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Black Box and possibilities of application to driver education

Introduction

The project “Black Box” is solved in the frame of R&D of the Ministry of Transport of the Czech Republic in the period IV.2004-XII.2006.

Black Box (Event Data Recorder) allows to collect, record, store and export data related to motor vehicle pre-defined events. The name of project is derived from the "black box" data recorders used in airplane cockpits. Also we would like to build up a small black box which anybody can have built into their car. Simply put this accident data recorder should download pre-crash, crash and post-crash data from the vehicle, setting the standard for accurate and reliable products designed to help professional accident reconstruction, law enforcement, the insurance industry, and others do their jobs better and faster and also to make vehicle and highway transportation safer and reduce fatalities.

1 History

Event Data Recorders (EDRs) have been used for many years to record crash related measurements, including the crash deceleration of a vehicle. Early efforts conducted by National Highway Traffic Safety Administration (NHTSA) incorporated a device, circa 1970s, which used analog signal processing and recording devices to analyse and store the crash data. In 1974, The NHTSA Disc Recorder Project equipped 1000 vehicles in several fleets that totalled 26 million miles. Twenty-six crashes were analysed, measuring delta-Vs up to 20 mph. Actual deceleration-time histories were collected. During the same year, General Motors (GM) introduced the first regular production driver/passenger airbag systems in selected vehicles. These units contained a data-recording feature for deploying air bags in severe crashes.

In 1976, General Motors (GM) introduced SDM (Sensing & Diagnostic Module) technologies on a limited number of vehicles. By 1990, General Motors (GM) added DERM (Diagnostic and Energy Reserve Module) technologies to record closure times for both the arming and discriminating sensors as well as any fault codes present at the time of deployment of the air bag. During the early 1990's, General Motors (GM) installed sophisticated crash data recorders on 70 Indy Formula One race cars.

In 1992, the European Union Drive Project II 2007 SAMOVAR (Safety Assessment Monitoring on Vehicle with Automatic Recording) research program in the United Kingdom, The Netherlands and Belgium involved 850 vehicles for a 12 month period with results indicating that EDRs reduced the accident rate by 28 percent and costs by 40 percent.

2 State of the art

The current situation of the mounting Black boxes into the vehicles is very self-conscious, cause available products are focused more on passenger vehicle. Device as UDS (Unfalldatenspeicher = Event data recorder) cost about 1500€ . There is necessary to notice, that one of the obstacle enabling to enlarge the black boxes is that evaluating software is not distributed to officially appointed experts for free.

2.1 World activities

Driven by the lack of uniform scientific crash data needed to make vehicle and highway transportation safer and reduce fatalities, the Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA) has begun working to create the first universal standard for motor vehicle event data recorders (MVEDR).

The IEEE standards project, IEEE P1616 "Motor Vehicle Event Data Recorders," brings together industry and government experts to formulate a minimum performance protocol for the use of onboard tamper and crash-proof memory devices for all types and classes of highway and roadway vehicles. This international standard will help manufacturers develop devices the public commonly refers to as "black boxes" for cars, trucks, buses, ambulances, fire trucks and other vehicles.

The MVEDR standard will define what data should be captured, including date, time, location, velocity, heading, number of occupants and seat belt usage. It will also define how that information should be obtained, recorded and transmitted.

The IEEE P1616 project builds on more than a decade of ongoing MVEDR research and development. Major studies in this field have been or are being done by the Department of Transportation (USDOT), the National Highway Transportation Safety Administration (NHTSA), the Federal Motor Carrier Safety Administration (FMCA), the Federal Highway Works Administration (FHWA), the Transportation Research Board (TRB), the National Academy of Sciences (NAS), and many of the world's automotive, truck and bus manufacturers.

Related to this topic is also proposal from the French experts concerning the standardization study of an events data recorder (EDR)

During its 132nd session, GRSG was mandated by WP.29 to work on the international standardisation of an events data recorder (EDR), so that the equipment of EDR on new cars might become mandatory. The suggested purpose is to record, at low cost, the main driving parameters during a few seconds before and after a crash when airbags have been operated, in order to analyse the causes and circumstances of this crash. It is therefore proposed to collect and record relevant data from the existing calculators on M1 category vehicles. The precise list of recorded parameters could for example be as follows :

- vehicle speed ;
- driver and passenger safety belt data, if available ;
- lighting controls, including the following items :
- position lamps ;
- headlights ;
- headlamp driving beams ;
- direction indicators ;
- brake contact ;
- V.I.N.

Data recording duration and frequency must also be defined. Data recording duration could for example be 10 s before the crash and 5 s after the crash, and the frequency could be10 Hz. The interface for data recollection must be precisely defined, especially data structure and plug standards. This standardisation requires ISO co-operation.The French expert proposes to develop a new Regulation, in co-operation with all interested experts and ISO, in order to transmit a proposal for consideration at a future GRSG session.

