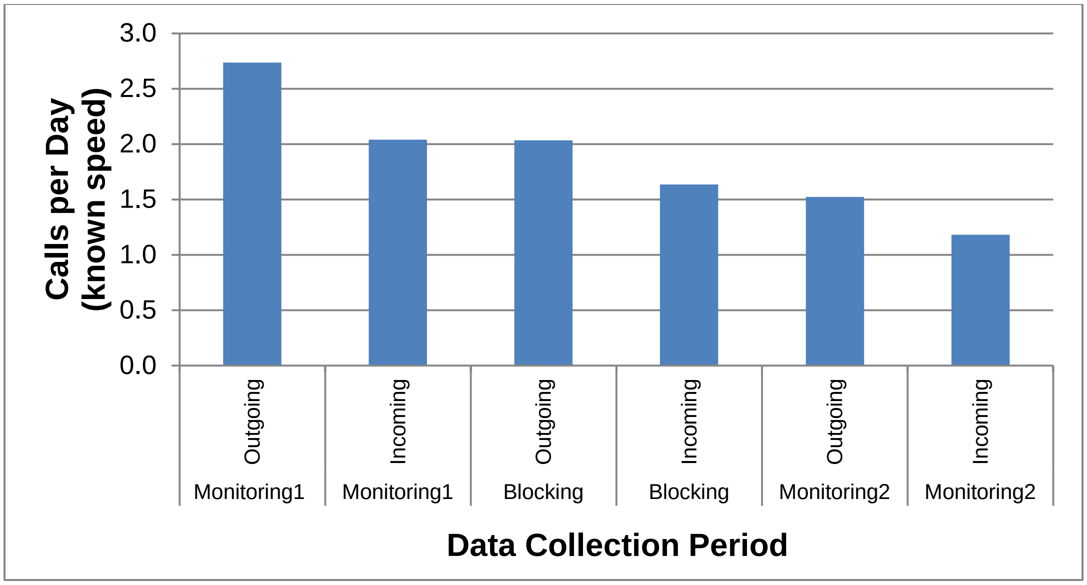

Figure 2: Average calls per day split by data collection period, for the Software-Only application

From Figure 2, it is clear that the number of calls per day is decreasing over the course of the study for both incoming and outgoing calls. This general trend is significant (F (2,100) =4.35, p=.0176). Pair-wise, there were marginally more calls in the first monitoring period than in the blocking period (t(1,100) =1.8, p=.078) and significantly more calls than in the second monitoring period (t(1,100)=2.92, p=.005). Table 4 below breaks down the outgoing calls by the data collection period and speed at which they were initiated.

Table 4: All outgoing calls for participants who received the Software-Only application split by blocking period

	Software-Only		
	Monitor1	Block	Monitor2
Days of data collected for period	443	424	297
Outgoing call count by period, known speed	1,212	863	452
Outgoing calls per day, known speed	2.74	2.04	1.52
Zero-speed outgoing calls per day	1.98	1.61	1.11
Non-zero speed outgoing calls per day	0.75	0.42	0.41
Percentage of calls made at zero-speed	72.44%	79.14%	73.23%

From Table 4 above, during the second monitoring period there were significantly less zero-speed outgoing calls initiated than during the first monitoring period (t(100)=2.02, p=.046) or during the blocking period(t(100)=1.97, p=.05) . Most importantly there was a significantly larger proportion of outgoing calls initiated at zero-speed during the blocking period than during the first monitoring period (t(100)=2.39, p=.0187) and a marginally larger proportion of calls initiated at zero-speed during the blocking period than during the second monitoring period (t(100) = 1.90, p=.0607).

After removing all zero-speed calls, a significant effect of the cell phone filtering/blocking software can still be seen. Figure 3 below displays the mean speed at which outgoing calls were initiated, split by data collection period. This only includes outgoing calls placed at speeds above zero. From Figure 3 below, during the blocking period participants placed calls at significantly lower speeds than during either the first monitoring(delta=8.4492, p=.0001) or the second monitoring period (delta=8.4846, p=.0001).

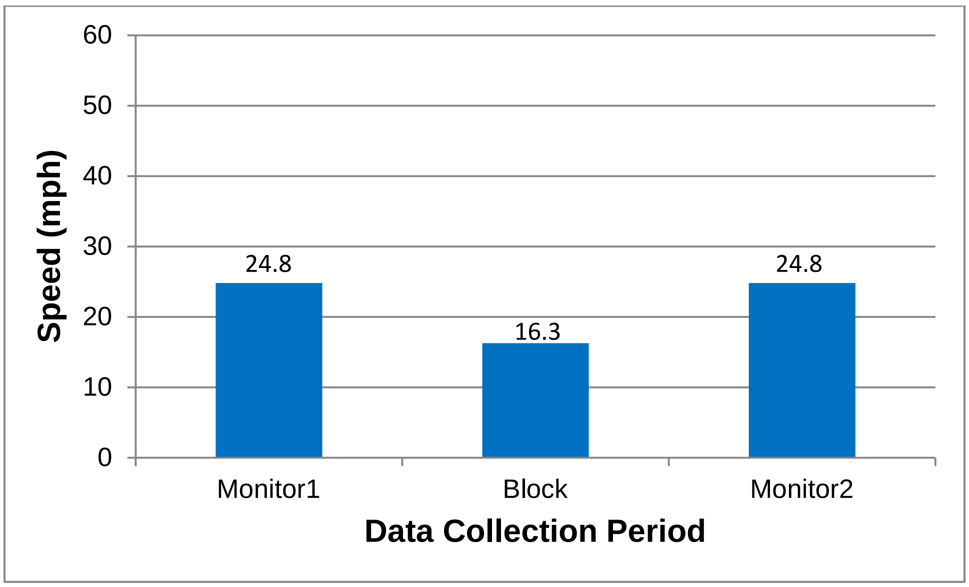

Figure 3: Mean speeds at which outgoing calls were placed split by data collection period for participants who received the Software only application. For this plot, all calls initiated at zero-speed were removed from the data.

3.1.1.2 Hardware/Software Application

All outgoing calls from the final dataset for the Hardware/Software application were grouped for all 22 participants. A total of 2,102 outgoing calls were collected for the Hardware/Software participants. Information on these calls is presented in Table 5 below.

Table 5: All outgoing calls for participants who received the Hardware/Software application

	Hardware/Software
Total outgoing calls, known speed	1,875
Zero-speed outgoing calls	107
Percent of calls at zero-speed	6.0%

From Table 5 above, it is clear that the majority of outgoing calls initiated by participants using the Hardware/Software application were initiated at non-zero-speed. This is not surprising based on the nature of the custom Hardware/Software application. For the custom Hardware/Software application to be collecting data, the participants would need to be within the module-equipped vehicle and moving at speed greater than zero. These few zero-speed outgoing calls were likely initiated during the blocking latency period at a stoplight or stop sign or immediately after ending a trip in a parking lot or driveway.

Figure 4 below breaks down the frequency of outgoing calls by the data collection period in which they were initiated.

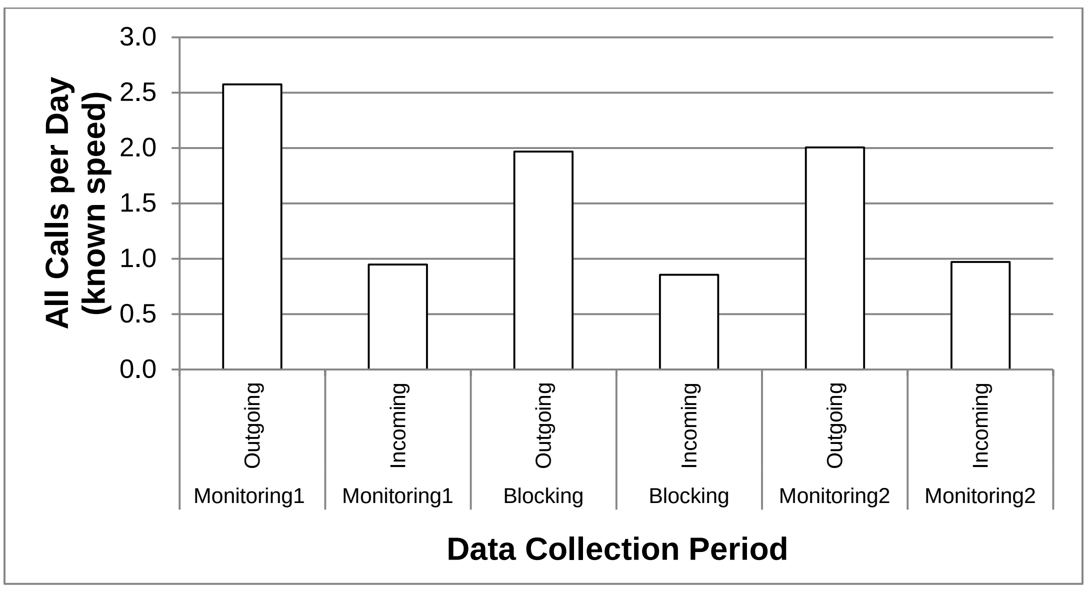

Figure 4: All calls per day split by data collection period for the Hardware/Software application

From Figure 4 above there were fewer calls placed in both the blocking Period and in the second monitoring than were initiated in the first monitoring period. No differences between the overall frequencies of outgoing calls across data collection periods proved significant for the participants receiving the Hardware/Software application.

Table 6 below breaks down the outgoing calls by the data collection period and speed at which they were placed.

Table 6: All outgoing calls for participants who received the Hardware/Software application split by blocking period

	Hardware/Software		
	Monitor1	Block	Monitor2
Days of data collected for period	336	289	220
Outgoing call count by period, known speed	865	569	441
Outgoing calls per day, known speed	2.57	1.97	2.00
Zero-speed calls per day	0.01	0.32	0.04
Non-zero speed calls per day	2.56	1.65	1.96
Percent of calls made at zero-speed	0.40%	15.98%	1.66%

From Table 6 above, during the blocking period with the blocking software active, significantly more calls were placed at zero speed than in either the first monitoring period ($t(40)=4.70$, $p=.0001$) or the second monitoring period ($t(40)=4.44$, $p=.0001$). Also, there was clearly a larger percentage of calls placed at zero-speed during the blocking period (almost 16% versus under 2% for the monitoring periods). However, because of the small proportion of calls placed at zero-speed in the monitoring periods, statistical analysis could not be used.

After removing all zero-speed calls, a significant effect of the cell phone filtering/blocking software can still be seen. Figure 5 below displays the mean speed at which outgoing calls were initiated, split by data collection period. This only includes outgoing calls placed at speeds above zero. From Figure 5 below, during the blocking period participants placed calls at significantly lower speeds than during either the first monitoring period(delta=3.7057, $p=.0001$) or the second monitoring period(delta =3.3581, $p=.0001$).

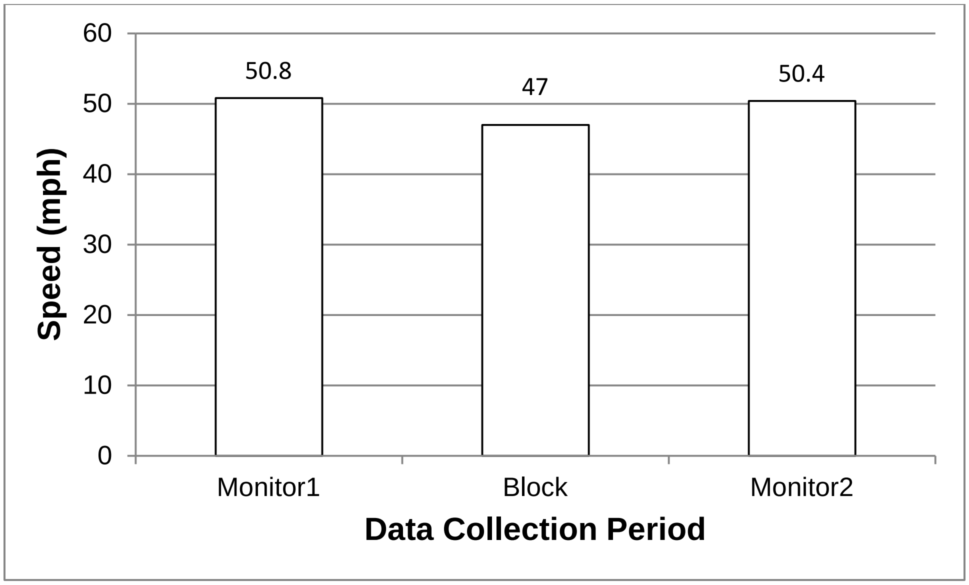

Figure 5: Mean speeds at which outgoing calls were placed split by data collection period for participants who received the Hardware/Software application. For this plot, all calls initiated at zero-speed were removed from the data.

3.1.2 Unanswered Incoming Calls

Another potential safety benefit of the cell blocking/filtering technologies was the potential for an increase in unanswered incoming calls while driving. Participants in the blocking period of the data collection would only be able to answer incoming calls while driving if they had previously overridden the cell phone filtering/blocking software before the call was received on the handset.

3.1.2.1 Software-Only

Information on all incoming calls collected from participants using the custom Software-Only application is presented below in Table 7.

Table 7: All incoming calls for participants who received the Software-Only application

	Software-Only
Total incoming calls, known speed	1949
Zero-speed incoming calls	1566
Percent of calls at zero-speed	80.4%

Again, similar to Table 4 the majority of calls collected from participants who received the Software-Only application began at zero-speed. A larger percentage of incoming calls were answered at zero-speed (80.4%) as compared the percentage of outgoing calls initiated at zero-speed (74.3%) by participants who received the Software-Only application.

The relative frequency of unanswered calls may provide some insight into the effects of the cell phone filter/blocker technology on driving safety. While no flag was provided in the data for unanswered calls, based on an analysis of the data (discussed earlier in the Method section) calls in the data files less than 3 seconds in duration were considered unanswered for this analysis.

Table 8 below breaks down the incoming calls by the data collection period in which they were placed.

Table 8: All incoming calls with known speeds for participants receiving the Software-Only application split by data collection period

	Software-Only		
	Monitor1	Block	Monitor2
Incoming calls at non-zero speed	178	132	73
Unanswered Incoming calls at non-zero-speed	0	35	1
Percent of calls unanswered	0.00%	26.52%	1.37%

The activation of the blocking software clearly had an effect on the proportion of incoming calls that went unanswered while the phone was traveling at speeds greater than zero. For participants receiving the Software-Only application, nearly all calls were answered when the blocking software was inactive, with participants only missing one call in either monitoring period. During the blocking period, 26.52 percent of incoming calls went unanswered when the phone was at non-zero-speed. There were not enough unanswered calls to perform statistical analysis here.

3.1.2.2 Hardware/Software

Information on all incoming calls collected from participants using the Hardware/Software application is presented below in Table 9.

Table 9: All incoming calls for participants who received the Hardware/Software application

	Hardware/Software
Total incoming calls, known speed	780
Zero-speed incoming calls	22
Percent of calls at zero-speed	2.5%

Similar to Table 5, participants using the Hardware/Software application received very few calls at zero-speed. This percentage (2.5%) is even smaller than the 6 percent of outgoing calls initiated at zero-speed. Table 10 below breaks down the incoming calls by the blocking period in which they were placed.

Table 10: All incoming calls with known speeds for participants receiving the Hardware/Software application split by data collection period

	Hardware/Software		
	Monitor1	Block	Monitor2
Incoming calls at non-zero speed	317	231	210
Unanswered Incoming calls at non-zero speed	8	117	10
Percent of calls unanswered	2.52%	50.65%	4.76%

The activation of the blocking software clearly had an effect on the proportion of incoming calls that went unanswered while the phone was traveling non-zero speeds. For participants receiving the Hardware/Software application, nearly all calls were answered when the blocking software was inactive, with participants only missing 18 calls between the two monitoring periods. During the blocking period, 50.65 percent of incoming calls went unanswered when the phone was at non-zero-speed. This large percentage is due to the fact that these participants were always driving, and any incoming calls received at non-zero-speeds would have to have been preceded by an override to have been answered. There were not enough unanswered calls to perform statistical analysis here.

