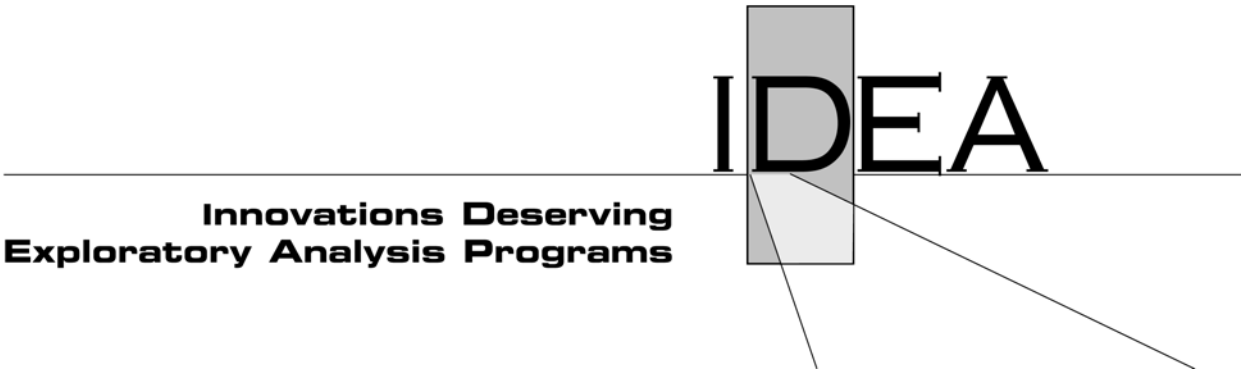

Intelligent Transportation Systems Program

I-Witness Black Box Recorder

Final Report for ITS-IDEA Project 84

Gary and Sophia Rayner, I-Witness Inc., San Diego, CA

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TRANSPORTATION RESEARCH BOARD • NATIONAL RESEARCH COUNCIL

INNOVATIONS DESERVING EXPLORATORY ANALYSIS (IDEA) PROGRAMS MANAGED BY THE TRANSPORTATION RESEARCH BOARD (TRB)

This investigation by I-Witness Inc., San Diego, CA was completed as part of the Intelligent Transportation Systems (ITS) IDEA program which fosters innovations in development and deployment of intelligent transportation systems. The ITS-IDEA program is one of the five IDEA programs managed by the Transportation Research Board (TRB). The other four IDEA program areas are: Transit-IDEA, which focuses on transit practice in support of the Transit Cooperative Research Program (TCRP), NCHRP-IDEA which focuses on highway systems in support of National Cooperative Highway Research Program, High Speed Rail-IDEA (HSR), which focuses on high speed rail practice, in support of the Federal Railroad Administration, and Transportation Safety Technology (TST), which focuses on motor carrier safety practice, in support of the Federal Motor Carrier Safety Administration and Federal Railroad Administration. The five IDEA program areas are integrated to promote the development and testing of nontraditional and innovative concepts, methods, and technologies for surface transportation systems.

For information on the IDEA Program contact IDEA Program, (phone: 202/334-3310, fax: 202/334-3471, http://www4.nationalacademies.org/trb/dive-idea.nsf)

Acknowledgements

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1 Executive Summary

I-Witness Incorporated's first product, DriveCam-I, is a digital video event data recorder. The concept is similar to the "black box" data recorders on airplanes. When triggered by a collision, erratic driving, or even a near miss DriveCam saves information from 10-seconds before the trigger event to 10-seconds after. It can then replay the event showing video, audio, and acceleration/deceleration forces (G-forces) experienced during the incident. Captured events are date and time stamped and can be downloaded to a laptop computer or VCR for viewing and/or long-term storage. Events can be displayed immediately on a television or camcorder - DriveCam has the same familiar fast-forward, rewind and play buttons as a VCR.

Lawsuits are very expensive. The current methods of determining fault in traffic crashes are police reports, skid mark measurements, and telephone interviews with the drivers. DriveCam can enhance crash reports by providing a more reliable record to enhance prosecution (or defense) of accidents, traffic violations, road rage, and insurance fraud. This can increase driver accountability and reduce the time and cost of court appearances. By supporting driver testimony with video and audio data DriveCam is better than a perfect human eyewitness. It allows jurists to see the same event repeatedly, no expert witnesses or interpretations are required.

DriveCam includes a sensitive black and white CMOS camera, microphone, 4-direction accelerometer, a real time clock, and other electronic components all controlled by software. Video resolution is 256 x 200 effective pixels. Field of view is 120 degrees out the front windshield. It retails for about $800 and installs behind the rear-view mirror in about a minute (15 minutes for hardwired fleet versions). This has been achieved by combining all of the required sensors into a single small self contained "black box", a little larger than a pager using innovative design techniques.

DriveCam continuously records Video, Audio, and 4 directions of G-Forces, in a circulating digital memory buffer of 16 MB. When triggered, DriveCam records for 10 more seconds and then stops and saves 20 seconds of data. A green indicator light shows that the system is armed and ready to capture an event. After the DriveCam has been triggered, the indicator light will turn red and begin blinking. The driver can also trigger DriveCam manually to capture road rage events, hit-and-run accidents, or other road hazards.

