The Impact of in Vehicle Video Cameras on Unwanted Driver Behavior

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used language, ideas, expressions, or writings of another.

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Abstract

Between 1988 and 1997, 1,584 fatal accidents involving emergency vehicles occurred. (Becker, Zaloshnja, Levick, Li & Miller 2003) While this rate is relatively low given the high mileage and acute stresses many log behind the wheel, the need to avoid accidents and infractions is obviously tremendous. Toward this end many fire departments are equipping their fire apparatus with cameras that can be triggered to record the behavior and actions of the driver and vehicle occupants. Often referred to as drivecams (the Drivecam Corporation trade name for the device), these devices are meant to deter erratic behavior as repercussions for being recorded can be significant, e.g. resulting in loss of driving privileges.

Rural/Metro Fire Department (RMFD) in Knox County Tennessee installed Drivecams in all apparatus during fiscal year 2006-2007. The aim of this project is to investigate whether driver behavior has been impacted by the presence of these cameras, specifically to address whether employee driving actions are improved by the presence of cameras and also whether apparatus operators have modified their behavior since the introduction of the cameras.

After a process of evaluative and descriptive research, this examination indicates the clear ability of the drivecam to have a positive impact on unwanted behavior. The RMFD should continue to utilize this tool and the associated counseling and training activities of the Drivecams.

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Introduction

Undoubtedly, distracted drivers are more likely to be involved in a crash and also are at a greater risk of being hospitalized compared to attentive drivers (McEvoy et al. 2005). Although distraction is most easily defined as any act that takes away from a focus on driving, there are many root causes of distracted driving. Cell phone use is the most common culprit with the use of phones while driving associated with upwards of 2,600 deaths per year in the United States (Clayton, Helms & Simpson 2006). Driver injuries and fatalities are also associated with failure to use seatbelts. Unfortunately, emergency vehicle operators are no different with regards to distracted driving and lack of seatbelt use (Fahy, LeBlanc & Molis 2010). The need to guarantee the compliance and safety of emergency personnel is clearly great. The National Safety Council conducted an online survey of their 13,742 member companies. Fifty percent of these companies had either handheld or full cell phone bans while driving (Bello 2010). Clearly this demonstrates the desire of companies to limit this type of distracted driver.

As such agencies have installed dashboard mounted cameras to document in vehicle behavior and activities. This study examines the impact of these recording devices upon driver behavior; to assess whether camera presence reduces instances of distracted driving.

Seat belt use is a known entity in the prevention of fatalities and significant injuries (Fernandez et al. 2006). With fire apparatus this is no exception. In 2009, there were 82 fire service line of duty deaths. While this is the lowest since 1993, unfortunately many deaths occurred while responding to or returning from calls (Fahy et al. 2010). In 2009, 11 separate crashes accounted for the deaths of 14 firefighters, 6 of whom were not wearing seatbelts (Fahy et al. 2010). Seat belts are a designed restraint system that attempts to prevent or mitigate

injuries to the person. In various countries seatbelts are required, though implementing consistent use of these devices has seen a lack of success, especially in the United States.

The use of seat belts have increased as the technology of seatbelts has increased. New York in 1984 was the first state in the USA to require the use of seat belts. In 1983 the use of seatbelts in the USA was at around 17%, an incredibly low number considering the huge volume of vehicles fully equipped with these restraint systems, (and for how long they had been provided in vehicles, which is for literally decades) this has increased to 75% in 2002 (Houston and Richardson 2005). This is a huge increase but a still rather amazing percentage considering the injuries to a person whom does not wear a seat belt. As governments and safety agencies attempt to increase these numbers, not only in the United States but across the world, understanding the pattern of injuries associated with wearing and not wearing seatbelts, along with other factors that deal with seatbelt usage would be helpful to the policymaker and researcher.

Seatbelt use alone is not a sole guarantee for driver and occupant safety, the reduction of distractions to the driver must also be addressed. Though numerous distractions are known, several include reading, eating, and interacting with other passengers. However, at present, the use of cell phones by drivers is clearly problematic. The problem of distracted driving, especially in the form of cell phone usage has become such a problem in New York, that officials instituted a ban on handheld cell phone use while driving in November of 2001 (McCartt & Geary 2004). Moreover, given the inherent job related pressures of operating emergency services vehicles, the potential to add to that base level of distraction through phone use, navigation, and passenger interaction can have deadly consequences. As such, executives within emergency services organizations should seek out means to reduce the negative influences to drivers.

In March of 2007, Rural/Metro Fire Department (RMFD) installed a commercial video recording device in all of its fire apparatus. This device is known to the people in the field by its proprietary trade name, Drivecam. These were purchased from the drivecam company and their function is to record cab activities and forward view activities for 10 seconds prior and 10 seconds after the event that sets the camera off. To date, it has never been quantified if the presence of cameras have any impact on the behavior of drivers at Rural/Metro. The purpose of this research is to ascertain if these cameras are effective and to answer the questions of 1) whether drivecams change unwanted behavior of drivers, specifically in regards to distracted driving and seatbelt use, 2) whether interventions made by training and supervisors following observed poor behavior on drivecams change behavior, and 3) to what degree can they improve behaviors? A descriptive research method was used to answer part of this problem and in addition, an evaluative approach was used.

