MEASURING SEATBELT USAGE THROUGH EXISTING TRAFFIC SURVEILLANCE SYSTEMS: PILOT PROJECT

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ABSTRACT

Strategic Highway Safety Plans (SHSP) provide states with an excellent opportunity to identify and engage local traffic safety partners in a program under the auspices of the SAFETEA-LU goal to reduce fatalities on the nation's roadways. States have completed the initial plan and have moved into implementation and assessment phases. A critical component in program success and sustainability is reliable traffic safety data. While measures may not be readily available for rigorous assessment of every SHSP facet, it may be possible to enhance available measures by generating additional data through the use of existing Intelligent Transportation Systems (ITS) architecture. This research report explores the capabilities of video camera equipment for observing seatbelt use. The goal of this project is to investigate the potential to utilize existing ITS assets as well as other video cameras and recording systems in occupant protection projects. With the evolution of camera technologies, it may be useful to field test existing ITS assets into the future to determine capabilities and opportunities for collecting reliable traffic safety data.

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1. INTRODUCTION

Direct observation has predominately been used to provide statistically reliable data on vehicle occupant seatbelt use in North Dakota. Traditional observational seatbelt studies have been based on a random sample of vehicles observed by an individual or individuals assigned to various locations such as intersections, county roads, highway exit ramps and other sites. Individuals are trained to cope with a variety of traffic problems and weather conditions such as road construction, site accessibility, rain, traffic congestion, etc. In particular, too many vehicles passing by the observer(s) creates a situation in which the observer(s) must stop counting for a period of time until the observer(s) can catch up with data collection and again resume observations. During this time period a number of vehicle observations are skipped or missed. With this in mind, urban areas can present more of a challenge than rural areas in collecting data on seatbelt use.

The goal of this project is to investigate the potential to utilize existing Intelligent Transportation Systems (ITS) assets as well as other video cameras and recording systems in occupant protection projects. Cameras currently used to monitor traffic flows and incidents were used to collect information on seatbelt usage. Utilizing surveillance cameras with pan-view enhancements and the ability of the Upper Great Plains Transportation Institute (UGPTI) to capture and view the traffic flows may create a new seatbelt use data source. This project was conducted in the Fargo metropolitan area, with the specific activities and location(s) determined by factors such as traffic density, camera placement, road characteristics, observational survey sites, weather, lighting, and traffic speed. Testing of video camera equipment was also conducted during a one-month seatbelt education campaign launched by Safe Communities Coalition of the Red River Valley (SCCRRV) and the Maple Valley High School's Students Against Destructive Decisions (SADD) Chapter in Tower City, North Dakota. As a part of the assessment, factors such as technological issues, time requirements, and data reliability will be discussed. The information gained in the research will be useful to researchers, policy makers, and practitioners interested in primary data collection for traffic safety. Outcomes from this pilot project may be of interest to other states and communities.

Strategic Highway Safety Plans (SHSP) provide states an excellent opportunity to identify and engage local traffic safety partners in a program under the auspices of the SAFETEA-LU goal to reduce fatalities on the nation's roadways. States have completed initial plans and have moved into implementation and assessment phases. A critical component in program success and sustainability is reliable traffic safety data. While measures may not be readily available for rigorous assessment of every SHSP facet, it may be possible to enhance available measures by generating additional data by using new techniques to generate new observations via existing ITS architecture. This pilot project is one such potential technique. It will be beneficial in ongoing deployment and assessment of occupant protection initiatives. In addition, it would provide traffic safety officials with a means for continual feedback to the public about local traffic safety decisions and initiatives.

2. LITERATURE REVIEW

The AASHTO Strategic Highway Safety Plan identifies goals that need to be pursued to achieve a significant reduction in highway crash fatalities. The strategies are divided into three broad categories affecting drivers, vehicles, or the highway. Strategy 8 in the driver area addresses occupant protection. Increasing use of seatbelts and child passenger and booster seats is the first category identified in the report. Other categories include: improving knowledge of airbag function, and designing safer vehicle interiors (NCHRP Report 500 v11, 2004).