3 Black box study shows a reduction in the number of accidents

Human behaviour is a determining factor in road safety. For this reason, it is of crucial importance to encourage people to behave safely in traffic. It is known that people aware of being observed tend to modify their behaviour. By observing and recording the behaviours of drivers, it might then be possible to confront them with their behaviour. This could mean that drivers who realise that this can happen will adjust their behaviour ahead of time. They can also react this way as a result of an actual confrontation. For this form of behaviour influence to prove effective, it would ultimately have to result in fewer road traffic accidents.

Within this context, then, the goal of the study (R-97-8) was to investigate if road safety could actually be increased by creating the possibility of confronting drivers when necessary with objective data about their own driving behaviour being recorded by telematic monitoring devices mounted inside their vehicles. For this purpose, a study would monitor whether using this feedback mechanism would result in fewer and/or less severe road traffic accidents in actual everyday experience.

The first phase of this study was carried out within the framework of SAMOVAR, a project within the European Union Commission's research programme known as 'DRIVE 2'. Implementing the follow-up phase was made possible by the cooperation of the Association of Dutch Insurers.

The attentive employment of these devices have indeed made drivers drive more carefully, resulting in fewer collisions and less costs as can be seen from this overview:

	Pokles nehod	Pokles nákladů
Samovar (1995)	-28 %	-40 %
WKD Security (1995/1996)	-30 %	-
Federal police Vienna (1995/1996)	-18 %-	-40 %
Suedbaden Bus Co. (1996)	-18 %-	-59 %
Taxi Hatscher (1996/1997)	-66 %-	-
Berlin police (1997/1998)	-20 %	-25 %
Border police (1997/1998)	-9 %	-34 %
Rotterdam police (1999/2000)	-	-25 %
London Met. Police (2000/2001)	-25 %	-

source: Siemens VDO-automotive

4 Outlook For Success

This technology has a huge chance for success. The ability to have real time, objective crash data is truly exciting. NHTSA's first administrator developed a matrix that shows the information related to a crash. All we currently know is:

TABLE 1 Haddon Matrix before EDR application

	Human	**Vehicle**	**Environment**
Pre Crash		Skid marks	
Crash		Calculated Δv	
Post Crash	Injury	Collision damage	Environment after crash

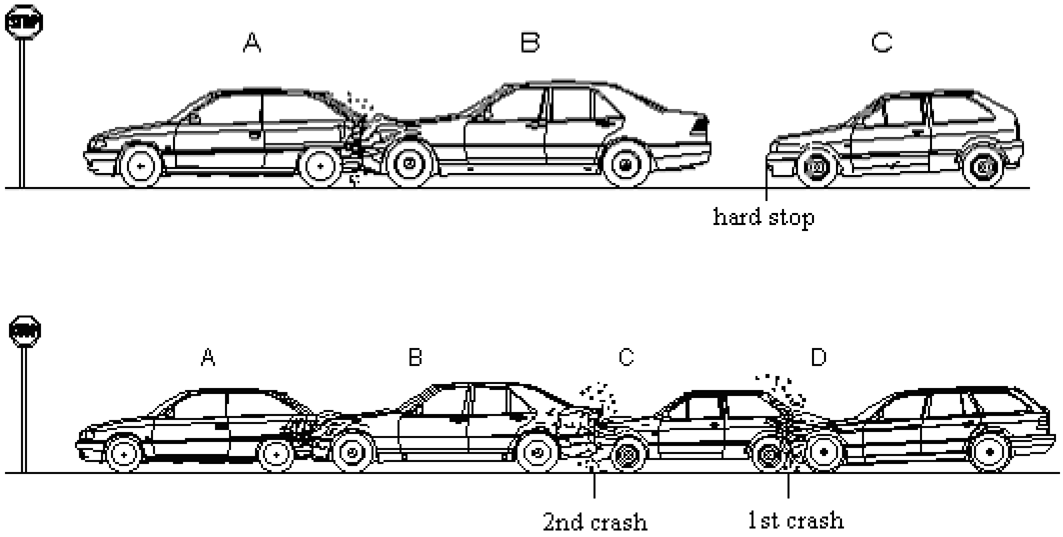
With event data recorders we can fill in the blanks, creating this matrix:

TABLE 2 Haddon Matrix after EDR application

	Human	**Vehicle**	**Environment**
Pre Crash	Belts, steering, braking	Speed, ABS, Other controls	Conditions at the time of crash
Crash	Air bag data, pre-tensioners	Actual crash pulse, Actual Δv, Vehicle dynamics, Air bag deployment, time	Location
Post Crash	Injury	Collision damage	Environment after crash

This is much more data than is currently know. The fact that this data is already in electronic form also allows it to be attached to an electronic accident report form, supplementing an accident investigators post-crash assessment. There is also the possibility of instant crash reporting.