Fleet-customers report DriveCam is effective in encouraging their drivers to drive more safely. This is evidenced by dramatic reductions in the number of erratic driving events. After installing DriveCam units, one customer reported a reduction from 80 erratic driving events captured the first month to only 2 erratic driving events the second month! Drivers very quickly learn the threshold to trigger DriveCam and begin driving in the safe zone, below the threshold.

2 IDEA Product

I-Witness Incorporated's first product, DriveCam-I, is a digital video event data recorder. The concept is similar to the "black box" data recorders on airplanes. When triggered by a collision, erratic driving, or even a near miss DriveCam saves information from 10-seconds before the trigger event to 10-seconds after. It can then replay the event showing video, audio, and acceleration/deceleration forces (G-forces) experienced during the incident. Captured events are date and time stamped and can be downloaded to a laptop computer or VCR for viewing and/or long-term storage. Events can be displayed immediately on a television or camcorder - DriveCam has the same familiar fast-forward, rewind and play buttons as a VCR.

DriveCam includes a sensitive black and white CMOS camera, microphone, 4-direction accelerometer, a real time clock, and other electronic components all controlled by software. It retails for about $800 and installs behind the rear-view mirror in about a minute.

2.1 Technical Description

DriveCam continuously records what the driver sees, hears and feels while making his or her driving decisions, but only stops and saves "event data" after it is triggered. DriveCam is triggered automatically when it senses G-force values that exceed programmed thresholds which have been determined to represent erratic driving or collision events. The driver can also manually trigger DriveCam to capture road rage, a hit-and-run accident, or other safety threat.

The user interface is very simple and has been designed to minimize driver distractions. A green indicator light shows that the system is armed and running; ready to capture an event. After the DriveCam has been triggered, the indicator light will turn red and begin blinking. DriveCam can be manually triggered by pressing any of its three buttons.

DriveCam was designed to be compact and simple to install. By using innovative design techniques all of the required sensors and other electronics have been combined into a single small self contained "black box" a little larger than a pager. DriveCam includes a sensitive black and white CMOS camera, microphone, 4-direction accelerometer, a real time clock, and other electronic components all controlled by a microprocessor with embedded software. The case material is stainless steel reinforced with ABS plastic which is very tough and can withstand extremely high temperatures.

DriveCam's video field of view is 120 degrees out the front windshield with a resolution is 256 x 200 effective pixels and a frame rate of four frames per second. This is continually recorded, along with audio and 4 directions of G-forces, in a 16 MB circulating digital memory buffer. The buffer can hold 20 seconds of data and is maintained by an internal battery in case of power interruption. When the unit is triggered, DriveCam continues recording for 10 more seconds and shuts down, saving its 20 seconds of data in memory. DriveCam's camera has good sensitivity in light and dark and performs well in both daylight and at night.

DriveCam is fully self-contained in a tiny, rugged black box that installs unobtrusively behind the rear view mirror and for fleet vehicles it is typically hardwired to the electrical system. Installation for consumer versions takes less than a minute. The unit is attached with a suction cup and powered by a wire to the vehicle's cigarette lighter. Installation of hardwired fleet systems takes about 12 minutes. There are no moving parts, nothing to maintain, and DriveCam is tamperproof. The suction cup mount and cigarette lighter adapter power cord allow quick transfer from vehicle to vehicle.

DriveCam is designed to record the 20-second period surrounding an event and may be triggered by any of three means:

Priority	Event
1	Crash
2	Erratic Driving
3	Manuel Button Push

Each event type is assigned a priority. An event already recorded in memory may only be overwritten by an event of equal or higher priority. For example, a crash event is the highest priority and will always overwrite previous events. An erratic driving event will record and overwrite previous erratic driving or manually triggered events, but cannot record over a crash event. Manually triggered events are lowest priority; they may only record over previous manually triggered events, but not crashes or erratic driving events.

DriveCam triggering levels are factory programmed. "Soft", "Medium", and "Hard" versions are planned to meet varying preferences of fleet managers. The soft threshold version will easily capture moderately reckless driving while the hard threshold version will only trigger when it senses G-forces that represent extreme driving events. G-forces are sampled 60 times per second in each of 4 directions. G-force sensors can measure up to 50 G accelerations (almost 500 m/s/s) with a resolution of 0.1G.

2.2 General Specifications

Connections

Power Input: 2.1/5/5 mm (ID/OD) barrel connector,
Video Output: center positive RCA connector x1,
Audio Output: RCA connector x1

Dimensions (approx.):

90 (W) x 60 (H) x 50 (D) mm (3.5"x 2.4" x 2.0")
Note: does not include mounting bracket.

Weight (approx.): 0.2 kg (8 oz.)

Video System: NTSC-M

Audio System: 15 KHz 8-bit sampled monaural audio.