Traffic safety resources are frequently used to increase seatbelt use. A critical factor in maximizing gains from these limited resources is understanding the relative effectiveness of a plethora of nationally recommended strategies (U.S. DOT, 2008; TRB, 2004). These strategies may have different results in local environments and in targeting user groups given the context of local cultures. According to the National Highway Traffic Safety Administration (NHTSA), in 2007, seatbelt use in the United States ranged from 63.8% in New Hampshire to 97.6% in Hawaii. North Dakota’s seatbelt use rate in 2007 was ranked 28th among states (82.2%). Seatbelt use nationwide was 82% in 2007, as measured by NHTSA’s National Occupant Protection Use Survey (NOPUS) (NHTSA Traffic Safety Facts, May, 2008). In addition, NHTSA’s report indicates that jurisdictions with primary seatbelt laws continue to exhibit higher rates than those with secondary laws or no seatbelt laws (May, 2008). The annual NHTSA seatbelt survey does provide important information regarding gains in general trends but has limitations for applications in assessing effectiveness of individual seatbelt programs (NHTSA, 2007). The method offered here provides information for a potential local, flexible supplement to the current point-in-time statewide and national seatbelt data. While some states, such as Washington and Minnesota, have directed local resources towards collecting additional seatbelt usage data, it has not been suggested for any of the states in this region. Therefore, non-traditional approaches such as the one offered here may be beneficial to states with more limited local traffic safety resources.

2.1 Direct Observation and Speed Factors

Numerous seatbelt studies have been conducted to gather baseline data on seatbelt usage by U.S. states. A majority of these studies use direct observation methods. Eby, Streff and Cristoff have looked at a comparison of two direct-observation methods for measuring daytime safety belt use (1996). The study compared looking into vehicles when stopped at traffic control devices and looking into vehicles as they traveled along a traffic corridor. Two direct observation experiments were conducted. In one, the methods were compared on overall seatbelt use rates and reliability. In the second experiment, the observer’s ability to accurately measure seatbelt use while the vehicle was moving at speed was measured. Results indicated that the two experiments produced nearly identical results. Seatbelt measurement accuracy was not affected by vehicle speeds of up to 60 miles per hour and overall accuracy was above 95 %. This study, like others, used direct observation techniques and did not use video or camera equipment on traffic control devices. The ability of video technology already in use to play back, pause, and advance images frame-by-frame provides interesting potential to conduct seatbelt observations.

In 2002, a study involving seatbelt usage by commercial motor vehicle drivers was conducted for the Federal Motor Carrier Safety Administration (FMCSA). The purpose and scope of the project was to gain knowledge on the level of seatbelt usage by commercial vehicle drivers. The study investigated photo imaging techniques including videotape, digital cameras and high-speed flash imaging. According to the report, videotape and digital cameras provided inadequate imaging. Only high-speed flash imaging provided somewhat reliable images. However, the procedures required (a van was required to park along the shoulder of the road with a flash activation as a truck passed by) raised issues regarding observer safety, inconspicuousness, and the requirement of permission by each individual agency at each study site (FMCSA, 2003).

2.2 Traffic Cameras

Very little research has been published on the use of traffic cameras for identifying seatbelt usage. The term “traffic camera” is often used interchangeably for traffic video cameras and high-speed digital flash imaging traffic cameras. As mentioned in the previous section, FMCSA noted that only high-speed flash imaging provided somewhat reliable images. Traffic video cameras are an innovative and extremely functional use of video surveillance technology. Oftentimes, they are placed atop traffic signals along busy roads, and at busy intersections. Whether recording traffic patterns for future study or monitoring for enforcement, traffic video cameras are a popular form of video surveillance. Typically, pan tilt zoom (PTZ) cameras range in price from $5,000 to $15,000.