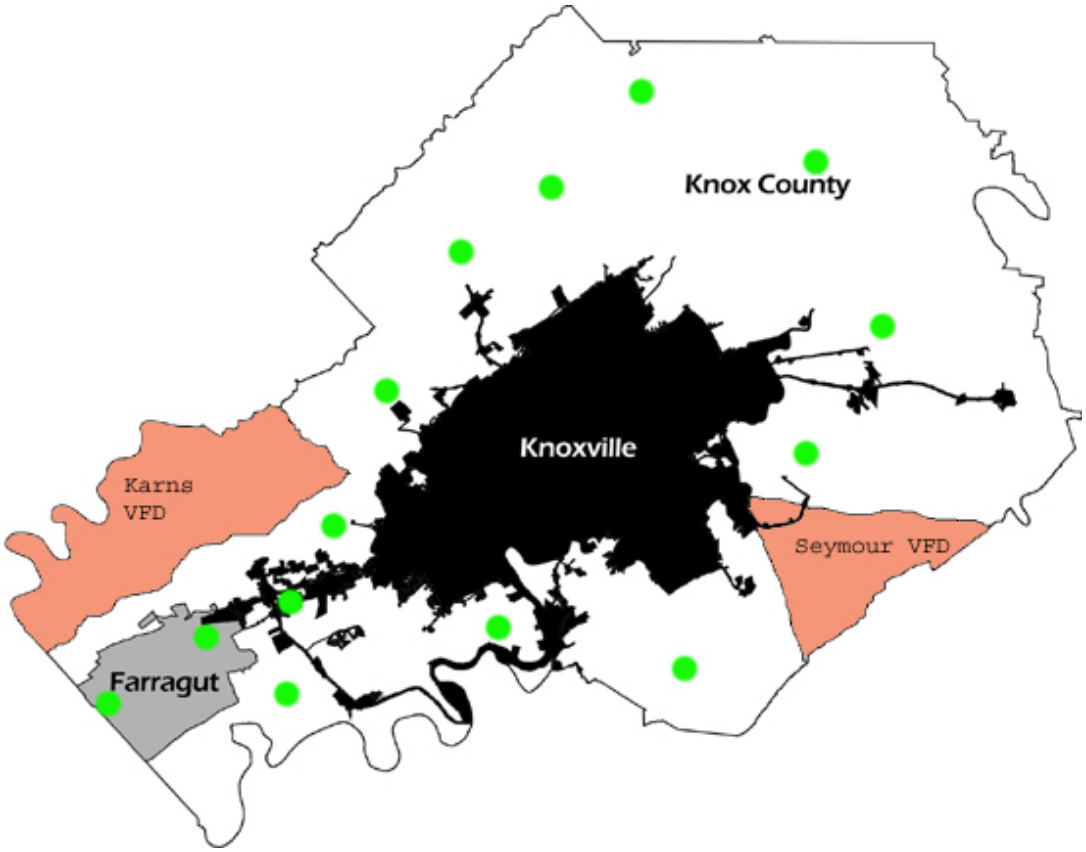
Background and Significance

Rural/Metro Fire Department was formed in 1978 through the separate absorption of 6 volunteer fire departments in Knox County Tennessee. Rural/Metro is unique in that it is a private fire department involved in community fire protection, and that it is subscription based. Today the East Tennessee operation provides fire service to the majority of people in Knox County and the Town of Farragut (see Figure 1). Rural/Metro Corporation was formed in 1948, in Scottsdale, Arizona where there is still a large presence (RMFD Almanac 2008). Today Rural/Metro has fire and other emergency operations in approximately 400 communities in the United States. One of the largest fire operations for Rural/Metro is located in East Tennessee.

Rural/Metro Fire Department protects 205,963 Knox County citizens across 273 square miles, making Rural/Metro, in terms of population protected, the third largest fire department in

Tennessee (colored white and gray in Figure 1). The population of the Town of Farragut is 20,083, the city of Knoxville is 183,546 and the unincorporated areas of Knox County include 220,245 citizens (RMFD Almanac 2008). The City of Knoxville, located centrally within Knox County is protected by the Knoxville Fire Department (marked in black on Figure 1). In

Figure 1: Fire Service Jurisdictions in Knox County Tennessee



addition, there are three volunteer fire department jurisdictions within Knox County. The Heiskell volunteer F.D. is a department that Rural/Metro responds with on every call within Heiskell and for the purpose of this estimate remains in the Rural/Metro population served category. There are also Karns and Seymour volunteer fire departments that operate in the northwest and southeast parts of the county respectively (colored orange in Figure 1). They

operate their own independent response areas with a protected population of approximately 34,365 citizens.

Rural/Metro Fire Department is divided into four operational battalions and several support divisions with a total of 14 fire stations (designated by green dots in Figure 1). The four fire battalions are Battalion One, which covers the west end of Knox County, including the Cedar Bluff, Rocky Hill, Bluegrass areas, and is protected by four fire stations. Battalion Two covers the east end of Knox County, including the Forks of the River, Carter, Mascot and South Knox County comprised of four fire stations. Battalion Three is located in north Knox County and includes the Halls, Powell, Gibbs and Corryton communities with four fire stations. Battalion Four protects the Town of Farragut (RMFD Almanac 2008) and includes two fire stations. Each Battalion is managed by a Battalion Chief who also supervises the captains and lieutenants within the battalions who are responsible for the career and reserve firefighters respectively. One Battalion Chief is tasked with supervising the fleet maintenance division and the training division. The Fire Chief and Division Chief supervise the Battalion Chiefs and the administrative division of the department.

In March of 2007, Rural/Metro in a corporate wide decision, installed recording devices in the cab areas of all ambulances and fire apparatus (see Appendix A). In addition, all staff & fleet vehicles were also outfitted with such devices. Cameras record video of the driver and occupants in the cab of the designated apparatus, and also shoot video forward outside the cab of the apparatus. The Company that produces these recording devices and associated interpretive software is Drivecam-Corporation. The video recorders are commonly known as “drivecams” throughout the fire department, and herein will be referred to as Drivecams. Significant changes in forward or lateral forces and shock forces can trigger the camera to begin recording. A red

light illuminates and indicates the unit is recording. Each recording consists of a total film time of 20 seconds, both 10 seconds before and after the occurrence of the event that activated the camera. Each individual device is capable of storing up to 20 recordings which are then downloaded to a dedicated laptop for assessment (See Appendix B). Video footage is reviewed by the Battalion One Chief at scheduled intervals (fewer were analyzed in 2009 due to leave because of injury). Downloaded videos are analyzed using the proprietary Drivecam software which allows categorization and grading of each event. In the event of the observation of unwanted occupant behavior, the supervising Battalion Chief is notified and provided with the video footage. The employee is counseled regarding the unwanted behavior. These interventions may consist of simple coaching for improved actions, remedial training, revocation of driving privileges, or termination; dictated primarily by the severity of the incident.

Given the costs involved with the installation and maintenance of the Drivecams, coupled with the time dedicated to review and analysis of the footage, knowledge of whether Drivecams are effective prevention tools is important for the RMFD and fire departments nationwide. To date, a large collection of videos has been both downloaded and subjected to follow-up and review. However an assessment of the influence of camera presence on vehicle operators has not yet been conducted. Such an examination falls within the parameters of the National Fire Academy (NFA) Executive Development course as it promotes the practice of high quality research that can positively impact the fire service.

