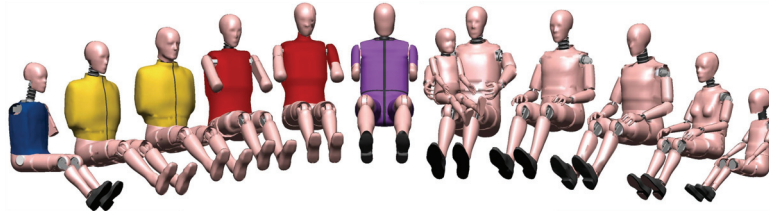


# **Enhancements in FTSS Dummy Model Development and Outlook**

J. Rasico (FTSS, Inc.)



## Enhancements in FTSS Dummy Model Development and Outlook

Slide no. 1



## Contents

---

- **New Development Methodology**
- **FE Dummy Modeling as a Data Source**
- **Model Updates**
- **New Model Development**
- **Model Handling**

Slide no. 2



---



**New Development Methodology**

Slide no. 3




## **Geometry**

---

### **Geometry Improvements**

- Sub assembly Upper Torso CT Scan data check
- External assembled dummy geometry check

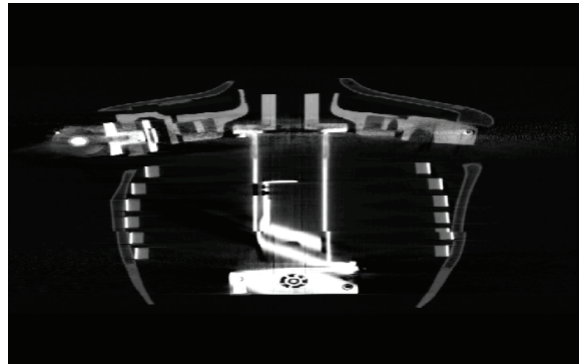
Slide no. 4



## Geometry

---

New x-ray geometry in H350 Pelvis & Thorax – vinyl/foam separation



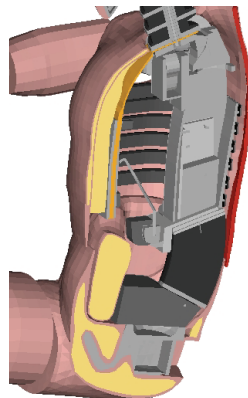
Slide no. 5

 **First Technology**  
Innovative Solutions

## Geometry

---

New x-ray geometry in H350 Pelvis & Thorax – vinyl/foam separation



Slide no. 6

 **First Technology**  
Innovative Solutions

# Geometry

Geometric Confirmation (Laser Scanning and Dimensional Fixture)

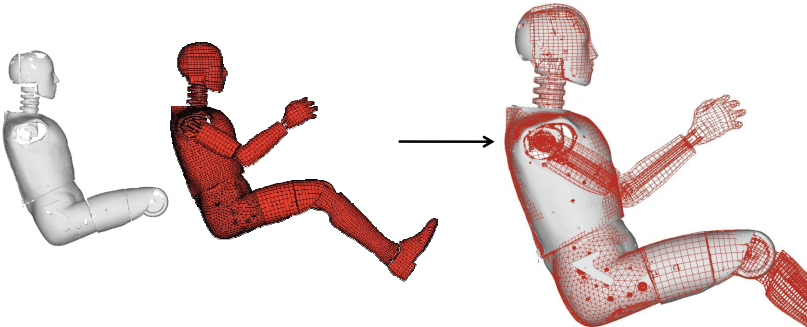


Slide no. 7



# Geometry

Geometric Confirmation (Surface and FE overlay)

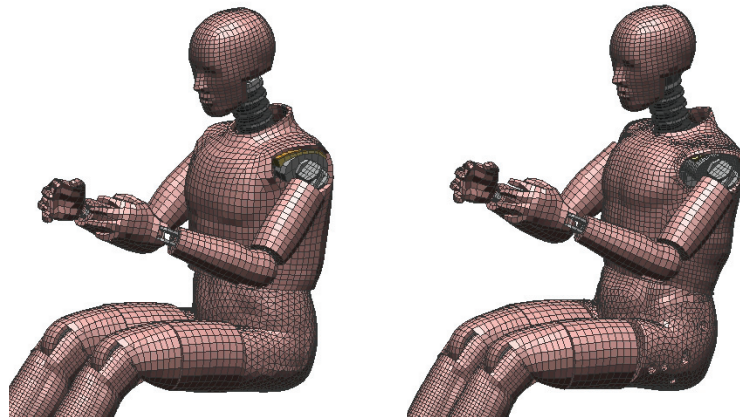


Slide no. 8



## Geometry

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Slide no. 9



## Test Data

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### New Validation Models

- FTSS Development Testing
- Customer Supplied Data
- Evaluation of Validation Models

