Use of Event Data Recorder (EDR) Technology for Highway Crash Data Analysis

DETAILS

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USE OF EVENT DATA RECORDER (EDR) TECHNOLOGY FOR HIGHWAY CRASH DATA ANALYSIS

This digests presents the results of NCHRP Project 17-24, "Use of Event Data Recorder (EDR) Technology for Highway Crash Data Analysis." This study developed recommendations for the enhancement of EDRs to meet the specific needs of highway crash data analysis. It also developed a recommended EDR database format for agencies that seek to collect and systematically store EDR data. This digest is based on a draft final report authored by the principal investigator, Hampton C. Gabler, and Douglas J. Gabauer and Heidi L. Newell, all of Rowan University, and Michael E. O'Neill of George Mason Law School.

SUMMARY

This digest summarizes the final report for NCHRP Project 17-24 (available as *NCHRP Web-Only Document 75*). This digest examines the benefits and the costs of using EDR data in highway crash data analysis and research. Although EDRs hold tremendous promise for improving highway crash data analysis, this digest identifies several issues that may impede the use of EDR data for this purpose. These impediments include technological, legal, and consumer acceptability concerns. These issues were investigated in depth and recommendations were developed for resolution of these potential barriers to the use of EDR data.

INTRODUCTION

Widespread deployment of EDRs, sometimes called "black boxes," promises a new and unique glimpse of the events that occur during a highway traffic collision. The EDR in a colliding vehicle can provide a comprehensive snapshot of the entire crash event—pre-crash, crash, and post-crash. In 2004, an estimated 40 million passenger vehicles were equipped with EDRs. By carefully collecting and analyzing the details provided by the growing number of EDR-equipped vehicles, state transportation agencies, federal agencies, and the highway safety research community have an unprecedented opportunity to understand the interaction of the vehicle-roadside-driver system as experienced in thousands of U.S. highway crashes each year.

State and federal transportation agencies can expect both immediate and longer term benefits from the collection of EDR data. The initial benefit for state transportation agencies will be the use of EDR data from individual traffic crash investigations as a powerful new form of evidence in legal proceedings, e.g., to defend against lawsuits or to recover costs of repairing collision damage to the highway infrastructure. With a more methodical system of EDR data collection, state and federal

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transportation agencies can expand this benefit to significantly improve the efficiency of data collection for crash statistic databases. For example, in state crash databases designed to meet the Model Minimum Uniform Crash Criteria (MMUCC) format, one-third (24 of 75) of the recommended data elements could be provided by EDRs. In the longer term, one of the crucial benefits of EDRs will be their influence on highway crash safety research. The ready availability of EDR data in a crash statistics database will enable highway safety researchers to address a number of elusive research questions that directly affect state transportation agencies, e.g., the relevancy of the NCHRP 350 crash test guidelines for roadside safety features.

RESEARCH OBJECTIVES

The objectives of NCHRP Project 17-24 were (1) to recommend a minimum set of EDR data elements for roadside safety analysis and (2) to recommend procedures for the retrieval, storage, and use of EDR data from vehicle crashes to include legal and public acceptability of EDR use.

CONCLUSIONS AND RECOMMENDATIONS

EDRs offer a remarkable new data source for improvements in highway crash data analysis and research. However, several difficult issues may impede the use of EDR data for highway crash data analysis. These impediments include technological, legal, and consumer acceptability concerns. The following subsections summarize the benefits of EDR data as well as the impediments that must be overcome to use EDR data. The subsections also present recommendations that will permit transportation agencies and safety researchers to capitalize on the full potential of EDRs for highway crash data analysis.

