TEG-065

Design of a Proposed Upper Body Mass (UBM)

NHTSA's Vehicle Research and Test Center (VRTC)

Ann Mallory, Transportation Research Center, Inc
Jason Stammen, National Highway Traffic Safety Administration
Flex TEG Meeting
March 2008
BASt, Cologne

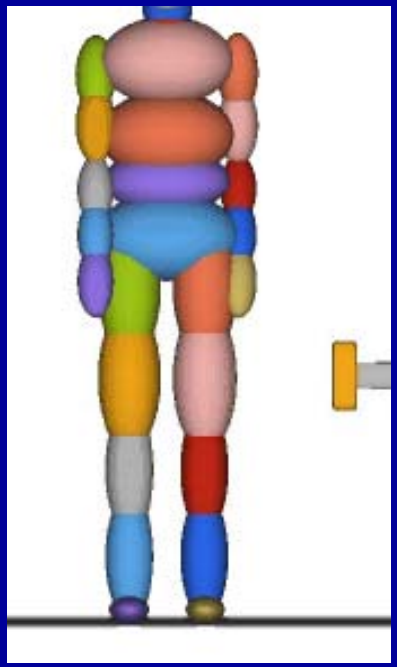
Background

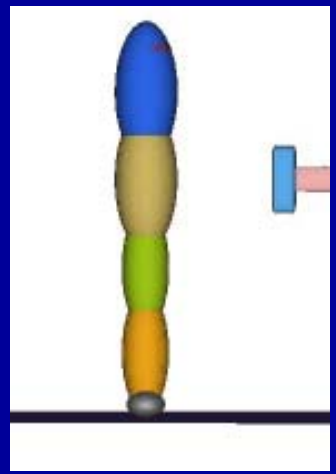
- Preliminary testing (Mallory and Stammen, 2006) showed adding upper body mass improved correlation between legform testing and full-body testing
- Konosu et al (ESV, 2007) proposed launch height of 75 mm
  - Intended to correct for difference in knee height at max. loading between full body and Flex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

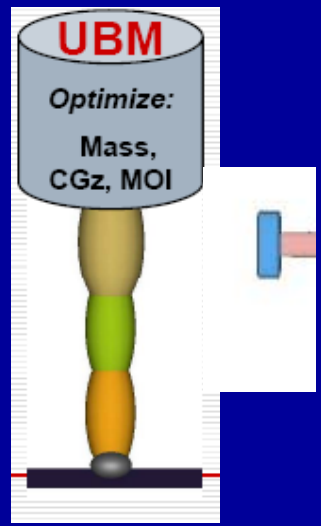
UBM Design Approach

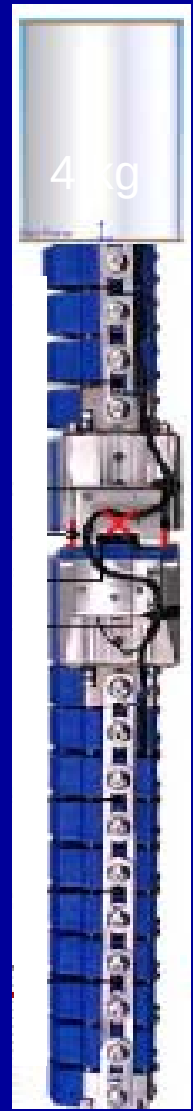
- Modeled MADYMO lower extremity from full-body pedestrian ATD impacts
- Re-ran MADYMO simulations with projectile legform only
- Optimized uUBM design (mass, MOI, CG height) using full-body data as target for each leg measure, while considering practical test-related implications
- Evaluated UBM robustness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

UBM Design Approach (cont.)