3.1.3 Speed at which participants sent SMS

Another potential surrogate of the impact of cell phone filtering/blocking applications on phone use is the frequency at which SMS text messages are sent while driving. Overall, very few SMS were sent by either participant group. Incoming SMS were recorded in the data files when they were received on the handset whether the participant viewed them or not, therefore only outgoing SMS will be analyzed. Only 9 total outgoing SMS were sent by participants who received the Hardware/Software application, and these encompassed only 2 participants during the first monitoring period of the data collection. Outgoing SMS by participants who received the Hardware/Software application will not be analyzed here.

3.1.3.1 Software-Only

Table 11 below presents all outgoing SMS with known speeds for participants who received the Software-Only application.

Table 11: All outgoing SMS for participants who received the Software-Only application

	Software-Only		
	Monitor1	Block	Monitor2
All Outgoing SMS with known speed	157	151	45
All outgoing zero-speed SMS	128	125	36
All outgoing non-zero speed SMS	29	26	9
Percent of zero-speed SMS	81.5%	82.8%	80.0%

In total 353 outgoing SMS were captured in the data files with known speeds. These were sent by only 10 unique participants, with 1 participant accounting for 175 of these. Three participants only had 1 outgoing SMS. While a slight increase in the percentage of zero-speed SMS can be seen in Table 11 for the blocking period, this difference is not significant.

While only 64 outgoing SMS were sent by participants who received the Software-Only application, the speeds at which these messages were sent was analyzed across periods in the data collection. During the blocking period, participants' non-zero speed, outgoing SMS were sent at a marginally lower speed than those sent during the first monitoring period ($t(58) = 1.82$, $p = .073$.)

3.1.4 Call duration while driving

3.1.4.1 Software-Only Application

In Figure 2 in the previous section a steady decline in the frequency of both incoming and outgoing calls was seen over the course of the study for the participants receiving the Software-Only application. Of interest here is the duration of both the incoming and outgoing calls. For this analysis only calls initiated or answered at non-zero speeds will be analyzed as calling behavior while not driving is not of interest. Table 12 below presents the mean durations of the non-zero-speed outgoing calls for participants who received the Software-Only application.

Table 12: Mean durations of non-zero speed outgoing calls for participants receiving the Software-Only application

	Software-Only		
	Monitor1	Block	Monitor2
Non-zero speed outgoing calls per day	0.75	0.42	0.41
Mean duration of non-zero speed outgoing, answered calls(min)	1:41	1:22	1:33

From Table 12, Software-Only participants in the first monitoring and the second monitoring period had non-zero-speed outgoing calls with slightly longer durations than those initiated during the blocking period. The longer duration in the first monitoring period is partly due to 2 calls with unusually long durations (roughly 14 minutes and 38 minutes) while no other outgoing calls had a duration over 9 minutes. Boxplots of the Software-Only outgoing call durations are presented below in Figure 6. As with all analyses in this report, these outliers are accounted for in the statistical analyses when looking for significant differences in cell phone usage across data collection periods. No statistically significant difference was found between outgoing call durations for the participants who received the Software-Only application.

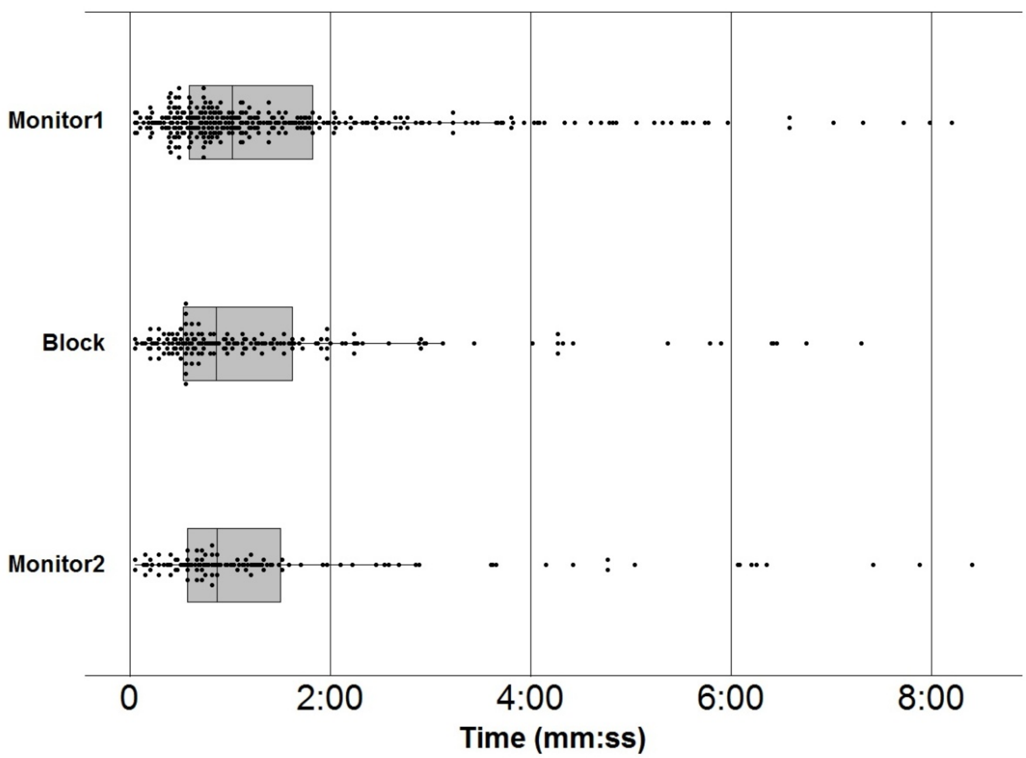

Figure 6: Boxplots of outgoing call durations for participants receiving the Software Only application

Table 13 below presents the mean durations of the non-zero-speed incoming calls for participants who received the Software-Only application.

Table 13: Mean durations of non-zero speed incoming calls for participants receiving the Software-Only application

	Software-Only		
	Monitor1	Block	Monitor2
Non-zero speed incoming calls per day	0.40	0.31	0.25
Mean duration of non-zero speed incoming, answered calls(min)	1:28	1:30	1:16

From Table 13, an opposite trend can be seen from that in Table 12 above. Again however, 2 incoming calls with unusually long duration were held during the blocking period accounting for a large portion of the difference in duration between the blocking periods.

If these outliers are removed, the actual effect of the data collection period on the duration of non-zero-speed incoming calls follows the same trend as for the non-zero-speed outgoing calls, (with calls in the blocking period having a shorter duration), despite what the descriptive mean indicated in Table 13. Boxplots of the Software-Only incoming call durations are presented below in Figure 7. In neither case were any differences in call durations statistically significant.

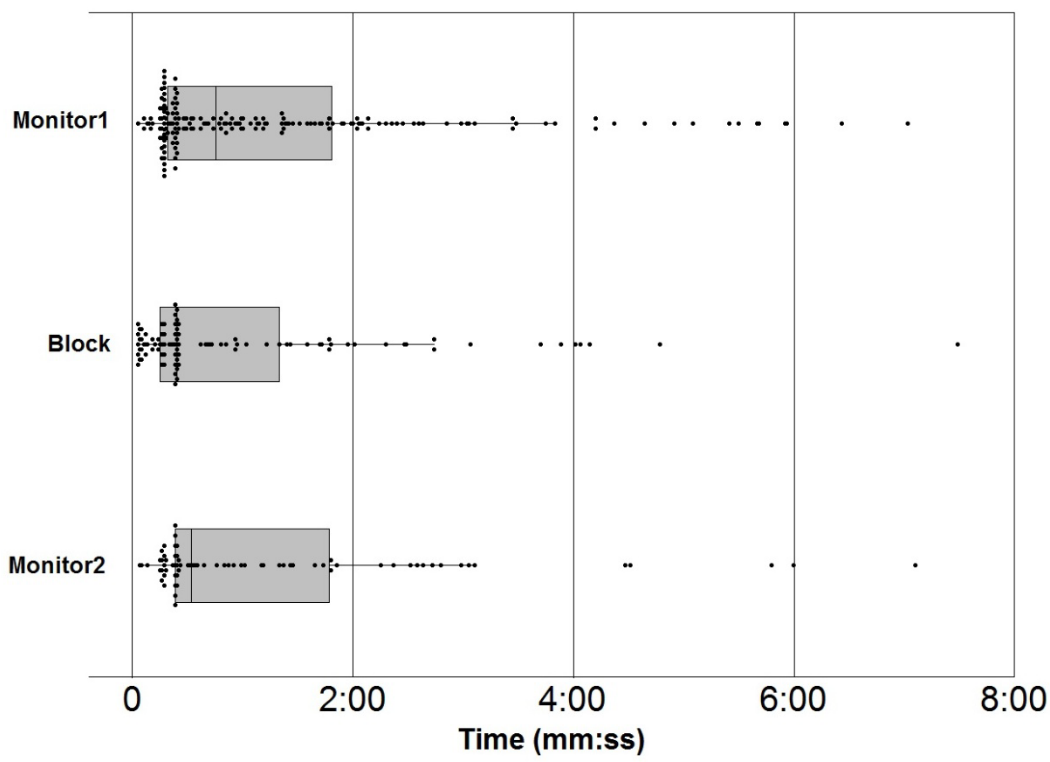

Figure 7: Boxplots of incoming call durations for participants receiving the Software-Only application

3.1.4.2 Hardware/Software Application

Table 14 below presents the mean durations of the non-zero-speed outgoing calls for participants who received the Hardware/Software application.

Table 14: Mean durations of non-zero speed outgoing calls for participants receiving the Hardware/Software application

	Hardware/Software		
	Monitor1	Block	Monitor2
Non-zero speed outgoing calls per day	2.56	1.65	1.96
Mean duration of non-zero speed outgoing, answered calls(min)	2:30	2:33	2:32

From Table 14, outgoing calls initiated at non-zero speeds had very similar durations for participants receiving the Hardware/Software application. None of these differences were significant. Boxplots of the Hardware/Software outgoing call durations are presented below in Figure 8.

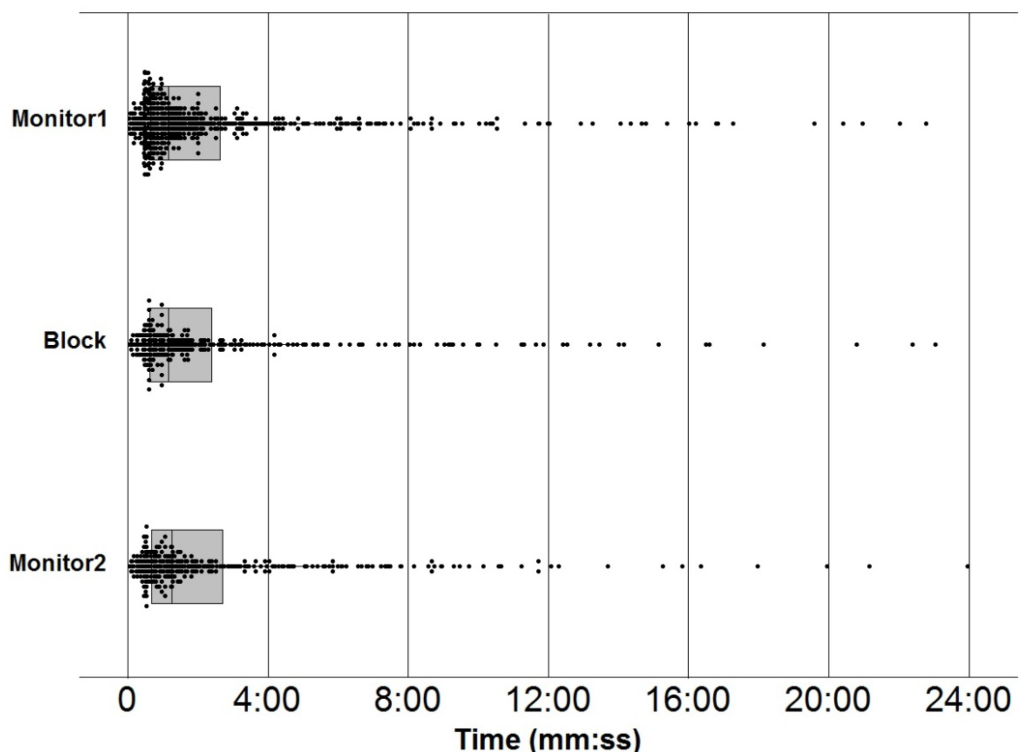

Figure 8: Boxplots of outgoing call durations for participants receiving the Hardware/Software application

Table 15 below presents the mean durations of the non-zero-speed incoming calls for participants who received the Hardware/Software application.

Table 15: Mean durations of non-zero speed incoming calls for participants receiving the Hardware/Software application

	Hardware/Software		
	Monitor1	Block	Monitor2
Non-zero speed incoming calls per day	0.94	0.80	0.95
Mean duration of non-zero speed incoming, answered calls(min)	3:10	3:24	3:48

From Table 15 above, durations of incoming calls tended to increase over the course of the study for participants who received the Hardware/Software application. Boxplots of the Hardware/Software incoming call durations are presented below in Figure 9. Despite the magnitude of these differences, because a small number of calls drove the descriptive means, none of these differences were significant.

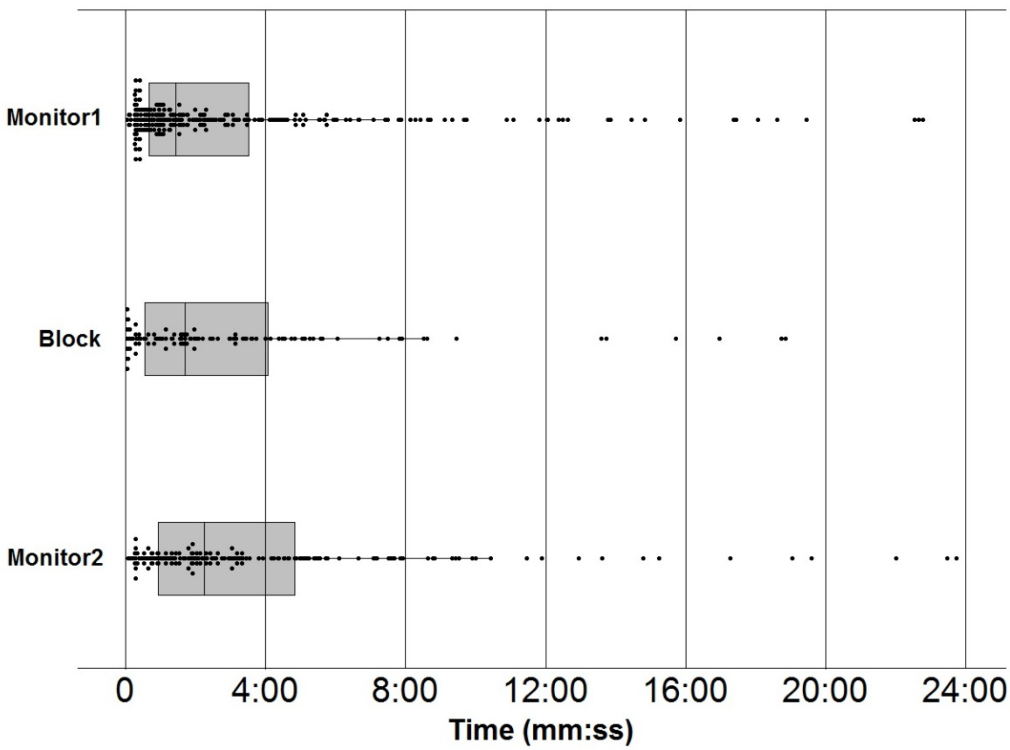

Figure 9: Boxplots of incoming call durations for participants receiving the Hardware/Software application

3.1.5 What were the overrides use patterns?

One way to estimate the loss of productivity associated with blocking cell phone use while driving would be to look at the overrides performed by the participants. Both subjective and objective data is available on override behavior.

