

THOR Update

GRSP Informal Working Group on Frontal Impact
April 18, 2012

Dan Parent
Human Injury Research Division

Test Device for Human Occupant Restraint

1992

2001

2005

2009-2010

2011-2013

TAD-50M



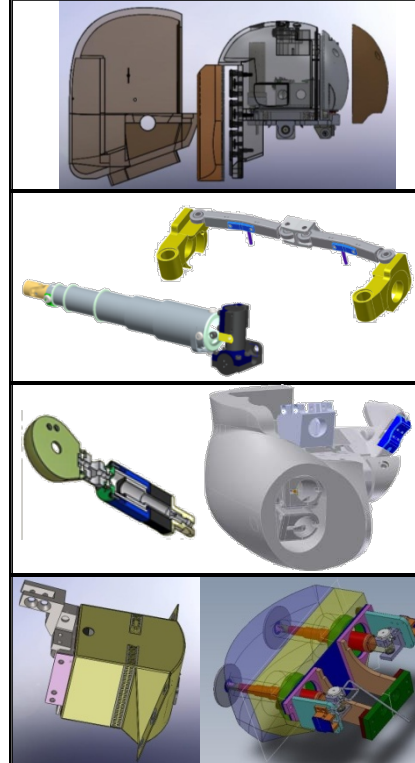
THOR Alpha



THOR-NT



Mod Kit



Mod Kit THOR Evaluation



THOR Schedule

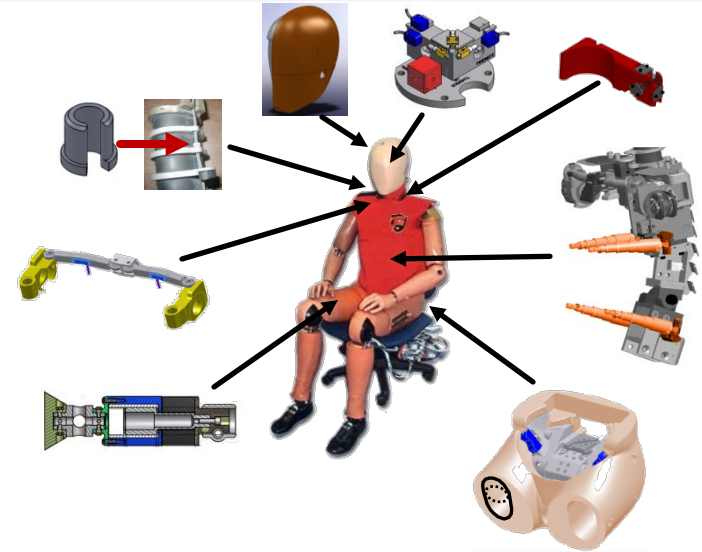
NHTSA Priority Plan

Agency Decision in 2013

- 2012 Plan
 - Update NHTSA-owned THOR ATDs
 - THORAX chest, shoulder evaluation
 - Release Technical Data Package (TDP)
 - Usability testing
 - Biofidelity evaluation
 - Injury criteria development
 - Update THOR FE model
- 2013 Plan
 - R&R testing to finalize:
 - Certification corridors
 - Seating procedure
 - Data processing procedures

Update NHTSA-owned THOR ATDs

- Two (2) Mod Kit THORs Under Evaluation
 - One Fabricated by Denton, FTSS, GESAC
 - Status: sled testing, vehicle testing
 - One Fabricated by Humanetics
 - Status: certification testing
 - Next: THORAX shoulder evaluation
- One (1) additional Mod Kit THOR Under Construction
 - Due April 2012
- One (1) Fully-Metric Mod Kit THOR Under Construction
 - Due June 2012