In the case of common crash investigation is hard to find a confirming evidence. One of the sources are statement of witness that are subjective interpreted. The typical example of subjective accidence's description of drivers are accidences caused by bumping in the queue of more cars. This art of accidence come about especially often in the highways or expressways. Its are characteristic by small times differences between individual accidences. Statement of the witness can be used only if its are authentically accessible or can't be used at all. Black box could give this art of information in this situation exactly. On this information is possible to specify crash time and its details exactly. (see picture 1)



picture 1

By using data from the Black box it is possible to confirm or refute a statement of the witness. So the Black box opens a new possibilities of the research in the psychology area. The Black box data inform us also about drivers behaviour. So attributes like hectic, aggressive, usual or unmatched to the road condition could be replaced by real definition of the drivers´ manner.

By using black box in vehicles is possible to reach new accident research possibilities because it makes possible to analyse a rise of the accidents on the basis of the exact data. Here are included mainly the results of the analyses, that make possible validate and optimise a existing safety conception of the vehicle construction e.g. dynamic dimension or new technical devices (Adaptive Cruise Control, Breaking Assistant,). Important think is that is possible to analyse a real reaction caused by a fear and panic, instead of control driving tests. By this way of analysis we can get not even findings about behaviour of the "usual" driver, but also we can get a model behaviour divergent from normal to misuse.

5 Conclusion

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A black box mounted in the vehicle could help to answer following questions, that could be very helpful for the crash research, investigation and education of a drivers.

Questions related to the mass crash:

- Was it given the intention to change the lane in time?
- Were the caution lights switched on in time?
- Have the cars in the accident used warning (siren, the left indicator lamp)?
- Are there mentioned the mistakes of the driver with high vertical acceleration (for example by avoid movement)?
- Was the accident affected by side wind (in the connection with high speed)?
- Was the stabilisation of ride stigmatised by the state of drive way (rut depths)?
- Was it by optimum used the breaking power of vehicle (short reaction time or braking shortly under wheel blockage limit)?
- Were there braking and the avoiding movement carried out at the same time?
- What was the speed and distance differences between the cars before accident?

Questions related to the crash on the crossroads:

- Was the direction indicator of the direction change used in time?
- Were the lights on?
- Was the second accident participant by optical and acoustical signs warned in time (horn, light hooter)?
- Were the brakes used quickly and without any delay?
- Was the avoiding movement made in time of using brake. What direction was made in?
- How high was the acceleration in the time of starting (cogitation about possible prevention of the crash in the crossroad)?
- What is average acceleration of the vehicle in the crossroads (with or without lights)?
- How much is the percentage of potential capacity of the car to accelerate in the critical situation really used?

Questions related to the accident with a pedestrian:

- Were the car lights (passing or full beam) on?
- When was a first driver reaction on pedestrian (breaking or throttle release)?
- When the driver used the horn?
- Was the break pedal activity immediately (break delay)?
- Was the braking continual and with highest possible retardation?
- Made the driver the avoidance manoeuvre with fully usage of the brakes?
  In which direction was it made (to the left, to the right)?

Following questions are relevant for the pre-crash phase research.

- How close to adhesion limit are getting the drivers when they are going thought the curve?
- When and how drivers accelerate and brake in the curves?
- How strong is the car braked before the crash and critical situation? How much percentage of deceleration is usually used?
- How high is average acceleration by driveaway? Are there differences by passing of crossroads, driveaway on crossroads or driveaway when entering on expressway (highway)?
- How high is the lateral acceleration when a driver change a lane? (leaving the lane, shifting in the lane) Which bend the car goes in? How much width of the way is used? Is there any dependence?
- How often is the car equipped by ABS braked and driven in the same time?
- Is it possible to use advantages of a new axle road kinematics and chassis construction effectively.? (for example both steered axle)
- When drivers' unavailable movement in passing thought double curve (passing left - right) leading to the loosing of stability of vehicle?.

So we can get conspicuous attributes for group of cars or drivers, like>

- Are there differences among (acceleration, breaking, driving etc.) younger and older drivers' behaviour in pre-crash phase?
- Are there the drivers' behaviour different among male and female?
- Are there differences in the risk willingness during the day and the night ? (e.g. driving from the night party)
- Does affect different conceptions of the vehicle (front-wheel drive and back-wheel drive) happenings in the pre-crash phase?
- Does the risk willingness depend on the engine power or other relevant car characteristics?