Camera technology is being used in several ways to enhance safety and improve enforcement. According to the Arizona Department of Public Safety (DPS), traffic cameras have shown great potential in reducing the likelihood of crashes resulting from speeding. Although this topic is beyond the scope of this project on seatbelt use, Arizona DPS’s use of traffic cameras presents other potential uses of traffic cameras. The Arizona DPS notes that the criteria for places to put freeway cameras include construction zones, approaches to freeways, junctions and areas with high numbers of serious collisions where speed is a factor (Arizona Department of Public Safety, 2008). A comprehensive statistical analysis conducted by the Arizona State University for the Arizona Department of Transportation (ADOT) and the Arizona DPS indicates the use of a photo enforcement program has reduced average speeds (-9.5 mph), side swipe crashes (-58%), single vehicle crashes (-71%), and total injuries (-40%). In addition, the Arizona DPS indicates an estimated $10 million financial savings due to reduced property damage, medical expenses, insurance costs, etc. The Arizona DPS also describes additional untold benefits such as less congestion time following a freeway accident, community productivity, safety of highway patrol officers responding to an accident, and safety of highway patrol officers pursuing a speed related incident (Arizona Department of Public Safety, 2008).

Additionally, traffic surveillance cameras are often used at busy intersections across the nation to issue citations to drivers who run red lights. Buried sensors in the intersection or crosswalk trigger the cameras, which are mounted on traffic signals to capture the time, speed and date of the violating vehicle. Advocates of these traffic cameras claim that the system is a cost-effective way to catch red light violators, make the roads safer, and give law enforcement officials the ability to address other areas of need. Typically, red light and speed cameras range in price from $50,000 to $100,000.

The method and discussion that follows will focus on PTZ, mobile, and handheld video camera field testing.

3. METHOD

This research report identifies some of the capabilities of video camera equipment for seatbelt observation and usage. To gather data on seatbelt use, field tests were conducted with an existing PTZ camera and Dakota Micro Inc. ID-Mobile video camera equipment in Fargo, ND, as well as a relatively low-cost Sony Handycam DCR-SR45 handheld video camera used for observation testing at Maple Valley High School in Tower City, ND. Site locations for using PTZ and ID-Mobile video equipment were selected that coincided with site locations identified in previous direct observation studies in the Fargo, ND, metro area by the North Dakota Department of Transportation (NDDOT). Driver and passenger seatbelt use for all classes of vehicles were observed through the use of video capture equipment.

Convenience sampling was used for the mobile and handheld video observations. The criteria for the sampling was to use the methods and site locations that coincide as close as possible to those identified in previous NDDOT seatbelt use studies. The location of the PTZ camera was in close proximity to prior NDDOT direct observations. When using mobile camera equipment, the cameras were positioned to achieve the best observation angle and as close as possible to previous NDDOT direct observation sites.

4. CAMERA FIELD TESTS

The following describes the field tests undertaken to observe seatbelt use among drivers and passengers with existing PTZ traffic camera equipment. Additional camera testing was also conducted with Dakota Micro Inc. using the company's ID-Mobile Digital Video Systems products. An ID-Mobile digital in-vehicle camera and recording system was tested, as well as an external ID-Mobile video camera system with in-vehicle recording capability. Each test is described, findings from the field demonstrations and subsequent analyses are documented, and results are summarized. All camera field tests took place in Fargo, ND.

4.1 Existing PTZ Traffic Camera Test

A seatbelt observation test was conducted on June 3 and June 12, 2008, from approximately 7 a.m. to 8 a.m. using existing PTZ video equipment. The location of the testing took place on 12th Avenue N. and 18th Street N. with an existing traffic camera attached to a traffic signal positioned facing west and overlooking one lane of traffic traveling toward the camera in an eastbound direction. The test was designed to explore camera positions, lighting variations and feedback to display monitors and recording equipment located in the North Dakota State University-Advanced Traffic Analysis Center (ATAC). The location provided a good setting for experimenting with the existing traffic camera equipment and the variety of camera positions available. The existing PTZ camera was trained on vehicles on 12th Avenue N. in the eastbound traffic lane. Weather conditions during the preliminary observation on June 3, 2008, were difficult due to rain and wind which hampered the clarity of the video observation. It was determined by researchers that, due to weather conditions, the testing would have to be postponed to a later date. On June 12, 2008, a subsequent observation test was conducted with better field testing conditions with weather conditions sunny and clear.