Benefits of Collecting EDR Data

State and federal transportation agencies that collect EDR data can expect several benefits:

- The initial benefit of EDR data for state transportation agencies will be improved investigation of individual crashes. EDR data are increasingly being used in the courtroom as another means of reconstructing aspects of the crash, such as vehicle speed. Many state and local law enforcement organizations already collect EDR data on a regular basis for fatal crash investigations. State transportation agencies will find EDR data to be a powerful new form of evidence in legal proceedings involving collisions with roadside hardware—either to defend against lawsuits or to seek damages to recover costs of repairing roadside hardware. State transportation agencies are cautioned however that the use of EDR data to assign blame for a crash is precisely what the public finds least acceptable about EDR use.
- State and federal transportation agencies that use EDR data can significantly improve the efficiency of data collection for crash statistic databases. The use of EDR data can improve the accuracy of these databases and may, in the long term, reduce the costs of data collection. Based upon the methodical examination of eight existing crash databases and three recommended database formats, the researchers conclude that a significant fraction of data elements currently being collected could be provided by either existing or future EDR data elements. For example, 56 of the 175 Fatality Analysis Reporting System (FARS) data elements could be provided by EDRs. For state accident databases designed to meet MMUCC format, 24 of the 75 recommended data elements could be provided by EDRs.
- One of the crucial long-term benefits of EDRs will be their influence on highway crash safety research. The ready availability of EDR data in a crash statistics database will enable vehicle and roadside safety researchers to address several elusive, and often technically controversial, research questions. For example
  - How relevant are the impact conditions used in NCHRP 350?
  - For roadside crashes, is there a linkage between vehicle acceleration and occupant injury? How realistic is the flail space model when evaluated against actual EDR crash pulses and hospital injury records?
  - Are current vehicle designs compatible with current roadside safety hardware designs?
  - Do impacts with soft roadside safety devices, e.g., crash cushions, lead to late airbag deployments?
  - Are advanced occupant restraint systems, e.g., dual-stage inflator systems, performing as designed?

- How accurate are the delta-V estimates in U.S. national crash databases?
- What is the distribution of impact speeds as a function of roadside object struck?
- Coupling EDR pre-impact data with highway design data, what are the relationships between highway geometric design and the probability of a runoff road event?

This research project conducted an extensive review of the roadside safety literature, which suggests that many of the data elements recommended for collection by previous research studies could either be obtained with current EDR devices or in future EDR designs. Examples of critical research data needs that could be met by either existing or near-future EDRs are pre-crash vehicle trajectory, post-crash vehicle trajectory, and the orientation of the vehicle (yaw, pitch, and roll) at the time of impact.

Costs of Collecting EDR Data

Both startup and operational costs are associated with EDR data collection. Startup costs include the purchase of EDR data retrieval units and the training of the crash investigators or law enforcement personnel who will be performing the actual EDR downloads. In addition, EDR data collection will add somewhat to the time required for crash investigation. These costs are summarized below:

- **Purchase of EDR Retrieval Equipment.** To download EDR data from crashed vehicles, state DOTs will need to purchase an EDR data retrieval unit. Currently, the only publicly available EDR download device is the Vetronix Crash Data Retrieval (CDR) system. At the time of this report, the list price of the Vetronix CDR system is $2,500. In addition, use of the Vetronix system requires data download to a portable computer or laptop; some jurisdictions may need to purchase this equipment as well for their investigators.
- **Training.** State and federal transportation agencies that wish to extract EDR data, for applications such as crash databases, should anticipate the need for specialized training in EDR data retrieval. NHTSA found that a key component of a successful EDR download program is specialized EDR training for its crash investigators. In 2002, approximately half of NHTSA's unsuccessful EDR downloads were attributed to "technical/training problems." In 2003, after conducting specialized EDR training for crash investigators, "technical/training problems" was noted as the reason for an unsuccessful download in only 10% of the cases.
- **Implementation.** State crash databases and many federal crash databases (e.g., FARS and National Automotive Sampling System [NASS]/General Estimates System [GES]) are based on data extracted from police crash reports. The exceptions are in-depth crash databases (e.g., NASS/Crashworthiness Data System [CDS] and Longitudinal Barrier Special Study [LBSS]), which are based upon data collection by crash investigators. In the near term, the collection and use of EDR data is unlikely to be a widespread practice in police-level crash data collection because the initial costs associated with the required equipment and training may present a formidable obstacle to police departments. In addition, the increased time required at the scene would likely render EDR data collection unacceptable to many law enforcement agencies for routine data collection.