Electrical Specifications

Video Output Level: 0.0-2.0V p-p, 75 ohm unbalanced
Audio Output Level: -4dBs, 825 ohm unbalanced (OdBs=0.775 Vrms)

Triggering Levels
Acceleration range is +/- 50 g-forces in 2 axes, 0.1g resolution (1g = 9.8 meter/second/second)

Type	Standard	Aggressive	Highly Aggressive
Firmware/Version	VDL 5.0	VDL 5.1	VDL 5.2
Forward G-Forces	.65	.75	1.0
Lateral G-Forces	.65	.75	1.3
High	1.3	1.8	2.0

3 Innovation

3.1 Technical Basis

When a G-Force threshold is exceeded (due to unusual or erratic driving such as a jack rabbit start or hard cornering) all information surrounding the "event" is stored in permanent digital memory. Being digital, the system has no moving parts so it never wears out, is maintenance free, durable, and tamperproof. An internal lithium battery continues to provide power during recording if the main vehicle power is lost during a crash. The lithium battery also maintains the real time clock should the vehicle have a kill switch or if DriveCam is wired to be off when the vehicle ignition is off.

DriveCam protects the "evidence". A triggered event is immediately stored in a permanent digital memory chip. In the case of fleet vehicles, the "event" can be erased and the unit rearmed only with a fleet manager or supervisor's authority.

3.2 Drivecam's Uniqueness

Captured "events" can be downloaded from DriveCam to a standard TV, VCR, camcorder, or laptop computer for replay. DriveCam has the same Play, Rewind and Fast Forward controls familiar to VCR users. An onscreen overlay shows, in real time, the forward and lateral G-Force measurements experienced along with audio and video. Each captured "event" is also date-and-time stamped.

Lawsuits are very expensive. DriveCam can greatly aid in the defense or offense in a court case. The data is intuitive, it is easily understood by the man "off-the-street" which is advantageous for a jury. The crash or incident can be viewed on a large screen TV or camcorder. Also the crash data can be downloaded to a personal computer for research purposes. No expert witnesses or interpretations are required. The evidence is self-explanatory. The current methods in determining fault in traffic crashes are police reports, skid mark measurements, and telephone interviews with the drivers. DriveCam is better than a perfect human eyewitness, since it allows others to see the same event repeatedly. DriveCam's simplicity is ideal because it focuses on three major areas: Sound, Video, and G-forces.

DriveCam saves time and money. Benefits customers receive are accurate, real time data, easy to interpret data, a tamperproof system, and additional security. Other benefits include being able to see what the driver could see, hear, and feel in a crash, and real-time speed measurements of all objects in field of view with the DriveCam video record. Road rage can be recorded by a press of a button. G-force measurements can be helpful in assessing injuries and crash records can reveal insurance fraud. Emergency personnel can view the accident in seconds with a camcorder.

Other valuable reasons for installing DriveCam are improved road safety through greater driver accountability and better crash research that may produce improved driver education programs, and safer vehicle and road designs.

3.3 Safety Benefits

DriveCam helps vehicle fleets improve their safety record. Fleet customers report that DriveCam installation has improved the safe driving habits of their drivers. DriveCam is a tool that gives drivers the feedback they need to better understand how they are driving and what driving behaviors cause wear-and-tear on the vehicle. Supervisors can review near miss or erratic driving "events" with drivers and assist them in learning ways in which they can improve their driving so that they are better protected while on the road. Of course, an event recorder can be used to identify drivers who are reckless or fail to show

proper respect for their vehicles. However, simply reviewing DriveCam information often is sufficient feedback to encourage most drivers to self-correct their driving behavior after one recorded event. Safe driving further reduces maintenance costs, improves fuel economy and ultimately may reduce insurance premiums as a result of an improved safety record with fewer collisions.

DriveCam provides an easily understood and irrefutable video playback of "exactly what happened". In the event of a collision, DriveCam can prevent drivers from being incorrectly blamed for crashes. The DriveCam event data can also be used to study crashes and improve highway safety. Emergency personnel, upon arriving at the scene of a crash, can replay DriveCam event data to identify the intensity of a crash and assist in identifying injuries that otherwise might go undetected.

3.4 Financial Benefits

Financial benefits are derived from driver accountability, reduced fraud, determining fault in insurance claims and court cases, and streamlining accident reconstruction. Ultimately it is anticipated that most insurance companies will act by reducing rates to policyholders who have DriveCam. Insurance companies, government agencies, and research institutes who access data will derive benefits of accurate accident reconstruction data in a simple and cost effective way.

In addition, DriveCam's long-term benefits will include: collision data for research, reduction in lawsuits, lower insurance premiums, promoting and encouraging conscientious driving, data to improve vehicle design internally and externally, a reduction in insurance fraud, and a reduction in road rage.

DriveCam is affordable and cutting edge. DriveCam is miniature, unobtrusive, has relatively low manufacturing costs, is easy install, no maintenance is required, and output is intuitive. Audio-video playback is easily understood because of everyone's familiarity with VCRs. DriveCam was designed with the average person in mind and therefore was designed to be affordable.