Video observation data was recorded at the ATAC on June 12, 2008. The video was then converted for use with Windows Media Player software and reviewed. Using the Windows Media Player software allowed play pause, reverse, and frame-by-frame capability that helped verify seatbelt observations that would be otherwise impossible under real time viewing conditions. Using the occupant protection survey (Appendix A) developed by the UGPTI, the video was reviewed and information relating to the observation video written to the Occupant Protection Survey: Seatbelt & Helmet Observation Data Collection Form. The information from this form was later compiled in electronic form for further analysis.

Table 4.1 presents information regarding driver gender and seatbelt use during the June 12, 2008 – 7:09 a.m. to 8:05 a.m. observation time period. In addition to "Seatbelt" and "No Seatbelt" category columns, a third category column is included in the table to show the number of vehicles in which gender could be determined but seatbelt use could not be determined. During the test period 475 vehicles were observed. Although the PTZ video equipment provided conclusive occupancy, various factors played a role in not being able to determine seatbelt use in 100% of the vehicles observed during the test period. Seatbelt use for drivers could not be determined in 45% of the vehicles observed. A variety of problems such as camera angle, car design, glare, tinted windows, changing light conditions, and other elements made it impossible to obtain seatbelt use information in 100% of the vehicles. An advantage of video capture is being able to capture 100% of the vehicles passing the observation site. In comparison, other ongoing direct observation studies currently being conducted by UGPTI staff with 200 to 400 total direct observations have indicated between 6 to 10% of the vehicle statistics not being captured. When traffic becomes heavy and there are too many vehicles to count, direct observation becomes problematic as vehicles must be skipped under these circumstances.

4.2 Use Rate among Valid Observations

Forty-three out of a total of 53 passengers (more than 80% of the total passengers observed) were wearing a seatbelt; 5 were observed not wearing a seatbelt and 5 observations could not be determined as to whether or not the passenger was wearing a seatbelt. Note that the higher percentage of confirmed passenger observations may be due to the same variety of factors that can also negatively affect observations such as the conditions and elements which were previously discussed.

Table 4.1 Seatbelt Observations June 12, 2008 (7:09am to 8:05am)

Driver					**Passenger**		
	Seatbelt	No Seatbelt	Unknown		Seatbelt	No Seatbelt	Unknown
Male	145	9	125		22	3	4
Female	102	5	89		21	2	1
Total	247	14	214		43	5	5
Percentage	52%	3%	45%		81%	9%	9%

In addition, cell phone usage by both drivers and passengers was also compiled from the observation video. Although passenger cell phone use may be irrelevant to the topic of motor vehicle crashes, the test exercised the capability of the PTZ camera observations. Fifteen of the 460 drivers and one of the 54 passengers appeared to be using cell phones. However, caution with these statistics must be exercised because wireless protocol technologies for exchanging communications over short distances from mobile devices exist (i.e. hands free headsets, Bluetooth, etc.). Table 4.2 provides observation statistics on cell phone use.

Table 4.2 Driver and Passenger Cell Phone Use

Driver			**Passenger**		
	7:09-8:05			7:09-8:05	
	Cell Phone	No Cell		Cell Phone	No Cell
Drivers			Passengers		
Male	8	277	Male	0	29
Female	7	183	Female	1	24
Total	15	460	Total	1	53

Statistics were also compiled for gender and vehicle type. These statistics demonstrate that video capture can be used to identify the gender of the driver in the vehicle and the type of vehicle more conclusively than it is to determine seatbelt use/non-use. Table 4.3 displays the number of drivers observed by gender and vehicle type. Of the vehicles observed, 271 were cars, 87 were SUVs, 72 were trucks (light to medium duty trucks and pickups) and 44 were vans. One male motorcyclist was also observed wearing a helmet, however this information was omitted for the purpose of this study. Overall, 1% of the observations provided non-conclusive/unknown gender results.

