Design of a Proposed Upper Body Mass (UBM)

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Background

- Preliminary testing (Mallory and Stammen, 2006) showed adding upper body mass improved correlation between legform testing and full-body testing.
- Konosu et al (ESV, 2007) proposed launch height of 75 mm.
  - Intended to correct for difference in knee height at max. loading between full body and Flex model.
  - Showed improved correlation of injury measures (upper tibia moment and bending angle) between full body and legform-only impacts with 75 mm height.
UBM Design Approach

- Modeled MADYMO lower extremity from full-body pedestrian ATD impacts
- Re-ran MADYMO simulations with projectile legform only
- Optimized uUBM design (mass, MOI, CG height) using full-body data as target for each leg measure, while considering practical test-related implications
- Evaluated UBM robustness on range of generic vehicle designs
UBM Design Approach (cont.)

- Fits Flex Legform
- Minimizes Vehicle Damage
- Alignment During Flight
Robustness Study

- 50 different generic vehicle designs using PCDS and literature
  - Varying stiffness and geometry

- Legform only vs. UBM vs. Full body
  - Compared leg measurements for each vehicle design
Results

• Addition of UBM moves leg measures closer to full-body impact legform response
Kinematic Comparison
Discussion Points

• Addition of UBM improves similarity to our full-body model
  – Most improvement above/at knee
  – Important for high-bumper vehicles (femur fracture)
• Proposed UBM design seems practical
  – Need to conduct physical tests to be certain
• Flex GT more flexible than our MADYMO model
  – UBM optimized for rigid femur and tibia
  – Unclear if optimized UBM works for Flex
• Could upper body mass:
  – Produce vertical knee displacements similar to full-body displacements *for individual vehicles (rather than universal 75 mm)*?
  – Improve correlation with full-body measures for femur moments and ACL as well as tibia moments and MCL/bending angle?
**Next Steps**

- Optimize UBM properties for Flex GT
- Fabricate the UBM and test with Flex
- Find pedestrian-friendly vehicles in US for additional testing
- Validate against full-body PMHS test