D1 Vehicle Seat-Adjuster Failure in Collisions: Unreliable Safety Devices

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The goals of this presentation are to: (1) inform forensic and field investigators for police, medical, and traffic safety organizations how and why various seat adjusters fail in various collisions; (2) teach methods of recognizing, analyzing, and documenting such failures; (3) explain how such seat failures affect vehicle occupant safety; and, (4) demonstrate via static and crash testing how alternative designs prevent such predictable failures.

This presentation will affect the forensic science community by providing information on largely hidden vehicle safety defects that affect the motoring public. Many severe injuries and deaths have occurred due to such failures, which are not adequately addressed by many government or auto-industry safety standards.

Seat adjusters are not merely devices to assist motorist comfort and fit within a vehicle. Vehicle manufacturers warn motorists to never adjust seat tracks, recliners, or other adjusters while vehicles are in motion and that seatbacks must be upright. They warn that any seat movement due to release of a seat adjuster can reduce the effectiveness of seat belts and increase the likelihood of injury; however, the vast majority of seats in vehicles are subject to exactly that kind of predictable unsafe seat movement due to inadequate crashworthiness of seat structures and seat adjusters. Most seats are too weak to be capable of meeting the requirements for occupant protection set forth in the vehicle owner's manual. There are no sensors or warnings provided in vehicles to indicate that seats adjusters are not fully engaged or that seatbacks are not adequately upright while the vehicle is in motion. These seats are legal to sell due to inadequate or non-existent seat safety and occupant protection regulations and resultant lack of meaningful testing. The enhanced potential for serious and fatal injury to front and rear seat occupants, including children, is clearly demonstrated.

Decades of research into vehicle crashworthiness and occupant protection effectiveness of various seat and belt combinations have demonstrated numerous random modes of seat adjuster failure in foreseeable collisions. Over time, seats have grown more complex, often adding vertical and tilt adjusters as well as recliners and latches that allow fold-flat capability of not only rear seats in utility vehicles but also some front seats. This study involves analysis of various seat adjuster failures during static, sled, and crash tests, as well as related forensic evidence found on front and rear seats and vehicle structures during field investigations. This includes: seat track-to-floor anchors; seat track adjusters; seat cushion-to-seat track separation; seat cushion vertical and tilt adjusters; recliner gear, bolt, and frame fracture; and, adjuster friction mechanism slippage. Seat adjusters also fail due to occupant and/or seat belt contact to unshielded controls. Inertial release of seat controls which are engaged merely by spring tension is also a risk. Bending and fracture of inadequate seat frames can contribute to catastrophic failure of one or more seat adjusters, especially in offset and angular impact loading. Angular loading of seats can often reduce static strength capacity by 30%-40% compared to straight rearward loading. One type of seat has demonstrated at least seven random failure modes, often with multiple adjuster failures in one collision. Seats with multiple adjusters or multi-function recliners often show greater potential for failure at lower occupant load levels than those achieved by more basic seats. Seat adjusters have also shown significantly reduced strength, crashworthiness, and reliability if they are placed in less than optimal mechanical engagement, within their normal operating range. All of these factors contribute to the unreliability of seat adjusters as an occupant safety device.

This study shows direct comparisons between evidence found in field investigations of front and rear seat failure and laboratory studies performed to demonstrate the circumstances of the collision. This includes sled testing with adult and child dummies, vehicle-to-vehicle crash testing, and vehicle-to-fixed object crash testing. These seat adjuster failures usually involve rear impacts but have also occurred in front, side, and rollover collisions. Seat adjuster failure modes, seat belt slackening effects, resultant occupant kinematics, ejection, and injury are analyzed in detail. This includes static testing as well as side-by-side dynamic testing of various seat, seat adjuster, and seat belt designs under identical collision circumstances.

Seat-Adjuster Failure, Rear Impact, Vehicle Occupant Injury