Literature Review

Undoubtedly, the consequences of distracted driving can be deadly. Previous studies have focused upon two relevant areas; seatbelt research and distracted driving (see for example McCartt and Northrup 2003 & McEvoy et al. 2005). McEvoy, Stevenson and Woodward

(2006) demonstrate that distracted drivers can result from a lack of basic concentration, adjustment of in vehicle equipment, interactions with passengers and those outside the vehicle, and from other objects or events. Also as Clayton and colleagues (2006) note, cell phone usage is also a foremost cause of distracted driving. Given the injury risk from a crash, the use of a cell phone 10 minutes before a crash increases the likelihood of that crash being associated with cell phone use (McEvoy et al. 2005). However, people continue to take that risk and become distracted. In one particular study, McEvoy and coworkers (2006) found that drivers are distracted 14.5 percent of the time they are behind the wheel. It is important to note that McEvoy et al. (2005) also state there is no advantage to using hands free devices for cell phones; that all who use phones are four times more likely to crash a vehicle and require medical treatment (McEvoy et al. 2005).

The work of Clayton et al. (2006) examining the use of active prompting as a tool to assist in getting drivers to suspend cell phone use and to wear seat belts found this to be an effective way of accomplishing this. The active prompting consists of immediate reminders of these desirable behaviors through prominent signage displayed for workers exiting the parking lot. The percentage of compliant drivers was high (Clayton et al. 2006). In comparison, laws such as those enacted in the State of New York, banning cell phone use have been found to initially be successful in decreasing phone use but over time compliance has been observed to decrease (McCartt and Geary 2004).

The review of research work done into the arena of seat belts for the purposes of this paper are broken down into two main, but quite easily cross-referenced areas. These two areas include injuries dealing with seat belts and overall seat belt use. Injuries can be sustained from seatbelt use if the device is not used properly. Clinically referred to as “seatbelt syndrome”, this

can result from lap belt malfunction or the inappropriate placement of the strap across the body. Lap belts can cause even more trauma, most commonly affecting the abdominal cavity (Smith and Hall 2005). Chest cavity injuries, such as rib and sternal fractures have been associated with seat belts. These injuries may be linked to lung herniation and pericardial rupture (Benckert et al. 2007). In addition, bone fractures can easily cause secondary injuries to associated, or adjacent soft tissue and blood vessels. Similarly, aortic ruptures and cardiac events have been associated with seatbelt use during a motor vehicle collision. Likewise thoracic cavity injuries and pelvic injuries can be attributed to direct impacts from the seatbelt during a motor vehicle collision (Smith & Hall 2005). When there is sudden deceleration to the body, (which happens when a seat belt restrains someone, and there can be injuries to bones and less flexible blood vessels like the aorta. While direct injury to the carotid artery (in the neck) is rare, it does happen and requires immediate intervention and diagnosis (Pugh & Taylor 2005).

There are also design issues with seat belts occasionally causing injury. For example the Ford Explorer was found to cause a higher likelihood of head contact with the roof in a rollover due to the seat belt allowing a vertical movement of the occupant in a vertical motion (Bidez, Cochran, King & Burke 2007). This could lead to possible spinal injuries when there is compression of the head and neck. Ongoing investigations continue to address the design of all types of restraint and safety features on vehicles, including seatbelts. Nonetheless, the advantages to seat belt use are tremendous which is a commonly held perspective supported by research (Guo, Eskridge, Christensen, Qu & Safranek 2007). Malara, Malara and Drugacz (2006), noted that while maxillofacial injuries to the teeth, soft tissues, and skeletal elements, are commonly seen in motor vehicle crashes a 25% decrease was noted in the occurrence of these types of injuries with seat belt use. However, Inaba, Sharkey, Stephen, Redelmeir and

Brenneman (2004) concluded there are increases in the amount of pelvic injuries in motor vehicle crashes regardless of the frequency of seatbelt usage.

Vehicle occupants are exposed to public messages to wear seatbelts, such as the “click it or ticket” campaign. The use of seatbelts in films has also been examined. In a review of the top grossing movies distributed between 1978 and 1998 there was a massive discrepancy between the actual use of seat belts in the United States compared to the use of them in the movies. An almost three fold difference was found with less than 30% usage in the movies compared to 75% usage by actual occupants (Jacobsen, Kreuter, Luke & Caburnay 2001).

The enforcement of seat belt laws falls into 2 categories: primary and secondary enforcement of seat belt laws. Secondary enforcement involves law enforcement personnel writing a citation for failure to use seat belts only when the vehicle is stopped for another traffic violation. Primary laws, refer to law enforcement officers being able to stop a vehicle because seat belts are not in use by occupants. Clearly, as Fernandez and colleagues (2006) found, the latter is a more effective deterrent than secondary enforcement in getting people to wear seat belts. However, in many areas across the United States there is a greater emphasis on secondary enforcement then on primary enforcement. The imposition of fines is also a factor as there is also some information that the amount of the fine also has an impact on behavior. According to Houston and Richardson (2005), there is a direct correlation between fees and seat belt use, with communities that have larger fines demonstrating a higher the rate of seat belt use.

The literature review is important and has an impact on this research due to some important and relevant findings. The finding that seat belt use, while important and crucial is not the sum of safety and injury prevention. In fact, findings show that seatbelts can and will occasionally cause injury. What this impacts and highlights is the need for not only the obvious

compliance with seat belt usage, but the goal to avoid a crash in the first place. This seems obvious, but the question is how best to do that. This is where the literature review demonstrates that the distracted driver becomes an important way to avoid a crash in the first place. The literature review blends well with the installation of the drivecams in RMFD vehicles, and points to a need to find out answers to the research questions. In particular the survey is tailored to deal with the various ways that the literature review has findings that do not seem to mesh well on enforcement and compliance. In RMFD's case, the research looks to clarify the why drivers and occupants change their unwanted behavior, in addition to answering the basic question of do the drivecam videos work in changing behavior.

Procedures

To effectively investigate the effectiveness of dashboard mounted cameras in fire apparatus, evaluative and descriptive research, consisting of the administration of a questionnaire and an analysis of video footage, was performed. A total of 68 surveys were reviewed and 2262 films were assessed in this study.

