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Event Data Recorders: A New Resource for Traffic Safety Research?

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Introduction

The use of on-board electronic recorders in the aviation industry is well known. In the event of a crash, the recovery of in-flight recording systems is a priority for collision investigators, and the data obtained becomes an integral part of the crash reconstruction process. Less well known is the fact that event data recorders (EDR) are present on most late-model cars and light trucks. These systems offer tremendous potential to traffic safety researchers, affording access to a wealth of new data, enabling better understanding of on-road traffic safety issues, and providing opportunities for the development of new and effective countermeasures.

On-board electronic data recorders are not a new concept; such systems have been developed over several years. However, recently there has been a proliferation of such technology into the vehicle fleet, primarily as a result of the introduction of supplementary air bags and, in particular, due to the need to monitor and control the deployment of these systems.

Many current air bag systems have adopted single-point sensing where a vehicle-mounted accelerometer is used to monitor the crash pulse. A microprocessor analyzes the vehicle's acceleration-time history and, based on pre-programmed decision logic, determines when air bag systems should be deployed. Using some of the computer memory present in such systems, manufacturers have been able to store certain data relating to a given collision event. Retrieving and analyzing such data has provided a means to refine vehicle safety systems, particularly the logic paths implemented to deploy air bags and seat belt pre-tensioners.

Many other systems on the vehicle now utilize electronic technology. For example, engine management and emission control systems often use microprocessors, as do anti-lock braking and traction-control systems. As a result, manufacturers are moving to the use of computer-bus systems to facilitate the flow of required information around the vehicle. The ready availability of such signals provides for the capture of certain pre-collision data elements such as vehicle speed and brake switch application status.

The quantitative and objective information recorded by on-board systems is an invaluable resource for safety researchers wishing to identify specific factors which may have precipitated a collision, and to reconstruct the nature and severity of the collision itself.

While many late-model vehicles are already equipped with event data recorders, there is currently no standardization as to the nature of the data which is recorded, the format in which it is stored, and the means by which it can be retrieved. In fact, the data format and data retrieval tools are generally proprietary to any given motor vehicle manufacturer.

A notable exception to the latter is the approach taken by General Motors Corporation in developing a system which can be used to interrogate the sensing and diagnostic modules installed on their vehicles. It is this Crash Data Retrieval (CDR) system which will be used to exemplify the type of data which can be obtained from current event data recorders.

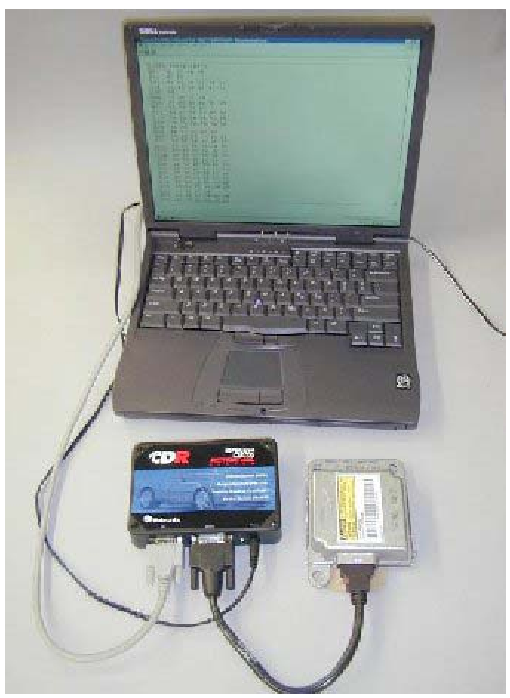

Figure 1. Crash Data Retrieval System

Crash Data Retrieval System

For a number of years General Motors Corporation has installed event data recorders on many of their vehicles equipped with air bags. Initially very limited information, including the presence of any air bag fault codes and a variety of times associated with sensing and deployment, were recorded. Over time, the recording systems have evolved so that additional data, such as the vehicle's longitudinal change in velocity (delta-V), are captured. The most recent generation of sensing and diagnostic modules (SDM) also records some pre-crash data. Specific data elements recorded are vehicle speed, engine rpm, brake light status, and throttle position. These variables are currently recorded at each of five, one-second intervals prior to the occurrence of a crash. Also stored is the state of the driver's seat belt switch which can provide an indication of restraint use.

The EDR in General Motors' vehicles can record both an air bag deployment event and a so-called "near deployment". If the SDM identifies a potential crash, it monitors the vehicle's acceleration-time history and its built-in algorithm determines whether or not the air bag systems should be deployed. If the collision is not of sufficient severity to warrant deployment, the incident is recorded in the near-deployment file. Minor near-deployment events are over-written by more severe near-deployment events, or are cleared after 250 ignition cycles. In the event that a command to deploy is issued, the associated pre-crash and crash data are permanently written out to the deployment file in the SDM's memory. In the latter case, a warning code is set and, if the vehicle is to be repaired, the SDM must be replaced.

