The Examination of Occupant and Vehicle Responses to Low Speed Rear-End Crashes

Team 2

Presenters: Dylan Tinsley,
Caroline Walker, and Orion Yeung

Caroline Walker

Team Introductions

Caroline Walker
Team Leader

Dylan Tinsley
Financial Advisor

Jacob Dunne
Instrumentation Engineer

Orion Yeung
Modeling Engineer

William Smith
Design Engineer

Caroline Walker

Introduction to the Sponsor

- **Cummings Scientific, LLC.**
  - Forensic engineering consulting firm
  - Specializes in accident reconstruction analysis, biomechanics, and biomedical engineering
  - Located in Tallahassee, FL and Atlanta, GA

Summary of the Project Brief

- **Goal:** Model of low speed rear-end collisions
  - Empirical
  - Occupant and vehicle responses
  - Based on live crash testing and dynamic modeling in the MAthematical and DYnamic MOdels (MADYMO) software suite
  - Scientifically defendable in litigation
- **Prototype Expectations:** Low speed impact bumper mounting assembly
  - Allows for multiple response tests

Dylan Tinsley

Project Scope

- **Description**
  - Observe occupant and vehicle responses to low speed* rear-end crashes for the provided test vehicle
  - Obtain empirical model of responses
  - Conduct live crash tests
  - Design bumper mounting device
- **Primary Market**
  - Cummings Scientific, LLC
- **Secondary Market**
  - Accident reconstruction industry
  - Society of Automotive Engineers (SAE), Insurance Institute for Highway Safety (IIHS), etc.

*Low-speed: a crash that "will not result in permanent vehicle deformation" (Wang, 2007)

Dylan Tinsley

Customer Needs

- **Topic:** Goal of the project
  - **Customer response:** Produce an empirical model of the occupant and vehicular responses to a low speed rear-end crash
    - Current models are extrapolated from higher speeds
  - **Interpreted need:** Develop a method to collect data on low speed collisions to allow for building of model

Customer Needs

- **Topic:** Cummings Scientific's need for a low-speed model
  - **Customer response:**
    - Customer takes many cases where injury results from low-speed collisions
    - No current low-speed response model
  - **Interpreted need:** Formulate a model that allows for validation of injury occurrence in low-speed rear-end collisions

Customer Needs

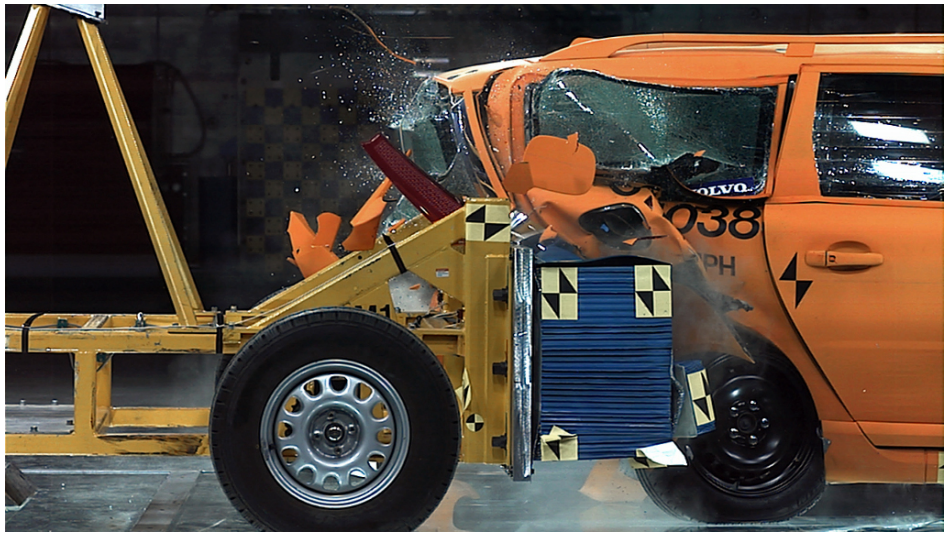

Figure 1. A destructive, rear-end collision test (Autoevolution, 2010)