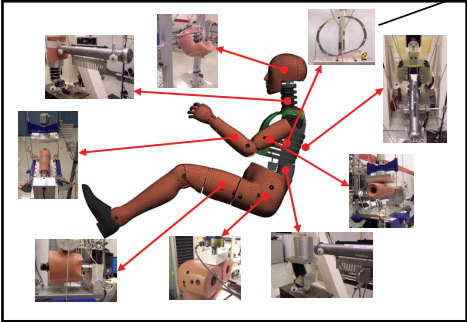
Slide no. 10



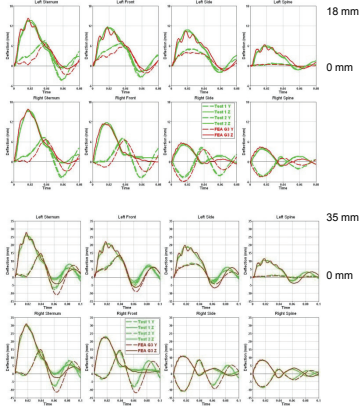
# Test Data

## Detailed Model Project

### New Component Testing



## Oblique Rib Drop Test 2m/s and 4 m/s

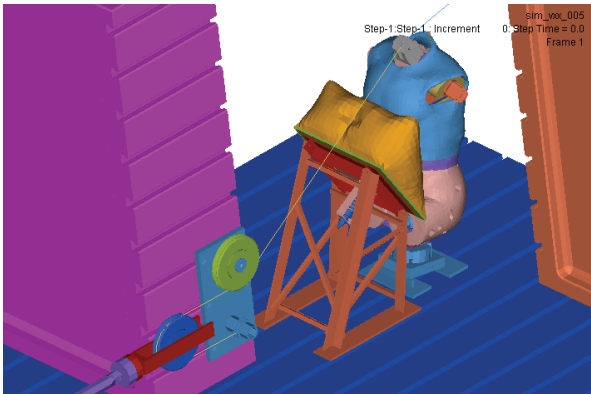


Slide no. 11



# Test Data

## PDB Supplied Test Data – Sub Assembly



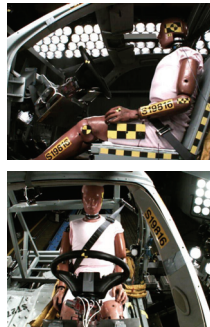
Slide no. 12



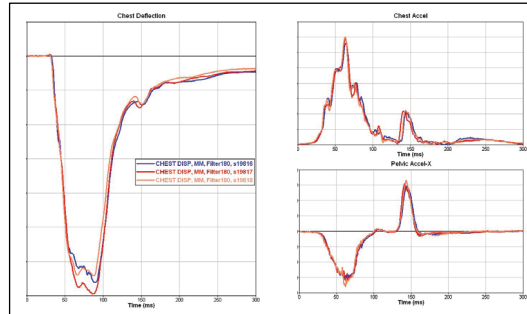
## Test Data

### CMM digitized coordinates

- 26 key controlled/recorded dummy positioning points
- 44 environment points



### High Level of Repeatability



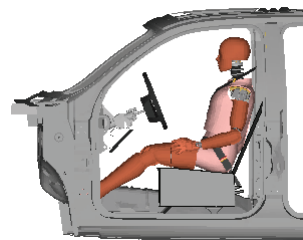
Slide no. 13



## Test Data

### FE Model Quality

- Geometry
- Validated Materials



Slide no. 14

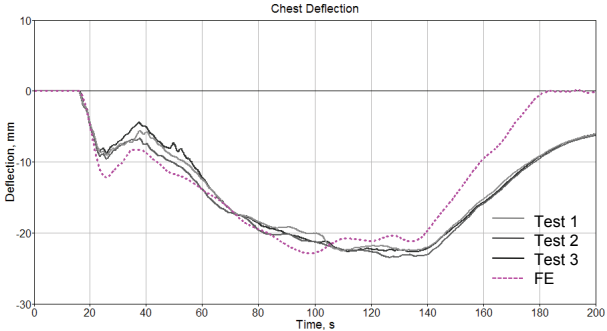




# Performance Criteria

## Rating Methodology

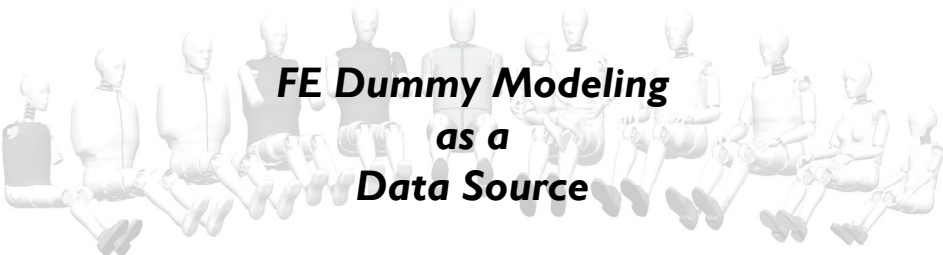
Sample Error Calculation				
	Test 1	Test 2	Test 3	Average
Mag. Error-Min (%)	0.8	2.4	1.4	1.6
Shape Error (%)	9.7	11.2	8.9	9.9



Slide no. 15



# FE Dummy Modeling as a Data Source



Slide no. 16



## FE Dummy Modeling as a Data Source

### Additional Functionality

- Instrumentation
- E-Dummy Technology

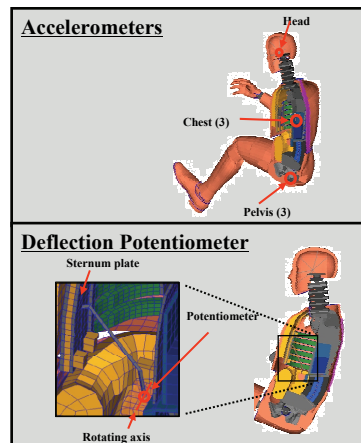
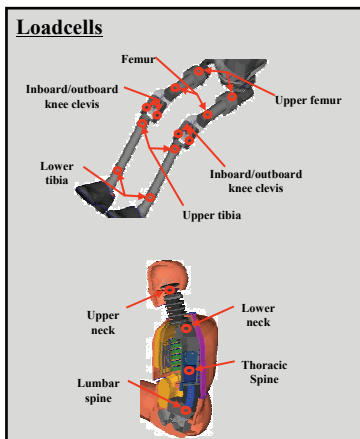


Slide no. 17



## Instrumentation

### Standard

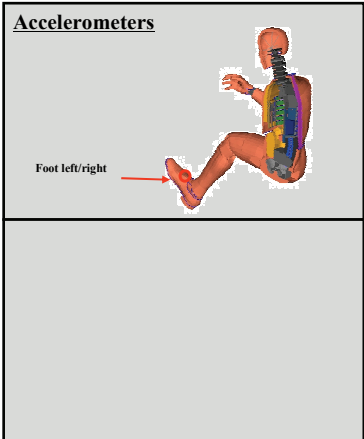
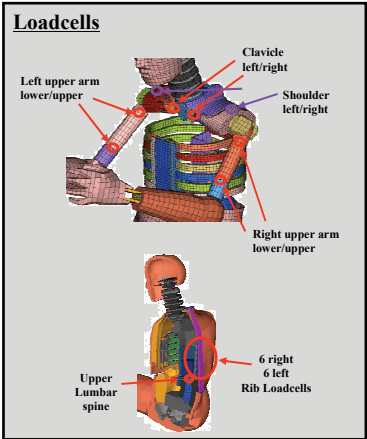


Slide no. 18



# Instrumentation

## Optional



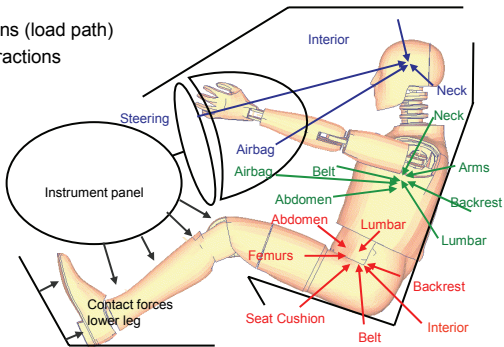
Slide no. 19



# E-Dummy Technology

## E-dummy Technology

- Energy/Force balance
- Dummy internal interactions (load path)
- Dummy and restraint interactions



