REAL-WORLD PERCEPTIONS OF EMERGING EVENT DATA RECORDER (EDR) TECHNOLOGIES

Thomas Michael Kowalick
Click, Inc. Transportation Safety Technologies
United States of America
Paper Number 146

ABSTRACT

This research focuses on what college-age motorists perceive to be the positive and negative aspects of implementing on-board Event Data Recorders (EDR's) in the highway mode of transport. The achievements and findings offer safety researchers insight as to which societal issues need to be addressed and overcome to assure successful implementation. A number of key issues ranging from perceived safety benefits versus fear of privacy invasion are included. Research was conducted by a professor/member of the USDOT/NHTSA "EDR Working Group" at a North Carolina Community College.

INTRODUCTION

More than 6.7 million police-reported motor vehicle crashes occurred on U.S. highways in 1997-one every five seconds. Since 1997, serious efforts by dedicated transportation safety specialists have focused on emerging Event Data Recorder (EDR) technologies to reduce this unacceptable statistic. The objective of the EDR is to provide increased and reliable pre-crash, crash, and post-crash data. Initiatives by the National Transportation Safety Board (NTSB), via recommendations & symposiums and the National Highway Traffic Safety Administration (NHTSA) via ongoing EDR Working Groups continue to seek and share knowledge towards implementing EDRs in the highway mode. Much progress has been reported. This research adds to prior efforts by providing timely societal perceptions of eighty college-age motorists who attended a community college in North Carolina. The premise of this research effort confirms that there is a great need and a strong desire within the public for awareness and understanding of emerging technologies. This is especially true regarding on-board recorders. The question, "What is that box doing under my hood?' is a real issue for most motorists. Debate concerning the promise of potential safety benefits versus the fear of privacy invasion requires public involvement. Although public interest is very high in this area, public discussion is very low. Experts knowledgeable in the technological aspects are often lacking in the societal implications and ramifications, which limits public input and feedback.

Thus, this research aims to address key issues such as safety and privacy at a time in transportation history when on-board recorders are being considered for the highway mode. The specific findings and achievements will provide insights and stimulate additional interest, discussion and research towards the overall conference goal of enhancing the safety of vehicles.

More than 6.7 million police-reported crashes occurred on our highways in 1997-one every 5 seconds.

Definitions

An <u>Event Data Recorder (EDR)</u> is an on-board device or mechanism capable of monitoring, recording, displaying, storing or transmitting pre-crash, crash, and post-crash data element parameters from a vehicle, event and driver.

Almost every psychology text deals with <u>perception</u> as the processing of information received through the five senses. For this research study, "perception" is used in a different way, in a use closer to its conversational meaning. That is "perception" here means a summary attitude based on all our past and present sensory information. Although this is a technical paper presented at a scientific convention the importance of this research is to underscore that it is not reality that matters but rather the perception of that reality. Nothing could be truer, especially when safety vs. privacy issues dictate emerging technology success or failure.

Symptoms of a Problem

Automobiles have been in existence for over a century (1898-2001). Today, we have over two hundred and fourteen million (214,000,000) registered in America alone, and approximately seven hundred million (700,000,000) worldwide. There are one hundred and eighty five million, five hundred thousand (185,500,000) licensed drivers in the United States. In 2000, approximately seventeen million (17,000,000) vehicles were manufactured in America. Approximately fifty-six million (56,000,000) vehicles were built worldwide. In America, forty-seven million (47,000,000) vehicles are continually in-motion during daytime usage. Within twenty years, these numbers are expected to double. During 1998, more than twelve million, seven hundred thousand (12,700,000) crashes occurred involving approximately twenty one million (21,000,000) vehicles. 41,200 people died (115 daily) and there were two million, two hundred thousand (2,2000,000) disabling injuries. The total economic cost is estimated at 191.6 BILLION dollars.

The personal, social, and economic costs of motor vehicle crashes include pain and suffering; direct costs sustained by the injured persons and their insurers; indirect costs to taxpayers for health care and public assistance; and for many victims, a lower standard of living and quality of life.

During the past two decades, motor vehicles accounted for over 90 percent of all transportation fatalities, and an even larger percentage of accidents and injuries.

