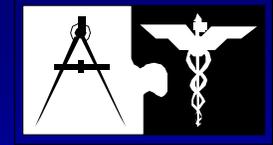


CIREN Public Meeting

Overview of Thoracic Injury Research & Development at NHTSA

Dr. H. Keith Brewer

**Nov. 30, 2000
Washington, DC**



Before We Begin!

Special Thanks To:

Dr. Andy Burgess - Maryland

Dr. John Siegel - New Jersey

Dr. Stewart Wang & Dr. Larry Schneider - Michigan

Dr. Jeffrey Augenstein & Dr. Kennerly Digges - Miami

Dr. David Hoyt - San Diego

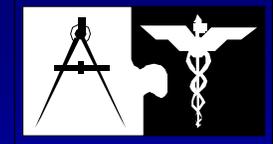
Dr. Martin Eichelberger - DC Children's

Extra Special Thanks To:

Dr. Jeffrey Augenstein - Miami

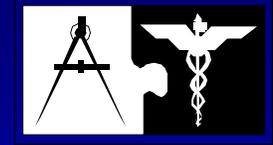
Mr. Lou Brown and Ms. Kathy McCullough - CIREN

Mr. Mark Haffner - NTBRC



NHTSA Thoracic Injury R&D

- **Magnitude of the Problem - Statistics**
- **Understanding Injury Mechanisms - CIREN**
- **Improved Injury Criteria**
- **Computer Models for Injury Analysis**
- **Advanced Crash Dummies**



Serious Thoracic Injuries

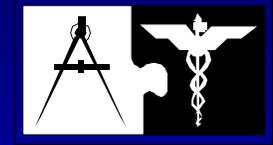
Estimated Number per Year

Occupants of Cars & LTV's

(All Crash Modes)

- AIS 3 47,000
- AIS 4 20,000
- AIS 5 7,000
- AIS 6 2,400
- Total 76,000

Excludes Shoulder, Back & Spine Injuries

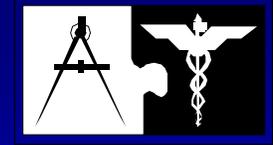


Serious Organ Injuries

Estimated Number per Year

Occupants of Cars & LTV's (AIS 3+)

- Kidneys 1,300
- Liver 4,000
- Spleen 4,000
- Vascular 5,000
- Heart 7,500
- Pulmonary 27,000
- Total 48,800

