Recording Automotive Crash Event Data

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National Transportation Safety Board
Symposium On Recorders
Crash Scene
1914 Car Crash in Scotland

Source: http://www.sol.co.uk/s/scott.wilson/Old_Traffic_DundAcc1914.jpg
The Opportunities Are Vast

- 18,000 Tow-away crashes per day
- Equivalent to about $600 million worth of crash Tests per day (18,000 crashes * $35,000 / test)
- Current total production of crash tests conducted for US vehicles is estimated around 5,000 / year
Background

- Need for real world crash data - crash pulses
- Today - methodology based on observation of post crash vehicle deformation
- Need for more detailed data to define crash conditions (pre-impact conditions, detailed deceleration data)
- Recommendations from NTSB & JPL
• NTSB public forum on air bags and child passenger safety (March 1997)

• NHTSA (H-97-18)
  – “Develop and implement, in conjunction with the domestic and international manufacturers, a plan to gather better information on crash pulses and other crash parameters in actual crashes, utilizing current or augmented sensing and recording devices.”
• 1997 recommendation for NHTSA to work on EDRs
• Study feasibility of installing and obtaining crash data for safety analyses from crash recorders on vehicles

• JPL findings
  – Crash recorders exist already on some vehicles with electronic air bag sensors, but data recorded are determined by the OEMs
  – These recorders could be basis for an evolving data-recording capability that could be expanded to serve other purposes
• Emergency rescues - information could be combined with occupant smart keys to provide critical crash & personal data to paramedics
• Questions of data ownership and data protection would have to be resolved, however
  – Where data ownership concerns arise, consultation with experts in the aviation community regarding use of aircraft flight recorder data is recommended
## Potential Uses of Event Data

### Category: Improve Vehicle Design/Highway Infrastructure
- **Potential Examples**
  - *vehicle systems*
    - airbag sensing system deployment criteria
  - *highway systems*
    - roadside safety feature design standards

### Category: Provide a Basis for Regulatory & Consumer Information Initiatives
- **Potential Examples**
  - offset frontal impact severity
  - average/extreme vehicle decel pulses

### Category: Provide Objective Data for Crash Reconstruction
- **Potential Examples**
  - alleged defects & litigation
    - unintended vehicle acceleration
    - crash & airbag deployment sequence

### Category: Develop an Objective Driver Behavior Database
- **Potential Examples**
  - pre-crash driver braking/steering
  - belt use
  - vehicle speed
<table>
<thead>
<tr>
<th></th>
<th>Human</th>
<th>Vehicle</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre Crash</strong></td>
<td></td>
<td>Skid Marks</td>
<td></td>
</tr>
<tr>
<td><strong>Crash</strong></td>
<td></td>
<td>Calculated Delta-V</td>
<td></td>
</tr>
<tr>
<td><strong>Post Crash</strong></td>
<td>Injury</td>
<td>Collision Damage</td>
<td>Environment after crash</td>
</tr>
<tr>
<td>Pre Crash</td>
<td>Crash</td>
<td>Post Crash</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td><strong>Human</strong></td>
<td><strong>Vehicle</strong></td>
<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td>Belt Use Steering Brake</td>
<td>Speed ABS Other Controls</td>
<td>Conditions During Crash</td>
<td></td>
</tr>
<tr>
<td>Air Bag Data Pre Tensioners</td>
<td>Crash Pulse Delta-V Yaw A/B Activation Time</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>ACN (Automatic Collision Notification)</td>
<td>ACN</td>
<td>ACN</td>
<td></td>
</tr>
</tbody>
</table>
## GM Airbag Systems
### Data Stored

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1990 DERM</th>
<th>1994 SDM</th>
<th>1999 SDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of Warning Indicator when event occurred (ON/OFF)</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Length of time the warning lamp was illuminated</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Crash-sensing activation times or sensing criteria met</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Time from vehicle impact to deployment</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Diagnostic Trouble Codes present at the time of the event</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Ignition cycle count at event time</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Maximum Delta-V for near-deployment event</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Delta-V vs. time for frontal airbag deployment event</td>
<td>■</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Time from vehicle impact to time of maximum Delta-V</td>
<td>■</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>State of driver’s seat belt switch</td>
<td></td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Time between near-deploy and deploy event (if within 5 seconds)</td>
<td></td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Passenger's airbag enabled or disabled state</td>
<td></td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Engine speed (5 sec before impact)</td>
<td></td>
<td></td>
<td>★</td>
</tr>
<tr>
<td>Vehicle speed (5 sec before impact)</td>
<td></td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Brake status (5 sec before impact)</td>
<td></td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Throttle position (5 sec before impact)</td>
<td></td>
<td>★</td>
<td>★</td>
</tr>
</tbody>
</table>
1999 EDR Simplified Block Diagram

- Engine Speed Sensor
- Vehicle Speed Sensor
- Brake ON/OFF Sensor
- Throttle Pos Sensor

Pre-impact data

Serial data bus

SDM

Accelerometer

Low-pass Filter

Microcomputer Including EDR
- RAM
- 32k ROM
- 640 EEPROM

Airbags

Driver Seat Belt Sensor

Manual Pass. Airbag Cutoff Sw. And Indicator

Power

Ignition Switch
EDR Data

Delta-V (mph)

Time (msec)
Pre-Impact Data
1999 EDR

Crash Time (sec)