Money and peace of mind are expected to compel consumers to buy DriveCam. People are interested in DriveCam because it has the ability to save them money. Many people have businesses or personal assets to protect, and do not want to lose these assets through needless negligence, fraud, improper blame, or damaged property. Ultimately, reduced insurance rates will be another powerful motivator. The low cost and simple installation of DriveCam will produce low barriers for the purchasing decision. Insurance fraud accounts for 17-20% of auto insurance premiums which translates to $100-$300 annually for the average American. If insurance companies give a 5% discount on premiums (typical for airbags or ABS brakes) the payback time from direct insurance savings would be 3-6 years.

4 Investigation

In 1996 while driving in San Bernardino, California, Gary Rayner was the victim of a road rage incident. Gary let several cars enter his lane of traffic at a grid locked intersection. As Gary finally began to move forward, through the intersection, two men in a lowered pickup truck attempted to force their way in front of him. The men became incensed that Gary had not let them in too. They rear-ended his car, pushed it, then pulled along side and yelled obscenities and made threatening gestures. Finally, the passenger leaned out the window and threw a brick that hit the hood and then the windshield of Gary's car. The criminal pair sped away.

4.1 The Idea

It all happened so quickly and was so shocking that Gary did not get the truck's license plate number. Gary later thought, if only I had a video camera! This terrifying event in 1996 would mark Gary's determination to create DriveCam.

More than just that event influenced Gary's thought process. The most famous car crash of the century occurred in France resulting in the death of Princess Diana. No one knew exactly how this crash occurred, but once again Gary thought, if there had only been a video camera!

4.2 Proof of Concept and Design

Gary Rayner began proofing by designing several of the modules for DriveCam. Then breadboards were produced at a local manufacturer. The breadboard was tested and adjustments were made and noted for the next generation prototype.

The second generation DriveCam printed circuit boards were designed and fitted to a rugged black box casing. A specialized manufacturer produced the DriveCam printed circuit boards and Gary populated the first ten boards by hand. After environmental and laboratory testing several changes and improvements were made.

The third generation DriveCam has undergone additional changes and improvements. The size has remained the same while more features have been added.

4.2 Enviromental Testing

Environmental testing was conducted for many months in a variety of vehicles on the road. Vehicles included ambulances, passenger vehicles, trucks, fire trucks, and commercial vehicles. One software bug was detected, duplicated, and fixed. Software additions were made to enhance applications of DriveCam’s data capture and operation.

Crash testing was performed in Sacramento, California and Jacksonville, Florida. DriveCam crash data was captured, transferred to videotape and analyzed. The DriveCam units were analyzed for damage. The DriveCams performed well and were reused with no functional problems. DriveCam data captured includes crashes, erratic and dangerous driving, running stop signs and red lights, avoiding crashes, a drunk driver crash, falling asleep at the wheel, and DriveCam tampering.

We tested a range of frequencies produced in the DriveCam circuit and made adjustments to ensure passing FCC Testing. The equipment used was a RF antenna and a spectrum analyzer to measure radio frequencies.

4.2.1 Storage Temperature Test

This test involved placing the unit in a chamber at –55 ºC for 1 hour and then slowly raising the temperature (rate was approximately 1 ºC per minute) back to +25 ºC. The unit then went through a full operational test and passed all portions of the test. The unit was then placed in a +105 ºC chamber for hot storage temperature testing. The unit was left in the chamber for 1 hour and, again, was slowly returned to +25 ºC. The unit retained the previously stored video information so the most crucial data was preserved.

4.2.2 Thermal Cycling

This test involved cycling the system between –40 ºC and +85 ºC approximately every two hours for 72 hours. The UUT (serial number 90302127) went through an operational test during the first and last cold and hot cycles. Since the UUT was exhibiting strange behavior during the first cycle, it was replaced with a new unit (serial number 90302133). This unit performed adequately over the final 68 hours with only a few noteworthy events.

4.2.3 Electrostatic Discharge (ESD)

All accessible buttons and plugs were subjected to 3 discharges at +3 kV. The same locations were then hit with +5 kV, +7.5 kV, +10kV, and +15 kV. A new UUT was used for the negative ESD testing and voltages of –5 kV, -10 kV, and –15 kV were used. The units went through a brief operational test after each 3 discharges and, for the most part, they functioned normally. Abnormalities were noted.

4.2.4 Random Vibration

The UUT (serial number 90302180) was randomly vibrated, 1 hour per axis, per the 3 spectral densities specified in SAE J1455, Figures 6, 7, and 8. The video output of the system was recorded for the entire test. The unit was operationally tested after each axis of vibration and no performance degradation was seen. The video was also reviewed and no abnormal behavior was noted.

4.2.5 Field Testing

Numerous field tests and crash tests have been conducted. Crash test locations were Sacramento, California and Jacksonville, Florida. Field testing has occurred across the country but primarily in Southern California. Please see beta testing for more detail.

Nearly all the installations were interested in reducing losses and improving safety with their fleets. Most agreed to install a few DriveCams in the beginning to see it would work for them. Over time as our installation sites were seeing positive results with DriveCam they wanted more DriveCams installed in their vehicles. A few have written letters expressing the savings in vehicle maintenance, improved safety, and costs in litigation regarding crashes.