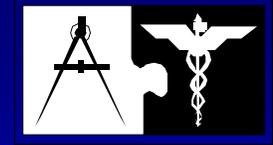


Serious Skeletal Injuries

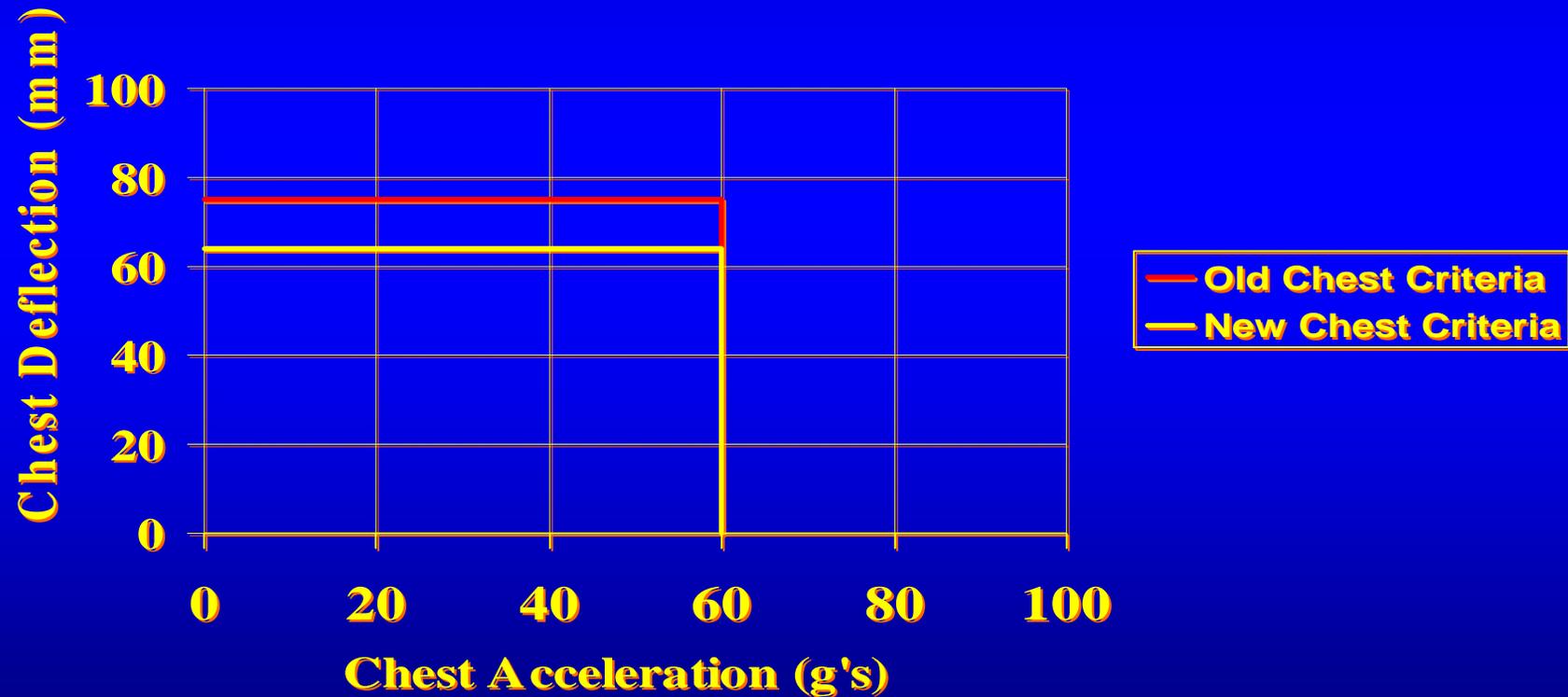
Occupants of Cars & LTV's

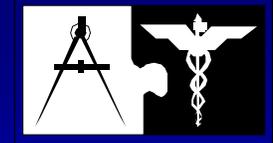
- AIS 3 16,700
- AIS 4 5,900
- AIS 5 2,200
- Total 24,800

(Estimated Number per Year)



Old & New Thoracic Injury Criteria (Frontal)