Questionnaire

A survey instrument was developed to provide an impression of past and current behavior of fire apparatus operators and to investigate whether and how the presence of Drivecams impacted driver behavior. An 11 question survey using a modified Likert Scale (always, often, sometimes, rarely, never) was used. In addition three open ended questions inquired of an individuals training and experience as a driver. A copy of the survey is provided in Appendix C. The survey was distributed to all full-time and part-time apparatus drivers of Rural Metro Fire Department who attended any of six training drills held during the month of July, 2010. Seventy-one apparatus drivers submitted the survey with four eliminated due to incomplete

responses. The survey was designed to elicit information in several categories: driver experience, behaviors used while driving ones personal vehicle, behaviors used while driving company vehicles, and driver awareness of the presence of Drivecams.

Specifically respondents were asked about the number of years they had been certified drivers, whether they had activated the Drivecam, and how many times they had been recorded. In addition, employees were questioned about their use of cell phones and seatbelts while driving. Inquires were made as to the use of these devices across the length of their career and since the installation of the cameras. Further, they were asked about these behaviors while operating their own vehicles. Additional questions addressed the attitudes and activity of the drivers towards the Drivecams; whether drivers were aware of the presence of the cameras and whether they have, or do, modify their actions because of the existence of the Drivecams. The goal of this survey is to answer the question of if Drivecams impact the behaviors of apparatus drivers and occupants at Rural Metro Fire Department, and if so, to what extent are they responsible for reducing unwanted behaviors. Responses at each level of the scale will be tallied and percentages for each choice will be calculated to facilitate interpretation of the potential impact of the Drivecams upon employee behavior.

Video recordings

The evaluative research component consisted of the examination of Drivecam videos captured during the time period beginning (at installation) March 3, 2007 through March 23, 2010. A raw number of 3337 videos were recorded by the system. Following initial review, six hundred and seventy-five films were discarded because they were not relevant to this project as they were activated and recorded due to hardware error or other non-driving activities such as raising the cab of the apparatus during vehicle checks. A total of 2662 Drivecam videos, each of

20 second duration, were used in this study. This is the maximum recordable length for Drivecam video. Video footage was initially reviewed by the author during the three year period. Footage was grouped based on the calendar year during which the videos were recorded. For the last three quarters of 2007 (following installation in March) a total of 988 films were reviewed, 953 videos were captured in 2008 and 451 in 2009. Through the first quarter of 2010, 270 Drivecam videos were recorded. The lesser amount reviewed during 2009 is due in part to the Battalion Chief being on injury leave.

Each segment of film was reviewed for cause of Drivecam activation using the proprietary software provided by the camera manufacturer. A representation of two still images from video recordings and the application of the evaluative process using the provided software can be found in Appendix B. Following identification of the driver, the initial stage of assessment seeks to discern the cause that triggered camera activation; known as event trigger. The software menu for coding the event trigger allows seven selections. These include: not specified, hard cornering, hard breaking, hard acceleration, collision, rough/uneven surface, and other. The software operator can then identify an outcome such as no collision, or collision.

The subsequent stage of assessment involves the identification of any and all root causes of the event. This categorization is based on the recognition of any observable company policy violations by the driver or occupants; focusing primarily upon the actions of the operator. Twelve options are available for the reviewer which consist of overall influences such as distractions or poor awareness and are self explanatory. Specifically the menu provided causes are cell phone, mapping/navigation, other work task, food/drink, passenger, and other (see Appendix B). Additional root causes include not looking far ahead, blank stare, not scanning roadway, not scanning intersection, mirrors not checked, blind areas not checked.

The reviewer can then identify any risky actions practiced by the occupants. Divided into two main categories of seat belt use and basic driving fundamentals, the reviewer codes the film for failure to use a seatbelt by the driver or passengers and then also tallies instances of any of six driving violations. These include following too close, traffic law violation, operating at an unsafe speed, failure to maintain a means of egress in traffic, poor lane selection, and driving in the blind area of other drivers. The reviewer can also note any adverse weather, road or traffic conditions. In addition, reviewers can customize portions of the software to assess the occurrence of other events and infractions. Complete assessment of a video clip includes the production of an event score which is a weighted representation of the severity of the observed behaviors and infractions. Following a review of a batch of footage, queries can be run to investigate the frequency of incident occurrence within any of the major categories. Graphic representation of these investigations is limited to illustrations of the six most frequently observed behaviors.

Following assessment of the 2662 videos, several queries were run. The films were batched by year and were first assessed for the total number of instances of failure to wear a seatbelt by the driver and/or passenger; the software does not make a distinction between driver and passenger when generating statistics. Subsequently queries were run for the total number of episodes of distracted driving per year. Finally, the specific root causes of these distractions were tallied for each year.

The collection of these data will enable investigation of whether, and if so, how Drivecams are useful as a tool to change unwanted behavior by emergency vehicle drivers and occupants. While the 20 second footage limits a complete assessment of the situation, combined with the fact that certain unwanted behaviors can occur without resulting in camera activation,

this examination will still enable a thorough review of the impacts of dashboard mounted cameras.

Results

A review of the 2,662 Drivecam recorded videos demonstrated several trends with respect to distracted driving across the period from March 2007 to March 2010 (see Table 1). In addition, root causes of distracted driving were determined for each year based on review of apparatus operator behavior and are presented in Figures 2- 5 (generated using Drivecam Corporation software). In addition, the assessment of 67 questionnaires yielded information regarding driver behaviors (See Table 2).