Our increasingly mobile society exposes all age groups to the risks of these crashes, as passengers, as drivers, and as pedestrians. The automobile is essential to the style of life we demand, and yet motor vehicle crashes remain a major public health problem. In contemporary society automobiles play an indispensable role in transporting people and goods, and yet, the health care cost of motor vehicle crashes is a national financial burden that must and can be reduced.

Highway safety affects us all. “Safety” is a priority in America. National and state customer surveys confirm highway safety a top transportation concern. Many states place safety at the top of their list of priorities. However, there has yet to be a highway safety countermeasure that has resulted in significant reductions to deaths, injuries, and crashes. One reason is because of the increasing demand on the transportation system. People are driving more miles each year, resulting in congested roadways. Over the past fifteen years, vehicle miles traveled has increased 35%, yet new road mileage has risen a mere 1%. Safer cars, roadway improvement, enhanced emergency medical services, increased seat belt use and other factors cut the rate of highway deaths per 100,000 population nearly in half since 1972 – to fifteen (15) deaths per 100,000 last year. More Americans of every age between one (1) and twenty nine (29) die from motor vehicle crashes than any other cause. In 1999, an average of 112 people were killed every day of the year – one every thirteen (13) minutes, for a total of forty one thousand, six hundred and eleven (41,611). Highway fatalities account for 94% of all transportation deaths.

At the current rate, over 100,000 people will die during the first decade of the century in motor vehicle crashes even though they are wearing safety belts without improvements to passenger compartment integrity and improved occupant protection systems. Over the past five years, the number of buckled drivers and occupants who have died in crashes has increased from 9,680 To 11,295. No significant effort has been undertaken to understand the failure mechanisms associated with these deaths or to explore potential restraint enhancements that could favorably affect these deaths.

On average, a person was injured in crashes every 9 seconds, and someone was killed every 13 minutes Midnight to 3 A.M. on Saturdays and Sundays proved to be the deadliest 3-hour periods.

Project Definition and Goals

The research project objective was to determine perceptions of college students regarding utilization of transportation recorders in the highway mode.

Method of Solution

Approximately eighty (80) college students were asked to read a press release from MSNBC dated June 1, 1999, regarding announcement of General Motors "black box crash data" technology. After reading this article and following a session of asking clarifying questions, these students completed a non-personal identifier form to permit establishing basic driving history information. The students were asked to express their perceptions (not opinions) regarding possible implementation of this technology. They were asked to list both the positive and negative aspects, and were encouraged not to draw and quick conclusions until carefully researching the topic. The goal was to be academic and objective, regardless of personal opinions. This was easy to state but hard to accomplish. To assure objectivity, two student advocates were asked to monitor and consolidate the group responses in compendium format. Thus, one very proactive student advocate in favor of emerging safety technologies was asked to coordinate all of the positive input, and one very proactive student advocate in opposition to emerging safety technologies was asked to coordinate all of the negative input from the group. I served as a professor with knowledge of transportation recorder history and the current initiatives amongst NTSB & NHTSA. I strove to provide an objective overview without inherent bias to assure that both sides of the issues were adequately addressed and equally represented. All statistical data were reviewed and compiled by a yet another proactive student without inherent bias. Additionally, a local amateur photographer was identified who contributed crash photographs to this research project. The data was tabulated and verified for objectivity, credibility, and relevance by three faculty reviewers.

The majority of persons killed or injured in traffic crashes were drivers (64%), followed by passengers (32%), pedestrians (2%), and pedal cyclists (2%).