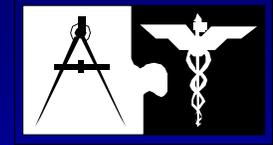




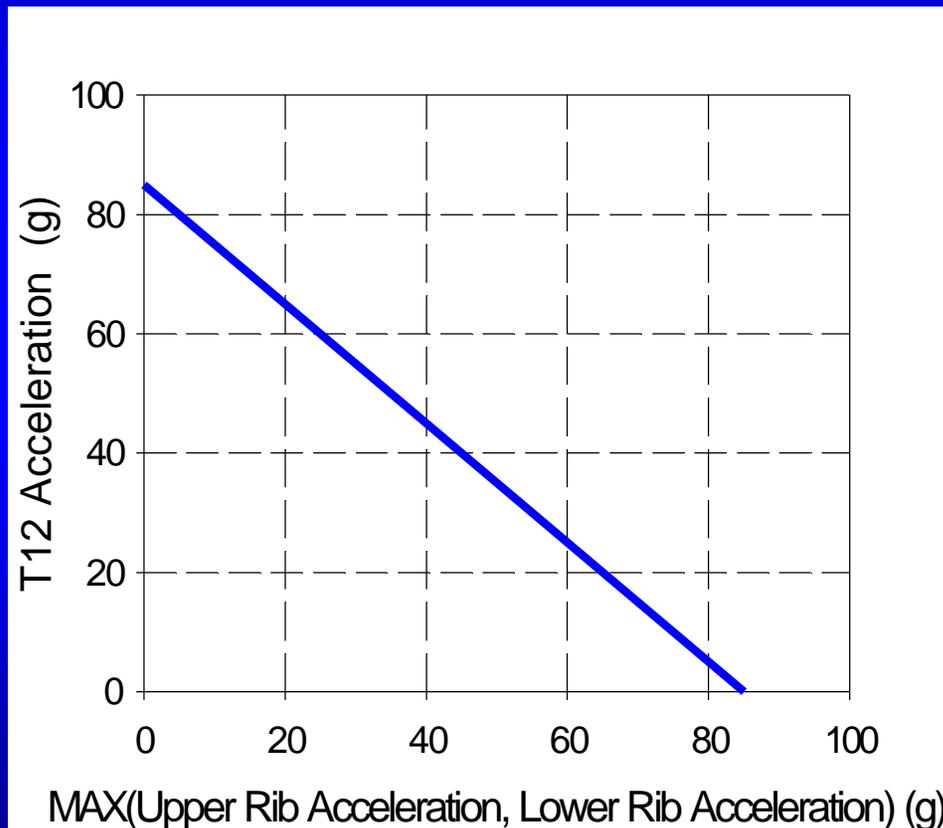
Thoracic Frontal Criteria

<u>Dummy Size</u>	<u>Chest G's</u>	<u>Deflection (mm)</u>
Mid Male	60	63 (2.5 in.)
Small Female	60	52 (2.0 in.)
6 YO Child	60	40 (1.6 in.)
3 YO Child	55	34 (1.4 in.)
1 YO Infant	50	30 (1.2 in*)

** The CRABI 12 month old dummy currently does not measure chest deflection*



Current Thoracic Criteria - Side

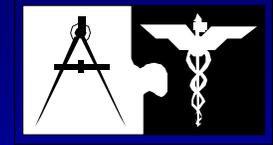


Thoracic Trauma Index (TTI) (*pass under curve*)