  These startup costs however are only expected to be a barrier to EDR data collection in the near term. As EDR data become more widely used in the courts and as EDRs become more widespread in the passenger vehicle fleet, legal incentives to collect EDR data will grow. In many severe crashes, EDR data collection is already commonplace. Many state police fatal accident investigation divisions collect EDR data, whenever possible, to aid in their accident reconstructions. The understanding of severe accidents would be greatly improved if EDR data collected in fatal crashes by state police and other law enforcement agencies were included with case submissions to the FARS database. NHTSA is encouraged to retrieve EDR data from state accident investigators when available for storage with, and enhancement of, the FARS database.

Recommendations for EDR Enhancement

EDRs are a rapidly evolving and, in many ways, still immature technology. Although the first research studies using EDR data are confirming their potential, numerous technological issues must still be

resolved to promote the widespread use of EDR data. Following are recommendations for needed enhancements to EDRs:

- **Standardize EDR Data Elements.** State transportation agencies are encouraged to actively support the NHTSA Notice of Proposed Rulemaking (NPRM) on EDRs. Until recently, there have been no standards that govern EDR format. This lack of standardization has been a significant impediment to national-level studies of vehicle and roadside crash safety. Recently, SAE J1698 and IEEE 1616 were issued, which prescribe industry standards or recommended practices for EDRs. To date, however, no automaker has installed, or announced plans to install, production EDRs that comply with these standards. Federal regulation appears to be the only alternative action that will result in standardization of EDR data elements.

  The proposed NHTSA rule requires that EDRs voluntarily installed in light vehicles record a minimum set of specified data elements useful for accident investigation, analysis of occupant restraint systems, and automatic crash notification systems. As noted in the following paragraph, the researchers also recommend that NHTSA extend the proposed rule to include data elements that will assist roadside safety research in general. Should this not be possible in the near term however, simple adoption of the NHTSA rule in its current form would greatly advance state and federal efforts to collect EDR data to improve highway crash research.
- **Add Recommended Data Elements.** NHTSA is encouraged to extend its proposed rule on EDRs to include data elements that will assist roadside safety research in general. Based on a comparison of EDR capabilities and highway crash data analysis needs, this project has developed a catalog of 66 data elements recommended for highway crash analysis. Nearly half of these data elements are already being stored in production vehicle EDRs. Thirty-eight of these elements are defined in the NHTSA NPRM on EDRs. In the near term, the researchers recommend adopting the data elements proposed in the NHTSA NPRM and adding the following four priority roadside safety data elements: (1) crash location, (2) Vehicle Identification Number, (3) yaw rate, and (4) roll rate. In the longer term, NHTSA should require that the entire list of recommended data elements be stored in future EDRs.
- **Increase Recording Duration.** To capture roadside feature crash performance, automakers should enhance future EDRs to record for a greater length of time than is the current practice. Roadside safety analyses require knowledge of not only the pre-crash trajectory but also the post-crash trajectory. Currently, these data could be obtained if EDRs stored pre-crash parameters, such as vehicle velocity for 5 seconds, before *and* after a crash. Likewise, the recording duration of the crash pulse should be increased. Impacts with roadside features, such as a guardrail, are relatively long events in comparison with vehicle-to-vehicle crashes. To capture the entire vehicle-to-roadside event, the crash pulse should be recorded for a minimum duration of 300 milliseconds. This recommendation is consistent with the NHTSA NPRM on EDRs.
- **Increase Number of Events Recorded.** Automakers should enhance EDRs to record a minimum of three crash events. EDRs that record only a single event (e.g., the current Ford design) lose approximately one-half of the events. EDRs that record only two events (e.g., the current GM design) lose approximately 17% of the events. An EDR that records three events, on the other hand, would capture 94% of the crash events. This recommendation is consistent with the NHTSA NPRM on EDRs.
- **Expand the Definition of an Event.** Automakers are encouraged to extend the definition of an "event" to include roadway departures. Currently, an event is a crash. In addition to crashes, roadway departure, with or without an impact, is also an important event. Lane-keeping and roadway departure warning systems, which could be adapted for this purpose, are now entering the market. Accurate recording and retrieval of roadway departure events would be invaluable for encroachment studies.