Table 4.3 Number of Drivers Observed by Gender and Vehicle Type

Vehicle Type				
	Car	**Truck**	**SUV**	**Van**
Male	136	69	50	23
Female	132	2	36	19
Unknown	3	1	1	2
Total	271	72	87	44

4.3 ID-Mobile Digital Video Systems

Driver seatbelt observations were conducted with Dakota Micro Inc. on various days throughout the month of June, 2008 using video surveillance and recording equipment. Dakota Micro Inc. provides high-end video surveillance equipment systems to law enforcement, the agricultural industry and others. According to company officials, the DM ID-Mobile digital in-vehicle recording system was designed with the intent to produce superior-quality video evidence for law enforcement purposes (Dakota Micro Inc., 2008). For the interest of further research possibilities, Dakota Micro Inc. was contacted as to whether the systems offered would provide the capability for observing and recording statistics relative to seatbelt use in rural settings and from remote locations.

4.3.1 Equipment Testing

Four field tests were made to develop, test, and demonstrate ID-Mobile Digital Video Systems capability for video capture of seatbelt use. A sport utility vehicle (SUV) equipped with mobile video was employed in the tests. This unit included four video cameras operated from a control monitor console having a split screen capability. System capabilities also included a recordable DVD storage device which allows automatic on/off and timed recording.

The initial testing focused on one camera view facing forward through the front windshield of the SUV. The initial testing indicated possible use for positively identifying and observing seatbelt use as vehicles passed by the SUV. During the initial testing, no recording took place. The initial testing was a first for Dakota Micro Inc. and it was determined by the company’s sales staff that further testing and other types of video equipment configurations could be explored to more accurately fit the need for vehicle seatbelt observation.

A second round of testing was conducted with Dakota Micro Inc. using a battery-powered single camera located outside of the SUV and attached to a power pole. The camera was attached in a way that allowed a video feed of traffic traveling in the eastbound lane of 12th Avenue N. and 18th Street N., very close to the same location as the PTZ camera discussed in the previous section of this report. Video feedback from the camera was relayed to a display screen in the SUV parked approximately 25 feet away from the camera. Due to technical glitches recording could not be conducted and the testing had to be prematurely aborted.

A third test was conducted on University Drive and 16th Avenue N. The camera was attached to a power pole and trained on southbound two lane traffic on University Drive. Again, a video feed was sent from the camera to a monitor in the SUV parked a short distance away. Problems with sun-glare on the oncoming vehicle windshields produced difficulty in capturing any useful seatbelt observation data. Due to previous technical difficulty with the single camera configuration, it was determined by Dakota Micro Inc. personnel that more than one camera should be employed to enhance video capture capabilities.

A fourth and final test was conducted at 19th Avenue N. and University Drive using four video cameras. Cameras were trained on traffic in two southbound lanes near the traffic signals at the intersection previously mentioned. Twenty-five minutes of continuous traffic footage was recorded. During the field test, the four-camera setup offered different camera angles, but seatbelt observation was extremely difficult due to lighting conditions. Figure 4.1 shows snapshots of the four-camera display.

Figure 4.1 Oncoming Four Screen Example 1

Additional snapshots can be seen in Appendix B. As can be seen in the figures above, certain vision-obscuring problems create difficulty in making a determination whether or not the vehicle occupant(s) are wearing seatbelts. In addition, ambiguous views present additional challenges. Vehicles having windows out of the range of eye level cameras such as trucks, buses, vans, etc. present additional difficulty in determining occupant seatbelt use. Some of these issues present the same difficulties for direct observation as well. For example, at the time of the video camera positioning, observers found it difficult to see inside the occupied vehicle due to window glare. During the 25 minutes of continuous recording for this particular field test, it was impossible to determine vehicle occupant seatbelt use in the playback of the video footage.

4.4 Maple Valley High School Video Camera Testing

In coordination with the Safe Communities Coalition of the Red River Valley, a study of seatbelt use by teens was undertaken at Maple Valley High School (MVHS) in Tower City, ND. The study was done in conjunction with educational activities being launched by the SADD chapter during the month of September 2008. The original intent of this study was to use direct observation methods to develop seatbelt use statistics. It was determined that field testing of handheld video camera equipment may provide another way to capture seatbelt usage among teenage drivers and passengers. Therefore, a Sony Handycam DCR SR-45 handheld digital video camera was purchased to determine the seatbelt observation capabilities of relatively low-cost video camera equipment in a rural area.