Results

POSITIVE ASPECTS

- ◊ The data may aid in regulatory initiatives
- ◊ The data may aid in alleged defect investigations
- ◊ The data may aid in litigation cases
- ◊ The data may help in initiatives to improve driver behavior
- ◊ The data may aid law enforcement efforts
- ◊ May help determine dangerous traffic areas
- ◊ May help engineers design a safer car
- ◊ May help gather accurate statistics
- ◊ May lead to decreased vehicle prices
- ◊ May lead to deceased insurance rates
- ◊ May identify conditions and situations
- ◊ Where additional safety devices could be used
- ◊ May provide information as to why some crashes are fatal and others are not
- ◊ May provide actual crash velocity data in real time conditions
- ◊ May reduce the amount of crash testing in labs
- ◊ May become so ordinary that owners/drivers will not know/care if it is present
- ◊ May help provide quicker emergency response time to crashes
- ◊ May provide better understanding as to how a driver responds to a crash
- ◊ May provide better understanding as to how occupants in various positions respond
- ◊ May provide a better picture of overall crash behavior
- ◊ May catch people who intentionally crash cars to collect insurance
- ◊ May determine the number of occupants within a vehicle and help cut down on insurance fraud
- ◊ May provide critical information that will determine causes o injuries and fatalities
- ◊ Will eventually allow us to better understand automobile crashes
- ◊ Will make the insurance company's job easier
- ◊ Will increase the safety of cars to be built in the future
- ◊ Will most likely increase seat belt usage
- ◊ Seat belts will save lives if increasingly worn with a an EDR sensor
- ◊ The speed of the vehicle at the time of the crash can be determined accurately-whereas before it could not
- ◊ We will have factual information instead of estimated data on police reports
- ◊ It may encourage safer driving habits
- ◊ Insurance reports may be more consistent

- ◊ Crashes without eyewitnesses will now have evidence
- ◊ Insurance fraud will be less frequent because objective data of the accident will be on the record
- ◊ Drivers may maintain safer speeds
- ◊ Data can distinguish between two parties who disagree on what really happened
- ◊ In crashes, the driver who was not at fault will receive justice, instead of being victimized
- ◊ Could help detect defective parts that cause crashes
- ◊ May assist doctors in understanding crash injuries
- ◊ May determine if the vehicle systems were all operating at the time of a crash
- ◊ Could determine if the driver was operating the vehicle in a reckless manner
- ◊ Could tell if the road conditions were poor
- ◊ Make people more aware of their vehicle
- ◊ May lead to improved occupant restraint systems
- ◊ May lead to improved air bag safety
- ◊ May determine if children were in-position or out-of-position
- ◊ May help locate stolen vehicles
- ◊ May provide an accurate number of daily, weekly, monthly, and yearly crashes in specific locations
- ◊ May provide a more realistic number of crashes that actually occur and are not reported
- ◊ May be tied into the defect/recall system of identifying unsafe products
- ◊ May help to reduce road rage behavior
- ◊ May aid in eliminating habitual drunk drivers from the highways
- ◊ May aid in school bus safety
- ◊ May provide exact time of crash
- ◊ May provide exact location of crash
- ◊ May provide actual seat belt usage
- ◊ May determine faulty systems
- ◊ May signal emergency response
- ◊ May cause the driver to drive more cautiously and considerately
- ◊ May create new industries and jobs
- ◊ The data could be used in your favor and help defend your interests
- ◊ Used on a select population of at-risk drivers (teenagers) it may cut-down on irresponsible driving and save precious lives
- ◊ Public involvement in automobile safety may be stimulated and increased via an EDR program
- ◊ Public participation would enhance safety

Negative Aspects

- ◊ EDR Technologies may make it possible to place private vehicles under continuous surveillance
- ◊ EDR Technologies could reduce informational and personal privacy
- ◊ Links to the GPS constellation of satellites may make it possible to track the whereabouts of private vehicles at all times
- ◊ The costs of installing and maintaining EDRs could increase vehicle prices
- ◊ The complexity of EDR devices could increase repair and maintenance costs
- ◊ The EDR data could be misused by government
- ◊ The EDR data could be misused by law enforcement
- ◊ The EDR data could be misused by insurance companies
- ◊ The EDR data could be misused in litigation, may prolong litigation, or increase lawsuits
- ◊ The EDR data could be misused by OEM's in warranty or drivers' related disputes
- ◊ The cost in introducing EDRs to the highway mode may increase the taxpayer's burden
- ◊ Personal identifiers available at local/state archiving levels may become entangled within the federal level of archiving crash data
- ◊ There are serious concerns regarding unauthorized third-party access to EDR data
- ◊ There are serious concerns regarding the validity and security of the data from unauthorized intrusion, access, corruption or alteration
- ◊ The permanent archival methodology needs to be defined
- ◊ The extent, nature and usage of archived EDR data needs to be defined
- ◊ The questionable need for such an archive needs to be rationalized and justified
- ◊ The public is unaware of the existence of ongoing research activities and projected deployment of EDR technologies
- ◊ The consumer has thus far been given no choice regarding the presence of EDR technologies in private vehicles
- ◊ There are serious concerns that no choice will ever be offered
- ◊ Transportation recorders and the data they gather could be used to infringe constitutional rights
- ◊ First Amendment rights to freedom of religion, speech, and assembly could be abridged if government agencies have detailed knowledge of private vehicle's movements
- ◊ Fourth Amendment of rights to freedom from unreasonable searches and seizures could be

abridged if government or law enforcement have access to transportation recorder surveillance data