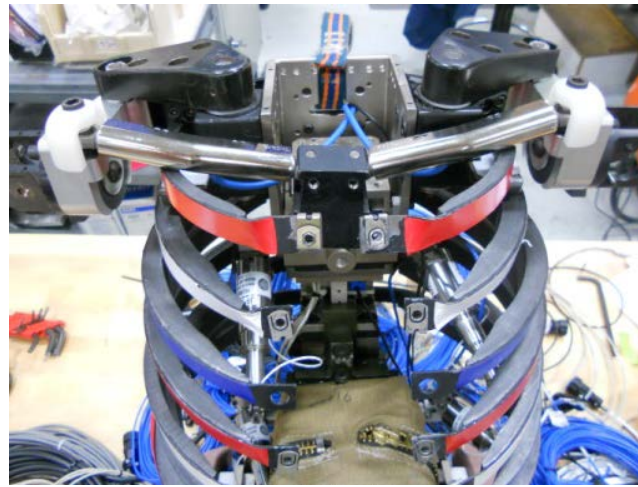


Update NHTSA-owned THOR ATDs

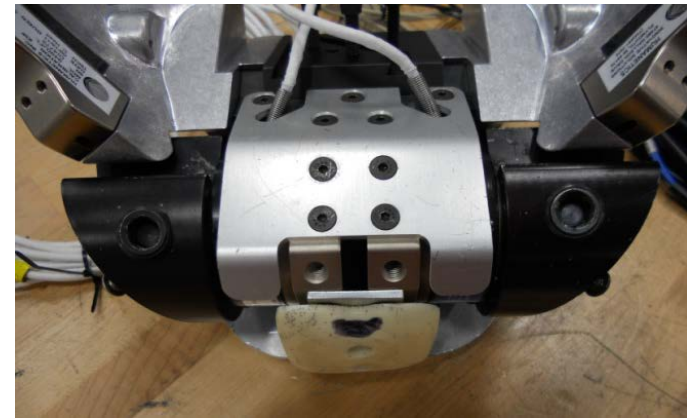
- Mod Kit components fabricated, installed by Humanetics
- Preliminary data show agreement with certification requirements