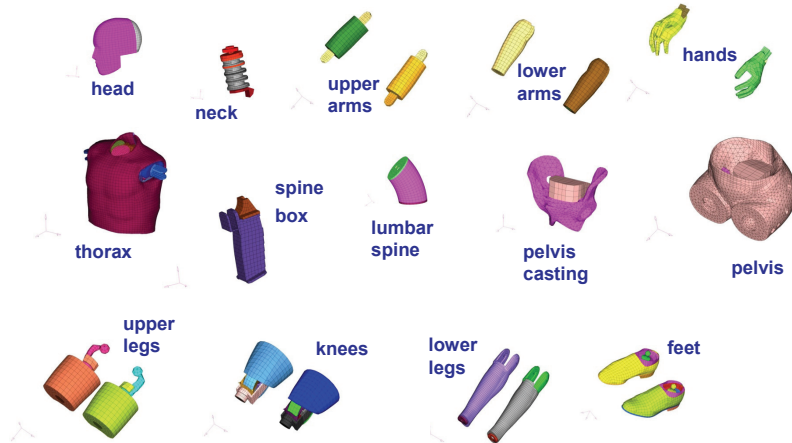
Many forces applied on a dummy in a typical vehicle test

Slide no. 20



## E-Dummy Technology

The E-Dummy is divided into 21 individual functional segments

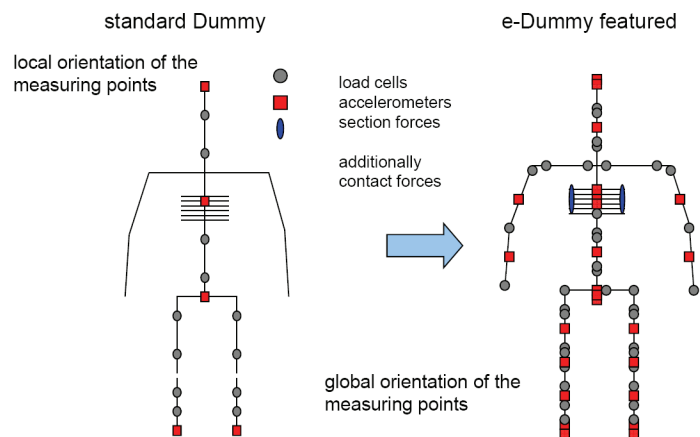


Slide no. 21



## E-Dummy Technology

21 Section force elements to measure internal forces

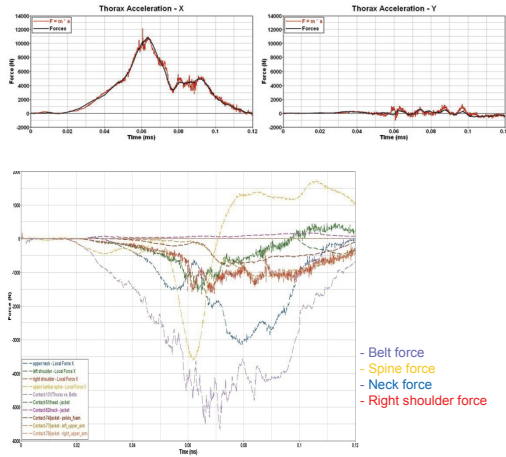


Slide no. 22

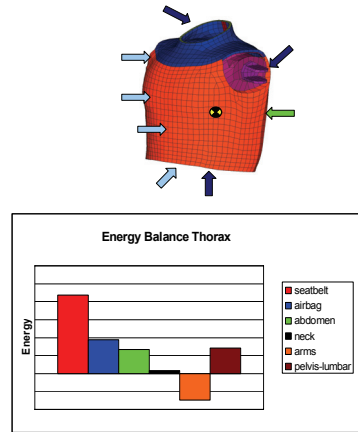


# E-Dummy Technology

## Force Balance for Thorax



## System Energy Evaluation



Slide no. 23



## Model Updates

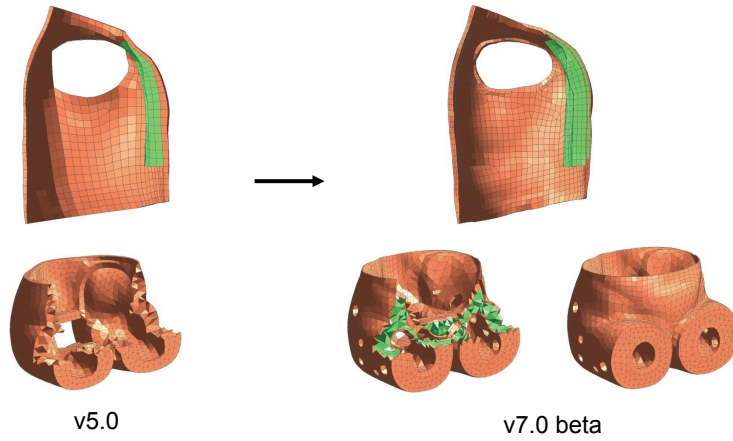


Slide no. 24



## H350 v7.0

Geometric Update – vinyl and foam separated



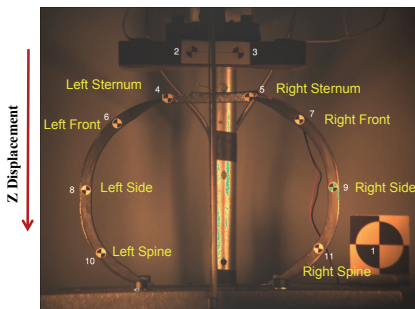
Slide no. 25



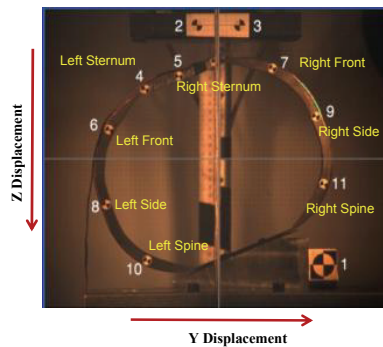
## H350 v7.0

Single Rib Drop Tests

Orthogonal -- 3.0m/s, 4.0m/s, 5.0m/s, 6.7m/s



Oblique -- 2.0m/s, 3.0m/s, 4.0m/s, 5.0m/s

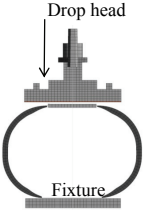
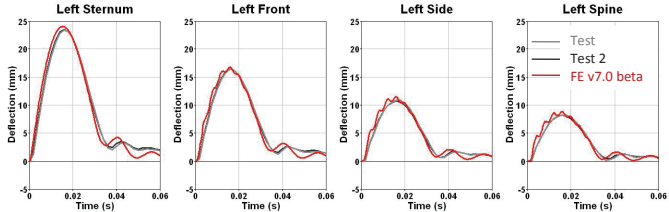