- ◊ Fifth Amendment rights to freedom from self-incrimination could be abridged by government and law enforcement access to EDR data
- ◊ No technology is infallible
- ◊ The EDR could malfunction or cease operating
- ◊ Electrical or other information related on-board systems could be damaged by EDR failures
- ◊ The EDR could be damaged or destroyed in a severe crash
- ◊ There are serious concerns regarding the admissibility of EDR data in litigation
- ◊ Specially in the case of malfunction, inaccurate data or contradictory eyewitness accounts
- ◊ Without common standards EDRs would provide differing degrees of accuracy
- ◊ There are serious concerns regarding the "big brother syndrome"
- ◊ The feelings of "being watched" could cause a reluctance to use private vehicles utilizing EDR technologies
- ◊ The existence of such surveillance could infringe the right of personal autonomy
- ◊ Ownership of EDR data is a critical issue
- ◊ Chain of custody of EDR data is a critical issue as the consumer may be denied access to the data
- ◊ Emergency calls for minor crashes would divert EMT/EMS from major crashes
- ◊ EDRs may provide only a part of a complex crash scenario excluding other vehicles
- ◊ EDR data may have little or no immediate value to victims of crashes
- ◊ EDR data may not provide sufficient information value to assist emergency room teams in caring for victims
- ◊ EDR data may substitute pre-market crash testing effectively using the victims as crash-test subjects
- ◊ EDR data may cite "human error" as the causative factor and thus provide nothing about the actual behaviors leading to the crash
- ◊ EDRs in rental fleets may be used against the consumer
- ◊ EDRs may open a legal can of worms that will increase litigation
- ◊ EDRs may only appear in luxury vehicles and limit others from having data

Persons 16 to 20 years old had the highest fatality and injury rates per 1000,000 populations.

Data Elements

Event Data Elements include, but are not limited to active suspension measurements, advanced systems, air bag inflator time, air bag status, airbag on/off switch position, automatic collision notification, battery voltage, belt status of each passenger, brake status-service, brake status-ABS, collision avoidance, braking, steering, etc., crash pulse-longitudinal, crash-pulse lateral, CSS presence indicator, Delta-V-longitudinal, Delta-V-lateral, electronic compass heading, engine throttle status, engine RPM, environment as ice, wet, temperature, lamination & other, fuel level, lamp status, location via GPS data, number of occupants, principle direction of force, PRNDL position, roll angle, seat position, stability control, steering wheel angle, steering wheel tilt position, steering wheel rate, time and date, traction control, traction coefficient estimated from ABS computer, transmission selection, turn signal operation, vehicle mileage, vehicle speed, VIN, wheel speeds, windshield wiper status, yaw rate, turn-key start time, vehicle movement time, location at start, velocity at crash, trip time at collision or crash, fire in cabin, water in cabin, audio-chip at air bag deployment.

Key Data Elements

Although an EDR may ideally provide any, or all, of the data elements mentioned above the most critical data elements are: 1) time, 2) location, 3) direction of impact, 4) velocity, 5) number of occupants, 6) seat belt usage, and crash pulse characteristic.

95% of the 12 million vehicles involved in motor vehicle crashes in 1997 were passenger cars or light trucks.