3.1.5.1 Objective Override Data

Override data were collected along with other phone activities through the course of the study. As it is impossible to determine whether any specific override was used when the participant was a driver or a passenger, no distinction will be made for this analysis.

Software-Only

As mentioned earlier, the override duration for the custom Software-Only application was set to default to 10 minutes. While participants could adjust this, it roughly doubled the steps required to perform the override and it appears most participants did not adjust this. Therefore, it is likely that in a single trip a participant with the custom Software-Only application may have performed multiple overrides. Based on difficulties interpreting the data files for the custom Software-Only application, it is impossible to determine with complete certainty what activities occurred under the overrides. However based on the assumption that all cell phone activity performed at speeds greater than zero during the 2-week blocking period would have required an override, an estimate of phone activity during overrides can be produced for participants receiving the Software-Only application. Overall, participants who received the Software-Only application performed 448 overrides of the blocking during the 2-week blocking period. Table 16 below presents information on the frequency of activities performed during overrides.

Table 16: Information on blocking overrides and the activities performed during these overrides for participants who received the Software-Only application (data from blocking period only).

	Count
Outgoing calls during overrides	61
Answered Incoming calls during overrides	33
E-mail	445
SMS (sent)	8
Applications	138
Total activities	685
Total overrides	448
Activities per override	1.53

From Table 16 above participants used the override for making and receiving calls, sending and checking SMS and e-mail and viewing applications. Overall, participants performed over 1.5 activities per override throughout the blocking period. The most common activity was checking their e-mail. No SMS were received during overrides, however 8 were sent. The monitoring function of the custom Software-Only application is unable to determine what activities occurred during e-mail viewing (such as composing, sending or viewing).

Figure 10 below displays the frequency of the overrides for participants receiving the Software-Only application. On average, participants performed just over 1 override per day during the blocking period. Over half of the participants who received the Software-Only application performed between .5 and 1 override per day during the blocking period of the data collection. One participant performed over 3.8 overrides per day.

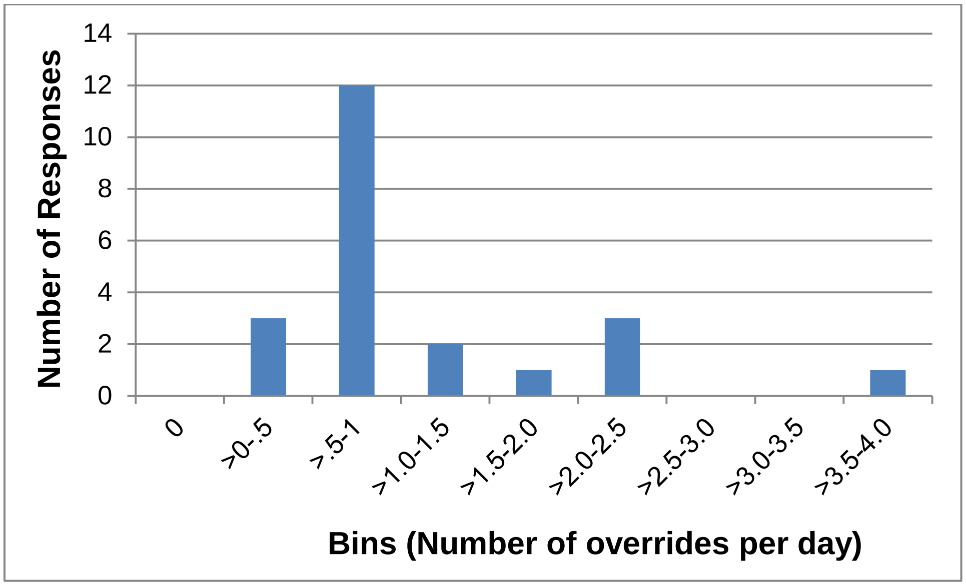

Figure 10: Frequency of overrides (overrides per day) for participants receiving the Software-Only application

While there is no direct surrogate for any productivity losses associated with the implementation of the cell phone filter/blocker technologies, had the participants not been provided with the ability to override the blocking, participants would not have been able to accomplish the tasks which they deemed important enough to necessitate performing an override of the blocking.

If it is assumed that checking e-mail is generally less urgent than receiving or initiating a call, it is difficult to estimate the impact had these participants been forced to wait until they reached their destination to check their e-mail. However it can be determined that 94 calls (which, if participants followed instructions, were necessary work related calls) would have been unanswered in the case of incoming calls, or not placed in the case of outgoing calls. While these 94 calls were spread over 424 work days, (meaning less than 1 call per day would have been delayed) it is impossible to determine the impact that delaying these calls would have had on the organization.

Hardware/Software

Participants who received the Hardware/Software application drove much more as a percentage of their normal workday than participants who received the Software-Only application, so it would seem likely that they would may feel much more dependent on the override feature in order to perform their job functions as normal—despite the implementation of the blocking by the cell phone filter/blocker software during the blocking period. One major difference between the functionality of the override for the custom Hardware/Software application and the custom Software-Only application is that overrides of the blocking for the custom Hardware/Software application would last for the entire duration of the ignition cycle in which it was performed. Therefore, while participants who received the Hardware/Software application may have been more dependent on the override, they would potentially have fewer discrete instances in which they performed the task of overriding the filtering/blocking.

The data files generated by the custom Hardware/Software application explicitly mark when overrides were performed by each participant. Overall, participants who received the Hardware/Software application performed 354 overrides of the blocking during the blocking period. Table 17 below presents information on the frequency of activities performed during overrides.

Table 17: Information on blocking overrides and the activities performed during these overrides for participants who received the Hardware/Software application (data from blocking period only).

	Count
Outgoing calls during overrides	569
Answered Incoming calls during overrides	131
E-mail checked	100
E-mail (sent)	7
SMS (sent)	0
Other applications	36
Total activities	843
Total overrides	354
Activities per override	2.38

From Table 17 above participants used the override for making and receiving calls, checking SMS and e-mail and viewing applications. Overall, participants performed 2.38 activities per override throughout the blocking period. The most common activity was initiating outgoing calls. No SMS were sent during overrides, however 7 e-mails were sent.

Figure 11 below displays the frequency of the overrides for participants receiving the Hardware/Software application. On average, participants performed 1.22 overrides per day during the blocking period. Participants' override behavior fell into one of two groups. Twelve of the 22 participants who received the Hardware/Software application performed 1 or fewer overrides per day on average over the course of the blocking period, while 10 of the participants performed over 1.5 overrides per day over the same period.

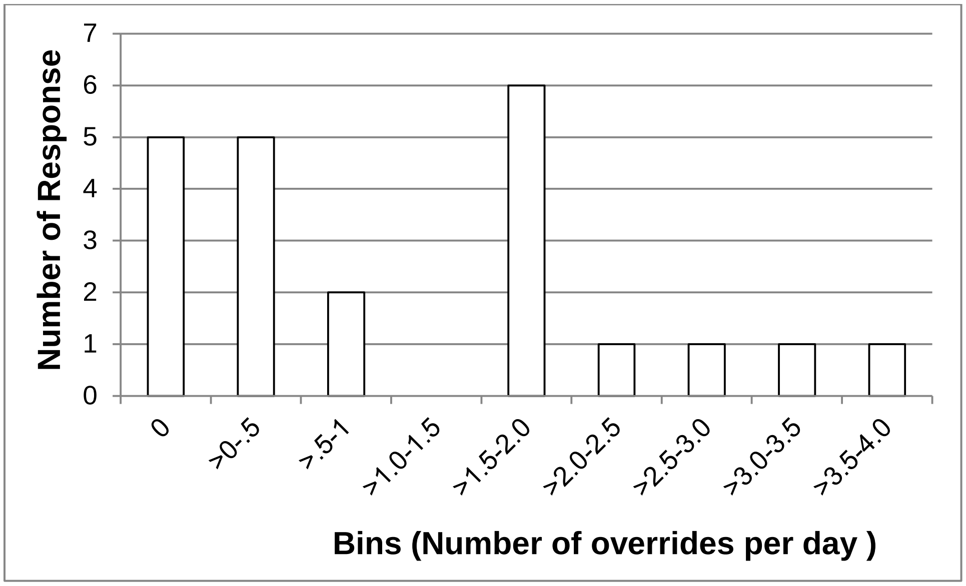

Figure 11: Frequency of overrides (overrides per day) for participants receiving the Hardware/Software application

In terms of the impact on productivity, over 731 calls would have been delayed over the course of just 289 days, meaning roughly 2.5 calls per day would have been delayed. Especially in the case of the participant pool receiving the Hardware/Software application, this has the potential to have a large impact on their work productivity. Often these participants were responsible for making decisions that affect the progress at various construction and maintenance projects around their region, and delays in their input could potentially delay the work of many MDOT or contractor employees relying on their guidance or permission to progress with these projects. Additionally, many MDOT employees, including some involved in this study, are termed "First-responders." These are MDOT employees who receive emergency calls from other state organizations and are charged with dispatching MDOT crews to respond to these emergencies— such as spills, weather issues, and bridge or road condition emergencies. Again, while it is difficult to determine the exact effect on MDOT had the overrides not been available to these participants, delays in even a few of the most important calls could have had a large impact on the ability of MDOT to function quickly and efficiently to complete their projects or deploy crews to deal with situations requiring immediate attention.

3.1.5.2 Subjective Responses

When asked how often they used the override while driving, responses were mixed. Nine participants responded that they never used the override while eleven responded that they used it more than once per day. Participants who received the Hardware/Software application were much more likely to respond that they used the override more than once per day. This seems consistent with their job function, in which they would be moving from job site to job site and doing business on these trips, with each trip requiring its own override.

Also not surprising, participants who received the Software-Only application were much more likely to report using the override as a passenger than the participants who received the Hardware/Software application. Seventeen participants who received the Software-Only application responded that they used the override as a passenger at least once during their experience while only 4 participants who received the Hardware/Software application responded that they had used the passenger override. Again, based on the nature of the participant pool, participants who received the Hardware/Software application would likely have been in their module-equipped vehicle for the majority of their work –related driving while participants who received the Software-Only application may have been more likely to be traveling to meetings in groups where they would find themselves as passengers in a vehicle.

3.1.6 What is the effect of cell phone filter/blockers on driver performance? (subjective)

Table 18 Questionnaire responses to Likert-scale questions Q14, Q15, Q22

		Yes	No
14	Have you ever been in a situation where using a cell phone while driving contributed to a crash or near-crash?	3	38
15	In the last 6 weeks, were you ever in a situation where using a cell phone while driving contributed to a crash or near-crash?	2	40

		Overall **Mean**(Std.Dev)	Software-Only **Mean**(Std.Dev)	Hardware/Software **Mean**(Std.Dev)
22	I think having this blocking software on my phone increased my driving safety. (1=Strongly Agree, 7= Strongly Disagree)	**3.88**(1.85)	**3.65**(1.67)	**4.09**(2.02)

Few participants responded that they had been in a near-crash while using a cell phone. Overall, 5 participants out of 42 indicated that at some point in their driving history they were on the cell phones and involved in near-crashes, with two of these occurring during the data collection period. These 5 "yes" responses were mutually exclusive, as all "yes" responses came from 5 different participants. Also, all came from participants who had received the custom Hardware/Software application. This may be in part related to the fact that participants who received the Hardware/Software application indicated in Q5 in Figure 7 that they drove more per week as a function of their job than did participants who received the Software-Only application.

Clearly at least 2 participants did not respond accurately about their driving history, as they indicated that while they had never been in a near-crash while on a cell phone (Q14), they indicated that they had been in a near-crash while on a cell phone during this study (Q15). UMTRI researchers believe the participants may have thought the period asked about in the first question (all driving experience) and the period asked about in the second question (the 6 weeks with the cell phone filtering/blocking technology) did not overlap, and had they understood this, the 2 participants indicating they had a near-crash during the last 6 weeks would also respond affirmatively to Q14.

Responses to Q22 were quite neutral, with the mean responses from both groups of participants between 3.6 and 4.1 on the 7-point Likert-scale. Participants who received the Software-Only application agreed slightly more with the statement that they received increased safety from the cell phone filtering/blocking software. The distribution of the response to Q22 is presented below in Figure 12.

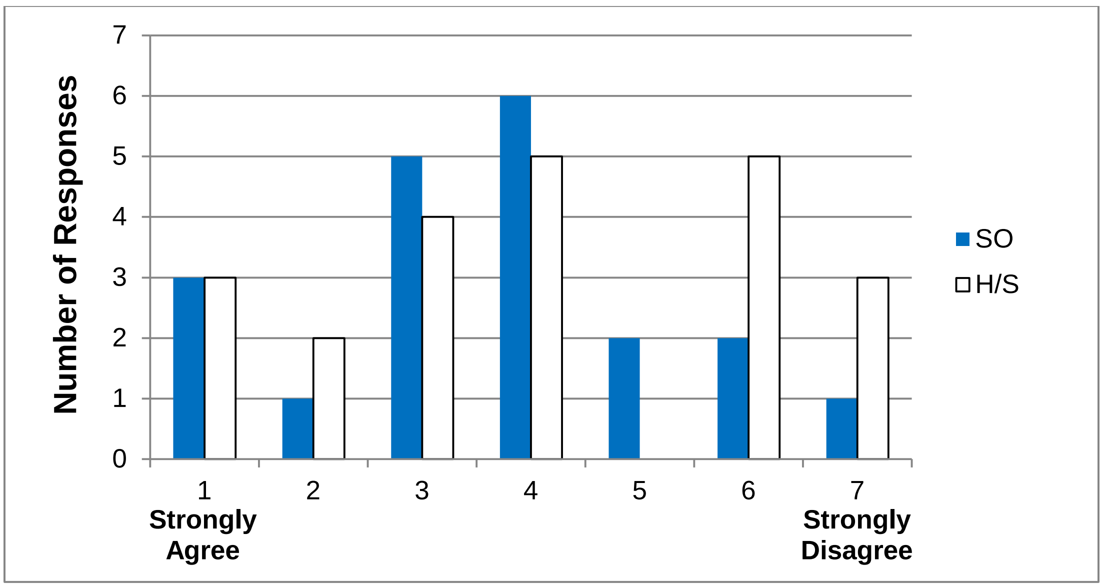

Figure 12: Distribution of responses to Q22, "I think having this blocking software on my phone increased my driving safety."

Eight participants who had received the Hardware/Software application, and only 3 participants who received the Software-Only application, scored this question a "6" or "7" (disagreeing strongly). While the means were similar between the two populations, a large proportion of the participants who had received the Hardware/Software application disagreed with the statement that they received additional safety benefit from the cell phone filtering/blocking software.

3.1.7 Were there lasting effects?

Of interest was whether the participants' experience with the cell phone filter/blocker software would influence their cell phone use while driving even after the blocking software had been removed from their phone.

Table 19: Questionnaire responses to Likert-scale questions Q21 and Q23

		Overall **Mean**(Std.Dev.)	Software-Only **Mean**(Std.Dev.)	Hardware/Software **Mean**(Std.Dev.)
21	I find that since my experience with the cell phone blocking software, I use my phone less while driving in my personal vehicle than I did previously. (1=Strongly Agree, 7=Strongly Disagree)	**4.64**(1.65)	**4.35**(1.53)	**4.91**(1.74)
23	I would like to have this software on my personal phone. (1=Strongly Agree, 7=Strongly Disagree)	**5.71**(1.77)	**5.75**(1.77)	**5.68**(1.81)

In terms of Q21, participants responded neutrally when asked whether their experience with the filtering/blocking application affected their phone use going forward. Seventeen of the 42 respondents scored this question a "4" indicating neutrality. Participants receiving the Hardware/Software application were more likely to strongly disagree with the statement that those who received the Software-Only application. Ten participants who received the Hardware/Software application scored this question a "6" or "7" indicating strong disagreement, while only 5 participants who received the Software-Only application scored it a "6" or "7." Responses from the participants who received the Hardware/Software application significantly differed from neutral (p=.0233). The distribution of responses to Q21 is presented in Figure 13 below.