Slide no. 26

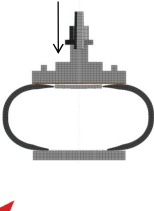
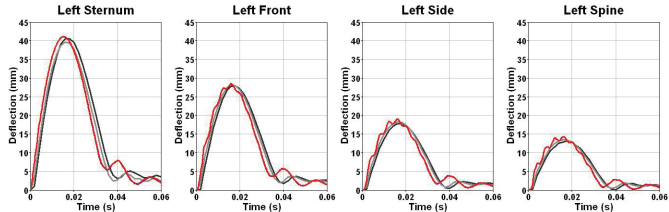


# H350 v7.0

## Orthogonal impact, Speed 3.0m/s



## Orthogonal impact, Speed 5.0m/s

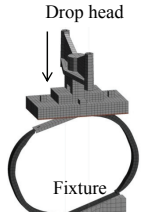
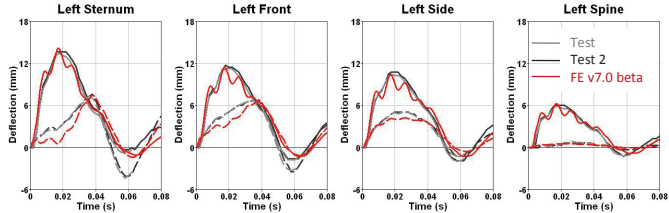


Slide no. 27

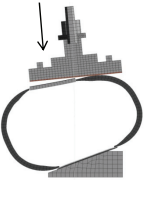
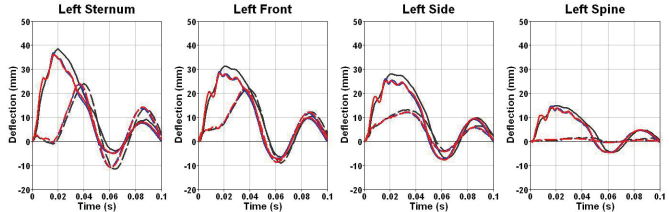


# H350 v7.0

## Oblique impact, Speed 2.0m/s

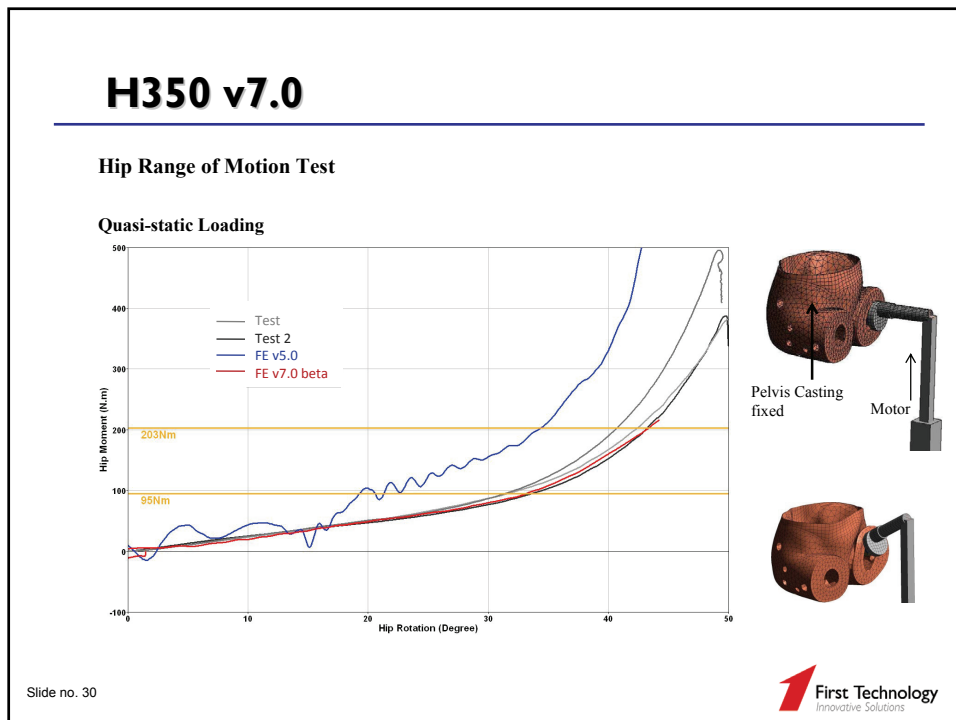
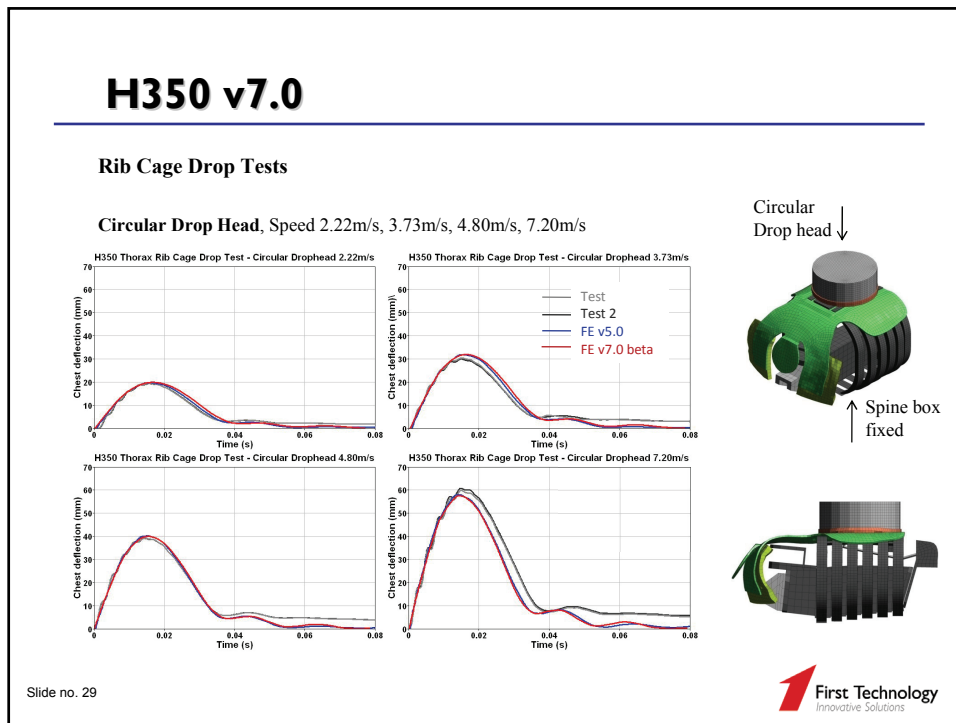