We have closely worked with each of our installations to help the manager implement the Driving Feedback System and operate DriveCam properly. After an event is captured we are notified and data is downloaded to a video tape which is sent to us for review. We look at and analyze each video in the beginning to make sure the manger does not miss anything. Afterwards the managers learn to look for certain clues in the videos. Working closely with our installations has helped implementation of the program in reducing fleet maintenance costs, erratic driving, and crashes by as much as 80%.

4.3 Driver Feedback System

I-Witness is currently selling and shipping DriveCam-I units to vehicle fleet operators. Scores of actual erratic driving events and crash footage have been captured by DriveCam customer installations. Supervisors are using DriveCam footage as unbiased and accurate feedback to the drivers about their driving habits. Drivers viewing DriveCam recordings learn from them and their driving awareness improves dramatically.

DriveCam is a great tool to encourage safe driving and reduce operating costs for fleets. Some fleet operators were asking how to explain DriveCam to their drivers and how to successfully implement DriveCam into day-to-day operations. Furthermore, there was a fear that the drivers would interpret DriveCam as "Big Brother" watching their every move.

We came up with a solution, the Driving Feedback System. The Driving Feedback System was designed and developed to help our customers use DriveCam to its fullest potential. The 7-minute VCR video and the Driver's Guide explain to drivers how DriveCam works and how DriveCam benefits them. Once the program was understood attitudes changed.

The Manager's Guide explains to the supervisor how to get started, how to introduce DriveCam, how to integrate the Power of DriveCam into your operation and how to follow up to use DriveCam to its fullest potential. Please see the Manager's Guide in the Appendix.

I-Witness reflective decals can be affixed to the back and/or side of DriveCam protected vehicles to encourage driver accountability and deter staged accidents while providing valuable publicity and increasing awareness for the Company. The decals read "Drive Safely - Driving Recorded" and include the DriveCam logo. The next decals will include an 800 number to call for information and our website address.

Fleet-customers report DriveCam is effective in encouraging their drivers to drive more safely. This is evidenced by dramatic reductions in the number of erratic driving events. After installing DriveCam units, one customer reported a reduction from 80 erratic driving events captured the first month to only 2 erratic driving events the second month! Drivers very quickly learn the threshold to trigger DriveCam and begin driving in the safe zone, just below the threshold.

4.4 Beta Testing

The table below is a break down of the DriveCam installations we have across the U.S.

Type	Location	Number of Units
Landscaping Company	West Bloomfield, MI	1
Ambulance	Austin, TX	2
Ambulance	Fulton, MO	5
Car Dealership	San Diego, CA	6
Ambulance	Tarpon Springs, FL	1
Transportation	San Diego, CA	18
Car Dealership	San Diego, CA	7
Doctor	Los Angeles	1
Ambulance	Durham, NC	5
Ambulance	Florence County, SC	1
Painting Company	San Diego, CA	3
Furniture Company	San Diego, CA	3

Law Enforcement	Huron County	2
Lighting Company	San Diego, CA	3
Delivery Company	San Diego, CA	6
Ambulance	Los Angeles, CA	67
Ambulance	Charlotte, NC	4
Ambulance	Eaton Town, NJ	7
Ambulance	Palm Beach, FL	2
Law Enforcement	Montclair, CA	3
Utility	Chicago, IL	2
Fire Department	Phoenix, AZ	4
Ambulance	Rancho Cucamonga, CA	2
Ambulance	Rochester, NY	3
Ambulance	Las Vegas, NV	2
Carpet Cleaning Company	San Diego, CA	2
College	Santa Barbara, CA	5
Ambulance	San Diego, CA	34
Employee Vehicles	San Diego, CA	11
Advisor Vehicles	San Diego, CA	4
	Total	**216**
	Costs	**>$100,000**

The cost of beta testing includes engineering salaries, technician labor, tools and parts, cost of DriveCams in raw materials and manufacturing, and research and development expenses.

4.4.1 Test Plan

Panel of Experts convened with the investigators to develop a set of requirements that the system must meet. The panel offered advice on a plan to achieve I-Witness test goals of DriveCam. Gary Rayner, Co-Investigator, refined DriveCam's design in functionality, interface, software, and packaging. The DriveCam underwent extensive lab and environmental testing. DriveCam has FCC approval.

Once DriveCam underwent environmental testing a number of DriveCam installation sites were made. During beta testing a number of things about DriveCam were evaluated. The user interface had to be easy to interpret and operate with familiar fast forward, rewind, and play buttons. Users had to easily operate DriveCam using these controls. Installation time had to be simple and short. DriveCam data had to be easily downloaded and able to see and interpret by almost anyone.

The installations showed us that DriveCam was easy to use. The play, fast forward, and rewind buttons were familiar and the DriveCam was labeled properly for the audio video leads and twelve volt power supply. The only problems encountered were a few users who forgot to take the lens cap off and returned the DriveCam thinking it did not work properly. However, reviewing these units we saw g-force readings and sound to be functioning as it should.

We received feedback on our user's manuel and how to improve it. Our goals were to have a user manuel that was easily understood for the fleet managers to install and operate DriveCam, and download data. A few drivers tampered with DriveCam during the beta test trials. DriveCam was able to catch these incidents by drivers on video and clearly showed when the tampering occurred, who was speaking, and showed on video what they did. These drivers were reprimanded and suspended in most cases.