Table 1: Overall Drivecam results for the period March 2007 through March 2010

Year	Total Drivecams	Distracted Driver counts	Percentage of total Drivecams	Seatbelts not in place counts	Percentage of total Drivecams
2007	988	60	6%	112	11%
2008	953	25	3%	16	2%
2009	451	6	1%	5	1%
2010	270	1	0.3%	3	1%
Full period	2662	92	3.4%	136	5.1%

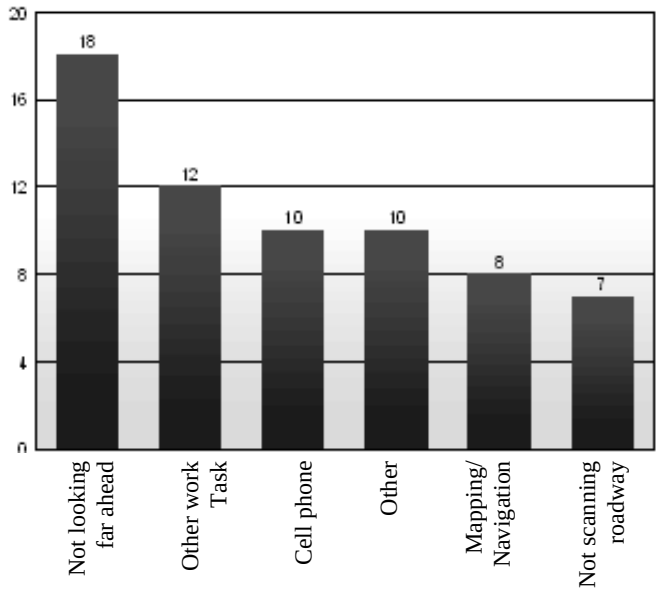
Table 1 illustrates the overall observations made during review of the Drivecam video footage. The total number of Drivecam videos varies across the years due in part, to a reduction in the number of driver actions that activated the recording devices. Throughout the three and a half year period, a decrease in the frequency of unwanted behaviors is apparent. Specifically, a continuous decline in the percentage of incidents of distracted driving is apparent with a high

occurrence of 6% in 2007 decreasing to 3%, 1% and 0.3%, respectively through time to the present year (data from 2010 cover the first quarter while the data from 2007 cover the last three quarters of the respective calendar years). The greatest shift occurs between 2007 and 2008. Similarly, with respect to non-compliance of mandatory seat belt use, these data demonstrate a trend towards fewer incidents across the years under review. In 2007, 11% of collected Drivecam videos were found to display lack of seat belt use with only 2% of the 2008 videos illustrating this behavior. Throughout both 2009 and the first quarter of 2010, only 1% of Drivecam videos exhibit incidents of failure to properly use seatbelts.

Root Causes of Distracted Driving

A review of the 60 separate incidents of distracted driving observed during 2007 (see Table 1) indicates several root causes for these unwanted behaviors. As illustrated in Figure 2, observations demonstrate that during 2007 distracted driving was associated with six causes: not looking far enough ahead (27%), engaging in other tasks (18%), cell phone use (15%),

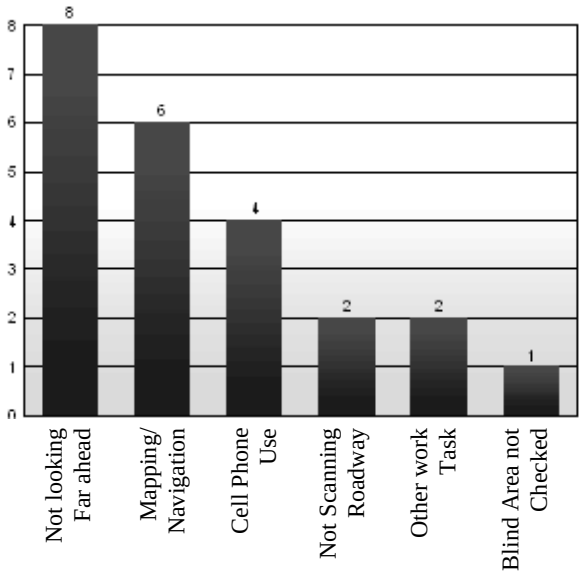
Figure 2: Root causes of distracted driving during the period March through December 2007.



navigation efforts (12%) and not scanning the roadway (10%). The ten incidents categorized as other (15%), may include distractions such as eating or tobacco use. In total, Figure 1 provides 65 root causes to account for the 60 observations of distracted behavior thereby indicating that at least one individual (likely several) was influenced by multiple root causes.

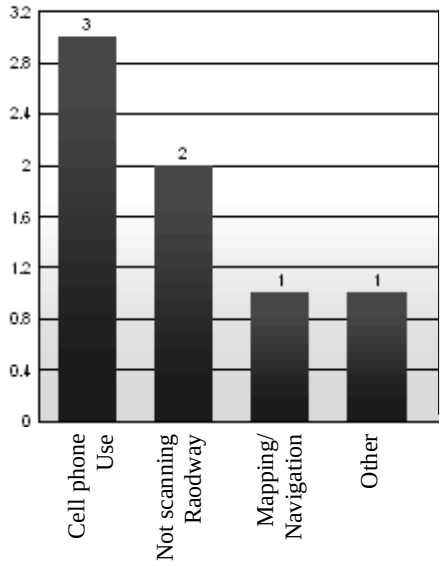
During the calendar year 2008, 25 separate incidents of distracted behavior were recorded. Drivecam observations indicate distracted driving was associated with eight root causes (illustration of only highest scoring 6 is a constraint of the software). See Figure 3. Not looking far enough ahead caused 32% of the distractions while navigation efforts accounted for 24% of the behaviors and 16% of the distractions resulted from cell phone use. A failure to scan the roadway and engaging in other work tasks both accounted for 8% of the distractions with 4% each of the distractions caused by the behavior of other passengers, not checking blind areas and engaging in other activities, respectively.

Figure 3: Root causes of distracted driving during 2008.



A review of the six incidents of distracted driving observed during 2009 (see Table 1) indicates several root causes for these unwanted behaviors. As illustrated in Figure 4, observations demonstrate distracted driving was linked to four causes. Cell phone use accounted for 50% of the distractions, with the failure to scan the roadway responsible for 33% of distractions and both navigation and other distractions accounting for 16% of distractions, respectively. Seven root causes account for six observations of distracted behavior thereby indicating that one individual was influenced by multiple root causes.

Figure 4: Root causes of distracted driving during 2009.

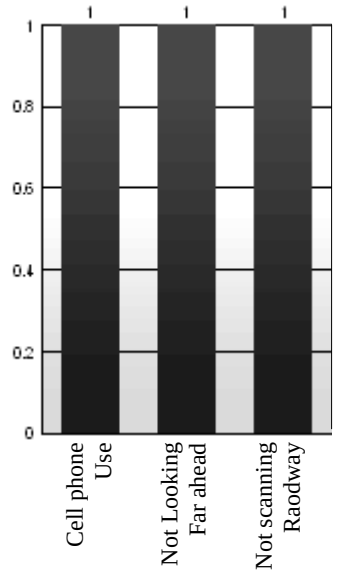


A single case of a driver being distracted was observed during the first quarter of 2010. A review of the film indicates this individual was influenced by multiple root causes (see Figure 5) including cell phone use, not looking ahead and failure to thoroughly scan the roadway.