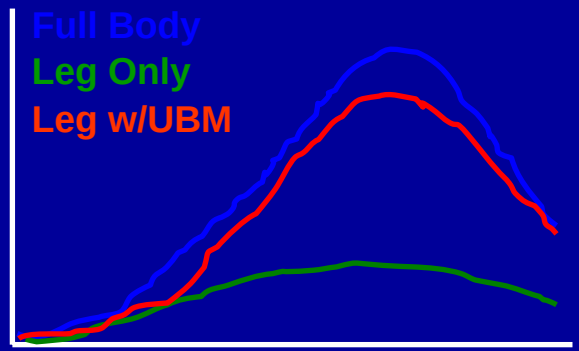








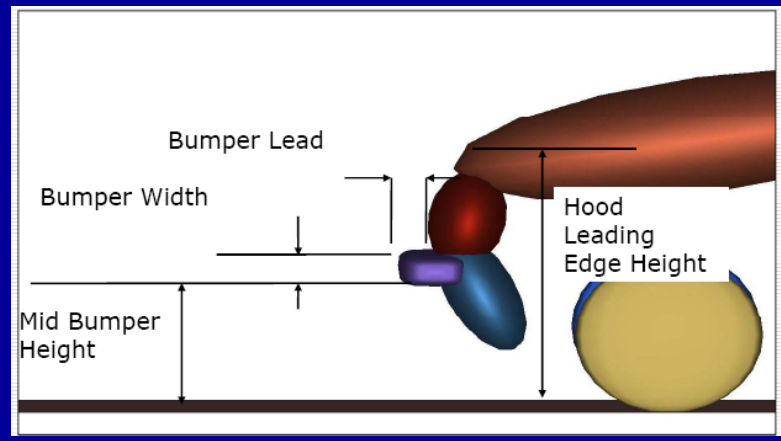
Legform Measurement

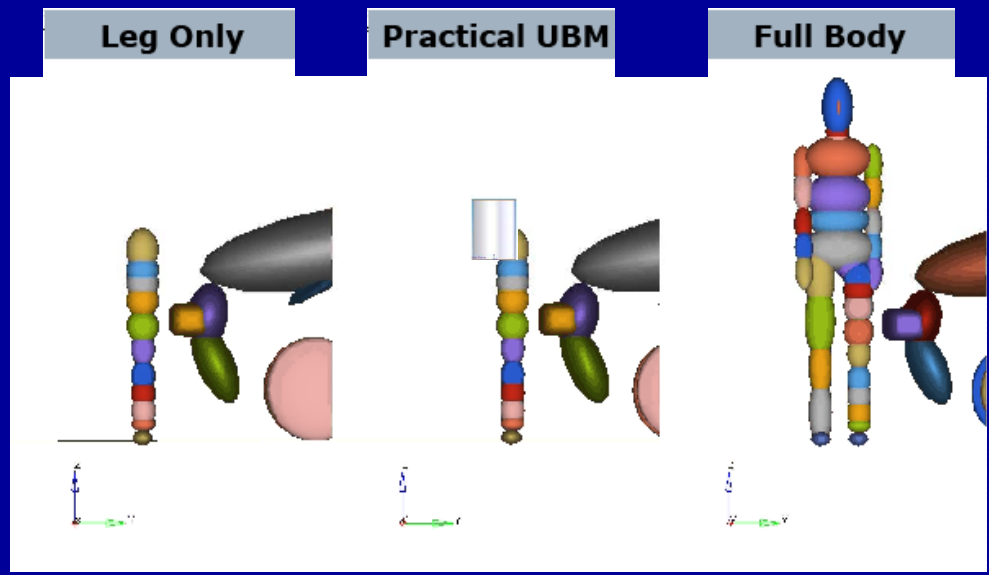


- Fits Flex Legform
- Minimizes Vehicle Damage
- Alignment During Flight

Robustness Study

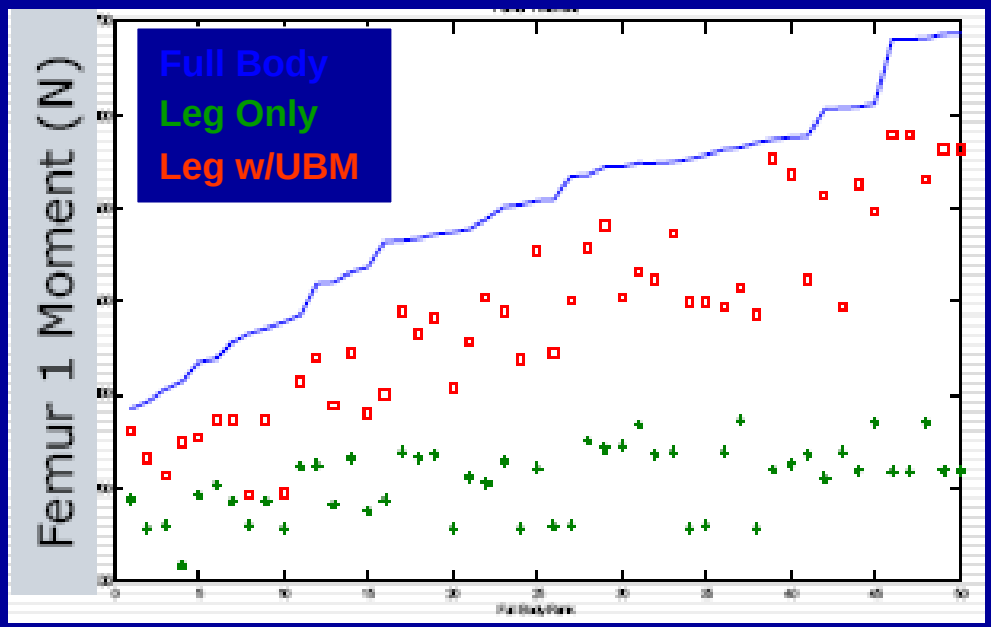
- 50 different generic vehicle designs using PCDS and literature
  - Varying stiffness and geometry
- Legform only vs. UBM vs. Full body
  - Compared leg measurements for each vehicle design