Crash Pulse

Crash pulse is an important concept used in analyzing crash data. A notice in the Federal Register about federal motor vehicle safety standards and occupant protection, noted that crash pulse means the acceleration time history of the occupant compartment of a vehicle during a crash. This is represented typically in terms of g's of acceleration plotted against time in milliseconds (1/10000 second). The crash pulse for a given test is a major determinant of the stringency of the test and how representative the test is of how a particular vehicle will perform in certain kinds of real world crashes. Generally speaking, the occupant undergoes greater forces due to the secondary collisions with the vehicle interior and restraint systems if the crash pulse is shorter, which would lead to higher overall g's. In a relatively "hard" crash pulse, a vehicle's occupant compartment decelerates relatively abruptly, creating a high risk of death or serious injury. In a relatively "soft" crash pulse, there is a lower rate of deceleration and proportionately lower risk of death or serious injury. The nature of the crash pulse for a vehicle in a given frontal crash is affected by a number of factors, including vehicle speed, the extent to which the struck object collapses and absorbs injury, and, in the case of non-fixed objects, the relative mass of the vehicle and the struck object. Large cars typically have relatively mild crash pulses, while small cars and utility vehicles typically have more severe crash pulses.

Classification of Event Data Recorders (EDRs)

Classification of EDRs into two major types—Type I and Type II—may accelerate the deployment of EDR technologies. Type I classification of EDRs should establish a minimum but essential set of data elements. A potential list of elements for a Type I EDR could be: 1) time, 2) location, 3) direction of impact, 4) velocity, 5) occupants, 6) seat belt usage, and 7) crash pulse characteristic. The specific goal is to simplify the equipping of a large fleet of vehicles to retrieve and analyze crash data. Type II EDRs will evolve with the emerging technologies and may include appropriate data elements targeting the vehicle type. The specific goal of Type II data element analysis will be to improve highway efficiency, mobility, productivity, and environmental quality by providing compelling cause and effect evidence of the types of crashes, the role of human error, systems engineering, and systems integration issues.

Respect for Ownership of the Data

Privacy is the most important issue regarding the success or failure of implementing Event data Recorders (EDRs). A position paper presented to the National Highway Traffic Safety Administration (NHTSA) EDR Light Vehicles and Automobiles Working Group entitled Information Privacy for Event Data Recorder (EDRs) Technologies (Kowalick) 1998, noted individual motorists or others within motor vehicles have a right to privacy. Although this right to privacy is not explicitly granted in the Constitution, it has been recognized that individual privacy is a basic prerequisite for a democratic society. Indeed an individual's sense of freedom and identity depends a great deal on governmental respect for privacy. Therefore, all efforts associated with introducing future EDR technologies must recognize and respect the individual's expectation of privacy and the opportunity to express choice. This requires disclosure and the opportunity for individuals to express choice specially about after-market products. Original Equipment Manufacturer (OEM) EDR technology limits an individuals right to privacy and choice. After market value added EDR products permit free market competition and a sense of ownership. Several stand-alone after-market technologies can be easily be combined to produce an after-market EDR virtually independent of the vehicle architecture thereby permitting a common standard for retrofitting to a vehicle fleet. Since individuals will operate and occupy vehicles equipped with EDRs that record data elements it follows that information is created about both individuals and vehicles. Individuals should have the means of discovering how the data flows. A visible means of the type of data collected, how it is collected, what its uses are, and how it will be distributed is basic to consumer acceptance. Consumers should also have a choice in making this data available for post-crash analysis. Numerous studies cite the number one concern of the public as understanding the reason that are being subjected to this technology up-front, candidly and directly. Responsibility for disclosure should be high priority and may be achieved through methodologies via print-material formats, etc. Disclosure must be constant and consistent. Any data collected via EDR technologies should comply with state and federal laws governing privacy and information use. All data collected and stored should make use of data security technology and audit procedures appropriate to the sensitivity of the information. EDR data storage should include protocols that call for purging of individual identifier information respectful of the individual's interest in privacy. Information collected should be relevant to the purpose and mission statement associated with the EDR disclosure statement. Consumers should have the reasonable assumption that they will not be ambushed by information they are providing. Information derived from EDR technologies absent personal identifiers may be used for other purposes clearly stated in the disclosure statement. Information including personal identifiers may be permissible if individuals receive effective disclosure and have a friendly means of opting out. Personal information should only be provided to organizations that agree to abide by the privacy principles stipulated in the disclosure statement. Should the EDR technologies be maintained in a government database Federal and State Freedom of Information Act (FOIA) obligations require disclosure. Such databases should balance the individual's interest in privacy and the public's right to know. Permanent or temporary storage of the data should preclude the possibility of identifying or tracking either individual citizens or private firms.