New Skull Casting
Fabricated



Clavicle Load Cells,
IR-TRACCs Installed

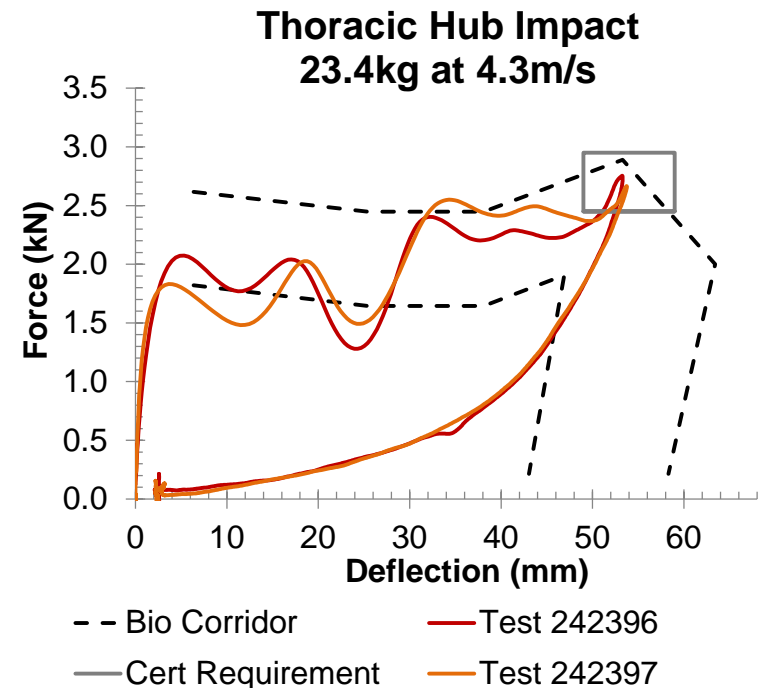


ASIS Load Cells, Attachment
Point for Lifting Apparatus

THORAX Project

Coordination: Chest Response

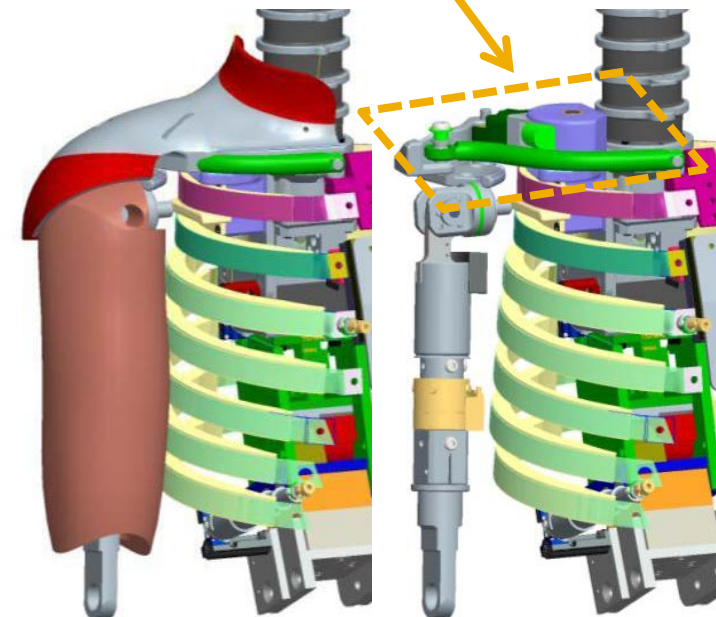
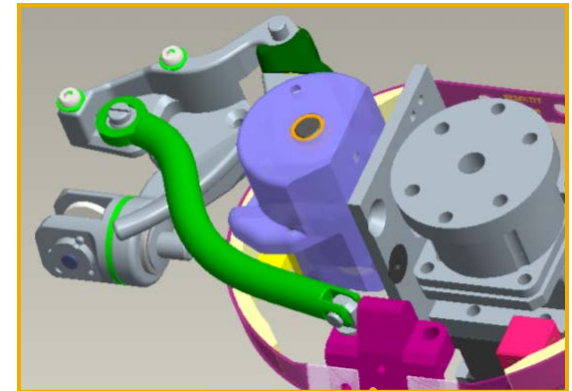
- Objective
 - Incorporate results of EU THORAX research
 - Design includes chest, shoulder, and upper arm
- Chest
 - NHTSA, THORAX have similar impact response target in 4.3 m/s blunt impact
 - Rib damping material thickness reduced compared to THOR-NT
 - Ribs 2, 3, 4 shaved to ~9mm



THORAX Project

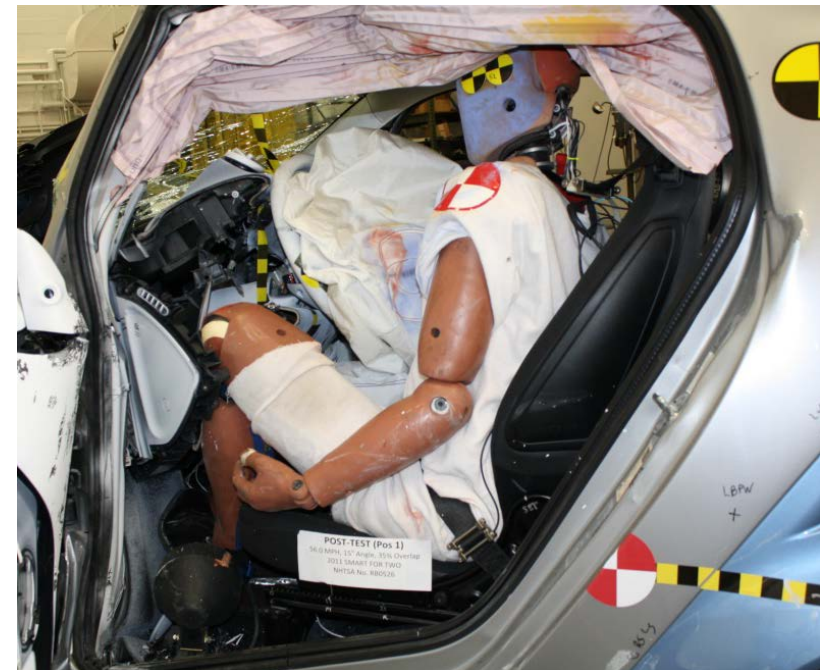
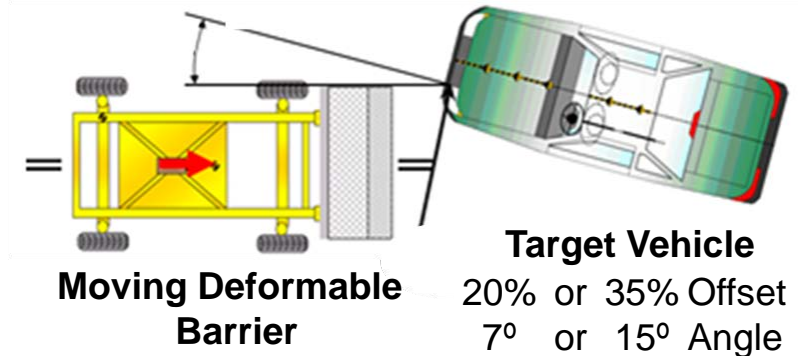
Coordination: SD3 Shoulder