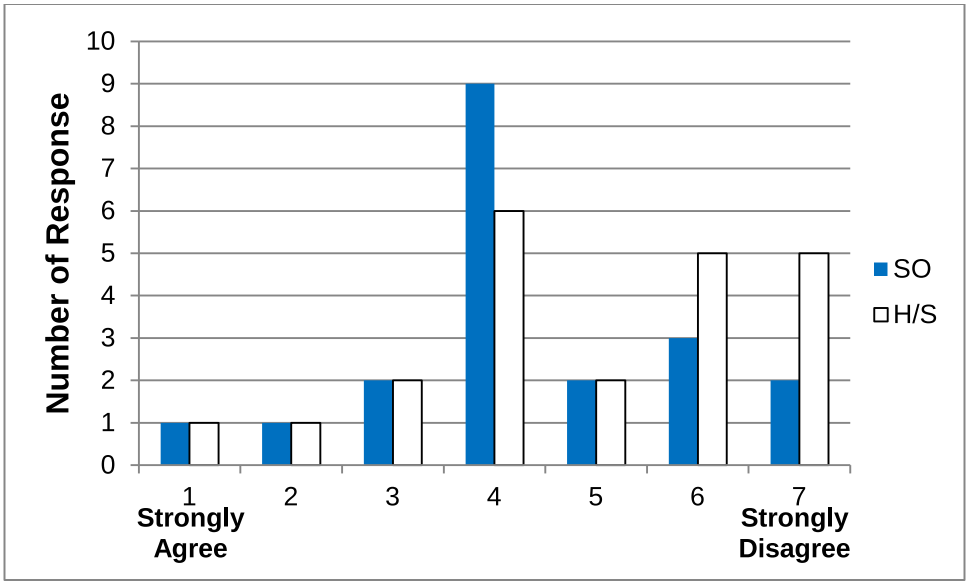

Figure 13: Distribution of responses to Q21, "I find that since my experience with the cell phone blocking software, I use my phone less while driving in my personal vehicle than I did previously."

In Q23, participants were asked whether they would like to have the custom software installed on their personal phone in order to continue to receive the benefits of cell phone blocking while driving. This question received the strongest disagreement across all participants when compared to the other questionnaire questions receiving an overall mean response of 5.71 (out of 7). This was consistent across both application groups. Twenty-two out of 42 participants scored this question a "7," with only 4 participants agreeing at all (responses less than "3"). The distribution of responses to Q22 is presented in Figure 14 below. Responses from the participants who received both applications significantly differed from neutral (H/S: p=.0003, SO: p=.0003).

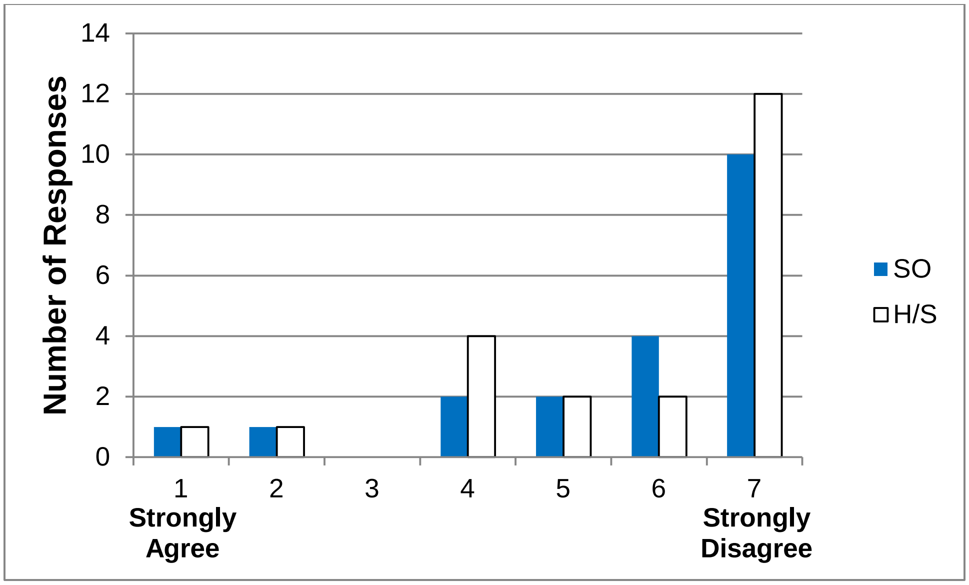

Figure 14: Distribution of responses to Q23, "I would like to have this software on my personal phone."

While the experience with the cell phone filter/blocker technology may affect the participants' phone use while driving going forward, very few participants gave any indication of this, and in general thought that their participation in this study would not have any lasting effect. Additionally, when asked if they would like to have the software on their own phone going forward, most participants were strongly opposed to this.

3.2 Technical Performance and User Acceptance

In order to examine the technical performance and user acceptance of the cell filter/blocker technologies on driving safety the following were examined:

- What was the technical effective/reliability of the cell phone filter/blockers?
- How did drivers feel about the cell phone filter/blockers?
- Did drivers "game" the system, and if so how?
- General participant opinions.

3.2.1 What was the technical effectiveness/reliability of the cell phone filter/blockers?

When assessing the effectiveness or the reliability of the blocking technologies, there is very little overlap between the custom Software-Only application and custom Hardware/Software application. Based on the nature of the two blocking technologies, and the way in which they achieved their purpose, the challenges associated with each one are unique.

3.2.1.1 Software-Only Application

The Software-Only application's dependence on a GPS signal to determine motion state information led to problems with participants who were indoors, away from strong GPS satellite signals, for large portions of their workday. When the software is not receiving a GPS signal, data is only being generated on phone activity. While for the most part the technology is able to receive a GPS signal when outdoors, it is impossible to tell only from the data files whether in fact a participant is outdoors (and maybe driving) or indoors as no speed or location data is being generated. A benefit of the custom Software-Only application was the ability to work in any vehicle, without having to transfer any hardware. Participants could have moved from one work vehicle to another and then to their personal vehicle and their phone use behavior was monitored (and blocked if necessary) the entire time.

Of the 22 phones in the final data set, data collection on 9 worked perfectly throughout the 9 weeks, and 6 worked very well – with only 1 drop-out in the data files during the 9 weeks. Three phones generated consistent data files through the study, however there were major holes in their GPS data. Four phones in the final Software-Only data set had to be restarted multiple times, and even occasionally needed to be reset from the server end by the technology provider. Again, it is important to distinguish that many of the problems encountered in this study are likely the result of having made significant modifications to a commercial product – and attempting to use this new custom-made application as a research tool.

Three phones not included in the data set had repeated problems and often could not be fixed from the handset or remotely from the server end by the technology provider. These problems may have been a result of tampering by the participants (very unlikely) or simply bad communication from the software back to the technology providers' servers.

Two participants withdrew because they felt the custom Software-Only application may have negatively affected their phone operation outside of the normal expected operations of the software. One of their comments was in regard to the operation of the calendar on the phone, and the other was in regard to the address book on the phone. The custom Software-Only application should have had zero impact on either of these phone features, and UMTRI researchers believe it is very likely that these problems were a result of changes to the central MDOT servers, not with anything related to custom Software-Only application.

3.2.1.2 Hardware/Software Application

The operation of the custom Hardware/Software application appeared more robust as the signal from the Bluetooth module was more consistent than the signal from the GPS required by the custom Software-Only application. This may contribute to a false sense of consistency however, because based on the nature of the Hardware/Software application data files, it is impossible to know "what you don't know." While it appeared that each time a participant used his module-equipped vehicle data was being collected, it is impossible from only the data files to determine if some trips or in-car phone activity was missed. As the data was event driven (versus continuous like that generated by the Software-Only application) there were no discontinuities to investigate. Additionally, there was no way to determine if a participant was using a different vehicle or if a participant had removed the module all together.

There were no reports from participants of modules failing to transmit the Bluetooth signal (the absence of blocking when a participant felt it should be blocking) or of the modules failing to remain firmly installed in the OBDII port.

3.2.2 How did drivers feel about the cell phone filter/blockers?

Table 20: Questionnaire responses to Q6, "What was your favorite aspect of the blocking technology?"

6	What was your favorite aspect of the blocking technology?			
		Overall	Software-Only	Hardware/Software
	Nothing	18	8	10
	No distractions while driving	15	7	8

When asked about their favorite aspects of the blocking technology, participants' responses were not very positive. Tabulated responses to Q6 are presented above in Table 20. Eighteen participants mentioned specifically that they liked nothing about having a cell phone filtering/blocking application installed on their cellular telephone. Of the participants who mentioned some aspect they liked, 15 participants mentioned that they liked not being distracted with business calls while driving. Additional responses included 1 participant (Hardware/Software) mentioning that they liked the override function, 1 participant (Hardware/Software) mentioning that they liked that it activated automatically upon driving and 1 participant (Software-Only) mentioned the consistent operation of the software. Based on these responses, opinions of the blocking software were split among participants with no correlation between the blocking approach of the custom application they received and whether they were able to find something positive to say about it.

Table 21: Questionnaire responses to Q7, "What was your least favorite aspect of the blocking technology?"

7	What was your least favorite aspect of the blocking technology?			
		Overall	Software-Only	Hardware/Software
	Reduced battery life	11	11	0
	Incoming calls blocked while driving	9	6	3
	Inconvenient not being able to make call	5	2	3
	General loss of productivity	5	0	5

Have to override often, override difficult	4	3	1
Can't read e-mail while driving	3	0	3
Had to pull off to call, dangerous	3	0	3
Post-drive blocking latency	3	3	0
Used personal phone to circumvent	2	1	1
Everything	1	0	1

Table 22: Questionnaire responses to Q8, "What would you change about the blocking technology in order to make it more beneficial to you?"

8 What would you change about the blocking technology in order to make it more beneficial to you?

	Overall	Software-Only	Hardware/Software
Block phone activity but not phone calling	9	5	4
Reduce latency when stopped	7	6	1
Not have it	7	2	5
Improve battery life	7	7	0
Override password too long/difficult	6	4	2
Don't block as a passenger	3	1	2
Blocking should be optional	1	0	1

When asked about suggestions to improve the custom applications, participants most commonly suggested the software should block only phone activities like e-mailing and texting, but not block actual calling. Predictably, the next most common suggestions dealt with issues mentioned above in Q7, reduced battery life and post-drive latency. For both cell phone filtering/blocking technologies, the override password was chosen as "aaaaaa" by UMTRI researchers in order to simplify the override process as much as possible. In addition to entering the password, three button presses were necessary to get to the password entry screen, and for the Hardware/Software application a username (always "aaa") was required as well. Tabulated responses to Q8 are presented above in Table 22.

Table 23: Questionnaire responses to Likert-scale questions Q16, Q17, Q18, Q19

		Overall	Software-Only	Hardware/Software
		Mean(Std.Dev.)	**Mean**(Std.Dev.)	**Mean**(Std.Dev.)
16	I found the operation of the software easy to understand. (1=Strongly Agree, 7=Strongly Disagree)	**2.71**(1.50)	**2.84**(1.50)	**2.59**(1.53)
17	During the blocking phase when the software was active, I like that I get an indication that I am receiving an incoming call even though I cannot answer it. (1=Strongly Agree, 7=Strongly Disagree)	**3.50**(2.04)	**3.50**(2.36)	**3.50**(1.79)
18	The software's effect on my battery life was not a problem during my participation. (1=Strongly Agree, 7=Strongly Disagree)	**5.02**(2.24)	**6.50**(1.19)	**3.68**(2.12)
19	The lag time after I finished driving during which the blocking was still active was not a problem during my participation. (1=Strongly Agree, 7=Strongly Disagree)	**4.61**(2.11)	**5.68**(1.45)	**3.68**(2.17)

In general, participants' feelings about the custom cell phone filter/blocker application based upon their Likert-scale responses were not especially positive, especially in terms of the custom Software-Only application. Tabulated responses to Q16 through Q19 are presented above in Table 23.

Participants were slightly positive about their understanding of the system, with users of both software applications mostly agreeing that the software was easy to understand. A distribution of these responses is presented below in Figure 15. Only 5 participants scored Q16 on the "Disagree" side, with 9 participants scoring it neutrally. Without more information it is hard to determine what aspect of the operation of the software was difficult to understand. Based on previous responses to the questionnaire (Q7, Q8) the difficulty may have arisen out of confusion with the override password or with the predictability/consistency of the post-drive latency. Both groups' mean responses to Q16 significantly differed from neutral (SO: p=.0035, H/S: p = .0003) indicating that the participants agreed that the applications were easy to understand.

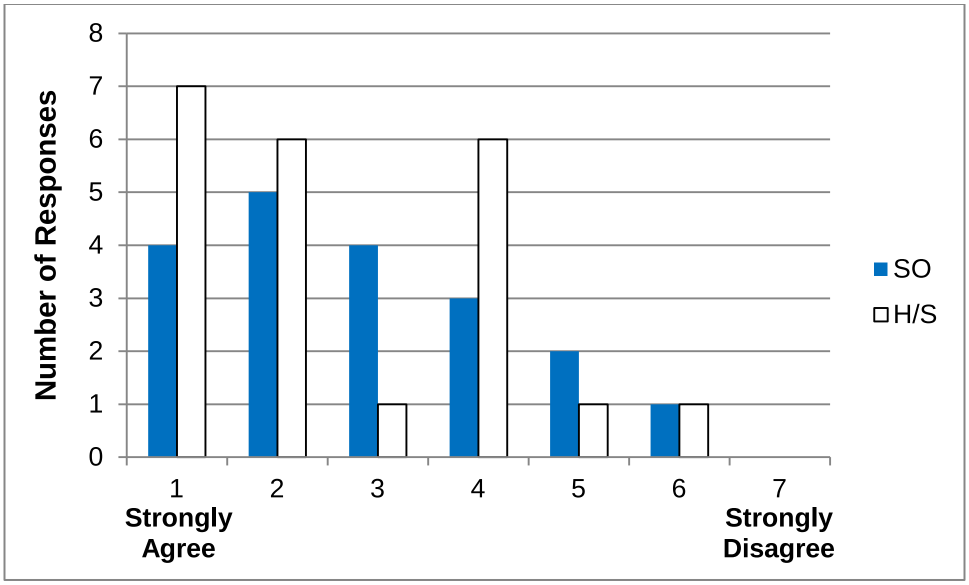

Figure 15: Distribution of responses to Q16, "I found the operation of the software easy to understand."

One aspect of the blocking software that received mixed reviews from participants during the orientations/installations was the fact that a tone or notification would be generated when calls were coming in—even when the phone was blocked. This would give an indication that a call was being missed. Before their blocking period of the data collection, anecdotally participants were unsure whether they would like this aspect of the software or not. Responses to Q17 in the post-drive questionnaire seem to illustrate that participant opinions are still split on this issue even within the two application groups. The distribution of responses to Q17 is presented below in Figure 16.