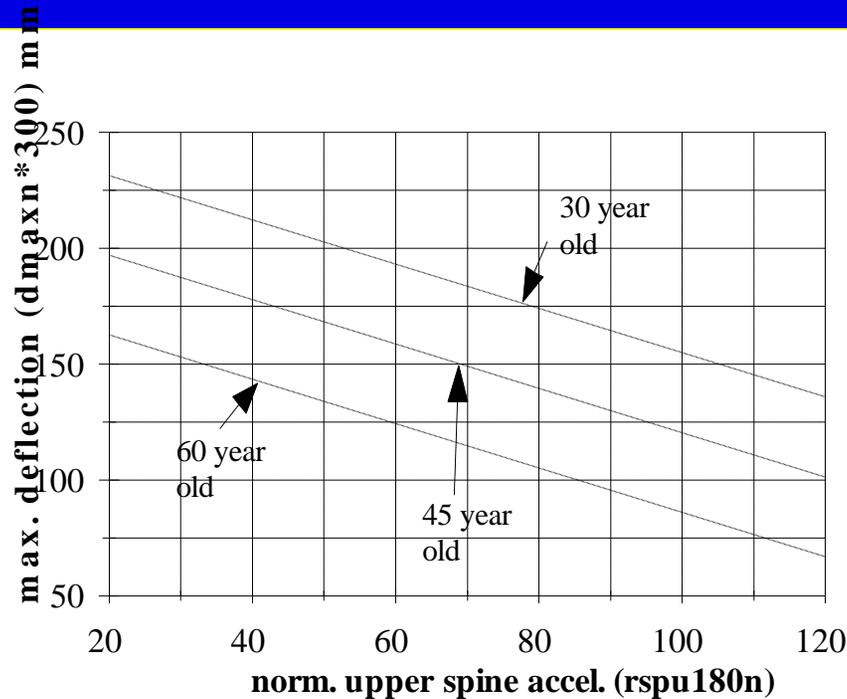
Linear combination of

- rib acceleration
- spine acceleration

$$\text{TTI} = 1/2 [\max(\text{upR or LowR}) + \text{T12}] (\text{G's})$$

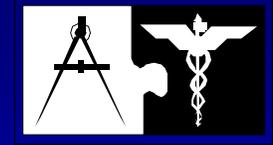


Improved Thoracic Criteria-Side



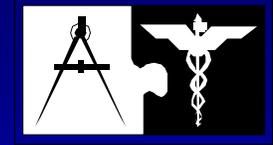
30% Probability of Injury

- Linear combination of
 - chest deflection
 - spine acceleration



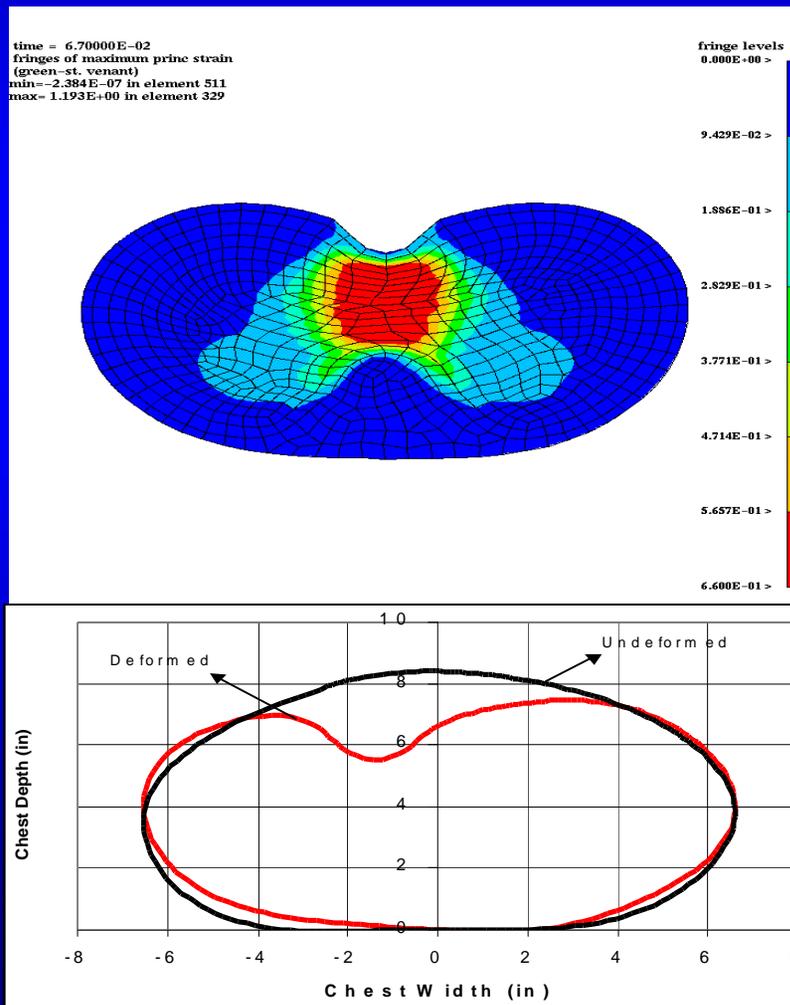
Advanced Computer Injury Models

- **Injuries caused by large rapid distortions & inertial loads - it is a local phenomenon**
- **Need injury criteria beyond gross anatomical responses.**
- **Modeling yields local stresses & strains - potentially new approach to injury criteria.**



Modeling Approach

(Frontal & Side)