DriveCam's ruggedness was tested in two separate crash tests which the DriveCam dislodged from outside the vehicle. The DriveCam kept recording and afterwards operated normally. This proved that DriveCam easily withstood over 25 g-forces of impact.

Our goals of testing DriveCam's technical feasibility and effectiveness in vehicles were achieved. DriveCam does what it was made to do in erratic driving events and crashes. With the first version of DriveCam we listened to what was important for fleet managers and drivers. We followed the installations closely to see how to improve the design to make DriveCam more user friendly and to include more features the users desired. The future DriveCam versions will include some of these features.

4.4.2 Accident Investigation Precedents

Since DriveCam installations numerous unexpected events on the road have been captured. A few of these events may be viewed on our website at www.drivecam.com. DriveCam has helped crash investigations in four main areas: eye witness testimony, insurance claims, police reporting, and driver safety.

Eyewitness testimony is often unreliable. There are conflicting stories from persons in most crashes. DriveCam has eliminated conflicting stories because the same event can be viewed numerous times by many people. In a few beta site tests it helped all parties involved deal honestly with each other.

Insurance claims process more quickly and accurately with DriveCam audio, video, and g-force evidence. There is neither speculation nor estimation of fault in filing a claim. Everyone can see, hear, and read what the driver did making his or hers driving decision. A real example clearly illustrates this. A woman in a car quickly switched lanes with no indication in heavy traffic leaving no room in front of a shuttle van behind her to brake in time. Because the woman was driving too fast she hit the car in front of her and then the shuttle van rear ended her. The police came on the scene and she began telling the policeman that the shuttle van had rear ended her causing her to hit the car in front of her. She made it clear she was planning on suing the shuttle company. The shuttle van driver requested the police look at the DriveCam video in fear of his losing his job. When reviewing DriveCam the policeman could clearly see that it was the woman's fault and that she had been lying. The police thought the DriveCam was great because it clearly showed what happened in video, audio, and g-forces. The shuttle company was very thankful that they do not have to defend themselves in a lawsuit. The insurance claim process has been straight forward and shortened because of the DriveCam evidence.

5 Plans for Implementation

Police are able to report crashes more accurately and see what exactly led up to an event. There have been a few instances that the police have used DriveCam data to incorporate into their report involving injuries. If it were not for the DriveCam data the report may have been inaccurate and litigation would have ensued.

5.1 Government

Under the NHTSA (National Highway Transportation Safety Administration) the EDR (Event Data Recorder) Working Group has been meeting to address issues pertaining to EDRs in consumer vehicles. Privacy issues, data ownership, policymaking and legal issues are currently being analyzed. I-Witness is recognized by NHTSA as representing after market EDR concerns. Gary Rayner has made presentations to NHTSA and has an open invitation to EDR Working Group meetings in Washington D.C.

The NTSB (National Transportation Safety Board) has been working to advance the use of high quality automatic information recording devices in all modes of transportation and has recommended the installation and use of crash severity recorders in vehicles. The NTSB made highway safety its top priority starting 1999.

5.2 Fleet and Passenger Vehicles

Motor vehicle crashes in California alone cost businesses over $4 billion each year, yet many employers have not taken steps to improve employee driving habits. Car crashes cost employers an average of $9,716 per collision according to the California Office of Traffic Safety. American taxpayers pay an estimated $3.7 billion a year to cover lifetime health care costs resulting from motor vehicle injuries. That's $2.6 billion at the Federal level and $1.1 billion at the state level.

According to the National Highway Traffic Safety Administration, motor vehicle crashes impose a $16 billion health cost on employers nationwide: $8 billion of employer health care spending for crash injuries and another $8 billion for sick leave and life disability insurance.

The large number of vehicles already on the road, the high number of collisions annually and the high cost of these crashes to business and society as a whole all suggest the need for DriveCam.

5.3 Customer Profile

Any business, with one or more vehicles, wanting to ensure that employees and drivers drive more safely and/or to protect their company assets is a potential user of DriveCam. A partial list of business types that benefit from installation and use of DriveCam include the following.

- Pest Control Services
- Airport Parking Vans/Shuttles
- Fire Departments
- Limousine Services
- Taxicabs
- Package Delivery Services
- Pizza/Food Delivery
- Utility Companies
- Ambulances
- Law Enforcement

There is an unlimited universe of potential customers who can benefit from DriveCam and the Driver Feedback System. On a larger scale, consumers will benefit from DriveCam in many ways. By capturing erratic driving events and crashes teen drivers will have a meaningful way to get driving feedback and education on how and where to improve their driving skills. Police will be able to more accurately report traffic incidents. Insurance companies will be able to save their insurers money by offering discounts for DriveCam installations because it will save them money by insuring safe drivers. Roadragers will be held accountable for their actions by people using DriveCam to capturing road rage crimes. Roadragers will no longer stay anonymous. People will have a tool to protect their assets against insurance fraud. By capturing insurance fraud on DriveCam the cost of insurance fraud will decrease over time. Insurance fraud currently accounts for twenty percent of auto insurance premiums. DriveCam will be able to capture hit and runs. Hit and runs will be easier to catch by identifying the vehicle and license plate number in the video.