In order to provide access to the stored information, General Motors, in conjunction with Vetronix Corporation, has developed the Crash Data Retrieval (CDR) system. This consists of an electronic interface and cabling between a sensing and diagnostic module and a microcomputer (Figure 1), plus software to analyze and display data downloaded from the SDM.

The crash data is recorded and retrieved as a stream of hexadecimal numbers. The computer software is used to interpret these data, and to provide both tabular and graphical displays of pertinent elements. An example of a set of pre-crash data is shown in Figure 2.

In the above-noted incident, one can identify that, approximately five seconds prior to the occurrence of the collision (five seconds before the time for "algorithm enable"), the vehicle was traveling at 54 mph (87 km/h). The driver was initially applying 100% throttle and, over the next one to two seconds, the vehicle accelerated to 60 mph (97 km/h).

Around three to four seconds prior to the crash the vehicle's driver removed his foot from the throttle and applied the brakes. Note that the brake light status being "on" does not indicate how much brake pedal effort was being applied; it merely shows that the brake light was activated. The last three recorded data points indicate that the vehicle's speed dropped from 60 mph (97 km/h) to 45 mph (72 km/h) over a period of 2 seconds. These data indicate that the vehicle's average deceleration over the period while the brakes were being applied was 0.35 g. Thus, it is evident that the driver was in the process of moderate to hard braking (depending on the available coefficient of friction) just prior to the incident.