- Updated “SD3” shoulder to be installed on NHTSA mod kit THOR
- U. Virginia Gold Standard
 - Condition 1: 40 km/h, standard belt
 - Condition 2: 30 km/h, load-limited belt
- Evaluate usability, durability
- Evaluate biofidelity vs. PMHS response
 - Chest deflection
 - Shoulder belt loads
 - Head, shoulder trajectories
- Decide on shoulder design
Standard vs. SD3
- Finalize Mod Kit Technical Data Package (TDP)

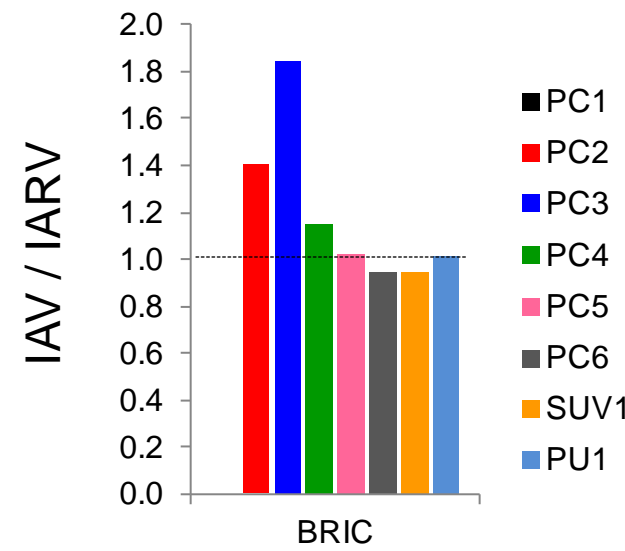
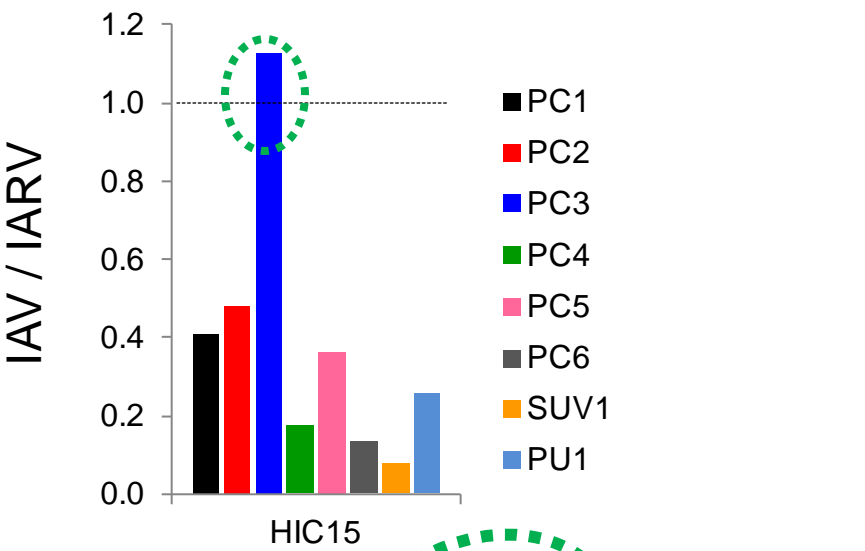