6 Investigator Profile

Gary Rayner, VP Engineering, Co-Principal Investigator, has developed several successful consumer electronics products prior to DriveCam. Gary Rayner is currently VP Development of I-Witness Inc. Prior to founding the Company to further develop the DriveCam, Mr. Rayner was the Chief Engineer for NiteRider, a San Diego based engineering and technical lighting company. At NiteRider, Mr. Rayner worked for 4 ½ years on a variety of projects, including digital lighting, component evaluation, design quality control programming, manufacturing engineering and new product development. Prior to NiteRider, Mr. Rayner was a founder and Design Director of Opal Technology, a computer graphics company, where he directed a team of hardware and software engineers for large-scale development of computer graphics systems. Mr. Rayner has also designed and invented hardware and software, and has successfully licensed these technologies.

Sophia Rayner, VP Administration, Co-Principal Investigator, currently heads the administration department at I-Witness Inc. Sophia is in charge of grant contract reporting and implementation, accounting, financing, acquisitions, and contact databasing. Sophia has worked for two multinational companies in San Diego and Tokyo, Japan. Sophia holds a degree in International Business, Japanese and Asian Studies.

Ed Andrew, President, has a very successful track record in marketing, sales, management, and working with both large and small companies. He has an intimate knowledge of financing, negotiation and team management. He is experienced in product licensing, manufacturing, and distribution issues. Mr. Andrew is responsible for assuring that the entire company stays focused on reaching all of its goals within time and budget constraints.

7 Appendix: DriveCam Installation and Operating Instructions

Installation

Adjusting The Bracket

The bracket should be adjusted before affixing it to the windshield. The bracket has a wide range of adjustment of 90 degrees, from horizontal to vertical. This will accommodate windshields with a long rake, such as on sports cars, to a very steep angle such as on bus windshields. The bracket may be adjusted to any of 8 screw-hole positions within this range.

Removing the two Adjustment Screws allows changing the angle of the camera in the bracket. Adjust the bracket so that the DriveCam camera lens is almost horizontal when the bracket is held against the windshield. The camera lens should be pointing horizontally, or slightly down (<10 degrees). Reinstall the two Adjustment Screws, with moderate force to prevent stripping of the thread.

Affixing the Bracket

Before affixing, the bracket should be adjusted to the correct angle. The mating area of the glass must be cleaned to remove any oil or dirt. Use cleaning alcohol or an alcohol wipe to thoroughly clean the mounting and lens view area of the windshield. Finally, wipe the cleaned area, one last time, with a soft, clean dry cloth to remove any remaining residue.

The DriveCam will mount directly behind the rearview mirror on the opposite side, away from the driver. The position should allow an unobstructed field of view for the driver, and permit the driver to access any of the buttons on top to manually record an event. The DriveCam lens must be placed far enough away from the rear view mirror mounting post so that the post does not block the camera lens field of view.

Before removing the protective film from the double-sided tape on the mounting bracket, place the DriveCam onto the anticipated mounting area to double check that the lens has an unobstructed field of view, and that the bracket is adjusted to the correct angle so that the lens is horizontal or very slightly pointing down. Be sure to remove the lens cap!

To achieve a good bond, the glass and bracket must be at least 50 degrees Fahrenheit (10 C) before affixing. Remove the adhesive backing from the double-sided tape and carefully press the DriveCam into place on the cleaned windshield. Apply firm pressure over the entire bracket surface to assure strong adhesion to the glass. From outside the vehicle, look through the windshield at the DriveCam bracket to ensure that there are no voids or gaps in the adhesion. If there are any voids or gaps, continue pressing the bracket. When mounting is complete, wiggle the DriveCam to check that it is firmly mounted. Maximum bond strength occurs after 72 hours.

Connecting The Power

The DriveCam must be hardwired to your vehicle. It may be wired so that your ignition will turn the unit off and on, or wired so that it always remains on. DriveCam places minimal drain on your vehicle battery (<120 mA), so it is suggested to only power on the unit with the ignition if you expect that the vehicle will be left without running for more than three weeks at a time. The DriveCam has four wires inside the cable jacket. The connection description for each wire is shown in the following table.

Wire Color
Name
Description
Black/22 Gauge
Negative
Power ground (-), connect to vehicle negative supply.
Red / 22 Gauge
Positive
Power positive (+), voltage range 11-16 volts. May be connected direct to vehicle power or switched with ignition. DO NOT connect to 24 volt supplies.
White / 22
Trigger Input

Power positive (+), voltage range 11-16 volts. May be connected direct to vehicle power or switched with ignition. DO NOT connect to 24 volt supplies
Green / 22 Gauge
Trigger Output
When the DriveCam is triggered by any means, this line will produce a TTL level 30 Hz, 5V peak-to-peak signal lasting 10 seconds. Do not connect to +12V or ground. This should only be connected to the trigger input of another event data recorder.
Table 1: Wiring Connection Descriptions
The DriveCam cable should be routed directly up the windshield to the headliner, concealed in the gap between the headliner and the windshield, then inside the door pillar molding down to the fuse-box or wiring position underneath the dashboard. Any unused wires should be left un-stripped and taped to prevent possible shorting or an unintentional connection. If you are unsure of how to make the wiring connections to your vehicle, you may take it to a local two-way radio or car stereo installation center. They will install DriveCam for a nominal charge.