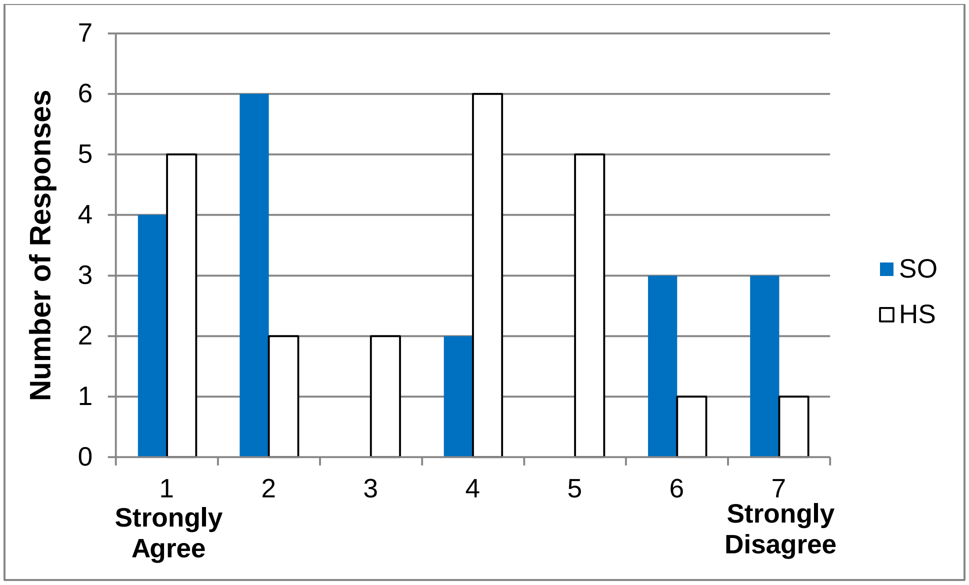

Figure 16: Distribution of responses to Q17, "During the blocking phase when the software was active, I like that I get an indication that I am receiving an incoming call even though I cannot answer it."

Questions Q18 and Q19 from the post-drive questionnaire did show a lot of separation between the two applications/groups of participants. It should be noted that the custom Software-Only application was more susceptible to the problems investigated in Q18 and Q19, which are in part due to the reliance on GPS signals to acquire the phone's speed. Also, as mentioned previously, these two aspects were also affected by the modifications made to the commercial product in order to customize it for use as a research tool. Both the battery life and the post-drive latency are reported to be much improved without the back-end monitoring functions incorporated on the custom-made, research-oriented applications in this study. While the post-drive blocking latency and reduced battery life were seen to some degree by participants with both application types, participants receiving the custom Software-Only application were more negative about both of these issues.

When asked if the application's effect on battery life was not a problem, 15 out of 20 participants who received the custom Software-Only application strongly disagreed scoring the question a "7," only 2 participants who received the custom Hardware/Software application scored the question a "7." Overall, 8 participants who received the Hardware/Software application and 19 participants who received the Software-Only application disagreed to some degree with the statement that the effect on battery life was not a problem.

A similar split was seen for Q19 regarding the post-drive blocking latency. When asked whether "The lag time after I finished driving during which the blocking was still active was not a problem during my participation," only 1 participant who received the Software-Only application agreed that it was not a problem while 13 participants who received the Hardware/Software application agreed. The distribution of responses to Q19 is presented below in Figure 17. Responses from participants who received the Software-Only applications disagreed significantly with the statements in both Q18 and Q19 indicating that they had problems with the reduction in battery life (p=.0001) the post-drive blocking latency (p=.0001)

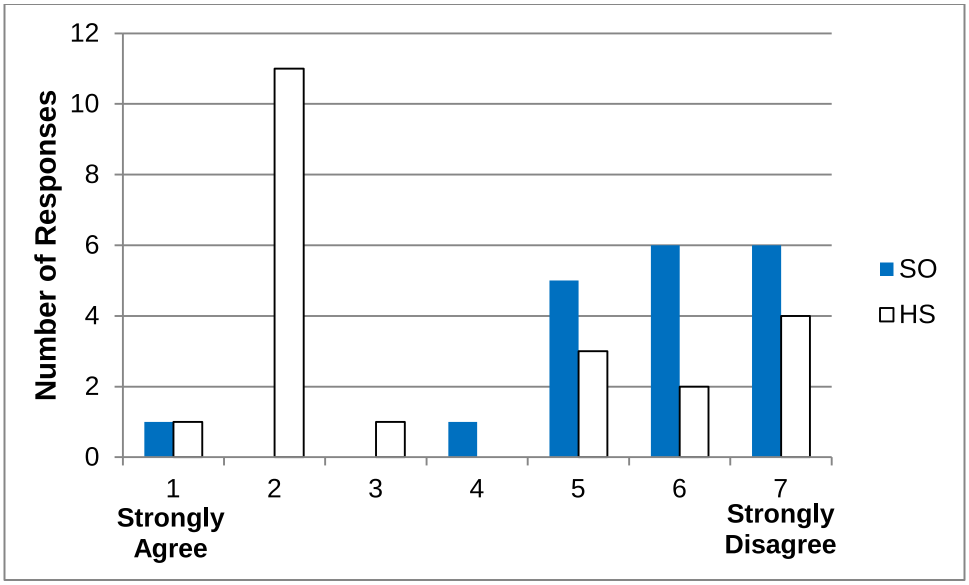

Figure 17: Distribution of responses to Q18, "The lag time after I finished driving during which the blocking was still active was not a problem during my participation."

3.2.3 Did drivers "game" the system, and if so how?

As discussed previously participants in this study were provided a password that could be used to override the filtering/blocking applications while driving (or as a passenger). Because the override function was provided, participants were not forced to "game" the system, however participants frequently used the override function. Additionally, 2 participants indicated resorting to their personal phones on occasion to receive incoming work-related phone calls, because their work phone was in the blocking state. This was the only "gaming" of the software technologies or of the cell phone filter/blocker study itself explicitly known to UMTRI researchers.

Participants may have also "gamed" the system by uninstalling or disabling their software without notifying UMTRI researchers. Both software systems are designed to identify un-installations of their software from participating phones. As there is no way of actually knowing whether the software had been uninstalled from a given phone, when software providers' servers fail to detect a phone for multiple days, a "tamper alert" from the Software-Only application provider (or "device not seen" e-mail from the Hardware/Software application provider) is generated and sent to whoever is monitoring the account (likely an employer or parent). For the sake of discussion going forward both notifications will be referred to as "tamper alerts."

This monitoring method would work well in an environment where the entity monitoring the accounts has a reasonable idea of when driving may be occurring. So, for example an employer may get a tamper alert for an employee who they know has been driving. In this case, they can be fairly certain that something has gone wrong with the software, either through intentional mischief by the user or through some software malfunction. In either case they would want to check the status of the phone and verify with the technology provider that the software is still installed and working correctly.

In the case of this study however, UMTRI researchers did not know a priori how much any given employee may be using their phone. With the custom Software-Only application, (and the associated daily data files) often UMTRI researchers would begin to see missing data files before the tamper alert was received. However, even at this point, it may be the case that the participants simply had a day or two off of work, which in combination with a weekend (3-4 days of inactivity) would be a long enough to appear like a problem may have occurred.

This was even more difficult with the Hardware/Software application as the inactivity periods could be much longer. Data files from the Hardware/Software application provider, which was not necessarily generated on a daily basis, did not provide enough clues to detect problem phones ahead of time. The nature of the Hardware/Software application was such that data was only generated when the specifically equipped vehicle was driven. So a vehicle may simply not be driven for a week (because of vacation or different work tasks).

In either of these cases a tamper alert (or a “device not seen” e-mail) would be generated despite no “gaming” by the participant. Because of this uncertainty, all tamper alerts were treated as software malfunctions. Participants in both application groups gave no indications that they tampered with any of the phones, and the fully voluntary nature of their participation in the study leads UMTRI to believe that if they were extremely unhappy with the filtering/blocking software that they would have simply withdrawn from the study.

3.2.4 General Participant Opinions

Three questions on the Post-Test Questionnaire queried participants about their general views on the custom cell phone filtering/blocking applications after their experience with the software for 6 weeks (3 weeks monitoring, 3 weeks blocking). The average responses to these questions are displayed below in Table 24.

Table 24: Questionnaire responses to Likert-scale questions Q24, Q25, Q26

		Overall	Software-Only	Hardware/Software
		Mean(Std.Dev.)	**Mean**(Std.Dev.)	**Mean**(Std.Dev.)
24	I think MDOT blocking cell phone use while driving is a good idea. (1=Strongly Agree, 7=Strongly Disagree)	**4.67**(2.01)	**4.55**(2.01)	**4.77**(2.05)
25	I think MDOT should adopt this software for all its employees. (1=Strongly Agree, 7=Strongly Disagree)	**4.95**(1.95)	**5.25**(2.12)	**4.68**(1.78)
26	I think all cell phone use while driving should be prohibited for all drivers in the U.S. (1=Strongly Agree, 7=Strongly Disagree)	**4.69**(1.77)	**4.75**(1.74)	**4.64**(1.84)

Participants overall scored all three general opinion questions on the negative side of the scale, although responses were spread widely among participants. In Q24, the participants are asked whether blocking cell phone use while driving is a good idea for MDOT. Participants who received the Hardware/Software application, who drove more than participants who received the Software-Only application as part of their workday, were slightly more likely to disagree that MDOT should block cell phone use. This is unsurprising for this population, as it would likely be perceived to have a greater impact on their work productivity relative to the participants who received the Software-Only application.

A slightly different distribution of responses was seen for the similar question, Q25. When specifically asked if MDOT should adopt the custom application that they had just experienced across the entire organization, participants who received the custom Software-Only application disagreed more strongly in their responses than to the vaguer Q24. These participants felt more strongly that the technology should not be adopted across MDOT. The distribution of responses to Q25 is presented below in Figure 18.

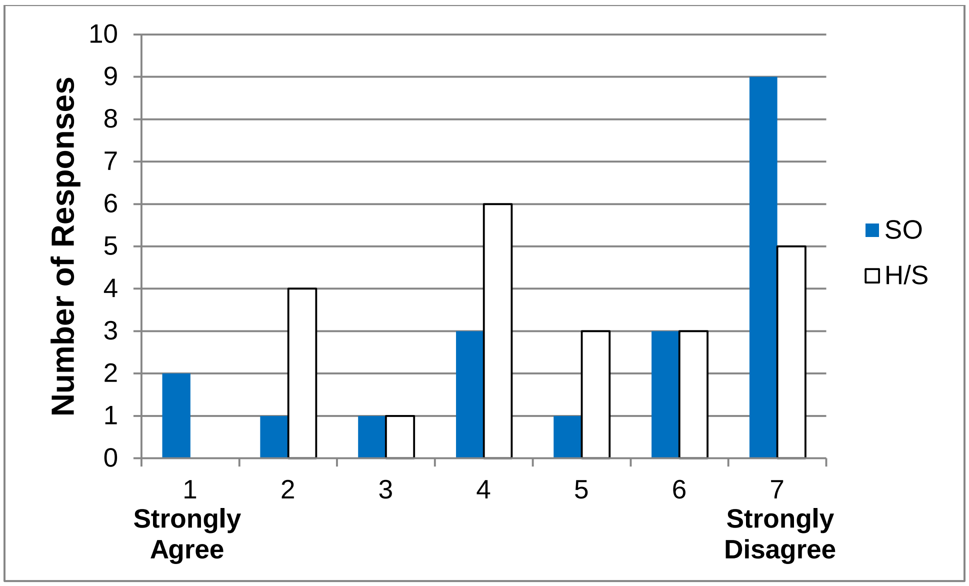

Figure 18: Distribution of responses to Q25, "I think MDOT should adopt this software for all its employees."

From Figure 18 above, while participants' responses were spread across the distribution (albeit skewed to the right or "disagree" side), almost half of the participants who received the Software-Only application (9 out of 20) scored Q25 a "7" indicating that they strongly felt MDOT should not implement this specific, custom Software-Only application across the organization. These Software-Only participants significantly disagreed with the statement in Q25 (p=.0164). This may be due to the issues encountered with the reduced battery life, or the post-drive blocking latency associated with the custom Software-Only application specifically mentioned in many questionnaires by many participants.

Finally, when participants are asked in Q26 for their opinions on a full ban of cell use while driving in the U.S., participants were surprisingly consistent giving responses very similar to those provided when asked about blocking only MDOT phones while driving in Q24. Specifically, mean responses were slightly in disagreement with the idea of banning cell phone use while driving.

3.3 Organizational Impacts

- What were the management opinions of the experience with implementing a cell phone filter/blocker system?
- What are the costs of savings or losses due to the cell phone filter/blocker implementation?

3.3.1 What were the management opinions of the experience with implementing a cell phone filter/blocker system?

Table 25: Questionnaire responses to Likert-scale questions MQ4, MQ5

		Overall **Mean**(Std.Dev.)
MQ4	I think that the safety benefit received by employees from prohibiting cell phone use while driving justifies any loss in productivity associated with such a policy. (1 = Strongly Disagree, 7=Strongly Agree)	**4.43**(1.27)
MQ5	If it was up to me to determine whether employees under my supervision would be prohibited from using the cell phone while driving, I would choose to prohibit all cell phone use while driving. (1 = Strongly Disagree, 7=Strongly Agree)	**4.29**(1.25)

Out of the 44 participants, 15 were selected to receive the "Manager" questionnaire along with the standard participant questionnaire. The manager questionnaire can be viewed in Appendix C. Seven questionnaires were completed.

When asked about any positive feedback they received from their employees regarding the cell phone filter/blocker technologies (either on their phone or their employees' phones), 4 managers reported no positive feedback. Three managers received positive feedback in terms of the general reduction in drivers' distraction, with 1 manager specifically reporting "I heard that blocking texting was good."

When asked about any negative feedback they received from their employees, the responses were not unexpectedly similar to responses to the standard questionnaire. Three managers reported employees' complaints regarding the reduction in battery life, and two reported complaints about difficulty performing overrides. Three managers also mentioned difficulty in communications with their employees, with two using words like "urgent situations" and "important business calls."

When asked about the impact of the cell phone filter/blocker technologies on employees' productivity, responses were split. Four managers specifically responded "no" or "not really," with two mentioning small adaptations they had to make to avoid productivity losses ("had to leave more messages, wait for return calls."). The other three managers did respond affirmatively to this question although they were vague in pinpointing the exact area of impact. One manager did respond “especially the employees in the maintenance work areas were less timely and productive dealing with urgent matters.”

Managers were also asked more general questions regarding their opinion of cell phone filtering/blocking in general. The mean responses to these two Likert-scale questions are presented above in Table 25. As one can see, responses to these questions were basically neutral, with no manager responding to either question with a “1” or a “7” (extremes on the response scale). Both means were slightly above “4” (neutral) indicating that in general, managers were slightly more positive than negative on the concept of cell phone filtering/blocking in their organization.

3.3.2 What was the effect of the cell phone filter/blockers on work productivity?

When considering implementing cell phone filtering/blocking technology on any population or organization, the potential for impacting productivity needs to be taken into consideration. As many people use and rely on cell phone communication as a means to accomplish their daily jobs and social functions, and often this use occurs while driving. In part, MDOT was chosen to supply the participant population in this study as its employees are representative of this, often traveling to different job sites or meeting locations in one day.

From the very first contact UMTRI researchers had with the participants, many were eager to discuss their normal work routine in terms of cell phone use and driving. Cell phone use for work purposes and driving certainly appeared prevalent, at least anecdotally among MDOT employees. Of the 42 participants responding to the questionnaire, only 2 responded that they drive on average less than a half hour each week for work. Twenty-three participants responded that they drive at least 2 hours per week. A distribution of the responses to Q5 is presented below in Figure 19.

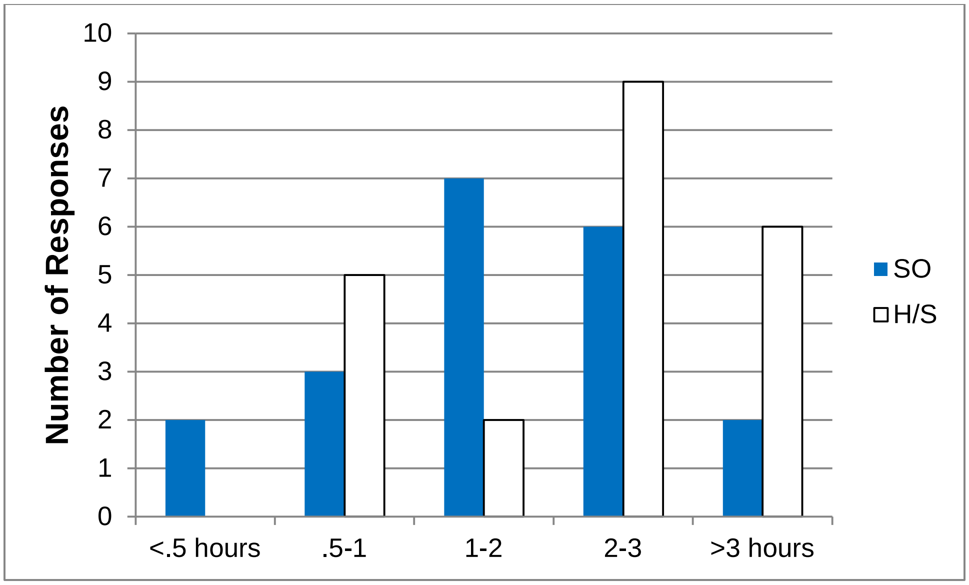

Figure 19: Distribution of responses to Q5: "On average, over the last 6 weeks, how much time did you spend driving as a portion of each 8-hour workday?"