Usability Testing: Small Overlap/Oblique Vehicle Tests

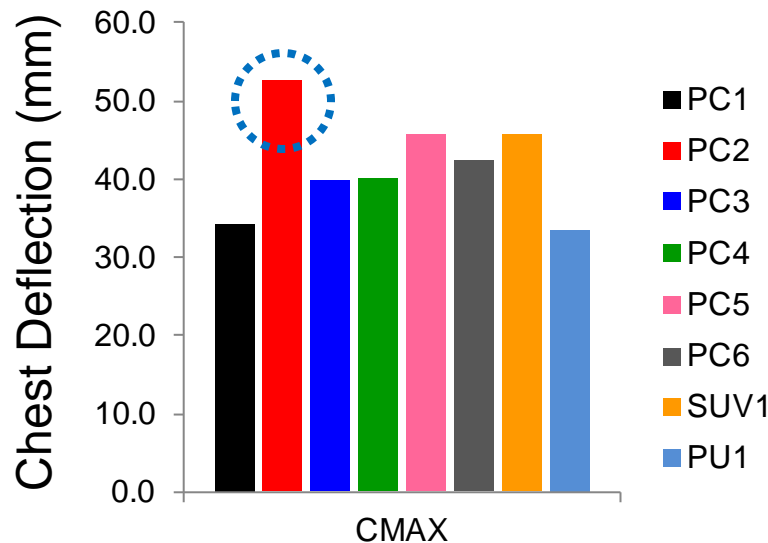
- Support NHTSA crashworthiness research in small overlap/oblique crash modes
 - 15 vehicle tests completed
 - 8 Small Overlap
 - 7 Oblique
 - Full results presented at SAE World Congress (Saunders et. al, 2012)
- Refinements to Documentation
- Polarity test checklist
 - Inspection guidelines
 - Data processing scripts



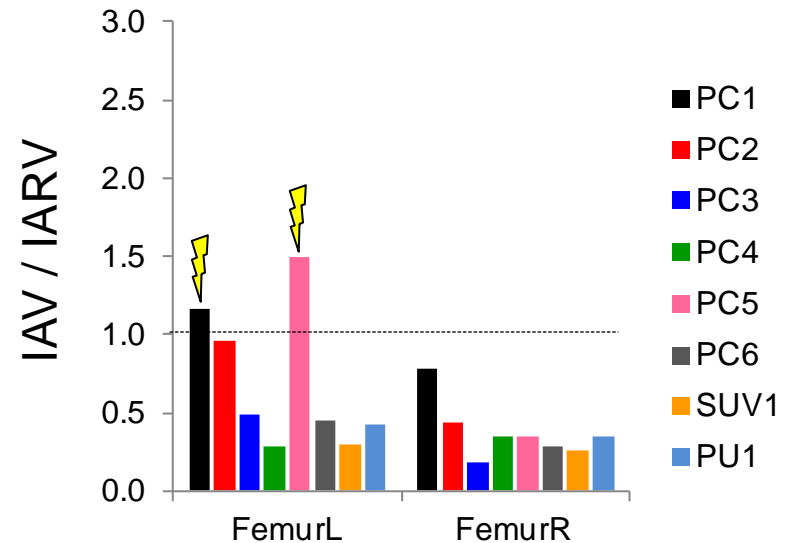
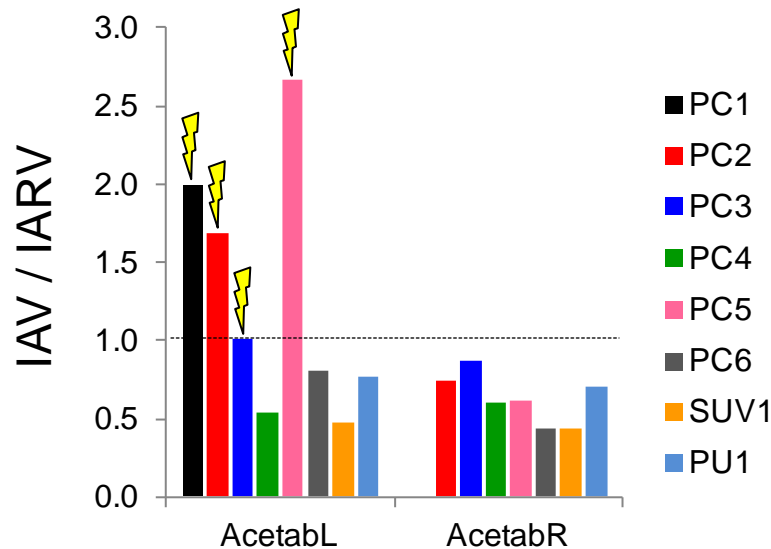
SOI: Head Response



