A NEW DATA OPTION FOR A SAFE SYSTEM

Prepared by: Astrid Linder & Jim Langford
Monash University Accident Research Centre

Prepared: June 2005

1. A BRIEF STATEMENT OF THE ISSUE

All Australasian jurisdictions use mass databases based upon police reports as a primary data source for investigating crashes - perhaps supplemented by other data sources where available and appropriate (for example, in Australia the National Coroner Information System). At best, mass databases provide only a limited insight into crash issues and particularly into the actual crash phase itself, with other data sources often examining only limited parts of the total road safety problem.,

With further road safety gains proving increasingly difficult to achieve, it is important that the best available technology be used in the collection and analysis of crash data.

2. AN EXTENDED ASSESSMENT OF THE ISSUE

Crash data can be used at least for the following purposes:

- to describe the extent and seriousness of the problem
- to identify possible countermeasures for reducing crashes or crash severity
- to evaluate the effectiveness of implemented countermeasures in reducing crashes or crash severity.

All Australasian jurisdictions currently use mass databases based upon police crash reports as a primary data source in achieving these three purposes. At the same time however, it is accepted that police crash data necessarily suffer from a number of deficiencies. Apart from issues of data ascertainment, arguably the greatest limitation relates to detailed knowledge of the actual crash phase itself in providing detailed information about what produced the particular crash outcome. Retrospective assessments of crash circumstances and particularly the impact severity, will inevitably have major limitations. A detailed understanding of the loading forces in the crash as they interact with the occupant, the vehicle and features of the road environment, are critical in further developing countermeasures aimed at improved protection of vehicle occupants.

The purpose of this paper is to describe a key data source that can greatly assist the further development of effective countermeasures.

3. A REVIEW OF THE RESEARCH

There is ample evidence to support the view that detailed understanding of crash events has directly led to improved vehicle occupant protection.

During the 1950s vehicles typically had a rigid structure that in the event of crash often left the vehicle relatively undamaged. However because the rigid structure effectively transferred the crash load to the occupants, the latter were much more likely to emerge injured. Our improved understanding of crash circumstances based on investigations of real-world collisions produced a design shift to vehicles with deformable structures, which serve to absorb much of the energy of the crash in a controlled way (see Figure 1). A specific example is the steering wheel column. Fifty years ago it was a rigid rod that could penetrate the chest of the driver in the event of a crash: today the column is designed to deform substantially during a frontal collision thereby reducing the amount of crash force passed on to the driver. Today's vehicles are designed so that after the crash there can be substantial damages to the vehicle but minimal injuries to its occupants.

Figure 1. Crash performance of the front of a vehicle. (Picture from www.racv.com.au).

Another development arising from our greater understanding of crash forces is the change from rigid road infrastructures like barriers and poles to deformable structures that absorb energy during the crash (see Figure 2).

Figure 2. Pictures of deformable road infrastructure (Pictures from www.brifen.com and www.flexfence.com).

In the past we have relied upon various protocols to retrospectively find out what happened during the crash phase. Examples are police reports, in-depth investigations of real-world crashes, insurance claims and hospital reports. Researchers and engineers have linked these data to understand what happened before and during the crash and from this knowledge have produced an effective array of countermeasures. One major limitation however, has always been that any reconstruction of real-world crash severity has been necessarily crude.

The limits of traditional data sources are well exemplified by our limited capacity to estimate Delta-V, that change in velocity that occurs during the crash and which is a major factor in determining the severity of the crash. Traditionally we have had no readily available fleet-wide direct way of measuring Delta-V and have been forced to estimate it through indirect means based on vehicle deformations. It has regularly been demonstrated however that estimating Delta-V through such means is inaccurate[1 2] and can have major limitations when estimating the severity of a crash[3 4].

Putting these inaccuracies to one side, estimates of Delta-V based on traditional indices cannot be used to estimate the duration of the associated crash pulse. The crash pulse is effectively the rapidity with which the change in velocity (Delta-V) occurs[5]. The faster the delta-V is generated the greater the likelihood of vehicle and occupant damage.

One example of the importance of knowing the crash pulse is the occurrence of soft tissue neck injuries after a rear impact. For several decades researchers were mystified as to how crashes that were the same in terms of vehicle deformation (and hence estimated Delta-V) could generate markedly different injury outcomes for the vehicle occupants. The mystery was answered only through combining data from in-depth investigations, acceleration pulse recordings made during the crash and occupant injury outcomes. It was found that the risk of long-term soft tissue neck injuries was determined by both the Delta-V and how fast the Delta-V was generated (i.e. the crash pulse) [6]. This relationship has also been found for the risk of soft tissue neck injuries sustained after frontal impacts[7].