## Oblique impact, Speed 5.0m/s



Slide no. 28

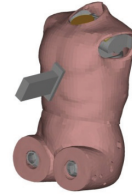
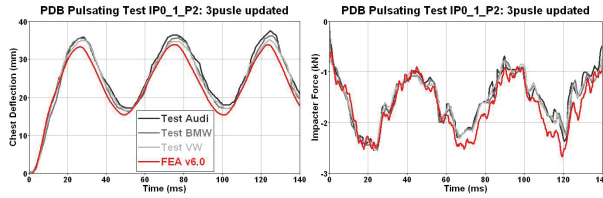




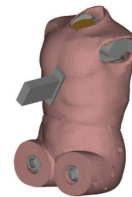
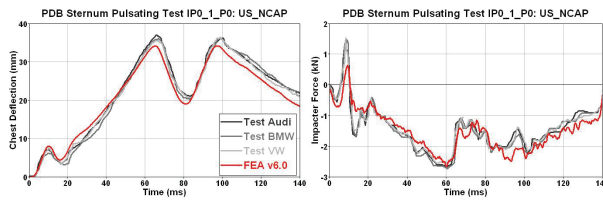


# H350 v7.0

## PDB Sternum Central Pulsating Impact IP0\_1\_P2 - 3 Pulse Updated



## PDB Sternum Central Pulsating Impact IP0\_1\_P0 - US\_NCAP

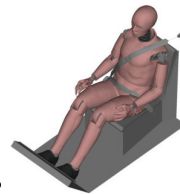
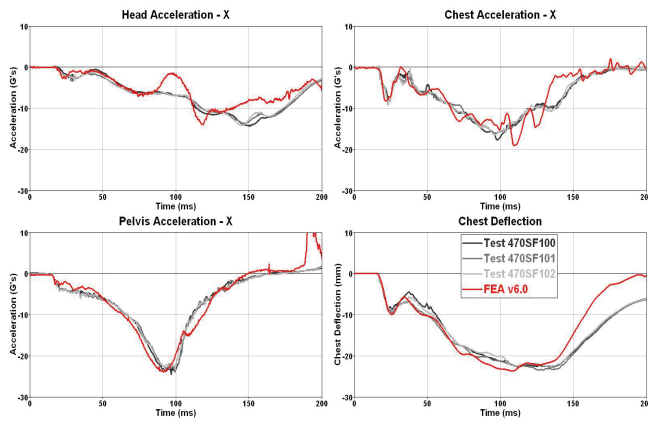


Slide no. 31



# H350 v7.0

## PDB Sled Test

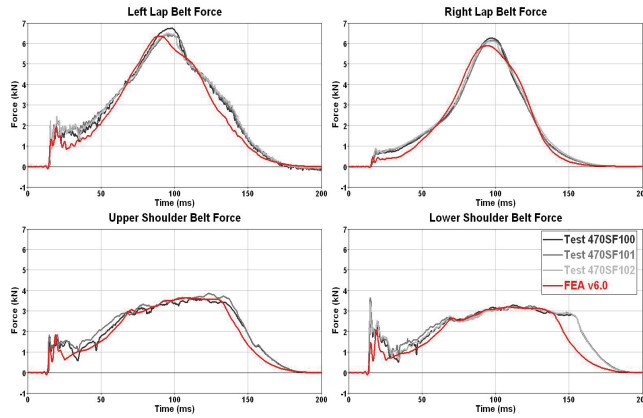


Slide no. 32



## H350 v7.0

### PDB Sled Test



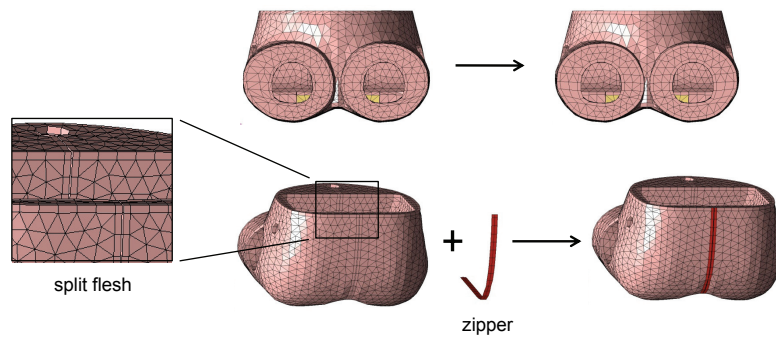
Slide no. 33



## SID-IIs v3.0

### Structural changes

- Symmetric Pelvis (Physical product update) implemented
- Pelvis flesh (vinyl) was split at the back; a zipper was added.
- A revolute joint was used to attach the pubic loadcell attachment to match physical connection
- Updated material properties of Iliac Wing



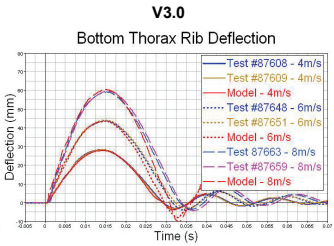
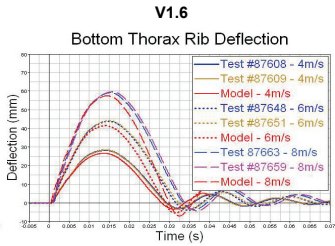
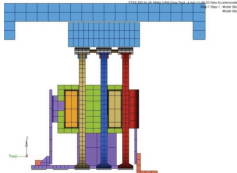
Slide no. 34