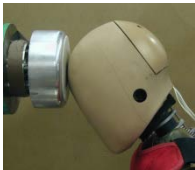


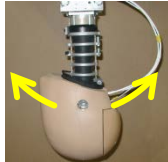






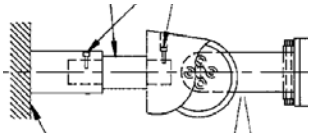
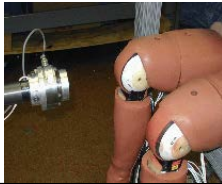
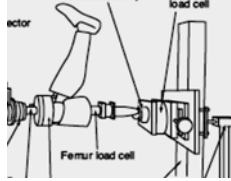
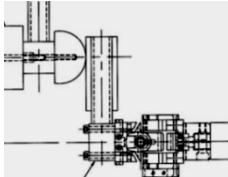
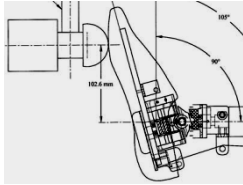
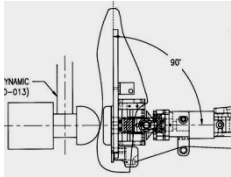
Test: Head Contact Locations					
Vehicle	Airbag	Side Curtain	Roof Rail	Door Panel	IP
PC1	X				
PC2	X		X	X	X
PC3	X	X	X		
PC4	X	X			
PC5	X				
PC6	X	X			
SUV1	X	X			
PU1	X				
Field Injury Source (Rudd, 2011)	4%		28%		12%



- NASS/CIREN SOI: Chest injury sources
 - Belt: 38%
 - Steering wheel: 16%
- SOI Tests: Chest deflection sources
 - Primarily belt interaction
 - Evidence of steering wheel interaction in smaller vehicles (e.g. PC2)

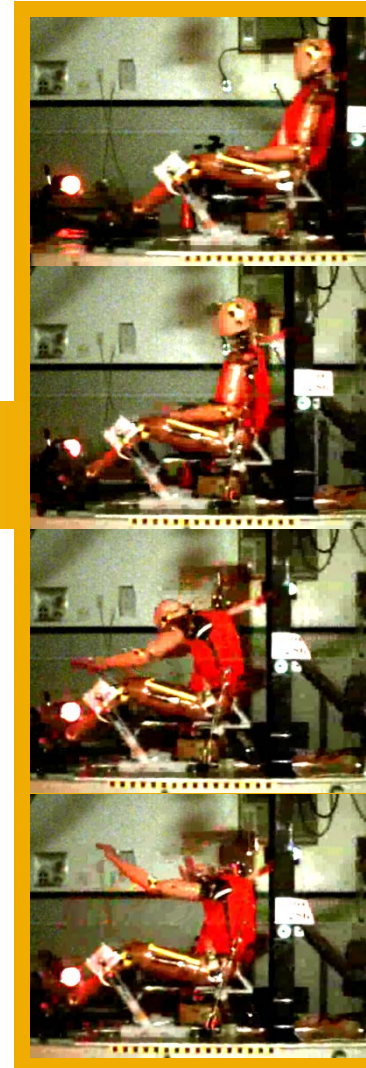


- 4 test exceeded acetabulum IARV
- 2 tests exceeded femur IARV
- 2 tests that exceeded acetabulum IARV did not exceed femur IARV
 - Rudd (2011) showed that over half of acetabulum injuries occurred in absence of femur injury