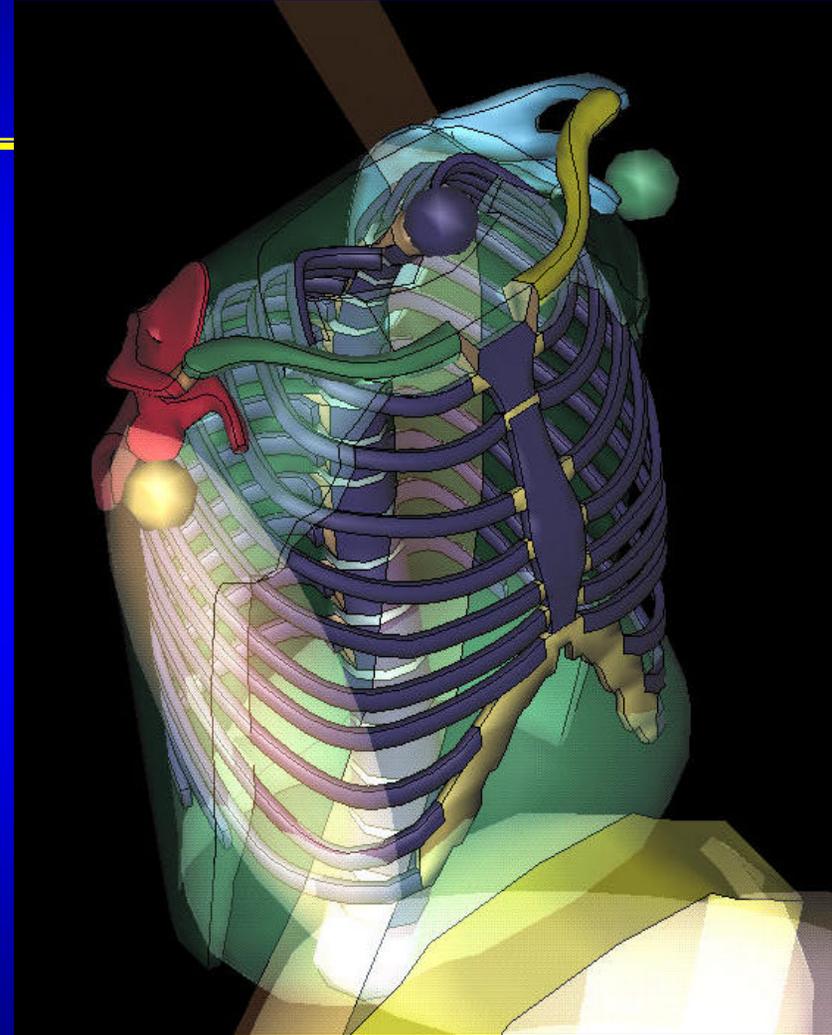
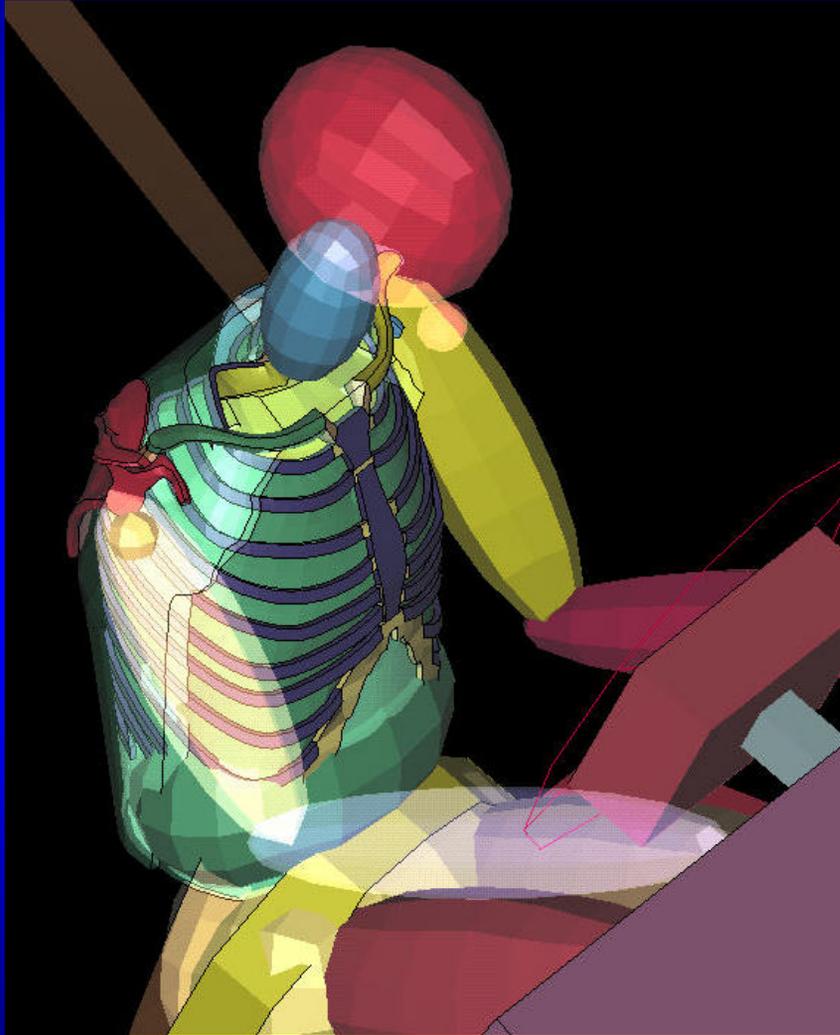
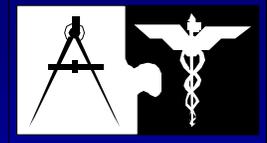


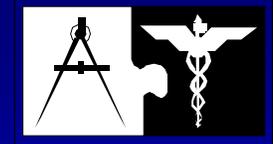
Develop 2 & 3D models and local stress/strain failure criteria from bio tests

Use multiple dummy deflections to calculate local stresses and strains.