3.3.3 What are the costs of savings or losses due to the cell phone filter/blocker implementation?

The main costs associated with implementing cell phone filter/blocker applications on cell phones across an organization are primarily associated with four aspects:

- The start-up and monitoring costs of the cell phone filter/blocker application;
- The initial education, training and installation;
- The continuous monitoring and maintenance of the software; and
- Productivity losses associated with blocking phone use while driving.

Any organization intent upon implementing cell phone filtering/blocking for their employees would have to meet a few criteria for the implementation to be successful.

First, they would have to be prepared (or already prepared) to supply phones to each employee who is intended to fall under the program. People would be likely to balk at requests to interfere with their personal phone, even if they often used it for business purposes and even if they saw potential benefits of having the cell phone filter/blocker application in place on their handset.

Second, they would have to have substantial buy-in and support from their upper management. It is difficult to assess the return on investment received when implementing cell phone filtering/blocking. Therefore the costs would have to be justified somehow, likely in terms of savings from increased driving safety (fewer driving accidents, fewer insurance claims, and fewer missed work days as a result of accidents). If an organization is not currently having problems with employees driving safely, the only tangible benefit may be good will from employees recognizing that the organization is sacrificing resources in the interest of their safety.

Third, they would need to have someone designated to manage the cell phone filtering/blocking program and enforce the policy. If an organization is already providing cell phones to some or all of its employees, it is likely (or probably necessary) to have an employee whose specific role is to manage the phone handsets and cell phone service accounts. In the event of the implementation of cell phone filtering/blocking across an organization, it is this employee who will see the most impact, and would likely be involved in the administration of the program.

3.3.3.1 Cost of the Application and Monitoring

It is unlikely that an organization would try to develop a cell phone/filtering blocking application internally; therefore the most basic cost of implementing across an organization would be the cost of the third party application. Additionally, while there is an initial cost for the software application, there is also a continuous cost in terms of a monthly (or yearly, or perhaps lifetime) monitoring fee.

With either of these costs, the marginal cost of adding one more phone or acquiring one more software license is likely small compared to the costs of providing an employee with a phone handset and cell phone service that is also associated with a continuous (generally monthly) cost.

Currently, according to its \Web site, obdEdge (designer of the custom Hardware/Software application) offers a commercial product, *Cellcontrol*, with the hardware module and the initial software package for $24.95 for a single phone (including the first month of monitoring) with a monthly monitoring subscription cost of $7.95. Illume (designer of the custom Software-Only application) currently charges a monthly fee of $2.95 or a yearly fee of $19.95 for a single phone for its commercial product, *iZup*. It is very important to note that these prices are for only a single phone, and are actually marketed more towards family use (a family package for monitoring five phones is advertised at a monthly fee of $5.95 or a yearly fee of $59.95). Both companies’ Web sites offer “enterprise” versions that would provide more administrative tools for larger fleets and would likely come at a much smaller marginal cost per installation than the cost advertised for installation on a single phone.

The actual cost of the application would likely be small in comparison to the other costs incurred as a result of implementing cell phone filtering/blocking across an organization.

3.3.3.2 Education

In order to gain the support of the entire organization, an education campaign outlining the risks associated with cell phone use and driving would aid implementation. This could take the form of large meetings or e-mails or posters around the workplace. Such campaign would not only help the individual employees (whose phones will be blocked) understand why this program is being implemented but also the supervisors who may later see tasks not being accomplished by employees who had previously accomplished them while driving.

If an educational campaign were not put in place before the organization made the policy choice to implement cell phone filter/blockers, employees might push back, making the implementation more difficult, which could increase other costs later.

Also, it would be beneficial to be clear that the organization is implementing this policy specifically and only to increase the safety of their employees and not to monitor or control the employees in their work environment. Many participants involved in this study, either seriously or in a joking manner, identified that they were somewhat uncomfortable with their device use being monitored so closely. Despite this, when it actually came time for the participants to choose whether or not to enroll in the study, they were likely to acknowledge that they had no reason to specifically resist the increased monitoring, as their phone use was already available to the administrator of their employer-provided phone account. Ultimately, it is in the best interest of a successful cell phone filter/blocker implementation if employees see the program as a benefit to them driven by a real concern for their safety, not as another way for the employer to monitor them on the job.

The cost of an educational campaign would be determined both by the costs associated with preparing materials and presentations as well as with any productivity losses incurred while employees are receiving this information. If the educational campaign is in the form of simple e-mails, these costs would be small. If the campaign is comprised of information sessions or "town-hall" type discussion-based meetings on the dangers of distracted driving, for example, these costs in terms of employee productivity would be larger.

3.3.3.3 Training

Any employee asked to submit to cell phone filtering/blocking to prevent phone use while driving would likely have to be trained in the operation of the cell phone filtering/blocking application. While little interaction with the software was necessary in this study, employees did need to learn how the application operated and what to expect when the software began actively blocking. This would likely be true of any cell phone filtering/blocking application at the very least.

If the implementation was on a large enough scale, information sessions could be held in which large numbers of employees could receive the training information at the same time. This would also likely improve their understanding as they would be learning about the applications at the same time as their peers. This would provide another avenue for learning and technical support for the employees as they would all be experiencing the same issues and operations and could help each other in understanding the functionality of the cell phone filtering/blocking application. This would likely also relieve some pressure on the organization's phone manager, as small issues with individuals' phones may be able to be resolved amongst their peers before going to the phone manager with questions.

Whether the training is done on a large scale or individually with employees, someone would, likely need to set-up and administer these sessions. They would have to be familiar with the software application and all phones across the organization on which it would be installed. Potentially, representatives from the software application provider could contribute here, but that is another cost to consider if it is not included in the purchase of the software applications and monitoring subscriptions.

Both custom software applications investigated in this study had very simple user-interfaces, and required almost no input from the participants throughout their participation. Other than the override feature, (which may or may not be provided in the case of organizational implementation), participants were not required to interact with the application at all. More complicated applications are conceivable where employees would be allowed specific functions in specific locations or allowed phone use only to contact certain entities. These more complicated applications would be associated with increased costs in terms of training the employees, especially if the policies were not the same across the organization and employees had to be trained individually.

The cost of training employees could be reduced by rolling this information in with the educational campaign. However, if the employees are not sold on the premise of filtering/blocking cell phone use while driving they may not buy-in to the training as they would if they truly saw benefit in the implementation of the program. Outside of reaching out to each employee involved, based on the experience with the two custom-designed cell phone filtering/blocking applications in this study, the cost of employee training would be relatively small.

3.3.3.4 Installation

The costs of the installation of cell phone filtering/blocking across an organization would depend on how the phones themselves are operated. In the case of MDOT, the employees' cell phones were controlled from a central server. In this case, the software applications could potentially be pushed out from the central server to the individual handsets. This method would avoid the need for an experienced installer to manually install on each phone handset, which would require physically traveling to each handset location. This may be trivial in the case of an organization operating from one or only a few locations, but in the case of MDOT (with employees spread across Michigan) this would entail substantial cost in travel time alone. Another option in this case would be to have the phone handsets sent back to a central location for installation; however this would mean that the employees would be without their phone for some period of time.

The easiest scenario (and likely cheapest) for implementing cell phone filtering/blocking software across an organization would be to have the software already installed when an employee is first provided with their work phone. If an organization is just beginning to provide cell phones to some or all of its employees, or if they are simply upgrading handsets the software would be installed during the initial phone set-up along with any other set-up steps that need to be taken to integrate the phone into the organization.

The costs of installing cell phone/filtering blocking applications on phones across an organization are primarily incurred in terms of either employee travel time, or time lost when an employee is without their phone. In the "easiest scenario" case above, this cost would be small as it is simply one more step in preparing the phone for deployment.

3.3.3.5 Monitoring and Maintenance

After considering the initial start-up costs of implementing cell phone filtering/blocking across and organization, the long term costs need be evaluated. These are primarily related to the monitoring of the software on each handset and occasional maintenance.

Although not necessarily true of all cell phone filtering/blocking applications, both custom applications investigated in this study used a "soft" method to prevent violations of the blocking. This means that any user can uninstall the software from their handset manually at any time. The way the "soft" method allows an organization to enforce their cell phone filtering/blocking policy is through the monitoring that occurs at the software provider level. Both custom software applications in this study reported back to the software providers' servers intermittently, and if a specific handset was not heard from for a pre-determined period of time, a "violation" was recorded and reported from the software provider to the administrator of the cell phone filtering/blocking policy, in this case UMTRI. In the case of an organization, at this point they can choose whatever steps they feel necessary to implore to the employee with the violated handset/software application to adhere to the organization's cell phone filtering/blocking policy (which must include the stipulation that employees are not to uninstall the cell phone filtering/blocking software off of their handset).

The difficulty arises when some employees simply do not use their phone or do not drive their equipped vehicle for longer than the "soft monitoring violation window" and a violation is generated despite no actual "violation" of the software occurring. In this case the employee's behavior would be investigated to determine if the phone has simply not been used or if the software was violated. Often it would be as simple as determining that the specific employee was on vacation or out of the office for some reason.

In addition to these violations, other maintenance problems will require the attention of at least the phone manager, depending on how much access individual employees have to technical support directly from the software application provider. Regardless of the level of support provided, it seems (and was the case in this study) that employees encountering problems will instinctively go to the phone manager first before going outside the organization for technical support. Also, whenever an employee receives new or replacement phone, some marginal set-up cost of installing the cell phone filtering/blocking software will be incurred.

While the custom cell phone filtering/blocking applications involved in this study both used a "soft" method for ensuring the integrity of the blocking policy on each phone, the potential for a "hard" method seems to exist. This would have its own costs associated different from the enforcement costs discussed above. A hard method would involve somehow locking out most phone users from uninstalling the application from the phone. Only an administrator could then make changes to the software application. This would also likely have to be in conjunction with a soft monitoring policy because it is likely than an employee could still defeat the hard security, and in the absence of the soft monitoring, the organization may never find out. Additionally, it is likely that any hard policy would also limit other occasional, legitimate or even necessary phone activities for the employees. When a work-around for this hard policy is necessary the administrator would then have to be contacted and spend their time dealing with each individual request.

The costs associated with the monitoring and maintenance of the cell phone filter/blocker applications after they have been deployed would mostly be in terms of the policy administrator's time and effort.

This administrator would have to be an employee with enough seniority (and organizational respect) to enforce the policy and also with enough time to separate legitimate violations of the software application from normal dead-periods in phone use. The actual amount of time required would be a factor of the general continuity of employees' driving and/or phone use behavior (resulting in more or less dead-period violations to investigate), and also on the cooperation of the employees with the software applications on their phones (resulting in more or less legitimate violations to investigate and remedy.)

3.3.3.6 Productivity Losses

This aspect of the cost of implementing cell phone filter/blocker technologies across an organization is especially difficult to estimate. Different factors involved were discussed in Section 3.1.5and Section 3.3 above in terms of the specific participants in this study and their experiences with one of the custom applications on their phones. Additionally in this section the productivity impact on other parties involved (education coordinator, phone manager, policy administrator, etc.) was discussed as any time spent dealing with the implementation of the cell phone filtering/blocking program would constitute lost productivity in another area of their jobs.

4. Conclusions

4.1 Phone Use Behavior

This section discusses the effect of cell phone filter/blockers on phone use behavior.

4.1.1 Speed at which participants placed outgoing calls

4.1.1.1 Zero-speed outgoing calls

For both application groups, proportionally more outgoing calls were initiated at zero-speed during the blocking period than in either of the monitoring periods. This may be a result of participants conscientiously making phone calls either before or after a trip.

In the case of the participants who received the Hardware/Software application, these zero-speed calls were made while in their vehicle, either at a stop light, in a parking lot or roadside just after stopping, or just at the end of a trip while still in the post-drive blocking latency period.

With participants who received the Software-Only application, these zero-speed calls could have been made anywhere.

In either case, the increase in the percentage of zero-speed calls is equivalent to a decrease in calls made at non-zero speed, which could be construed as a safety benefit.

4.1.1.2 Non-zero speed outgoing calls, speed at initiation of calls

For both application groups, non-zero speed, outgoing calls were initiated on average at lower speeds during the blocking period than in either of the monitoring periods. This may be a result of participants conscientiously making phone calls either on ramps or when moving slowly around intersections versus when driving at higher speeds.

Participants who received the Software-Only application had overall lower average speeds at the initiation of their non-zero speed outgoing calls than did participants who received the Hardware/Software application by over a factor of two. However, given the differences in the nature of the job requirements between the two groups, this result may be due to differences in travel patterns, such as road types used.

4.1.2 Unanswered Incoming Calls

For both application groups (based on the assumptions regarding unanswered calls), more incoming calls at non-zero speed went unanswered during the blocking period than during either of the monitoring periods. This would be expected as the blocking would prevent many of these calls from being answered. This constitutes a real effect of the software applications' blocking of phone use. While almost no incoming calls were missed during either of the monitoring periods for both software groups, during the blocking period, participants who received the Software-Only application had over a quarter (26.2%) of the incoming calls they received at non-zero speeds go unanswered while participants who received the Hardware/Software application had over half (50.7%) of the incoming calls they received at non-zero speeds go unanswered.

4.1.3 Speed at which participants sent SMS

Very few SMS were sent by either software group in this study at non-zero speeds. At non-zero speeds, only 9 SMS were sent by participants who received the Hardware Only application and 63 were sent by participants who received the Software-Only application.

Based on the data files regarding incoming SMS, while there were many for both groups, it is impossible to tell whether they were actually viewed by participants, therefore no analysis on incoming SMS is included in this report.

Also, because it is impossible to separate overrides while driving from overrides as a passenger, it is possible that these SMS sent during overrides were sent while the participant was riding in a vehicle.

The only marginally significant result relating to SMS found that during the blocking period, participants' non-zero speed, outgoing SMS were sent at a marginally lower speed than those sent during the first monitoring period. Similar to the lower speeds found at the initiation of outgoing calls during the blocking period, this could indicate participants self-regulated and made decisions to perform the override and send SMS in lower speed situations with the blocking enabled.

4.1.4 Call duration while driving

There were no significant differences in terms of the duration of either incoming or outgoing calls initiated at non-zero speeds for either of the software groups across the data collection periods. The amount of variability in the call durations made determining statistical differences impossible.

4.1.5 What is the effect of cell phone filter/blockers on driver performance? (subjective)

Only 5 out of 44 participants reported being involved in a near-crash while on a cell phone, with 2 of these reported incidents reported as occurring during the first 6 weeks of their study period.

When participants were specifically asked if they felt that they received a safety benefit from having the software application on their phone, responses were neutral, with participants who received the Hardware/Software application disagreeing more than those who received the Software-Only application. This result is somewhat surprising with the participants who received the Hardware/Software application driving more, it would seem that they would receive a larger potential safety benefit than participants for whom talking and driving was far less common in a normal workday.

4.1.6 Were there lasting effects?

While the experience with the cell phone filter/blocker technology may affect the participants' phone use while driving going forward, very few participants gave any indication of this, and in general thought that their participation in this study would not have any lasting effect. Additionally, when asked if they would like to have the software on their own phone going forward, most participants were strongly opposed to this.