# SID-IIs v3.0

## 3 Rib Drop Test

Optimized Rib Damping Material



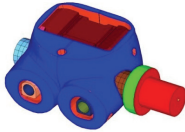
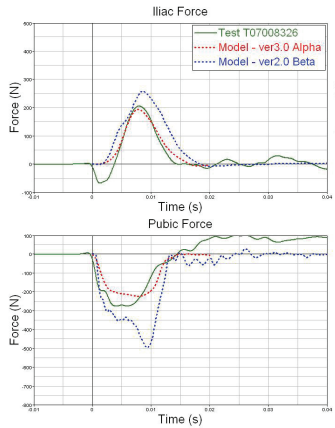
Slide no. 35



# SID-IIs v3.0

## Pelvis with Plug Pendulum Impact (5.0 m/s)

SBL-D NHTSA Iliac Wing

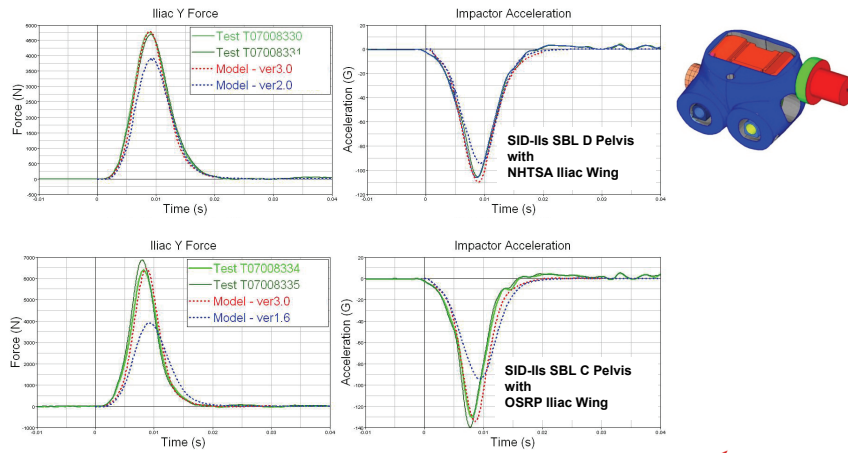


Slide no. 36



## SID-IIs v3.0

### Pelvis Iliac Pendulum Impact (5.0 m/s)

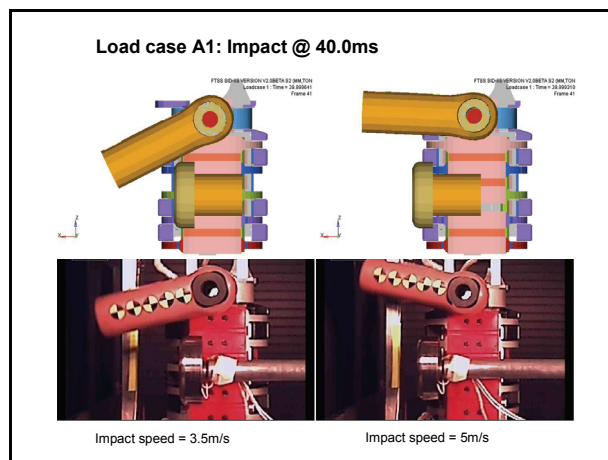


Slide no. 37



## SID-IIs v3.0

### Arm Kinematics



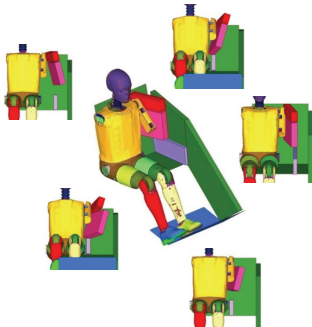
Slide no. 38



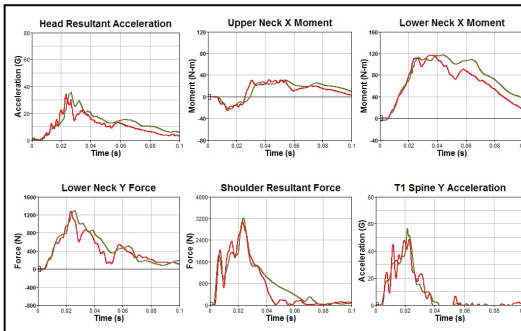
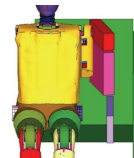
# SID-IIs v3.0

Updated SIDIIs

Oblique Impact



— Test  
— v3.0beta



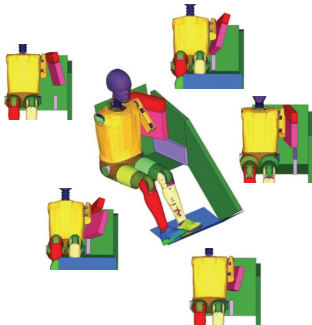
Slide no. 39



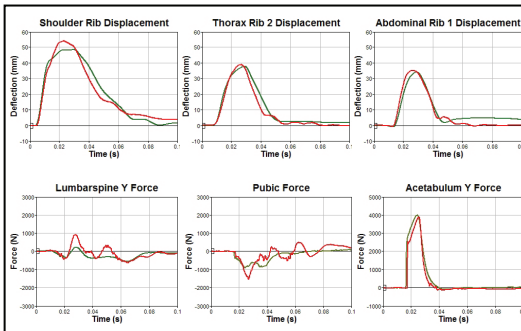
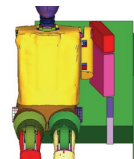
# SID-IIs v3.0