- **Topic:** Current crash test standards
  - **Customer response:** Single cars are not crash tested multiple times
  - **Interpreted need:** Devise a product that allows for a crash test to be performed on the same vehicle multiple times

Caroline Walker

Customer Needs

- **Topic:** Physical Deliverable
  - **Customer response:** A structure that mounts to the rear of a vehicle and allows multiple styles bumpers to be tested using the same vehicle
  - **Interpreted need:** A device that allows for repeatable testing of multiple bumper structures is needed

Customer Needs

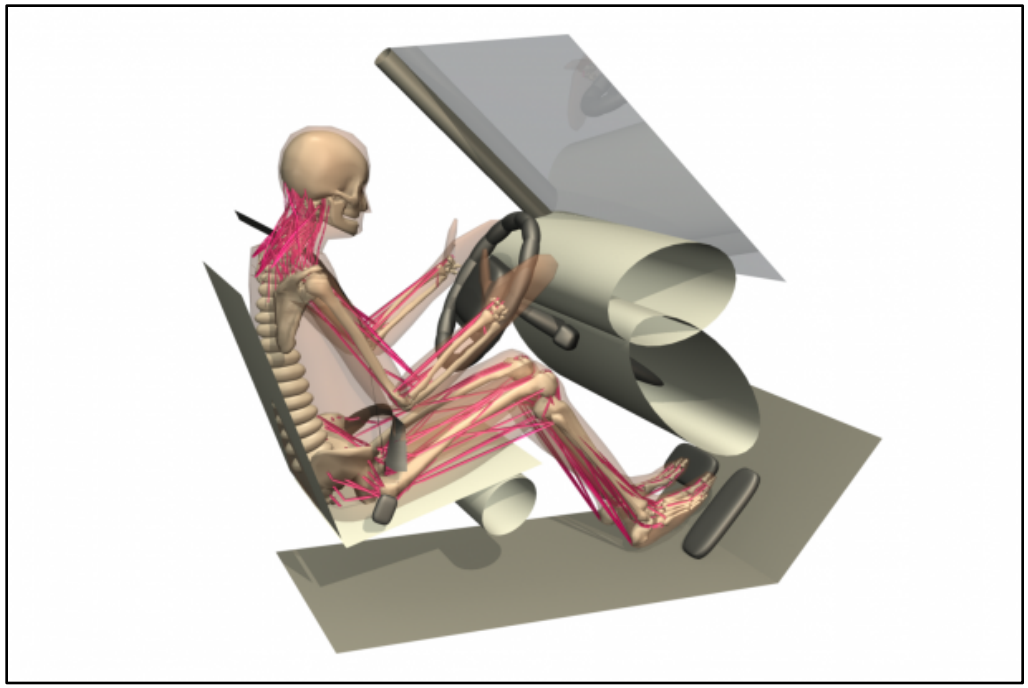

Figure 2. An example model in the MADYMO software suite (Tass International, 2017)

- **Topic:** Application of results
  - **Customer response:** Integration of results with dynamic simulation software
  - **Interpreted need:** Create high fidelity models of occupant and vehicular response for test vehicle

Caroline Walker

Functional Decomposition (Mount)

- Attach multiple bumper types to test vehicle for rear-end impact testing
- Transfer dynamic response of impact to vehicle and passenger
- Withstand multiple crash tests
- Allow sensor integration for measurement of crash parameters

Orion Yeung

Functional Decomposition (Model)

- Characterize vehicle response to low-speed impulse
- Transfer the input signal to a passenger response
- Output measures (i.e. force, acceleration, etc.) that are contained in the MADYMO output

Orion Yeung

References

- Autoevolution (2010, May 8). [photograph].Retrieved from https://www.autoevolution.com/news/volvo-crash-test-laboratory-behind-the-scenes-20231.html
- Tass International (2017). [Online Image].Retrieved from https://www.tassinternational.com/madymo
- Wang, Q.,& Gabler, H.C. (2007). Accuracy of Vehicle Frontal Stiffness Estimates for Crash Reconstruction. Retrieved from http://www.sbes.vt.edu/gabler/publications/esv-07-0513-O.pdf

Questions