Recommendations for Improved EDR Data Retrieval and Archival Methods

Currently, there is no standardized method to download data from EDRs. Similarly, there is no stan-

dardized format for storing EDR data in a crash statistics database. The following actions are recommended to alleviate these obstacles to implementation:

- **Standardize the EDR Retrieval Method.** The state DOTs should actively support the proposed NHTSA EDR rule that mandates automakers make the contents of their EDRs accessible with publicly available tools. Currently, there is no standardized method to download data from EDRs. Two automakers have awarded an exclusive license to the Vetronix Corporation to market an EDR retrieval tool for their EDRs. The remaining automakers use proprietary tools for EDR data retrieval—effectively preventing EDR access by either state or federal transportation agencies.
- **Require a Crashworthy, Universal EDR Download Connector.** NHTSA is encouraged to modify or extend its proposed rule on EDRs to require a uniform connection point for EDR download. NHTSA has found that, in a significant percentage of crashes, crash investigators were unable to use the OBD-II port, the primary Vetronix access point, to access the EDR data. Although investigators have the option to directly connect to the EDR, direct connection requires the partial dismantling of the crashed vehicle. Furthermore, direct connection requires the purchase of large numbers of different EDR connection cables because there is no universal EDR connector. The researchers recommend that NHTSA either require a crashworthy OBD-II connection to the EDR or mandate a universal connector for direct connection to the EDR.
- **Automate the Export of EDR Data.** Vetronix, producer of the only publicly available EDR download tool, is strongly encouraged to modify its CDR software to allow electronic export of EDR data to crash databases such as NASS/CDS. Currently, all EDR data must be manually transcribed from Vetronix CDR screens into a database—a tedious and error-prone process. Vetronix is however developing a CDR-to-XML conversion program that has promise for federal and state DOTs with existing or planned EDR databases. Vetronix is encouraged to release a production version of this program to improve data entry efficiency and accuracy for mass users of EDR data, e.g., federal and state transportation agencies.
- **Use the Recommended EDR Database Format.** State and federal transportation agencies seeking to create an EDR database are encouraged to use the recommended EDR database format developed by this project. The standardized EDR database was designed to (1) accommodate data from diverse existing EDR download formats including all publicly released GM and Ford formats, (2) store the future EDR data elements needed to comply with the NHTSA NPRM on EDRs, and (3) store the recommended list of data elements for highway crash data analysis developed by this research project.

Legal Acceptability of EDRs

Although the preceding technological issues are challenging, they are solvable. More uncertain are the concerns that have been raised about the legal acceptability of the widespread collection of EDR data. A special study was conducted as part of this research project to explore the legal issues surrounding the implementation and use of EDRs. The special study addressed four specific issues: (1) whether the Fourth Amendment to the U.S. Constitution in any way bars the collection of data recorded by EDRs, (2) whether the U.S.DOT has the authority to mandate the installation of EDRs in all new vehicles, (3) whether the data recorded by EDRs is admissible in court, and (4) whether the collection of such data violates privacy rights. The report's conclusions follow:

- With respect to Fourth Amendment concerns, the police (or other government crash investigators) may properly seize EDR devices (or otherwise collect the EDR data) without a warrant during post-crash investigations. This authority is premised upon one of two legal issues: either seizure of a required safety device does not constitute a search implicating the Fourth Amendment or, alternatively, seizure of a safety device qualifies under the exemptions for conducting a warrantless search. The police's authority to conduct warrantless searches may be affected by how soon after the crash the search occurs: the more immediately the search occurs following the crash, the greater the officers' authority to conduct a warrantless search. Absent a crash, however, police may not be able to seize such data routinely without either a warrant or express legislative

authorization (unless current thought changes on the individual's reasonable expectation of privacy regarding EDR data). Of course, police should have little trouble in obtaining a warrant to seize EDR data (or even the device itself).