Apparatus Operator Questionnaire

Survey responses are illustrated in Table 2. See Appendix A for a copy of the survey. These data indicate both influences and trends regarding behavior and the influence of the

Figure 5: Root causes of distracted driving during 2010.



Drivecam as a potential deterrent for unwanted behavior. All survey respondents (68 participants) were asked to report the number of years they had served as a qualified fire apparatus driver. The maximum length of experience was 27 years with a minimum of less than one year. The average number of years of driving experience is ten years with a median of nine to ten years of driving experience. Of respondents, 56 reported that the Drivecam had activated while they were operating a piece of fire equipment. Of these drivers, the majority were unable to accurately state the number of instances the camera had recorded them. As such, that specific information was removed from further consideration.

Seatbelt use was the focus of the first three questions (see Table 2 Q1, Q2, and Q3). Participants were asked about use of seatbelts while driving their personal vehicle (Q1), while a passenger in a fire truck (Q2), and while operating a fire truck (Q3). The results demonstrate a

Table 2: Counts and Percentages of Responses by Question for 68 survey participants.

	always	often	sometimes	rarely	never	Total
Question (Q)1	51 (75%)	9 (13%)	4 (6%)	2 (3%)	2 (3%)	68
Q2	42 (62%)	22 (32%)	4 (6%)	0	0	68
Q3	55 (81%)	10 (15%)	2 (3%)	0	1 (1%)	68
Q4	0	3 (4%)	14 (20%)	25 (37%)	26 (38%)	68
Q5	15 (22%)	14 (20%)	20 (29%)	13 (14%)	6 (9%)	68
Q6	10 (15%)	10 (15%)	12 (18%)	21 (30%)	15 (22%)	68
Q7	5 (8%)	10 (15%)	9 (13%)	32 (47%)	12 (18%)	68
Q8	6 (9%)	11 (16%)	2 (3%)	7 (10%)	42 (62%)	68
Q9	18 (26%)	12 (18%)	7 (10%)	4 (6%)	27 (40%)	68
Q10	8 (11%)	7 (10%)	14 (20%)	14 (20%)	25 (37%)	68
Q11	10 (15%)	0	7 (10%)	12 (18%)	39 (57%)	68

high level of respondents who *always* wear their seatbelt while operating their own car (75% of respondents) and a higher level of those who profess to *always* wear a seatbelt when driving fire apparatus (81% of respondents). Noticeably fewer *always* wear their seatbelt while a passenger in a fire truck (62%). The inquiries addressed career long behaviors with a disturbing single individual who admits to never wearing a seatbelt.

Cell phone use was the focus of Q4 with no respondents admitting to *always* using a cell phone while driving fire apparatus. The highest percentage of respondents (38%) state they

never talk on the phone while driving while 37% state they *rarely* do and 20% state they *sometimes* talk on the phone while driving.

Participants were asked about the presence of the Drivecam through three questions: Q5, Q6, and Q7. Most respondents indicated an awareness of the Drivecams being in the vehicles with 22% stating they *always* think about the presence of the Drivecam, 20% *often* do and 29% *sometimes* do while they are driving. With respect to concern about behaviors being recorded (Q6), the majority of respondents *rarely* (30%) and *never* (22%) think about their actions being recorded on the Drivecam. Nonetheless, many drivers, *always* (15%), and *often* (15%), are concerned about the Drivecams recording their behaviors. However, nearly half of all participants (47%) noted (Q7) that they *rarely* are concerned that their actions may trigger or activate the Drivecam recorder.

The final group of questions (Q8-Q11) inquired about driver behaviors following the installation of Drivecams. The overwhelming majority (62%) claim that the presence of the Drivecam has not (*never*) impacted their behavior with regard to wearing a seatbelt, with an additional 10% claiming it *rarely* influenced their actions. However, a review of the data indicates that the presence of the Drivecam has *often* (16%) brought about a shift in driver behavior. The use of cell phones following the installation of the Drivecams was assessed in Q9. Twenty-seven (40%) participants claim the Drivecam has *never* impacted their use of the phone while 18 drivers (26%) responded that they *always* changed their habits as a result of the cameras.

The last two questions focused on behavior after an employee had been recorded. Specifically, Q10 addresses the impact of actually being recorded on driver behavior while and Q11 seeks to know about the impact of supervisor intervention upon driver behavior. Twenty

five subjects (37%) stated that they *never* changed behaviors after being recorded with 20% claiming that they *rarely* changed behaviors. Overall, 41% claim that at some level being recorded had an impact on their behavior. However, 57% claim that supervisor intervention following a Drivecam recording *never* caused them to change their behaviors, while 25% stated that on some level intervention by a supervisor had an impact on behavior change.

Discussion

The results of this study indicate that the installation and use of the Drivecam equipment in the Rural/Metro Fire Department vehicles has had a positive impact in the reduction of unwanted behavior. The decrease in the number of instances of unwanted behavior, such as talking on a cell phone, demonstrates that the Drivecams have had a positive impact by limiting and reducing the number of instances of unwanted behavior in personnel, both drivers and passengers. The positive presence of the Drivecams is further demonstrated by the significant drop in recorded episodes of driver distraction and seat belt non-compliance from 2007 through the first quarter of 2010. While the current mechanism of observing the behaviors in vehicle is potentially biased as this study is limited only to those that are recorded, and hence potentially involves some level of driver error, it is appreciated that the trend is reflective of the department as a whole and in the overall reduction of unwanted behaviors. Similarly, while society in general also frowns upon these types of behavior, the overall survey results of firefighters within the RMFD have demonstrated that the Drivecams have had the desired impact in changing behavior. The outcome of this examination indicates that the time and expense to install and maintain the Drivecams at RMFD has been well supported, but can also be used to inform other fire departments and emergency service providers who are looking to lower the levels of their distracted drivers, along with their personnel who do not wear a seat belt.