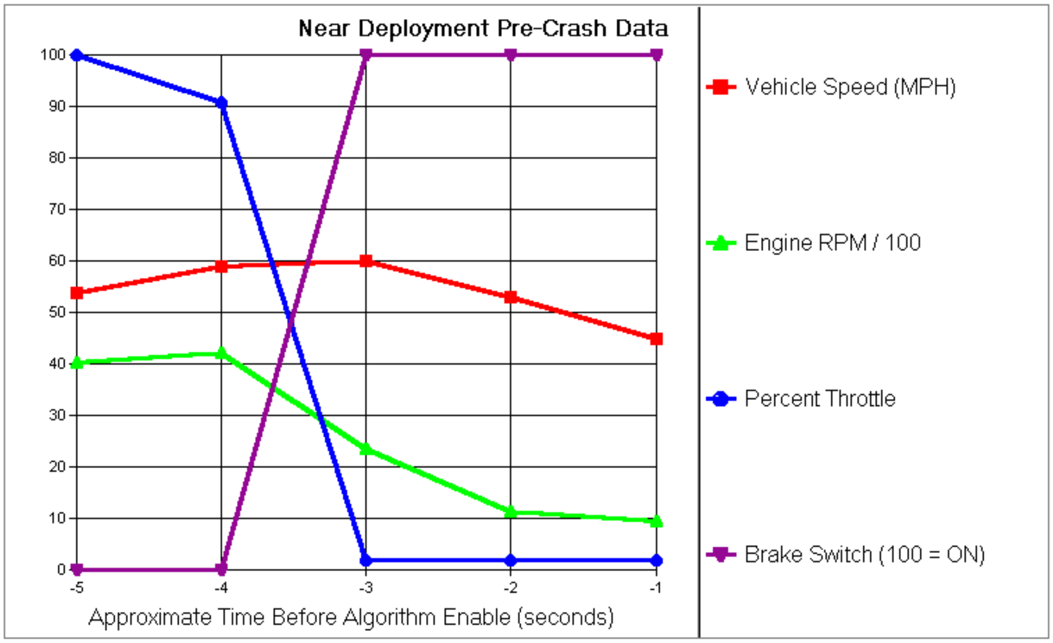

Figure 2. Chart of Pre-Crash Data

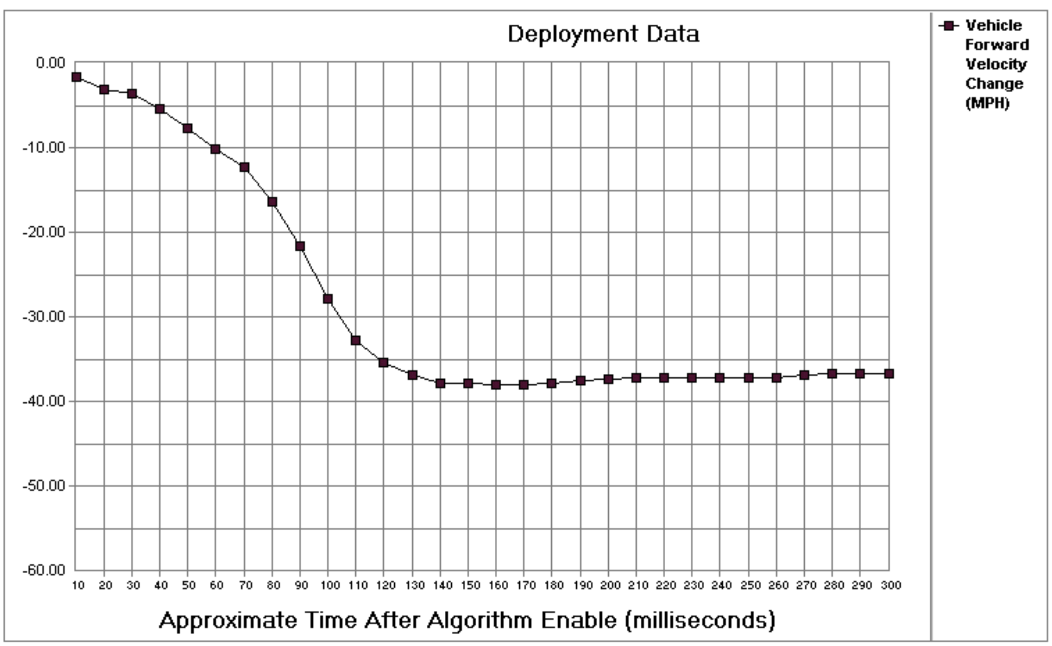

Figure 3. Chart of Delta-V versus Time

Figure 3 relates to a different collision event where a vehicle's SDM had issued a deployment command. The cumulative change in longitudinal speed for the vehicle has been calculated from the recorded acceleration-time history. The chart displays the computed delta-V, at 10 ms intervals, commencing at the time for algorithm enable. It can be seen that, during the crash phase of this incident, the case vehicle underwent a total change in speed of 38 mph (61 km/h), with this delta-V essentially occurring within a period of 140 ms.

Discussion

It is clear that data such as those presented above, when combined with other available information about a given crash, will be extremely useful both in identifying specific factors related to the occurrence of the collision, and in determining its severity. Furthermore, having a large database of such data would be helpful to researchers investigating a wide range of collision-related issues. The availability of such a database would be greatly enhanced if the electronic data were linked to more conventional collision data systems. Since such linkages could be effected in a manner such that specific collision events, and more particularly individuals involved in the crashes, could not be identified, in principle there are no impediments to developing such data systems. Nevertheless, consideration of the process by which this might be achieved raises significant questions.

Clearly, data could be captured by dedicated collision investigators equipped to access the electronic data which, when acquired, would be merged with collision data obtained from in-depth investigations and from other available sources (e.g. police reports, medical records) in an anonymous fashion. As with current in-depth collision investigation programmes, such a process would be extremely resource intensive and, while gathering extensive data on individual crashes, would necessarily be limited to relatively small samples of collisions.

At the other extreme one could envisage electronic data being downloaded from every collision-involved vehicle and stored in a mass database, in parallel with current police-reported information. Such a process would not be practical unless the crash data retrieval system was standardized, easy to operate, and affordable. Of course, technology may well come to our aid in this respect, and future vehicles may upload recorded crash data to a central location automatically!

While offering the potential for major enhancements to our traffic safety knowledge and ability to develop meaningful countermeasures, the future development of electronic crash data systems may be confounded by concerns relating to individual privacy. It is certain that recorded crash data will be of interest to a variety of groups outside of the research community. These would include law enforcement agencies, members of the legal profession, and insurance companies. These latter groups will do doubt wish to use recorded collision data to assign blame and support legal action, and so questions as to the ownership, accessibility, and use of such data in individual cases comes into question.

It is imperative; therefore, that the traffic safety community considers the utility of these data systems at an early stage, and actively champions their further development and use if they are seen to be beneficial to the cause of traffic safety.

Transport Canada has already implemented a series of pilot studies of collisions involving vehicles equipped with event data recorders. These are designed to develop expertise in the use of CDR systems, to identify problems in gaining access to electronic crash data, to develop methodologies for the storage and analysis of these data, and to evaluate the potential for application of the resulting data. Our current studies include both an evaluation of pre-crash factors involved in real-world collisions, and the use of the EDR data to assess the severity of specific crashes.

Initial experience from the above-noted research programme has been mixed. A variety of technical difficulties with the CDR system have been identified but, at the time of writing, remain unresolved by the unit's developers. Conversely, in a number of specific collision circumstances, the use of the CDR system has provided data which have been extremely useful to the understanding of pre-collision events and/or in quantifying the crash severity. Overall, the studies are demonstrating the promise of the technology. It is anticipated that further experience with these systems, together with the rapid technological advances which will no doubt occur, will prove the worth of the technology to the traffic safety community.

Further Reading

Proceedings of the International Symposium on Transportation Recorders; Washington, DC; May 3-5, 1999
http://www.ntsb.gov/events/symp_rec/proceedings/symp_rec.htm

U.S. DOT/NHTSA - Meeting Minutes of the MVSRAC/Event Data Recorder (EDR) Working Group; Docket No. NHTSA-1999-5218
http://dms.dot.gov/

Vetronix Corporation; Crash Data Retrieval System
http://www.vetronix.com/

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http://www.carsp.ca