Who Owns the Data?

There are many problems and concerns connected with the question of ownership of the EDR and the data that is generated. It has been argued that vehicles are sold to consumers without any vestigial interests retained by manufacturers, and thus the vehicle owner would presumably own the data as well. If this is true then the ability of public authorities to access the data is greatly reduced and may be impossible since the owners can withhold the data if they felt it would not serve their self-interest. Another problem arises when a supplier rather than a motor vehicle manufacturer retains ownership of the data, and controls access by utilizing proprietary protocols that essentially prevent anyone else from accessing the data. However, suppliers may report the result of the data extraction. It has been suggested that these problems might be overcome if the manufacturer retained ownership or if an agreement allowing access to the data could be arranged with the owner of the vehicle. The complexity of these solutions would hamper implementation of a Event Data Recorder. The simple solution is to design a system that transmits the data from the vehicle to a secure archive for post-crash analysis. An important concept here is that a minimum of essential data elements be transmitted.

An EDR can provide knowledge to reduce crashes and mitigate the consequences using cost-effective socially acceptable strategies.

This underscores the need to classify EDRs to permit simple implementation. All future vehicles should have the ability to transmit Type I data parameters. Problems associated with permission from the owner and access to the vehicle are overcome by transmitting data through a secure encrypted digital cell link to an archive. A simple release from the owner is all that is legally required. Positive incentives for the owner could include reduced registration fees and a disclaimer that personal identifiers will not be collected and privacy would be protected. An example:

DISCLOSURE INSIDE VEHICLE

THIS VEHICLE CONTAINS A SYSTEM TO TRANSMIT CRASH DATA ELEMENTS TO A SECURE ARCHIVE FOR POST-CRASH ANALYSIS. THE OWNER OF THE VEHICLE MAY ACCESS THE DATA.

Fires occurred in 0.1% of the vehicles in all traffic crashes in 1997. For fatal crashes, however, fires occurred in nearly 3% of the vehicles involved.

CONCLUSIONS

The vehicle safety problem is complex and multi-faceted. Event Data Recorder (EDR) technologies can serve as a catalyst for a national debate on the efficacy of emerging transportation safety technologies. Event Data Recorders (EDRs) will accelerate deployment of driver-assisted technologies, collision avoidance systems, vehicle diagnostic systems and advanced medical response capabilities. Event Data Recorder (EDR) technologies will include retrieving, gathering, storing and transmitting objective data which will improve highway efficiency, mobility, productivity, and environmental quality by providing timely and compelling evidence of the number and types of crashes, the role of human error, systems engineering and systems integration issues. Improvements in information technology will facilitate timelines and improved data collection and dissemination. Dramatic developments in advanced technologies will be the single greatest factor influencing changes in future transportation safety. These developments should be linked with advancements in today's $300 billion telecommunications industry. The transportation mandate is to move people and products, while communications moves data and ideas. Combining these two industries will provide a link and a network for billions of users across the globe and reinforce each other's growth. Real-time crash data collection via satellite-based services will become a major resource for planners of future transportation systems. There has never been a time in transportation history when so much was technically possible. Implementing Event Data Recorders (EDRs) would greatly enhance motor vehicle safety.

Motor vehicle-related injury and death is the nation's largest public health problem. The loss is unacceptable –it's about time we find a solution.

RECOMMENDATIONS

1. Place high priority on implementing Event Data Recorders (EDRs).
2. Encourage public involvement and protect privacy.
3. Increase research funding and hold international symposiums.
4. Establish technical standards.
5. Expand current initiatives to improve the collection, management and analysis of crash data.

ACKNOWLEDGMENTS

Thomas Michael Kowalick is a ranked professor of Holocaust Studies and History at Sandhills Community College, Pinehurst, North Carolina and president of *Click Global, LTD., / Click, Inc.--Transportation Safety Technologies,* Southern Pines, North Carolina, USA and London, UK. Professor Kowalick is a member of the two USDOT/NHTSA Event Data Recorder (EDR) Working Groups. His research publications appear in National Transportation Safety Board (NTSB) proceedings and numerous transportation dockets.