Updated SIDIIs

Oblique Impact



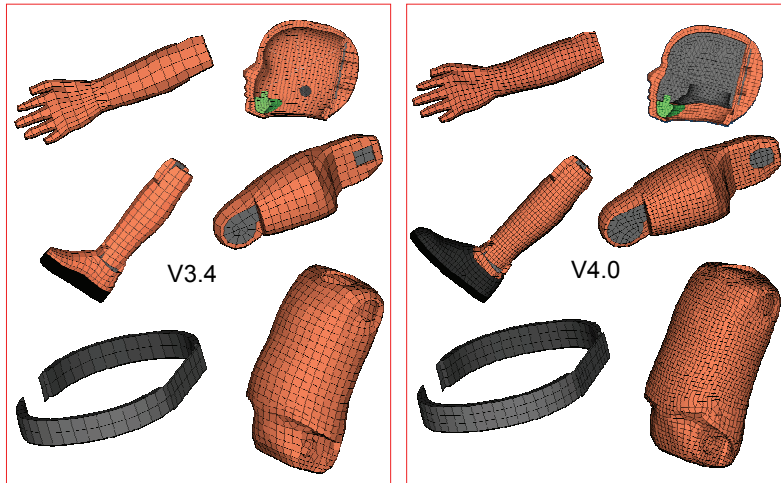
— Test  
— v3.0beta



Slide no. 40



## H303 v4.0

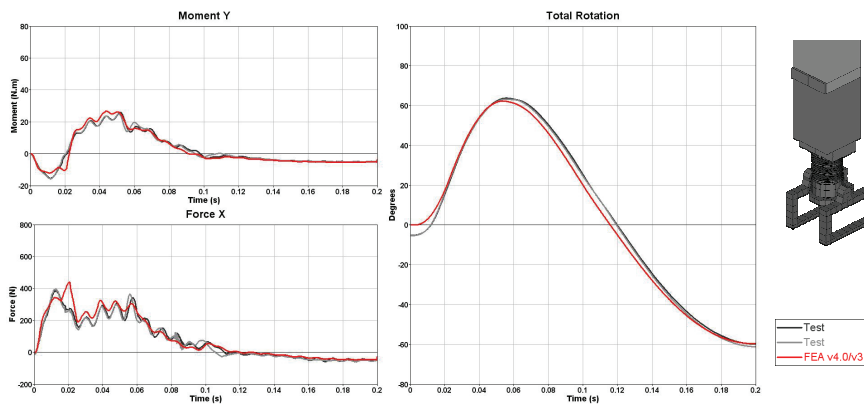


Slide no. 41

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## H303 v4.0

Neck Flexion Straight Loading (4.2 m/s)

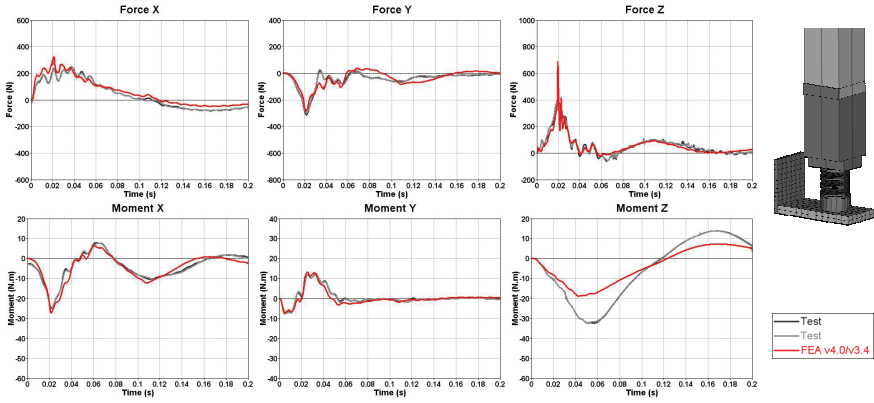


Slide no. 42

**First Technology**  
Innovative Solutions

# H303 v4.0

## Neck Flexion Oblique Loading (4.25 m/s)



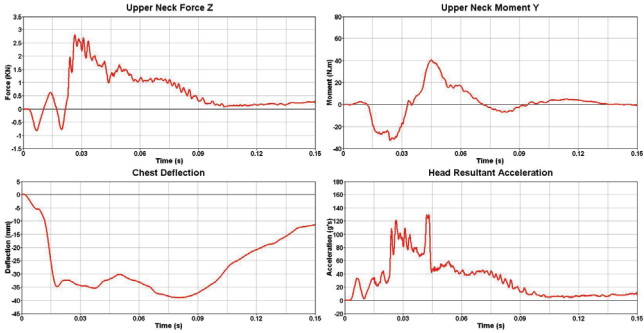
Slide no. 43



# H303 v4.0

## Robustness Testing

### Seatbelt loading case 1 (Initial velocity at 60 mph, normal seating position)



In FTSS applications, outputs have exceeded the NHTSA requirements

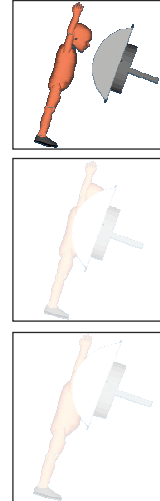
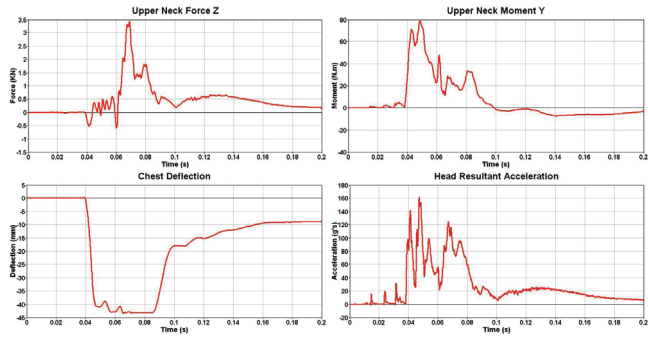
Slide no. 44



## H303 v4.0

### Robustness Testing

Airbag OOP loading case 1 (Initial velocity at 40 mph, fully deployed airbag impacting dummy chest)

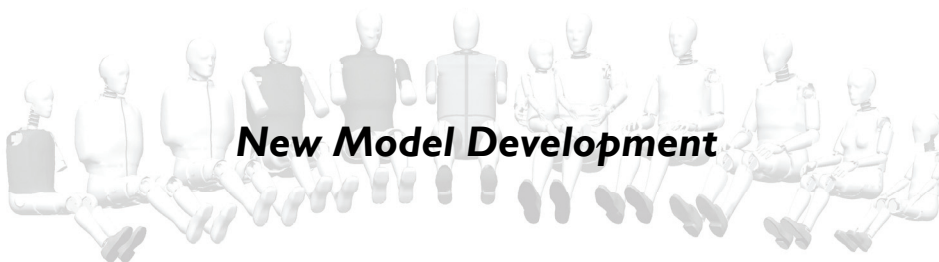


In FTSS applications, outputs have exceeded the requirements

Slide no. 45



## New Model Development



Slide no. 46

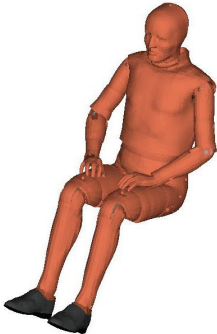




# H250 v1.0

## Hybrid II 50<sup>th</sup> Percentile Male

- SAE Seat Committee – Seat certification through analysis
- Release September 2008