Body Region	Test Condition		
Head	Forehead Impact 	Head Drop 	
Neck	NBDL Applied T1 Acceleration 	Neck Pendulum Flexion/Extension Lateral Bending 	
Thorax	Upper Thorax Blunt Impact 	Lower Thorax Oblique Blunt Impact 	Gold Standard Sled Test 
Abdomen	Upper Abdomen Steering Rim Impact 	Lower Abdomen Rigid Bar Impact 	Lower Abdomen Belt Loading 
Knee/thigh/hip	Knee Slider Impact 	Full-body Knee Impact 	Dynamic Femur Compression 
Lower Extremity	Inversion Eversion 	Toe Impact 	Heel Impact 

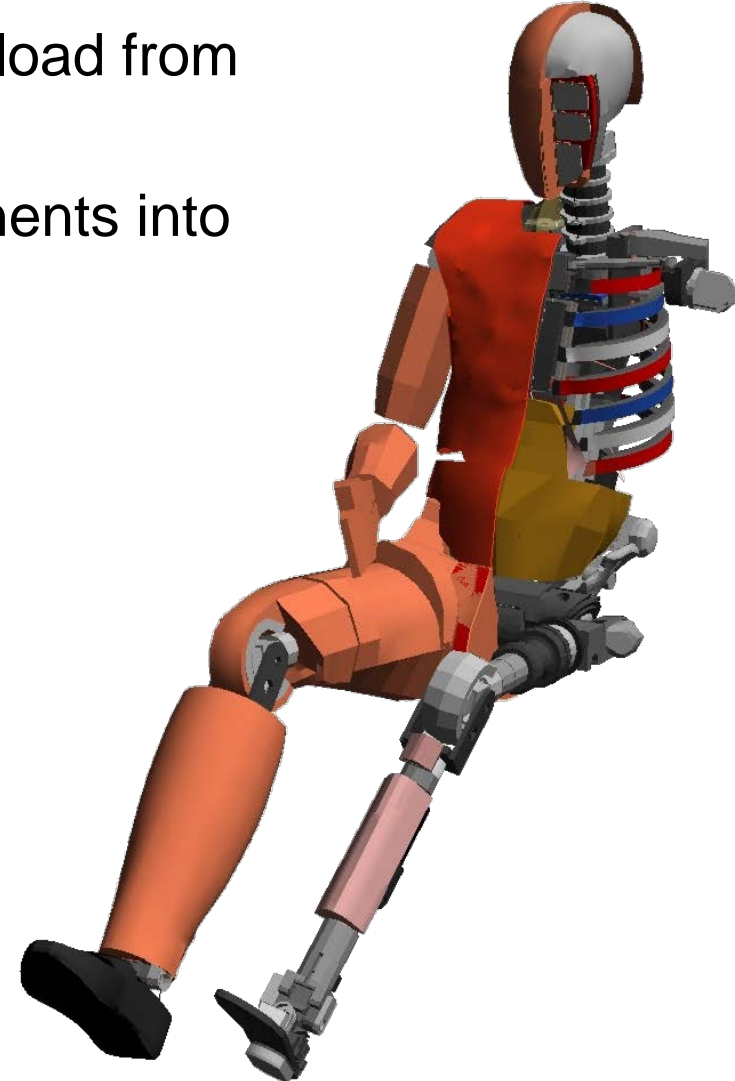
Injury Criteria Development

- Head
 - Rotational brain injury criterion (BRIC)
 - See Saunders et. al 2012 SAE World Congress paper
- Neck
 - Combined criterion
- Thorax
 - Multi-point thoracic deflection
- Abdomen
 - Bi-lateral deflection
- Knee-thigh-hip
 - Femur and acetabulum loads
- Lower extremity
 - Revised Tibia Index, ankle rotation



THOR Finite Element Model (U. Virginia)

- THOR-NT FE model available for download from “Collab” website
- Currently incorporating Mod Kit components into model
 - Knee, thigh, hip
 - Knee slider ✓
 - Femur compression element ✓
 - Pelvis flesh
 - ASIS load cells
 - Lower Extremity
 - Ankle response
 - Molded shoe
- Future collaboration
 - SD3 model
 - Head, neck, thorax



THOR Tentative Schedule