As demonstrated by this study, in 2007 when Drivecams were installed in RMFD vehicles, a large percentage of personnel did not regularly wear seatbelts while driving company apparatus. Undoubtedly failure to use a seat belt puts the driver and others at risk for injury. In addition, data collected here indicates that during this same period the frequency of distracted drivers was also high, and as the work of McEvoy et al (2006) demonstrates; a distracted driver is at much higher risk to be involved in an accident. The Drivecams have been shown, by the results of this investigation, to have a positive impact on not only improving seat belt usage and compliance with RMFD policy, but also to greatly lower the number of distracted drivers.

Seat belt use

Throughout the study period, there are several patterns that are evident with respect to seat belt use. Of note, more than half of respondents noted in the questionnaire that they *never* changed their behavior regarding seat belt use following installation of Drivecams. Of the study population, almost 90% of the respondents noted they wear seat belts in their personnel vehicles always and often while 96% state they wear their seatbelt while driving a fire truck. Interestingly, these statements are not reflected in the Drivecam video footage where numerous instances of non compliance were noted. Likely the questionnaire response is a reflection of the cultural pressure to acknowledge the use of seat belts. Nonetheless, the number of observed instances of failure to use a seat belt did decrease substantially during the early years of the study period. Data from the last year and a half does not demonstrate a continuation of this dramatic decrease, likely this recent shift is an illustration of a leveling off or the achievement of a plateau in the impact upon drivers. This reality suggests that the presence of the Drivecam does in fact have an affect of driver behavior. Following the initial installation period the cameras serve to bring about a rapid shift and or decrease in unwanted behavior, which is then followed by a

period of less adjustment as drivers primarily maintain these more positive behaviors. A deeper longitudinal study of the presence of the camera could confirm this conclusion.

Distracted Drivers

The study period demonstrates a pattern of unacceptable levels of distracted driving within the RMFD at the time of the installations of the Drivecams in 2007. This is clearly shown by the 6% level of occupants engaged in that behavior in 2007. Likewise, the questionnaire show similar results, with 24% of respondents claiming they *sometimes* or *often* used a cell phone while driving a fire apparatus. The results of this study show a decline in the percentage of Drivecam videos that recorded distracted drivers from a high of 6% in 2007 when the drivecams were installed to a 2010 level of .03%. The decrease was consistent across the studied period. The influence of the Drivecam upon driver behavior is also supported by results of the questionnaire, with 44% of respondents stating they have *always* or *often* changed their behavior regarding cell phone use while driving a fire apparatus. Overall, the results of this study show a powerful impact on changing driver distraction behavior in a positive way due to the Drivecams being installed. The results for the study period of the root causes of distracted driving include high rates of cell phone use and comparable levels of drivers failing to look far enough ahead; this is in line with Clayton and coworkers (2006).

Impacts of primary and secondary intervention

While the results of this study clearly demonstrate that the Drivecams have had an impact by decreasing unwanted behavior, the potential of remedial training and other interventions by a supervisor after the fact also had an impact in changing behavior, but at a lower rate. It is important to note that the results demonstrate and corroborate the work of Fernandez and coworkers (2006); that a primary enforcement is more successful than a secondary enforcement.

With respect to this project, the presence of the Drivecam can be considered as a mechanism of primary enforcement. The primary enforcement of having the Drivecams in place has been successful in changing unwanted behavior; as the survey results show a lesser degree of behavior change results a secondary enforcement of a follow up and intervention by a supervisor. This is further supported by the questionnaire with greater than half of the respondents claiming that any secondary follow-up did not have an impact on their actions. The lower level of distracted drivers in 2010 has demonstrated a change in that behavior.

McCartt and Geary (2004) discuss how the long term affects of punitive type actions, such as the State law in New York not being effective in lowering cell phone use through time, is not finite; people return to previous bad habits. Across the time period studied, this has not been observed as a continuous level of behavior improvement is apparent. The success at changing behavior has been maintained. The effectiveness of this is shown in the continuing decline in instances of distracted drivers in 2009 and 2010 after the initial drop to very low levels in 2008 for RMFD.

DeMar (2007) concludes that changing behavior in relation to seatbelt use presents an adaptive challenge and that the policy to wear seatbelts in his department is only a technical solution. With respect to this research and how it impacts the Rural Metro Fire Department, the results demonstrate that a technical solution such as that promoted by DeMar (2007) can be beneficial. A policy of wearing seatbelts and not engage in distracted driving can be coupled with technology (Drivecams) and a training/couching/discipline secondary intervention by supervisors will be the most effective and can have a significant impact on changing unwanted behavior and maintaining those positive behaviors. Clearly, this research has yielded information that can benefit the RMFD and bring added value to the organization. The RMFD

can know that the initial layout in terms of cost, coupled with maintenance and upkeep, and investment in secondary follow up by supervisors is worth the investment.

Recommendations

The research clearly demonstrates a need for the Rural Metro Fire Department to continue to use, and maintain Drivecams. In addition, providing secondary feedback to drivers observed on the Drivecams can further improve the overall quality of vehicle operations. There are, however, several recommendations that could be incorporated into future research to enrich and build upon this study. These may serve to further enhance the safety of all drivers employed by RMFD and other emergency services organizations across the world.

Further examinations at RMFD

The research undertaken at the Rural Metro Fire Department could be further analyzed to find out more about whether all employees respond to the primary and secondary enforcements in a similar manner. The department could be studied in terms of whether there are any distinctions based on the Battalion they work in. Employees could be studied in term of the age of the individuals associated with unwanted behavior, and experience level as a driver. This could bring great value to future researchers. Further research into the challenges regarding acceptance of appropriate behavior and the culture at the RMFD would be worthwhile especially given that some employees claim they *never* wear their seatbelt and they *often* use a cell phone. In addition, it would be beneficial to know how the rate of infractions as captured by the Drivecams compares to the actual number of infractions (those not recorded). Specifically, it would be informative to have non driver triggered video footage to use as a comparative baseline to see how the frequency of infractions observed on the Drivecam videos is reflective of the performance of all operators. Finally, more research should be undertaken to find out what

secondary follow-up mechanisms may encourage employees who engage in unwanted behavior to change those behaviors.