Injury Criteria to Limit local stress/strains

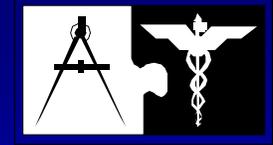
Anatomic Chest Integrated into Full Dummy FE Model





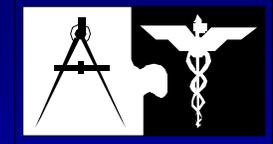
***Computed
Rib
Stresses
Under Impact***

***Study to Assess
Influence of:
Seat Belts,
Airbag Systems
and
Force Limiting
Devices***

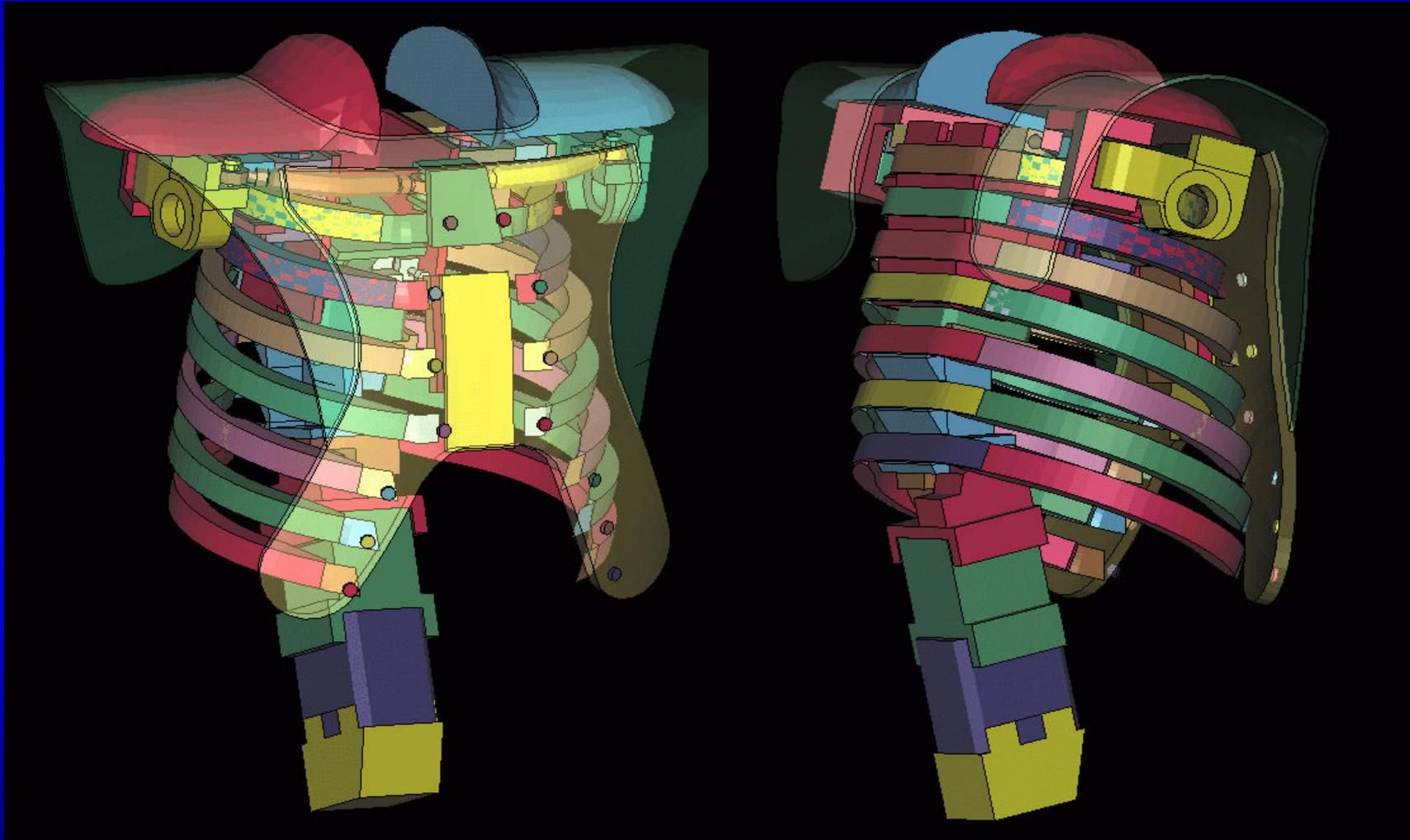


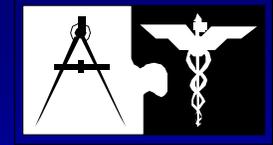
Advanced THOR Frontal Dummy





Details of New THOR Rib Assembly





Lateral Dummy Development



WorldSID

Enhanced biofidelity

Enhanced measurement capability

2004 availability