Vehicle arrivals and departures to and from the school parking lot were directly observed at three checkpoints. Observers were stationed at the east, west, and south access sites to the parking lot for the morning observations; and one observer was stationed at the south exit for the afternoon observations. On eight occasions direct seatbelt observations were conducted to provide baseline, intermediate post, and post-post measures for intervention and program effectiveness. On three of the eight occasions, the Sony Handycam DCR SR-45 handheld video camera was used. The three occasions described in the following paragraphs provided more suitable conditions for handheld video camera field testing. The south access location was used on two occasions because of higher traffic volume.

On August 27, 2008, an initial field test of the handheld video camera was conducted during student morning arrival at MVHS. A total of 22 vehicles were video captured using the south access. Direct observation at east, west and south access locations indicated a combined total of 32 cars observed. Of those vehicles, 69% were captured through the use of the handheld video camera. Video captured results were played back and reviewed upon completion of the field test. Although a large percentage of the total vehicles had been captured with the handheld video equipment, conclusive evidence on seatbelt use/non-use could not be obtained. Lighting conditions and windshield glare rendered the video capture unusable.

On September 15, 2008, a second test of the handheld video camera was conducted during students' morning arrival at MVHS. The video camera was again positioned at the south access location. Of the vehicles, 50% were captured with the handheld video camera. Seventeen vehicles were video captured using the South access. Direct observation at East, West and South access locations indicated a combined total of 34 cars observed. Visibility issues, especially glare, again provided unusable data results.

Further testing with the handheld video equipment was conducted during students' afternoon departure on September 15, 2008. During this field testing the video camera equipment was positioned to capture departures from the west access location. The west access location was chosen because the lighting conditions were thought to afford a better viewing angle. A total of 12 vehicles were video captured departing from the west access. Upon playback and review of the video captured, a total of 8 vehicles were displayed showing evidence of driver seatbelt use. In addition, 1 of 8 vehicles in the video playback showed evidence of front passenger seatbelt use. In this field test, approximately 67% of the vehicles video captured displayed conclusive evidence of seat belt use.

On September 26, 2008, field testing was again conducted at the west access location during students' afternoon departure from MVHS. A total of 21 vehicles were captured on video camera departing the west access. The direct observation method captured a total of 24 vehicles. Upon playback and review, visibility issues again provided unusable data on seatbelt use.

As discussed above, only one of the four days where field testing was conducted offered conclusive evidence on seatbelt use. Visibility issues, especially glare, made many of the video captured images very difficult to conclude seatbelt use/non-use. The reliability of this method was well below the 99.4% observation rate obtained with direct observation during the same study (Lofgren, Benson, Vachal, 2009).

4.5 Potential for Additional Field Testing

4.5.1 City of Fargo Traffic Engineering

The City of Fargo Traffic Engineering Department purchased 15 PTZ cameras in 2008. During the time of this study none of the cameras were in operation for testing seatbelt observation capabilities. The City of Fargo plans to have the cameras in operation in 2009. With the increased technologies provided by the city's new cameras, it may be useful to field test the video camera equipment to determine capabilities offered. The potential for further seatbelt observation testing exists as the city's cameras are installed and come online.

4.5.2 NDDOT District Office (Fargo, ND)

The NDDOT district office in Fargo, ND also provides the potential to further test PTZ video camera equipment. The NDDOT district office currently has five PTZ cameras in operation at various locations near Interstate Highways in the Fargo, ND, metro area. A particular PTZ camera of interest for further testing seatbelt usage is the tri-level bridge camera positioned for viewing traffic traveling over the eastbound ramp. The NDDOT district office was contacted for testing the use of this camera. However, due to weather conditions, schedule difficulties, and other maintenance concerns and priorities the camera was not utilized for this project.