Operational Instructions

Automatic Crash Recording

DriveCam senses a crash event when pre-determined G-force values are exceeded. Typically, this will be a collision of 7 MPH or greater. DriveCam will record the 20-second time period surrounding the crash event.
Once triggered, DriveCam will have captured the 10 seconds prior to the crash event and continue recording an additional 10 seconds. The status light will blink red until recording is complete. DriveCam then transfers the visual images to permanent memory. This will take approximately one minute. During this time, the status light will flash red and green. When the transfer is complete, the status light will be steady red.
Removing the DriveCam from the vehicle following a crash event is recommended, but first cut power to the DriveCam. This eliminates the possibility of inadvertently recording over the crash. Once a crash event recording has been reviewed it may be transferred to and stored on videotape for future reference.
Crash events are the highest priority type of recording. An erratic driving or manually triggered event will not record if there is a crash already recorded. Erasing the crash event will enable manual triggering and recording of erratic driving events.

Recording Erratic Driving

DriveCam senses an erratic driving event when pre-determined G-force values are exceeded. Braking too hard, accelerating too hard or cornering too hard will trigger the recording of an erratic driving event. DriveCam will automatically record the 20-second time period surrounding the erratic driving event.
Once triggered, DriveCam will have captured the 10 seconds prior to the event and continue recording an additional 10 seconds. The status light will blink red until recording is complete. DriveCam then transfers the visual images to permanent memory. This will take approximately one minute and the status light will flash red and green. When the transfer is complete, the status light will be steady red.
Erratic driving events are the second highest priority type of recording. Erratic driving events will not be recorded if a crash event has already been recorded. Erasing the crash event will enable manual triggering and recording of erratic driving events.

Manual Recording of Events

You may record any event that has occurred up to 10 seconds after it has happened! Simply push any of the buttons on top of the DriveCam unit. Manual triggering is used to record road rage, dangerous driving, criminal acts, crashes, stalkers, amazing events, or anything else of interest.
After pressing the button, the status light will begin blinking red and DriveCam will continue to record for an additional 10 seconds. 20 seconds total recording time is provided: 10 seconds before the button push and 10 seconds after. When recording is complete DriveCam will transfer the visual images to permanent memory. This will take approximately one minute. During this time, the status light will flash red and green. When the transfer is complete the status light will be steady red.

Manually triggered events are the lowest priority type of recording. You will not be able to manually record an event if either an erratic driving or crash event is already recorded. Erasing the erratic driving or crash event will enable manual recording.

Replaying Events

DriveCam is permanently mounted to the vehicle windshield. DriveCam event recordings may be viewed, inside the vehicle, using a portable TV, camcorder, or laptop computer. In emergency situations, such as a severe crash, DriveCam may be removed from the vehicle for later viewing.

During replay, there are three readouts at the bottom of the viewing screen. The 'FG' reading on the left shows 'Forward G-forces' (Front to back). The number beside 'FG' indicates acceleration, braking, and the magnitude of any impacts up to +/-50 G's. The 'LG' reading in the middle shows the 'Lateral G-forces' (side to side). This value indicates the forces during cornering, skidding, or magnitude of crashes. The reading to the right 'TIME' shows the time in seconds before (-) or after (+) the trigger. These numbers will automatically change during replay to coincide with the recorded video and audio.

At the end of replay, when the last recorded frame is displayed, the month/day/year and time of day when the event was triggered is statically displayed at the bottom of the viewing screen. This "Date/Time Stamp" is displayed where the 'TIME' readout was seen during replay.

Real Time Clock

DriveCam's real time clock includes the date and time. The date is shown as month/day/year. For example September 15, 2000 is represented as 09/15/00. Time is in 24 hour format and is formatted as hrs:mins:secs. 1:30 p.m. would be represented as 13:30:00.

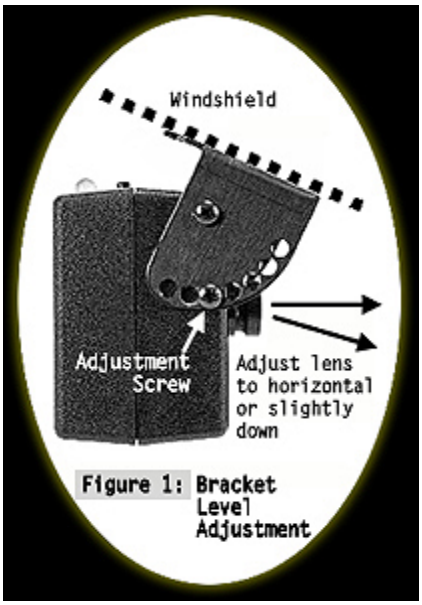

Figure 1: Bracket Level Adjustment