Results

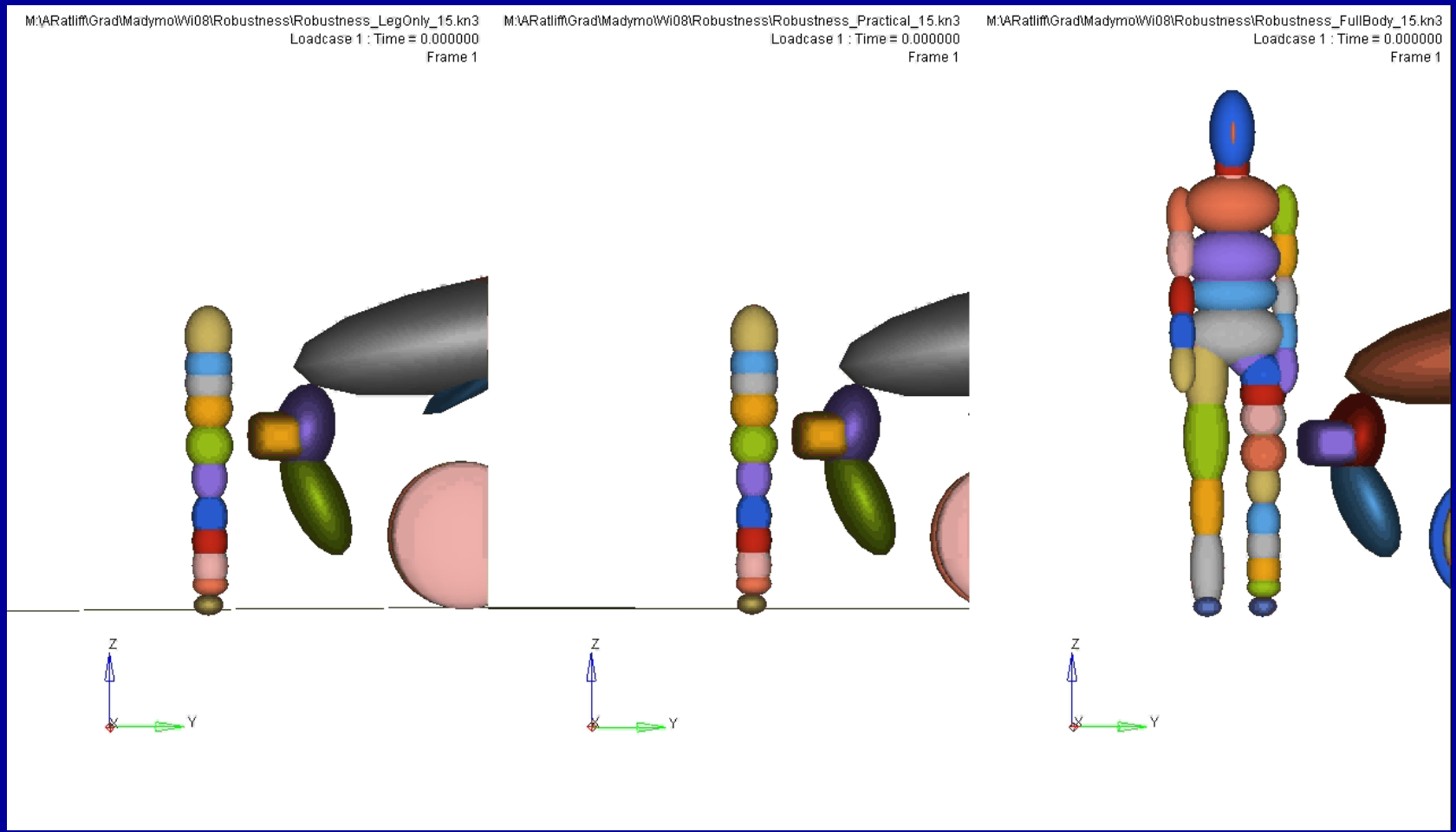
- Addition of UBM moves leg measures closer to full-body impact legform response



Least Aggressive ⟶ Most Aggressive

	Fraction Improved with UBM	Percent Improved with UBM
Femur 1 Moment	50/50	100
Femur 2 Moment	50/50	100
Femur 3 Moment	50/50	100
Knee Bend Angle	50/50	100
Femur 1 Shear	49/50	98
Femur 3 Shear	49/50	98
Tibia 1 Moment	44/50	88
Tibia 4 Shear	43/50	86
Tibia Acceleration	43/50	86
Tibia 2 Moment	40/50	80
Tibia 3 Moment	40/50	80
Tibia 2 Shear	38/50	76
Tibia 3 Shear	37/50	74
Tibia 4 Moment	30/50	60
Femur 2 Shear	26/50	52
Tibia 1 Shear	22/50	42

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