There is a ready means to measure crash pulses. The crash pulse is to various degrees of detail currently monitored in all vehicles that are equipped with airbags, by a device called the Event Data Recorder (EDR) [8]. This monitoring is necessary to determine whether there is a need to deploy the airbag and at least technically, can be readily downloaded and used in safety research. In addition, many EDRs can also provide data on a range of other factors of relevance to road safety researchers. Further, there are stand-alone after-market devices that monitor the acceleration pulse during the crash that have been and can be installed in vehicles.

An EDR works by constantly monitoring vehicle acceleration. These inputs are sampled at an appropriate rate and are stored usually for around five seconds until overwritten with new data. However if the acceleration exceeds some trigger level, normally about 2g, as would occur in an accident, the EDR stores all the preceding data permanently. This can then be downloaded and analysed to assist in understanding the accident dynamics. (The exact operation of any particular EDR will differ somewhat from this basic description, depending on the manufacturer's requirements.)

In 1974, General Motors included data recorders to record airbag firing information within the airbag system in selected vehicles[9.] More recent EDRs are capable of recording not only acceleration/deceleration data, but also driver inputs and vehicle status prior to the accident: for example braking and seat belt status, engine throttle, etc[10].

There is currently no standardization on EDR data format and storage aspects, with data format and data retrieval being generally proprietary to any given motor vehicle manufacturer[11]. Exceptions to this are both General Motors and Ford in the US. In 1990, GM released their EDR data format to Vetronix Corporation, so that they could build a Crash Data Retrieval (CDR) system. Vetronix developed a unit that could interface with GM's airbag controlling hardware and access the crash pulse and other data stored in the event of an accident. Recently Ford contracted Vetronix to write software to enable the CDR to access their EDRs. As a result, both GM and Ford EDRs record very similar data, displayed by the CDR in the same format.

The Vetronix CDR is publicly available for US$2,495 [12] .Looking at 2005 models, EDR data can now be collected from over 50 GM models, 10 Ford models, one Isuzu model and one Saab model. The equivalent figures for Australia and New Zealand are not known.

According to a NHTSA working group[13], the data obtained from EDRs have the potential:

- to improve the design of motor vehicles and diagnosis of vehicle systems
- to greatly improve traffic safety
- to reduce road fatalities, injuries and property damage
- to enable research related to vehicle performance and subsequent occupant injury outcome in accidents
- to improve crash reconstructions and analysis methodologies.

An extensive review of the usefulness of EDR data highlighted that "significant research breakthroughs will occur once EDR standards are established and adopted in the on-the-road vehicle fleet" [14]. Furthermore, it has been concluded that information from EDR "offers tremendous potential to traffic safety researchers, affording access to a wealth of new data, enabling to better understanding of on-road traffic safety issues, and opportunities for the development of new and effective countermeasures"[11]. The capacity to record and then analyse vehicle acceleration patterns in particular, means that EDRs can be useful in many contexts, including directly monitoring unsafe driver behaviours (as examples: driver fatigue and habitual speeding).

An additional use for EDR data can be identified – as a means to support to support the kind of information conveyed in the Australian New Car Assessment Program (ANCAP). By providing a more detailed statistical base to the ANCAP ratings for vehicles, EDR data could be used to support manufacturer's marketing efforts and, in turn, positively influence the overall safety standard of the Australian vehicle fleet[15].

An estimated 65-90% of all 2004 model year passenger cars and other light vehicle in the United States were fitted with some kind of EDR device, with more than half able to record the crash pulse, thereby representing an extensive and growing data source for road safety practitioners[10].

4. POLITICAL, SOCIAL AND OTHER FACTORS

There are at least two issues that would need to be addressed if the widespread collection of EDR data were to be undertaken in Australia and New Zealand:

- substantial consumer resistance might be expected, particularly if the full range of EDR data (rather than just the crash pulse recording) were collected. Apart from general concerns about privacy restrictions, drivers might also be concerned about allowing the collection of evidence attesting to their possible liability for the crash
- some measure of resistance might be expected from vehicle manufacturers. Apart from responding to consumer concerns, manufacturers might also be wary of allowing the provision of data that could possibly indicate vehicle fault in the event of a crash.

However there are means to address these concerns. Standard ethical provisions governing research programs to protect individual and corporate identities could also be applied in regard to the collection of EDR data. Furthermore, the examples of GM, Ford and others in the US in establishing arrangements that readily allow the downloading of EDR information augur well in this regard.

Once these issues are resolved, it remains to determine how many vehicle models currently released in Australia and New Zealand can be readily used in any subsequent research program entailing the collection of EDR data. Assuming that there are sufficient models either currently on the road or to be released, the research procedures then become relatively straightforward. Once an owner's permission has been granted, researchers need only locate the vehicles involved in crashes and in a simple operation download the range of EDR data particular to that vehicle.