5. CONCLUSION

The goal of this project was to investigate the potential to utilize existing Intelligent Transportation Systems (ITS) assets as well as other video cameras and recording systems in occupant protection projects. Cameras currently used to monitor traffic flows and incidents were used to collect information on seatbelt usage. Additionally, ID-Mobile digital video systems and a Sony Handycam DCR SR-45 handheld digital video camera were used to determine the seatbelt observation capabilities of relatively low-cost video camera equipment. Overall, video capture offers limited potential for measuring local seatbelt use given the capabilities of existing ITS assets and affordable stand-alone video devices. During both existing PTZ video capture and ID-Mobile Digital Video Systems testing, camera angles played an important role in determining vehicle occupant seatbelt use. Elements such as glare, tinted windows, changing light conditions, video frame rate and a variety of other elements provided difficulty in obtaining conclusive information on 100% of the vehicles observed. At the Maple Valley High School site, captured observations providing conclusive use/non-use statistics ranged from 99.4% with the direct observation method to 67% with the hand-held video capture method. Although conclusive vehicle occupant seatbelt information could not be distinguished in 100% of the vehicles observed, the PTZ video capture offered the best alternative of the pilot tests conducted. In the PTZ test, 55% of the driver seatbelt observations and approximately 90% of the passenger observations provided conclusive use/non-use statistics. When traffic becomes heavy and there are too many vehicles to count, direct observation becomes problematic as vehicles must be skipped. Preliminary findings from ongoing studies by UGPTI have indicated between 6 to 10% of the vehicles and occupant protection use/non-use could not be determined through direct observation in higher volume traffic areas of 200 to 400 vehicles per hour. Under real-time viewing conditions, it is very difficult to annotate seatbelt use in every vehicle observed. Therefore, video recording and playback may be important in the future for enhancing the accuracy of the seatbelt use results. Also note that Dakota Micro Inc. produces high quality video capture equipment. However, the equipment used in this research was designed for lower resolution purposes such as law enforcement traffic stop evidence and agricultural monitoring uses. Although findings suggest video capture at the present time is limited with regard to conclusive seatbelt observation capability, the evolution of future camera technologies, will make it useful to field test video camera equipment in the future to determine capabilities.

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APPENDIX A.

OCCUPANT PROTECTION SURVEY: SEATBELT & HELMET OBSERVATION DATA COLLECTION FORM

Occupant Protection Survey: Seat Belt & Helmet Observation

Date____________________ **Time:** _____________________________ **AM/PM**

County:_____________________________ **Location:**___________________________

Observer Names:______________________________________ **Observation Method:** Direct or Video Capture

Car=Car, Trk=Pickup Truck, S=Sport Utility Vehicle, Van=Van, Mcycl=Motorcycle

Obs	**Vehicle Type**					**Driver**						**Passenger**					
						Gender		Protection		Cell Phone		Gender		Protection		Cell Phone	
1	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
2	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
3	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
4	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
5	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
6	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
7	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
8	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
9	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
10	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
11	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
12	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
13	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
14	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
15	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
16	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
17	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
18	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
19	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
20	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
21	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
22	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
23	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
24	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
25	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
26	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
27	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
28	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
29	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N
30	Car	Trck	SUV	Van	Mcycl	M	F	Y	N	Y	N	M	F	Y	N	Y	N

APPENDIX B.
SCREEN SAMPLES

The photos in this section provide further illustration of video camera equipment capabilities. The images include examples from DM ID-mobile, Sony Handycam DCR SR-45, and an existing PTZ camera mounted at a traffic signal.

DM ID-Mobile Oncoming Four Screen, Example 1.

DM ID-Mobile Oncoming Four Screen, Example 2.

DM ID-Mobile Oncoming Four Screen, Example 3.

DM ID-Mobile Oncoming Four Screen, Example 4.

DM ID-Mobile Oncoming Four Screen, Example 5.

Hand-held Video Cam 12th Avenue N. and 18th Street N. Fargo, ND, Example 1.

Hand-held Video Cam 12th Avenue N. and 18th Street N. Fargo, ND, Example 2.

Hand-held Video Cam MVHS Tower City, ND, Example 1.

Hand-held Video Cam MVHS Tower City, ND, Example 2.

PTZ Camera Mounted on Traffic Signal 12th Ave N & 18th Street, Driver with Seatbelt.

PTZ Camera Mounted on Traffic Signal 12th Ave N & 18th Street, Driver without Seatbelt.

PTZ Camera Mounted on Traffic Signal 12th Ave N & 18th Street, Driver and Passenger with Seatbelts.