Crash Occurs @ Time = 0

Brake ON
Vehicle Speed
Engine Speed
Throttle Pos
Brake OFF
### Accuracy and Resolution

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Full Scale</th>
<th>Resolution</th>
<th>Accuracy</th>
<th>How Measured</th>
<th>When Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta V</td>
<td>± 55.9 mph</td>
<td>0.4 mph</td>
<td>~ ± 10%</td>
<td>Integrated acceleration</td>
<td>recorded every .010s, calculated every .00125s</td>
</tr>
<tr>
<td>Vehicle speed</td>
<td>158.4 mph</td>
<td>0.6 mph</td>
<td>± 4 %</td>
<td>Magnetic pickup</td>
<td>vehicle speed changes by &gt; 0.1 mph</td>
</tr>
<tr>
<td>Engine Speed</td>
<td>16383 RPM</td>
<td>1/4 RPM</td>
<td>± 1 RPM</td>
<td>Magnetic pickup</td>
<td>RPM changes by ≥ 32 RPM.</td>
</tr>
<tr>
<td>Throttle Position</td>
<td>100% Wide open throttle</td>
<td>0.4 %</td>
<td>± 5%</td>
<td>Rotary potentiometer</td>
<td>Throttle position changes by ≥ 5%.</td>
</tr>
</tbody>
</table>
EDR Uses
## SCIs Involving GMs’ EDRs

<table>
<thead>
<tr>
<th>MY - Make - Model</th>
<th>Driver Belted</th>
<th>Delta-V (mph)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998 Chevrolet Malibu</td>
<td>Y N</td>
<td>23 50</td>
<td>Final seat belt determination was &quot;not belted. Severe under-ride.</td>
</tr>
<tr>
<td>1995 Saturn SL</td>
<td>N N</td>
<td>13 16</td>
<td>Very minor damage</td>
</tr>
<tr>
<td>1996 Geo Metro</td>
<td>Y* Y</td>
<td>19 20</td>
<td>*Physical evidence indicated shoulder portion of the belt under the driver's arm</td>
</tr>
<tr>
<td>1995 Saturn</td>
<td>N N</td>
<td>NR 11</td>
<td>Driver stated belt used, no physical evidence</td>
</tr>
<tr>
<td>1996 Oldsmobile 98</td>
<td>Y Y</td>
<td>NR 17</td>
<td>Under-ride - visual of 14-18 mph</td>
</tr>
<tr>
<td>1995 Chevrolet Lumina</td>
<td>N N</td>
<td>12 24</td>
<td>Under-ride, 24 mph @ 150 msec</td>
</tr>
<tr>
<td>1995 Geo Metro</td>
<td>Y Y</td>
<td>14 9</td>
<td>The report writer specified the SDM Delta-V data as more representative of this crash</td>
</tr>
<tr>
<td>1995 Geo Metro</td>
<td>N N</td>
<td>NR 11</td>
<td>Undercarriage impact. Visual estimate of 9-14 mph</td>
</tr>
<tr>
<td>1998 Pont. Grand Prix</td>
<td>Y Y</td>
<td>NR 2</td>
<td>Inadvertent deployment</td>
</tr>
</tbody>
</table>

NR = No Results
**Delta-V**
- Struck a heavy, parked truck in a severe bumper under-ride impact.
- Such crashes typically generate long crash pulses.
- WINSMASH estimated a Delta-V of 23 mph.
- The investigator noted this Delta-V estimate appeared to be low.
- Data from the on-board recorder indicated a Delta-V of approximately 50 mph.

**Belt Use**
- Belt use status unsure Investigator.
- EDR was read.
- EDR indicate “Belt Used.”
- EDR was correct.

*Chevrolet Malibu*
On April 29, 1998, NHTSA staff presented a briefing to the MVSRAC committee. The purpose was to recommend that a working group be formed. MVSRAC members indicated:

- It would be several years before such devices would be widespread enough to give researchers information on crashes.
- Manufacturers were not far along in EDR technology.

A working group was formed, and the MVSRAC Crashworthiness Subcommittee would organize the EDR working group.
## MVSRAC WG Representatives

- AAAM
- Blue Bird
- CA DMV
- Chrysler
- FHWA
- Ford
- Navistar
- GM
- NASDPTS
- Honda
- NHTSA
- NTSB
- Private
- Transport Canada
- TRB
- UVA
- VW
- Worcester
Objectives of MVSRAC W.G.

• Define functional and performance requirements for on-board crash data recorders
• Understand technology presently available to meet these requirements
• Develop a set of data definitions
• Discuss the various uses of the data
Objectives (cont’d)

• Discussions of legal and privacy issues
• Historical overview of other agency’s actions related to data collection
Potential Outcomes of the MVSRAC WG

• Technical Report (by end of 2000)
• Recommendations to Full MVSRAC for EDR actions
  – Establish National Data Base for EDR Data
  – Encourage all manufacturers to develop EDR technology
Conclusions

• Potential to Greatly Improve Highway Safety
• Well-Coordinated Efforts will be Needed to Achieve the Results Envisioned by the NTSB
• NHTSA’s MVSRAC Event Data Recorder Working Group will Establish Guidelines for Future On-Board Data Recording Capability
• EDR Data is now being stored in NHTSA’s National Crash Data Bases
The End

[Image of group bending over a car]