C41 Utilizing Physical Evidence to Elucidate Seat Belt Usage in Automotive Collisions Through Biomechanical Simulation

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This presentation will affect the forensic community by offering leading-edge scientific techniques to determining seat belt usage in automotive collisions. The most recent data on collision-induced seat belt markings as a function of impact severity and occupant size will assist investigators in determining usage. Investigators will also gain insight into more advanced biomechanical simulation that will aid in performing effective investigations and documenting appropriate vehicle interior physical evidence for analysis.

This presentation will impact the forensic community and/or humanity by presenting a more advanced reconstruction method to determining seat belt usage through case examples with an emphasis on physical evidence. Accident investigators will gain knowledge on important physical evidence that will aid in making these determinations and providing for a more scientific analysis.

Reconstruction of automotive collisions often includes an investigation of seat belt restraint usage by the occupants. This paper presents a two-phased research project aimed at developing more advanced reconstruction method to determining seat belt usage with an emphasis on physical evidence.

Phase one investigates the “thresholds” of collision-induced seat belt markings. An assessment of seat belt usage in a collision is typically made by considering markings on the restraint system among other factors. Prior research on seat belt markings has focused primarily on the identification and classification of typical collision-induced and non- collision induced markings and how to distinguish between them. When collision markings are absent, additional information is needed to determine usage in circumstances where the collision severity and occupant weight are speculated to not be sufficient to create such markings. The goal of this research was to generate a “linked set” of data between collision parameters, occupant size, and seat belt collision marks. Another goal was to establish a preliminary threshold of belt loading to produce typical collision-induced seat belt markings. Frontal crash simulations of varying severity were performed on a Hyge sled test system with both male and female crash test dummies. Results will be presented on seat belt loading threshold for typical collision-induced seat belt marking as functions of crash severity and occupant size.

Phase two incorporates occupant injuries and vehicle interior physical evidence other than seat belt markings. Occupant kinematics and injury mechanics are used to determine how people move and are ultimately injured during a collision. Injury criteria are means by which biomechanical engineers relate injuries to quantitative engineering parameters that may be monitored during impact simulations. Used in conjunction with biofidelic human models, or crash test dummies, injury criteria relate the risk of injury to specific loading patterns during collisions. Injuries sustained during an automotive collision represent another form of physical evidence. These injuries are most often the result of contact to objects within the vehicle. These contacts may also leave physical evidence on interior components such as scuffmarks, biological transfer or broken components. Computer simulation may be performed to elucidate occupant kinematics and quantify injury risk, via injury criteria, to various body regions. Case-specific parametric Madymo simulations were performed and compared to injury patterns and vehicle interior contacts. Injury criterion were monitored for loading to injured body regions and compared to case-specific injury patterns. Occupant kinematics are compared to vehicle interior physical evidence. Seat belt web loading monitored during simulations are compared with physical evidence found on the subject seat belt with reference to experimental sled testing results.

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Biomechanics, Injury, Restraints

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