Across all objective measures analyzed no evidence of any significant positive lasting effects were seen during the second monitoring phase.

4.2 Technical Performance and User Acceptance

4.2.1 What was the technical effectiveness/reliability of the cell phone filter/blockers?

In assessing the reliability of the customized applications, they must be considered separately. The custom Software-Only application worked consistently on 15 of 22 cell phones in the final data set, but had also problems on some cell phones that did not make it into the final data set. These problems were inconsistent across the phones as occasionally some phones would simply stop transmitting data back to the servers and would need to either be restarted on the handset or restarted from the application provider's server. Additionally, GPS data was sparse for some phones. Certainly some, but it is not clear how many, of these problems were specific to the modifications made to the application by the vendor in order to use the application as a research tool specifically for this study.

The custom Hardware/Software application had fewer issues related to implementing its use in the study, but with the discontinuous nature of the data files it was harder to spot instances where the application may have not been operating as intended. Participants could go days without being noted in a data file if they did no driving in their module equipped vehicle. However, no problems were reported with the hardware modules and no participants reported inconsistencies in the blocking feature.

4.2.2 How did drivers feel about the cell phone filter/blockers?

When asked what aspect of the filter/blocker application was their favorite, 15 out of 42 participants responded that they liked having fewer distractions while driving. Eighteen responded that they could find nothing to report as their favorite aspect about the custom software application.

When asked what was their least favorite aspect of the filter/blocker application, the most common response (from 11 participants) referred to the reduction in battery life experienced with the custom Software-Only application. Fourteen participants did not like the restrictions on calling and 5 cited a negative effect on productivity.

When asked what they would change about the custom filter/blocker applications to make them more beneficial to the participants, 9 responded that calling should not be blocked, and 7 stated in one way or another to "not have it" at all. The other most common suggestions were to improve the battery life and reduce the post-drive blocking latency. Six participants also suggested the override could be easier to perform.

Participants generally responded that the operation of the custom filter/blocker application was easy to understand. Participants who received the Software-Only application strongly agreed that both the applications effect on their battery life and the post-drive blocking latency were problems during their participation. Participants who received the custom Hardware/Software application disagreed slightly that either of these issues was a problem for them.

4.2.3 Did drivers “game” the system, and if so how?

The only indications of participants “gaming” the system were 2 participants’ responses in the questionnaire regarding use of their personal phone to receive incoming calls occasionally. In these cases participants reported giving their personal phone number out for specific instances in which they knew they would be driving to ensure that they would receive these specific work-related calls.

It was made very clear to participants that their participation in the study was optional, so there was little incentive for them to try to game or get around the blocking of their phones when they could simply withdraw from the study if the filtering/blocking became too much of a problem for them during the 3 week monitoring blocking period.

While many “tamper alerts” from the Software-Only provider and violations from the Hardware/Software provider were sent to the administrator account, these appear to be the result of downtime in the participants phone or vehicle use. However, this is an assumption, and some participants could have potentially interfered with the custom software in ways that were impossible to separate from these dead periods.

4.2.4 General Participant Opinions

Participants overall responded that they were in slight disagreement with the concept of their employer blocking cell phone use while driving. In terms of the specific, customized software applications that they had experienced, participants who had the Software-Only application were especially likely to disagree with the concept of their employer adopting the application for its employees. The more negative response to the Software-Only application is likely due, at least in part, to participants’ opinions regarding the reduction in battery life they experienced on their phone, but that appears to be an artifact of having modified the commercial product in order to use it as a research tool.

4.3 Organizational Impacts

4.3.1 What were the management opinions of the experience with implementing a cell phone filter/blocker system?

Managers’ opinions were split on both the impact they experienced from this specific study and their views of cell phone filtering/blocking in general. Of 7 managers, 3 reported negative productivity impacts as a result of blocking cell phones while driving, and 4 reported no productivity impact. Managers as a whole slightly agreed that the safety benefit received by employees justified any loss in productivity, and they also slightly agreed that, if up to them, they would block employee cell phone use while they were driving.

4.3.2 What was the effect of the cell phone filter/blockers on work productivity?

Participants who received the Software-Only application as a group performed 1.06 overrides per day during the data collection period. During each override, on average 1.53 phone operations were performed with the most common being checking e-mail.

Participants who received the Hardware/Software application as a group performed 1.22 overrides per day during the data collection period. During each override, on average 2.38 phone operations were performed with the most common being initiating outgoing calls.

Had the overrides not been allowed, all of these operations would have been delayed or missed. The impact on productivity is difficult to assess, and would depend significantly on the nature of work for each employee. But the potential exists for there to be a considerable negative impact on productivity, and would therefore need to be considered on a case-by-case employee/phone basis.

4.3.3 What are the costs of savings or losses due to cell phone filter/blocker implementation?

The costs of implementing cell phone filtering/blocking come from 4 areas.

- Acquisition and subscription costs of the application and any associated equipment
- Education, training and installation
- Maintenance and monitoring
- Effects on productivity

The marginal cost of acquiring cell phone filtering/blocking software is small compared to other potential costs. Education and training costs are onetime costs incurred at the inception of the cell phone filtering/blocking program. Training future employees on the operation of the application would have a small cost on-top of other new employee intake procedures. Maintenance and monitoring carry long-term costs that will continue as long as the program is in place. These costs will generally come in the form of increased workload on the employee charged with managing the organizations' phones, and on administrators forced to track down and deal with employee violations of the policy. Effects on productivity are especially hard to assess, but based on the feedback from participants in this study, these costs are likely the highest when implementing a cell phone filtering/blocking program across an organization, particularly without consideration for any given individual/phone need to be available at all times.

5. Lessons Learned

5.1 Organizational Buy-in

Implementing a program like this comes with costs in terms of start-up costs, maintenance costs and, in some cases, productivity losses from dealing with the implementation to not being able to conduct business normally done while driving. Unless the organization currently has a problem with employee phone use while driving causing added costs in the form of accidental damage or missed work days, the benefits of such programs are likely to be primarily preventive in nature. Because of this distinction, parties primarily concerned only with financial factors may not see immediate financial benefit to implementing such a program. The same could be true of managers who only see the losses in productivity. All stakeholders need to buy-in to a program like this to make it be successful.

5.2 Installation

The easiest solution for the installation (for most employees with the current technologies) is to have the software installed on the phones before they are distributed to the employees throughout the organization. Putting this type of software on employees' personal phones is really not an option therefore implementing a policy like this will likely entail providing phones to the employees.

With these technologies, if employees already have company phones, the installations would still have to be done with each individual handset (to configure the handset) even if the general software can be pushed out from a server, (although his may not be the case with future technologies.) Involving the software providers in this stage of the process is critical. People familiar with the blocking software will likely be much more adept at troubleshooting installation issues on the various phones across the organization. If the phones are older or uncommon, these problems will be more difficult to solve, and upgrading the phones may ultimately save money in the long term.

5.3 Battery Life

With any software that relies on the GPS tracking within the phone, there will be some increased drain on the battery. Illume, the Software-Only solution provider, is investigating ways to mitigate this problem. While these ideas can be implemented easily on newer phones, on older phones where the GPS's effect on battery life is the worst, the same suite of sensors is not available and may make these new solutions difficult or impossible to implement. Again, as stated above, the best way to implement a program like this is to provide new phones to the employees. These would be more capable of taking advantage of the advances in this realm of technology.

5.4 Passenger Versus Driver

One issue with both of the blocking applications in this study was the inability to determine whether a phone user was driving a vehicle at a speed above the pre-set threshold or was simply riding in such a vehicle. A method for understanding this distinction would be helpful in the analysis.

5.5 Override Difficulty

While not difficult for an experienced user, for users with little experience, performing the override while driving may have been difficult. Additionally, based on the concept of the study, to prevent driving distraction, using a visual-manual task for the override may be counterproductive. In general, the override procedure has the potential to resulted in even more distraction than had the filter/blocking application not been installed.

5.6 Personal Phones

Nearly all Americans adults have personal cell phones. If employers intend to block phone use on the phones provided by their organizations, thought needs to be given to how to handle employees' personal phone use. In this study, 2 participants reported using their personal phones for work business to get around the blocking. These work-arounds were not nefarious but simply done to allow the participants to do their jobs. Any organization that intends to block cell phone use on its phones will also have to determine how to manage employees' personal phone use while driving as well.

6. Considerations for Future Research

While this project served to investigate both the impact on employees and on an organization upon implementing a cell phone filtering/blocking program, there are other areas where more information could be collected in future studies on this topic.

6.1 Custom Applications

While both application providers were able to modify their commercial products to meet the necessary requirements for this study, improvements were possible.

6.1.1 Software-Only

The Software-Only solution primarily suffered from its extra needs in terms of power from the phone handset battery. Mostly this was due to the need to transmit phone use data continuously back to the server, an additional feature instituted for this study. As it was, participants overwhelmingly complained about the battery life, which may have clouded their opinions of the software application and cell blocking in general.

Determining a method to allow for continuous monitoring without significantly affecting the battery life would be key to collecting useful data. Just by using current phones (with better GPS, accelerometers, etc.), and the most advanced algorithm from the Software-Only provider, the technology currently exists to mostly solve this problem. However, when entering an organization with the intention of implementing a cell phone filtering/blocking program with the monitoring function enabled, it would be important not just that the phones were supported by the technology provider, but that they are current enough to be able to take advantage of the most recent, well-developed algorithms.

6.1.2 Hardware/Software

In the situations for which it was designed, the Hardware/Software solution worked well. Unfortunately, without constant monitoring of phone use, it is impossible to tell whether data was always being collected when it should have been. Additionally, it is difficult to assess the effect on participant phone use without knowing about their behaviors when not driving in their assigned vehicles. In future research it would be helpful to have a continuous picture of driver phone use, whether paired with the GPS data or not.

6.2 Overrides

Based on the nature of the work performed by participants and the fact that all participants would have personal phones, overrides of the blocking were allowed. While this provided insight into the impact of the blocking on each participant (as any activities during overrides would have been delayed had overrides not been permitted) it made it difficult to precisely determine the impact on the organization. If overrides were not provided, a true picture of the impact on the organization could be more accurately analyzed. This approach may be more appropriate for an organization trying to reduce or eliminate casual conversation while driving, but for an organization like MDOT, where employees perform many work related functions on the phone while in vehicles, organizational changes would have to accompany this experimental policy change. Employees or participants who had blocking software on their phones would have to work in advance to find work-arounds for instances when they could identify that they would be in a vehicle and unable to communicate through the phone. Additionally, the organization would have to refine expectations of productivity if they expect no work to be performed over the phone while driving.

6.3 Only Block Visual Manual Phone Tasks

Possibly the best concept for future research would be to only block visual manual tasks such as text messaging, viewing e-mail and application use. Providing employees with a hands-free device and voice dialing capabilities would help keep their eyes on the road while they would still be able conduct business, but e-mails and text messages would be held in a queue until the vehicle was stopped. This would also put them in compliance with many State and local regulations across the country.

6.4 Data Verification

In addition to continuous monitoring, it would also be valuable to have employee phone records with which to verify the data being collected. If the organization is already allowing phone use monitoring through the application, providing phone records does not seem especially onerous. This would provide a ground truth with which the accuracy and continuity of the data files could be independently assessed.

6.5 Passenger Versus Driver Log

Based on the data collected, there was no way to determine when a participant was driving versus riding in a moving vehicle. Tracking this through an application would always be difficult, therefore in order to assess the frequency of riding and driving, in the future it is recommended to ask drivers for some kind of log detailing at least the instances when they were passengers in moving vehicles. With this log, these instances could be separated from other at-speed behaviors that could then be definitively recorded as occurring while driving.

7. References

(1) Cosgrove, L., Chaudhary, N., & Reagan, I. (2011, July). *Four High-Visibility Enforcement Demonstration Waves in Connecticut and New York Reduce Hand-Held Phone Use*. (Traffic Safety Facts Research Note. Report No. DOT HS 811 845). Washington, DC: National Highway Traffic Safety Administration, Washington. Available at www.distraction.gov/download/research-pdf/508-research-note-dot-hs-811-845.pdf

(2) Distraction.gov. (n.d.). State laws. (Web page). Washington, DC: National Highway Traffic Safety Administration. Available at www.distraction.gov/content/get-the-facts/state-laws.html . Accessed June 1, 2012.

(3) Highway Loss Data Institute. (2010, September 28). Texting bans don't reduce crashes, effects are slight crash increases. (News Release). Arlington, VA: Author. Available at www.iihs.org/news/rss/pr092810.html

(4) National Highway Traffic Safety Administration (2010, April). *Overview of the National Highway Traffic Safety Administration's Driver Distraction Program*. (Report No. DOT HS 811 299). Washington, DC: Author. Available at www.nhtsa.gov/staticfiles/nti/distracted_driving/pdf/811299.pdf

(5) National Highway Traffic Safety Administration. (2011, December 8). *U.S. Transportation Secretary LaHood Announces Lowest Level of Annual Traffic Fatalities in More Than Six Decades.* (Press Release NHTSA 21-11). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/About+NHTSA/Press+Releases/2012/U.S.+Transportation+Secretary+LaHood+Announces+Lowest+Level+Of+Annual+Traffic+Fatalities+In+More+Than+Six+Decades

(6) Olson R. L., Hanowski, R. J., Hickman, J. S., & Bocanegra, J. (2009, September) *Driver Distraction in Commercial Vehicle Operations.* (Report No. FMCSA-RRR-09-042). Washington, DC: Federal Motor Carrier Safety Administration. Available at www.fmcsa.dot.gov/facts-research/research-technology/report/FMCSA-RRR-09-042.pdf

Acknowledgements:

Kim Lariviere and Ben Popoff at MDOT

Oren Kagan, Mark Thirman, and the Illume Software, Inc., support staff

Joe Breaux and the obdEdge, LLC, support staff

Dr. Shan Bao

Zac Costello and Len Schneewind

8. Appendix A: Application Provider Overview

The following is an overview of technological solutions commercially available at the time of this reporting to provide filtering/blocking of cellular phone use and text messaging by a driver while a vehicle is in motion. The summary addresses two general types of technologies, Software-Only and Hardware/Software combinations, that are the most prevalent approaches currently being implemented to filter/block cellular phone use by drivers. Individual technology providers are identified and evaluated for functionality and the cellular phone platforms currently supported.

As of this writing, the following filter/blocker applications were commercially available, and publically available details regarding their operation are provided. Potential filter/blocker applications were initially identified through a combination of those listed on the Federal Communications Commission Clearinghouse Web site, and Internet searches using key words and phrases found on other Web sites.

8.1 Software-Only Applications

DriveAssist, DriveAssist Guardian, and DriveAssistant. These three applications are products of Aegis Mobility, of Burnaby, British Columbia, Canada. It is stated that the products can be configured to filter/block voice calls, text, and data transmissions. They are available for larger-scale, corporate type deployments, but it are not currently available to individual consumers. When enabled, the applications block outgoing communications and applications once GPS velocity exceeds a predefined speed. Incoming calls are routed to voicemail, outgoing calls are not allowed (except for 911,which can be dialed at any time), and incoming text and e-mail messages are accessible when driving stops. Additional information can be found at www.aegismobility.com/.

Guardian Angel. Guardian Angel is a product of Trinity-Noble, LLC, of Doylestown, Pennsylvania. It currently offers a software-only application, but has a hardware/software product under development. The application locks the keys of a cell phone while a vehicle is traveling above a predefined speed. Only predefined phone numbers can be phoned or texted while the phone is deemed to be in motion. This product is currently only available for BlackBerry phones. Additional information can be found at: www.trinitynoble.com/index.html.