In stressing the benefits of EDR data in developing improved occupant protection, other potential safety benefits must not be overlooked. For example, in combination with Geographical Positioning System and 'Emergency Mayday' technology, EDR data could be automatically transmitted to a hospital emergency department that would send a rescue team to the crash scene. First, EDR data would make it possible for the rescue team to be better prepared when arriving at the crash scene in response to the severity of the crash and the likely injuries to those involved in the crash. Secondly, as noted by the West Australian Office of Road Safety[15], trauma specialists in Western Australia have previously raised the clear need for a coordinated retrieval system to alleviate the 6-8 hour delay that the average crash victim experiences between the time of the crash and their subsequent admission to a major trauma facility. EDR data linked to Geographical Positioning System and 'Emergency Mayday' technology may assist victims to receive trauma services within the 'golden hour' after their crash, dramatically improving their chances of survival and their eventual health outcome.

As a final point, it needs to be recognized that collecting, managing and analysing new data invariably entails additional costs. If jurisdictions are to develop and use EDR data, it will be necessary to run a convincing argument for the benefits of this new data source.

5. CONCLUSIONS

Retrospective estimations of crash circumstances and particularly crash severity, have major limitations when attempting to understand what happened during the crash and what caused the injuries. There are currently techniques available that can measure the crash pulse and thus can provide a more accurate measurement of the severity of the crash. These techniques need to be promoted to assist engineers and researchers in their attempts to design safer systems offering better occupant protection.

REFERENCES

[1] Gabler, H. C., Hampton, C. E. and Hinch, J. (2004). *Crash Severity: A comparison of Event Data Recorder measurements with accident reconstruction estimates*. SAE Paper No. 2004-01-1194.

[2] Andersson, U., Koch, M. and Norin, H. (1997). *The Volvo Digital Accident Research Recorder (DARR): Converting accident DARR-pulses into different impact severity measures*. Proceedings of the International Conference on the Biomechanics of Impact, Hannover, Germany.

[3] Husted, D.C., Biss, D.J. and Heverly, D.E. (1999). *The appropriate Use of "Delta-V" in Describing Accident Severity*. International Congress and Exposition, Detroit, MI, USA, SAE Technical Paper Series, 1999-01-1295.

[4] Donnelly, B. R., Galganski, R. A., Lawrence, R. D. and Blatt, A. (2001). *Crash reconstruction and injury-mechanism analysis using event data recorder technology*. 45th Annual Proceedings of the Association for the Advancement of Automotive Medicine, San Antonio, Texas, USA.

[5] Linder, A., Avery, M., Krafft, M. and Kullgren, A. (2003). *Change of velocity and pulse characteristics in rear impacts: real world and vehicle tests data.* Proceedings of the 18th International Technical Conference on the Enhanced Safety Vehicles, Nagoya, Japan.

[6] Krafft, M., Kullgren, A., Ydenius, A. and Tingvall, C. (2002). Influence of Crash Pulse Characteristics on Whiplash Associated Disorders in Rear Impact – Crash Recording in Real Life Crashes. *Traffic Injury Prevention*, 3/2, 141-149.

[7] Kullgren, A., Krafft, M., Nygren, A. and Tingvall, C. (2000). Neck injuries in frontal impacts: influence of crash pulse characteristics on injury risk. *Accident Analysis and Prevention*, 32, 197-205.

[8] Kullgren, A., Lie, A. and Tingvall, C. (1995). Crash pulse recorder – validation in full scale crash tests. *Accident Analysis and Prevention*, 27 (5), 717-727.

[9] NHTSA EDR Working Group, *Event Data Recorders*, *Summary of Findings*, National Highway Traffic Safety Administration, Final Report, August 2001.

[10] NHTSA (2005). *Event Data* Recorders (EDR) Research History, National Highway Traffic Safety Administration. Available [online]: www-nrd.nhtsa.dot.gov/edr-site/history.html.

[11] NHTSA (2004). *Event Data* Recorders, *Proposal of Rulemaking*, National Highway Traffic Safety Administration, Docket No.: NHTSA-2004-18029.

[12] German, A., Comeau, J-L., Monk, B., McClafferty, K. J., Tiessen, P. F. and Chan, J. (2001). *The use of event data recorders in the analysis of real-world crashes*. Proceedings of the Canadian Multidisciplinary Road Safety Conference XII, London, Ontario, Canada.

[13] Vetronix (2004). *Crash Data Retrieval System*. Available [online]: www.vetronix.com/diagnostics/cdr/index.html.

[14] Marsh, J. (2004). *Standard Activity and Research Opportunities with Event Data recorders*. Proceedings of the Canadian Multidisciplinary Road Safety Conference XIV, Ottawa, Canada.

[15] Comment received from the West Australian Office of Road Safety, (their reference: 05/2708).