Electronic Crash and Injury Causation Analyses

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Learning Objective and Outcome: During this presentation, attendees will learn to determine and apportion motor vehicle accident and/or injury causation using system analysis.

Hypotheses: Any crash is related to a combination of roadway factors, vehicle defects, and/or driver errors. The ever-increasing electronic control of vehicles has its benefits and limitations. Modern vehicle drive-by-wire (DBW) systems can have lifesaving outcomes because they can identify and take action (e.g., deploy airbag) based on potentially-dangerous roadway factors and vehicle and/or driver errors. Most of the time, the DBW systems save lives. However, some DBW commands can be fatal (e.g., misinterpreted data causing a crash or preventing airbag deployment causing injury). A system analysis that utilizes the stored vehicle control module data, in conjunction with physical evidence and CDR download, enables the forensic engineer to quantitatively apportion causation and provide proof of roadway factors, vehicle defect, and/or driver error.

Objectives: A system analysis methodology to

- identify, collect and analyze the data stored by vehicle control modules, and
- interpret control module events, faults, limits exceeded, and Diagnostic Trouble Codes (DTC's) to determined and apportion accident and/or injury causation.

Impact Statement: This presentation will impact the forensic community and humanity by demonstrating the use of previously-unavailable information to analyze accident and/or injury causation.

Background: Modern vehicles are operated by an increasingly sophisticated DBW system. Sensors measure vehicle and occupant data. Data acquisition systems collect the data. Control modules analyze and store the data and trigger or inhibit vehicle-controlled corrections and/or safety system deployment. Communication networks transmit the data and commands. Currently, the system records up to an 18-second time history of vehicle data (e.g., accelerator pedal, throttle and brake position, steering angle; pre-deployment and deployment accelerations; frontal, side and window curtain airbag deployment and timing parameters) and occupant data (e.g., belt usage, seat position, and weight). The vehicle control modules analyze the data; identify the events, faults, limits exceeded, and DTC's and take action (e.g., command airbag deployment or nondeployment).

Systems Analysis Methodology:

1. Obtain and review Product Definition Documents (PDD) and DTC interpretations.
2. Scan the sensing and diagnostic module (SDM) for DTC's with the Tech 2 tool.
3. Scan the control modules for stored data with the NEO VI tool.
4. Analyze stored data to identify events, faults, limits exceeded and DTC's.
5. Reconstruct the accident from the physical evidence and electronic data.
6. Render opinions about accident and/or injury causation.

Downloadable Data: The content and coding of the downloadable Crash Data Retrieval (CDR) data is well documented. Presently, however, only selected data of these 40 or more vehicle control modules can be downloaded. The downloadable data is by no means **<u>all</u>** of the data stored in vehicle control modules. The CDR downloads include **<u>only</u>** the data that the manufacturers want the consumer to have.

Confidential and Proprietary Data: For years, sensors, data acquisition and processing algorithms and control module events, faults, limits exceeded and DTC's in the SDM were classified as confidential, proprietary, and inaccessible with commercially-available tools. Only recently, the courts ruled that the data and its interpretation are the property of the vehicle owner.

Example of a system analysis of the physical and electronic evidence in a real-world crash: The available CDR data in a 35-mph barrier crash documented driver belt usage and airbag inflation; belted passenger airbag deployment was prevented due to the "detected" presence of a small belted adult passenger. Physical evidence of vehicle contact with a redirecting Jersey barrier moments before frontal barrier impact suggested a vertical lift of the 170-lb adult passenger from his seat. Access to *confidential data* revealed the time history of instantaneous passenger weight. Analysis confirmed that the passenger weight was an instantaneous function of that vertical lift. The airbag deployment algorithm was confirmed as the defect. The alternate design utilized an averaged occupant weight algorithm.

Conclusion: A system analysis methodology is presented that utilizes the stored vehicle control module data, in conjunction with physical evidence and CDR download to enable the forensic engineer to quantitatively apportion causation and provide proof of roadway factors, vehicle defect, and/or driver error.

Algorithm, Microprocessor, Diagnostics