IZUP. IZUP is a product of Illume Software, Inc., of Newton, Massachusetts. Filtering/blocking includes voice calls, text, and data transmission. Logs of calls and associated data (GPS state, GPS velocity, time stamp, etc.) are transmitted from the host cell phone to a server. When enabled, the application blocks outgoing communications and applications once GPS velocity exceeds 5 mph. Up to three emergency numbers plus 911 are always allowed. The iZUP software is currently available through several cell phone carriers (Verizon, ATT, and Sprint) and is compatible with 65 devices. Additional information can be found at: www.getizup.com/.

PhonEnforcer. PhonEnforcer is a product of Turn Off the Cell Phone, LLC, that automatically turns off the cell phone when the user is driving. PhonEnforcer works on most GPS-enabled Blackberry, Android, and Windows phones. The purchasers select the features and criteria they want to implement, and as such can turn off their phones completely, allow hands free use, or include automatic restart of the application when the phones are no longer in motion. Emergency and white-listed numbers are also permissible, as specified by the purchaser. Additional information can be found at: http://turnoffthecellphone.com/.

TextArrest. TextArrest is a product of TextArrest, Inc., that is capable of disabling text messaging and calling capabilities while the phone is in motion. It also provides real-time information on phone usage and location. The application works on the following platforms: Droid Eris, Motorola Droid, Devour, Backflip, G1, MyTouch, Motorola CLIQ, HTC Hero, and Samsung Moment. By pressing an "emergency button" on the user interface, the phone's full functionality is accessible. Additional information can be found at www.TextArrest.com/.

TxtBlocker. The txtBlocker is a product of United Efficiency, Inc., of Lake Mary, Florida, that is capable of disabling text messaging and calling capabilities while the phone is in motion. The application can be used to limit or disable functions like texting in specific, predefined locations. It can also be used to locate a phone and monitor driving speed. The txtBlocker allows 911 calls and incoming or outgoing calls to other predefined numbers. The application works with a variety of phone platforms, including BlackBerries, HTC Aria, HTC myTouch Slide, HTC EVO, Droid Incredible, Samsung Captivate, Droid 2, Droid X, Motorola i1, Sanyo Zio, Samsung Intercept, Samsung Epic, and Samsung Vibrant. Additional information can be found at www.txtblocker.com/.

ZoomSafer. ZoomSafer, Inc., of Reston, Virginia, offers several products related to cell phone filtering/blocking. One, FleetSafer, uses one of three triggers (telematics, Bluetooth, or GPS) to detect when a phone is in motion. Another, TeenSafer, relies only on a Bluetooth signal from hardware installed in the vehicle's OBD port. The applications restrict inbound and outbound calls to predefined contacts and automatically reply to inbound texts, e-mails, and calls with personalized message. The application can also be used to track each time an equipped vehicle starts and stops driving. ZoomSafer only appears to support BlackBerries. Additional information can be found at http://zoomsafer.com/.

PhoneGuard. PhoneGuard is a product of PhoneGuard, Inc., of New York City. PhoneGuard uses GPS to determine the speed of the phone, and once a pre-set threshold is exceeded, phone use (including texting and application use) is blocked. From the Web site, it is unclear if calling (incoming or outgoing) can be blocked as well. Additional features offered by PhoneGuard include a Speed Violation alert, through which a message can be sent to the account administrator if the phone exceeds a pre-set speed. Also, through the GPS on the handset, PhoneGuard offers a service it calls "Geo-fencing." This feature will alert the administrator if the phone travels outside of a preset geographical area. Additional information can be found at http://phoneguard.com.

DriveSmart. DriveSmart is a product of Location Labs, Emeryville, California. DriveSmart can detect automatically when a phone user is driving based on a pre-set speed threshold and upon passing this threshold, sets the *phone* into a "Driving Mode". Once activated the service disables most texting and calling features and sends the incoming calls directly to voicemail while preventing access to text messages, except through applications specified by the customer. Also, an auto-response text message can be sent to the person who is trying to contact the driver, alerting them that the recipient is driving and unavailable to receive calls or messages. Drivesmart was specifically designed to work on Android smartphones on the T-Mobile network. While relying on GPS to determine vehicle speed, Android smartphones provide other data to DriveSmart that can be used to streamline this GPS tracking approach in order to conserve phone battery life. Additional information can be found at www.locationlabs.com/products/safe-driving/

CellSafety. CellSafety is a product of WebSafety, Inc., Irving, Texas. CellSafety can be set to block all phone activity (calling, text messaging, application use) when the phone exceeds 10 miles per hour. CellSafety is designed to be more than just a filter/blocker application and actually can look at the content of text messaging. Like other software-only applications CellSafety uses the phone GPS to detect when the phone is in a moving vehicle. Parents can actively check the location of the phone, and set up "no texting" zones where, based on GPS information, no texts can be sent or received (at school for example.)

8.2 Hardware/Software Combination Applications

Cellcontrol. Cellcontrol is a product of obdEdge, LLC, Baton Rouge, Louisiana. Cellcontrol uses a combination of hardware and software to block cell phone voice, text, and data communications while an equipped vehicle is in motion. The hardware component is a Bluetooth transmitter that mounts on the vehicle's OBDII. The cell phone that is to be filtered/blocked is loaded with an application that receives the vehicle speed signal from the transmitter and blocks communications once the vehicle is in motion; however, 911 calls are always allowed. Additional information can be found at www.cellcontrol.com/.

Key2SafeDriving. Key2SafeDriving is a product of Safe Driving Systems, LLC, of Salt Lake City, Utah. The application is activated when the car starts, and automatically disables the ability to send or receive calls or text messages from a cell phone with the associated software. The application also monitors, reports, and regulates mobile phone activity. Incoming calls go directly to voicemail, and incoming text messages are sent an automated reply indicating the recipient is driving and will respond later. Emergency call functionality is always enabled, allowing the person to place emergency 911 calls or calls to other predefined phone numbers. Key2SafeDriving can run on platforms including BlackBerry, Windows Mobile, and Nokia phones, and will soon be available on Android handsets. Additional information can be found at http://safedrivingsystems.com/.

Safe Phones 4u. Safe Phones 4u is a product of Device Control, located in the United Kingdom. This application is installed on a phone or other device (laptop, tablet, etc.) while a module is plugged into the OBDII. This module transmits the speed of the vehicle to the phone handset, which determines when the blocking will be active based on pre-sent conditions. A custom safety message can be set that drivers would see while the phone is blocked. Also, an override function is mentioned but the process is not defined. The application is customizable to allow calls to or from certain numbers (white list), or to allow calling at certain times of the day or week. Also available is a setting where only hands-free calls can be made. This works by requiring the driver to be using a Bluetooth headset device that is recognized by the software application. The application also has a "highway mode" feature, where based on certain conditions, the phone can be set to become fully functional when the driver is traveling exclusively on the highway.

8.3 Summary of Commercially Available Applications

In general, there are a relatively small number of commercial applications currently available for the explicit purpose of filtering/blocking cellular phone calls by drivers. Those that are available fall into one of the two technological approaches of software only and hardware/software combination. The Software-Only approach requires GPS enabled phones, and uses the GPS signal to determine in the phone is in motion. The Hardware/Software approach typically uses speed measures directly from the vehicle to determine the vehicle is in motion, and then sends a Bluetooth signal to block phone usage. Features offered by the individual vendors, and the customizability of any one product, make it difficult to make direct, side-by-side comparisons between products, and the selection of any particular product would seem to be heavily dependent on the intended use and preferences of the purchaser.

9. Appendix B: Recruitment Script

Participant Introduction Script

This project is funded by the Federal Government. They are interested in distracted driving, and they came to us and asked us to investigate some of the technology out there to block cell phone use while driving. The entire program lasts 9 weeks. For the first and last 3 weeks, the blocking software is not active. We will be collecting data so that we can get an idea of your normal phone use. During the middle 3 weeks, the blocking software will be active.

(Software-Only application)

During this time, whenever your phone realizes it is moving faster than 10 miles per hour, a screen will pop-up on your phone blocking all activity. Once the phone realizes it is not moving anymore, the blocking screen goes away and you can use your phone as normal again.

(Hardware/Software application)

During this time, if you are in your MDOT vehicle with the module installed, as soon as the vehicle starts moving a screen will pop-up on your phone blocking all activity. Once the phone realizes it is not moving anymore, the blocking screen goes away and you can use your phone as normal again.

During the blocking phase you will be provided with an override password that you can use to override the blocking software. While we discourage you using the blocking for casual conversation, it is ok to use the override in the event of necessary work related tasks.

The override lasts for 10 minutes (Software-Only application).

The override lasts for the duration of the trip (Hardware/Software application).

At the end of the blocking phase I will be sending you a link to an online questionnaire where you will be asked about your experience with the blocking software and about your opinions on the idea of cell phone blocking in general.

(Participant is then given the Informed Consent Document.)

This is an Informed Consent Document. Any time we do Human Subjects research at the University of Michigan we have all participants complete an informed consent to let you know what you're getting into. A couple main points I'd like to highlight:

During the monitoring phase, and throughout the entire data collection, we don't get the content of any of your interactions, and we don't get the phone numbers with which you may be interacting. We don't get the content or recipient of any e-mails or text message and we don't know who you're calling or who's calling you.

Also, no other MDOT employees know who is participating in this study. You are free to discuss your participation with your co-workers, but I will not be discussing your participation with anyone else at MDOT. If you should choose to withdraw, no one, including your supervisor, will find out.

And finally, your participation in this study is optional. I'd appreciate if you'd try the software today, but at any point if you'd like to withdraw you can contact me and no other MDOT employees will be aware that you withdrew. Would you be willing to participate?

10. Appendix C: Cell Phone Filtering/Blocking Field Test Post-experience Questionnaire

What is your phone number? ___________________

I am: (circle one)

MALE FEMALE

1) I am:

   20-35 years old 35-50 years old 50-70 years old

2) Which cell phone filtering/blocking software did you have installed on your phone?

   CellControl iZup

3) Do you regularly perform work functions using a cell phone during your commute to and from work?

   Yes
   No

4) Do you drive as part of your normal workday? (i.e. some driving at least 4 days/week)

   Yes
   No

5) On average, over the last 6 weeks, how much time did you spend driving as a portion of each 8-hour work day?

   (circle one)
   Less than a half hour
   Between a half hour and 1 hour
   Between 1 hour and 2 hours
   Between 2 hours and 3 hours
   More than 3 hours

6) What was your favorite aspect of the blocking technology and why?

7) What was your least favorite aspect of the blocking technology and why?

___

___

___

8) What would you change about the blocking technology in order to make it more beneficial to you?

___

___

___

9) How many times while you were driving, did you use the override function?

More than once a day
Once a day
Couple times per week
Once a week
Once or twice total
Never

10) About how many times while you were a passenger did you use the override function?

___

11) Were there specific situations you found yourself in repeatedly where you used the override function? If yes, can you explain…

___

___

___

___

12) Did you ever have an incoming call blocked that you wish you had received?

Yes

No

13) How often did you make a call as soon as you were done driving?

Every trip

Once a day

Couple times per week

Once a week

Once or twice total

Never

14) Have you ever been in a situation where using a cell phone while driving contributed to a crash or near-crash?

Yes
No

15) In the last 6 weeks were you ever in a situation where using a cell phone while driving contributed to a crash or near-crash?

Yes
No

16) I found the operation of the software easy to understand.

(circle a number between 1 and 7)

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

17) During the blocking phase when the software was active, I like that I get an indication that I am receiving an incoming call even though I cannot answer it.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

18) The software's effect on my battery life was not a problem during my participation.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

19) The lag time after I finished driving during which the blocking was still active was not a problem during my participation.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

20) I don't believe having the blocking software on my phone negatively affected my productivity as an MDOT employee.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

21) I find that since my experience with the cell phone blocking software, I use my phone less while driving in my personal vehicle than I did previously.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

22) I think having this blocking software on my phone increased my driving safety.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

23) I would like to have this software on my personal phone.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

24) I think MDOT blocking cell phone use while driving is a good idea.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

25) I think MDOT should adopt this software solution for all its employees.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

26) I think all cell phone use while driving should be prohibited by all drivers in the US.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

11. Appendix D: Management Questions (in addition to previous questionnaire questions)

A) Did you receive positive feedback from employees under your supervision regarding the cell phone filter/blocker technologies? If so can you elaborate briefly:

B) Did you receive complaints from employees under your supervision regarding the cell phone filter/blocker technologies? If so can you elaborate briefly:

C) Did you notice any impact on the productivity of your employees as a result of having this cell phone blocking/filtering technology? If so can you elaborate briefly:

D) If it was up to me to determine whether employees under my supervision would be prohibited from using the cell phone while driving, I would choose to prohibit all cell phone use while driving.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

E) I think that the safety benefit received by employees from prohibiting cell phone use while driving justifies any loss in productivity associated with such a policy.

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

12. Appendix E: Battery Life Readings with and without Custom Cell Phone/Filter Blocker Software Application Installed.

At the end of the study, participants were told that their participation was almost over, and they were asked to monitor their battery life for one full charge with the custom cell phone filter/blocker software still installed on their phone. The following e-mail was sent to all participants:

"Good Morning.
Thank you for your participation so far and for completing the questionnaire regarding your experience.

This week I will be uninstalling the software from your phone, but before I do, if possible, I would like you to track the *battery* life for 1 full charge.

Many of you have mentioned reduced *battery* life as a problem with the software. In order to report the actual reduction, ideally I will have you monitor the life (in hours) you get out of one charge with the software still installed, then later this week, after the software is removed, have you again monitor the life (in hours) you get from one charge so that the two can be compared.

If this isn't too much trouble, try to do this in your most common work environment (at your desk for example). Just e-mail me sometime with the hours of *battery* life that you get on one charge, and I'll be contacting you later this week to uninstall the software."

Unfortunately, with the study concluding around the Christmas holiday, and after most participants had been told that nothing more was required of them, feedback was sparse, with only 10 participants replying with a "before" battery life reading and 7 replying with a corresponding "after" battery life reading. All responses were from participants who had received the custom Software-Only application. Data from these reports is presented in Table 26 below.

Table 26: Battery life as reported by participant before and after cell phone filter/blocker software was uninstalled from the participants' phones

With Software-Only application installed	After Software-Only application uninstalled	Percent of uninstalled battery life
8 hrs	50 hrs	16%
3-4 hrs	1 day	15%
24 hrs	4 days	25%
11 hrs	No response	
9 hrs	No response	

With Software-Only application installed	After Software-Only application uninstalled	Percent of uninstalled battery life
7 -8 hrs	3 days +	10%
12-14 hrs	3 days	18%
10 hrs	1.5 days	28%
11-12 hrs	No response	
7-9 hrs	29 hrs	28%
Mean = 10.6 hrs (Std. Dev. = 5.4)	**Mean = 54.1 hrs** (Std. Dev. = 26.7)	20%

In Table 26 above, over all responding participants, with the custom software application installed, battery life was about 20 percent of what was reported after the custom software application was uninstalled. The large standard deviations in both the “before” and “after” reports illustrate the widely different experiences by each participant in terms of battery life. These large spreads could be due to many factors including:

- The location where the participants spends most of their time and the ease at which a GPS signal is available there.
- The amount of phone use, or even the amount of time the screen is on with no actual phone use.
- The strength of the battery itself, which, without the software, varied from one day to 4 days among the responses received.

It is possible or even likely that the participants who responded to this request were participants who had the worst experience with the reduction in battery life, and wanted to convey this to UMTRI researchers. Participants who noticed very little reduction in battery life may not have seen any purpose to fulfilling this request after they felt that they had completed their requirements for this study. Additionally, based on the wording of the request, participants may have interpreted it to be only directed at participants who had “mentioned reduced battery life as a problem with the software.”

Finally, while this information gives some legitimacy to participants’ complaints of reduced battery life (and their corresponding subjective responses to the question regarding reduced battery life) in large part this problem is due to the modifications made to the custom Software-Only application that allowed it to be used as a research tool for the purposes of this study and not applicable to the associated commercial product.

DOT HS 811 863
December 2013

U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

NHTSA
www.nhtsa.gov

9971-112913-v2