Use of technology to further safety and health

It is important to consider the role of seatbelts as a mechanism for causing injury. The nature of fire apparatus is different than automobiles and the potential for injuries to be caused by seat belts needs to be considered. This concern may account for the lack of seat belt use by drivers and riders in fire trucks. The research of Bidez and coworkers (2007), study the effects of vehicle rollovers and conclude there are an increase in injuries associated with seatbelt use and roof collapse. In addition, more research should be done on Drivecam type technology to see if there is value in monitoring injuries to drivers and occupants with the technology to see if training in seatbelt positioning on emergency vehicles would help avoid injuries as has been shown by the work of Smith and Hall (2005).

Drivecam prevalence

Further investigation into the prevalence of this technology within emergency services would be worthwhile to understand if the emergency services industry is taking advantage of this technology. This type of technology is likely becoming more common place and prevalent around the globe and could then provide a large data pool to enable future research which would no doubt enhance the safety of drivers and occupants.

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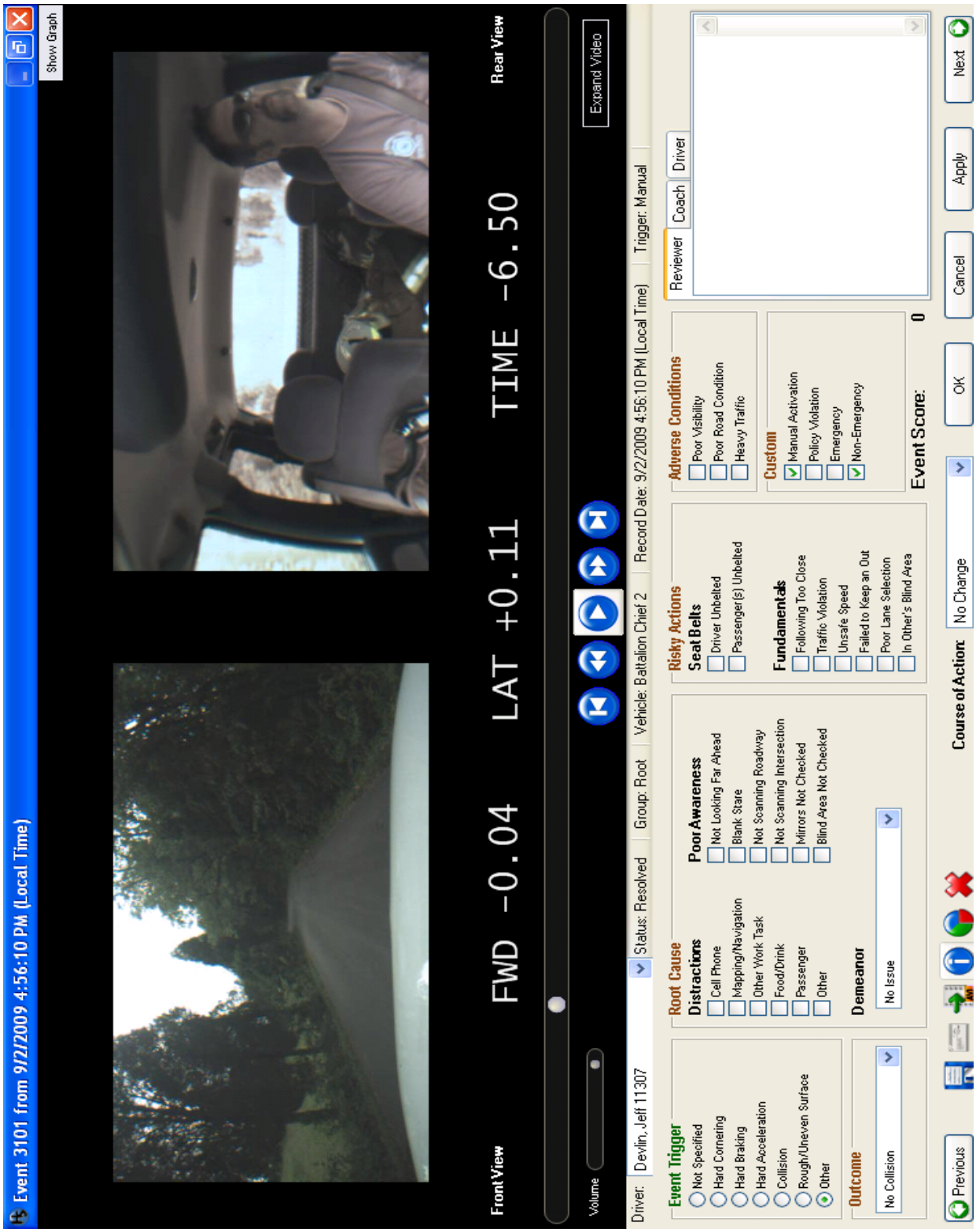
Appendices

Appendix A: Dashboard Mounted Recording Device

Appendix B: Screen Capture of Drivecam Video Clip and Associated Software



Appendix C: Survey Questionnaire

Please complete the following survey based on your actions. There are three short response inquires and then complete the remaining questions by selecting the number that most correctly reflects your actions.
The survey is anonymous and the data will only be used to complete a class research paper. Your time is very much appreciated.

How many years have you been a FIRE APPARATUS DRIVER _____years

Has the drivecam been activated while you were operating the fire apparatus? YES OR NO

IF yes, how many times has it recorded you? _____times

	Always	Often	Sometimes	Rarely	Never
1. I wear my seatbelt while operating my own car	1	2	3	4	5
2. Throughout my career I have worn my seatbelt while a passenger in a fire apparatus	1	2	3	4	5
3. Throughout my career I have worn my seatbelt while driving fire apparatus	1	2	3	4	5
4. Throughout my career I have talked on a cell phone while driving fire apparatus	1	2	3	4	5
5. I think about the presence of the drivecam while I am driving the apparatus	1	2	3	4	5
6. I am concerned my behaviors may be recorded on the drivecam	1	2	3	4	5
7. I am concerned my actions may activate the drivecam	1	2	3	4	5
8. Since the installation of drivecams, I have changed my behavior regarding seatbelt use	1	2	3	4	5
9. Since the installation of drivecams, I have changed my behavior regarding cell phone use while driving	1	2	3	4	5
10. I have changed my behavior because of actions recorded on drivecam videos	1	2	3	4	5
11. I have changed my behavior because of intervention by my supervisor regarding actions recorded on drivecam videos	1	2	3	4	5