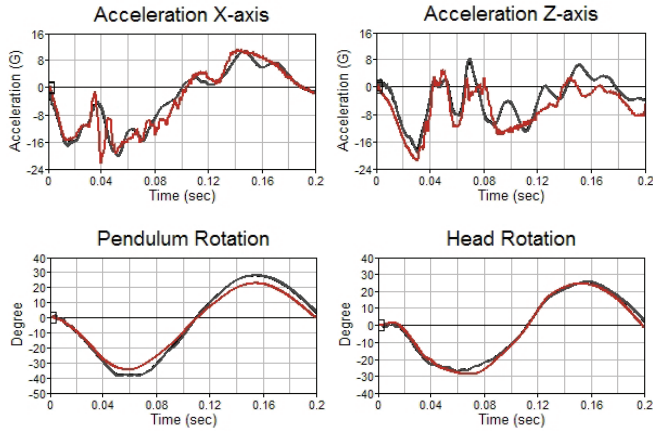


Slide no. 47



# H250 v1.0

## Neck Pendulum – Flexion (6.75 m/s)



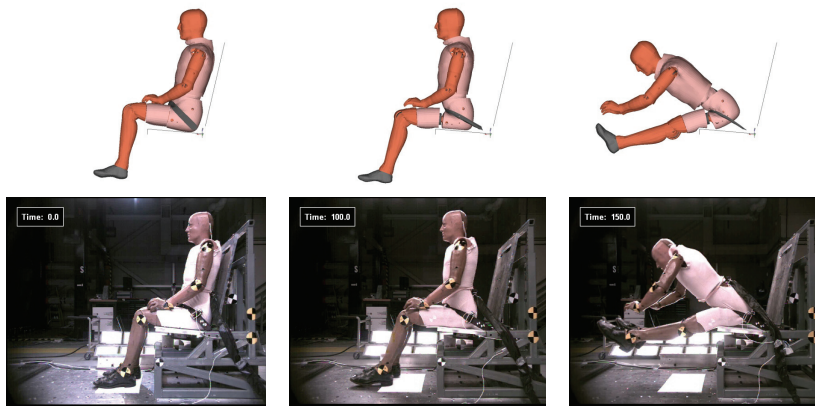
Slide no. 48



Test 1  
Test 2  
FEA v1.0 beta

## H250 v1.0

### 2 Point Belt - 16 g Pulse Sled Test

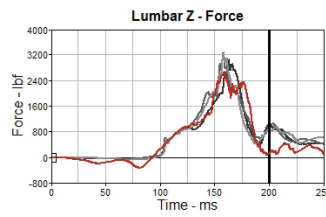
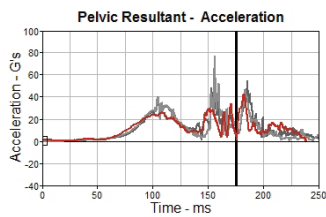
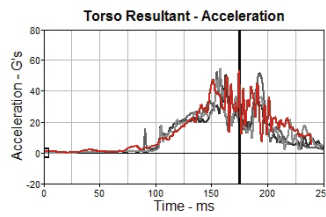
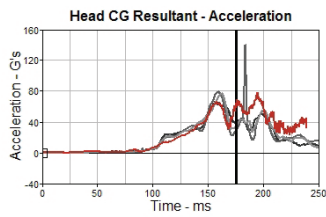


Slide no. 49



## H250 v1.0

### 2 Point Belt - 16 g Pulse Sled Test



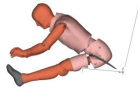
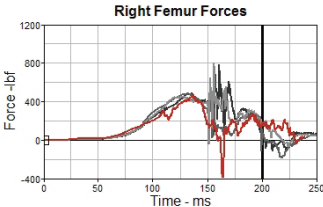
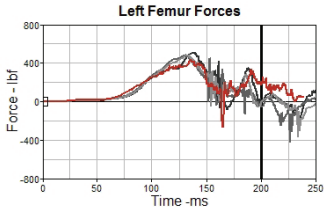
Test 1  
Test 2  
FEA v1.0 beta  
Evaluation

Slide no. 50



# H250 v1.0

## 2 Point Belt - 16 g Pulse Sled Test



Test 1  
Test 2  
FEA v1.0 beta  
Evaluation

Slide no. 51



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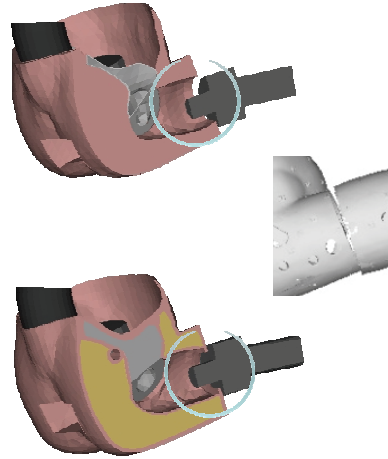
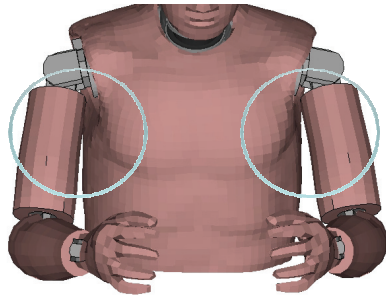
### Model Handling

Slide no. 52

## Model Handling

### Dummy Handling Update

- Improved Geometric Accuracy
  - Improved and non-standard positioning



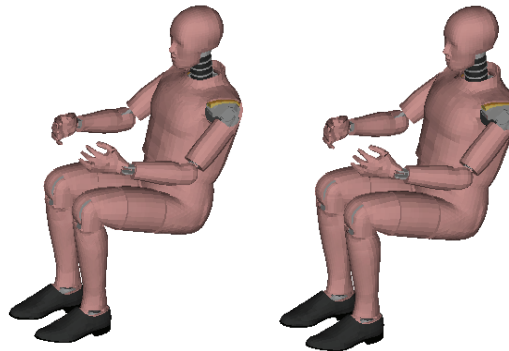
Slide no. 53

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## Model Handling

### Pre-simulation Process

- Determine application points
- Determine joint rotations
- Apply rotations about the pelvis
- Apply rotations about the femur and torso
- Application of gravity should also be considered
- Pre-processors



Slide no. 54

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