- U.S.DOT may require the installation of devices that demonstrably improve highway safety or advance some other significant public policy interest. The public policy interest in installing EDRs seems beyond peradventure. As a consequence, the U.S.DOT presumably enjoys the authority to mandate the installation of such devices on new automobiles.
- Although the data (and the recorder itself) may be "owned" by the automobile's owner or lessee, that data may almost certainly be used as evidence against that owner (or other driver) in either a civil or a criminal case. Certainly nothing within the Federal Rules of Evidence (FRE) or the Fifth Amendment's protection against compelled self-incrimination would exclude the use of data recorded by the EDRs. Similarly, owners might be prohibited from tampering with the data if litigation is pending.
- Finally, the issue here is not one so much of legal authority to use EDR data in court, but instead what the public will accept. Although the statutory authority to require EDRs may exist, the public may not want a device installed in their automobiles that appears to encroach upon their personal privacy interests. Understood in this way, the problem is less a legal concern than it is a battle to mold public perception. Not every life-saving device that is deployed with the best of intentions will be accepted by the public. Personal privacy and public safety must exist within the same sphere. Occasionally, respecting privacy rights will mean that harmful things may occur, but this is the cost of living in a free society.

Public Acceptability of EDRs

Paralleling the concerns over legal acceptability of EDRs are concerns over public acceptability. A consumer revolt against the installation of EDRs could negatively impact sales and/or lead many manufacturers to offer owners the option to turn off their EDRs or even to stop installation of them altogether. These options would seriously limit the amount of EDR data collected for research by personnel in law enforcement, insurance, government, manufacturing, and education.

A special study was conducted as part of this research project to determine the public awareness and level of acceptance of EDRs. The consumer acceptability study was conducted in two phases. In the first phase, a questionnaire, designed for this study, was mailed to 10,000 licensed drivers. In the second phase, focus groups were conducted, with a smaller sample of licensed drivers, to follow up on the survey results.

The survey results provided several key findings. A significant majority of all respondents were unaware of EDRs and their use. Most felt that EDRs would be beneficial in accident investigations, lower insurance rates for safe drivers, and encourage monitored drivers to behave more safely. Respondents expressed a preference for the use of EDRs to be optional and to maintain control of the data. The opinions expressed were reasonably consistent across demographic groups, but older, more affluent, Caucasian males were more likely to report concerns about control of EDR data and their use.

The results from the focus groups matched well with those obtained through the survey and from other related studies in the literature. Many of the participants were unaware of EDRs until contacted about participating in the focus groups, which matched the results of a survey that indicated most Americans are unaware of EDRs. Both survey and focus group participants felt that the devices could prove useful in accident investigations. Survey and focus group opinions mirrored what GM found in a recent survey: self-labeled safer drivers are more accepting of EDRs than those who admitted to some minor traffic "transgressions." Finally, as the results of this project's survey and focus group are in line with the results of similar surveys, clearly the gathered opinions reflect the general population's opinions, some of which are based on misconceptions.

To alleviate public concerns about EDRs, those organizations or agencies wanting to use EDR data should promote education about what EDRs can actually do. The automotive manufacturers, U.S.DOT, and state transportation agencies are encouraged to

conduct a more thorough public education campaign to inform the public about the presence of EDRs in passenger vehicles and about the safety and research benefits for the motoring public.

REPORT AVAILABILITY

The complete report for NCHRP Project 17-24 is available on TRB's website as *NCHRP Web-Only Document 75*.

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