Certification by Analysis Meeting

HyperWorks tools for Seat Certification thru virtual Testing's

Jean-Michel Terrier

Senior Director Solver Business Development

Managing Director Altair Development France

NIART, Wichita, August 7th 2012
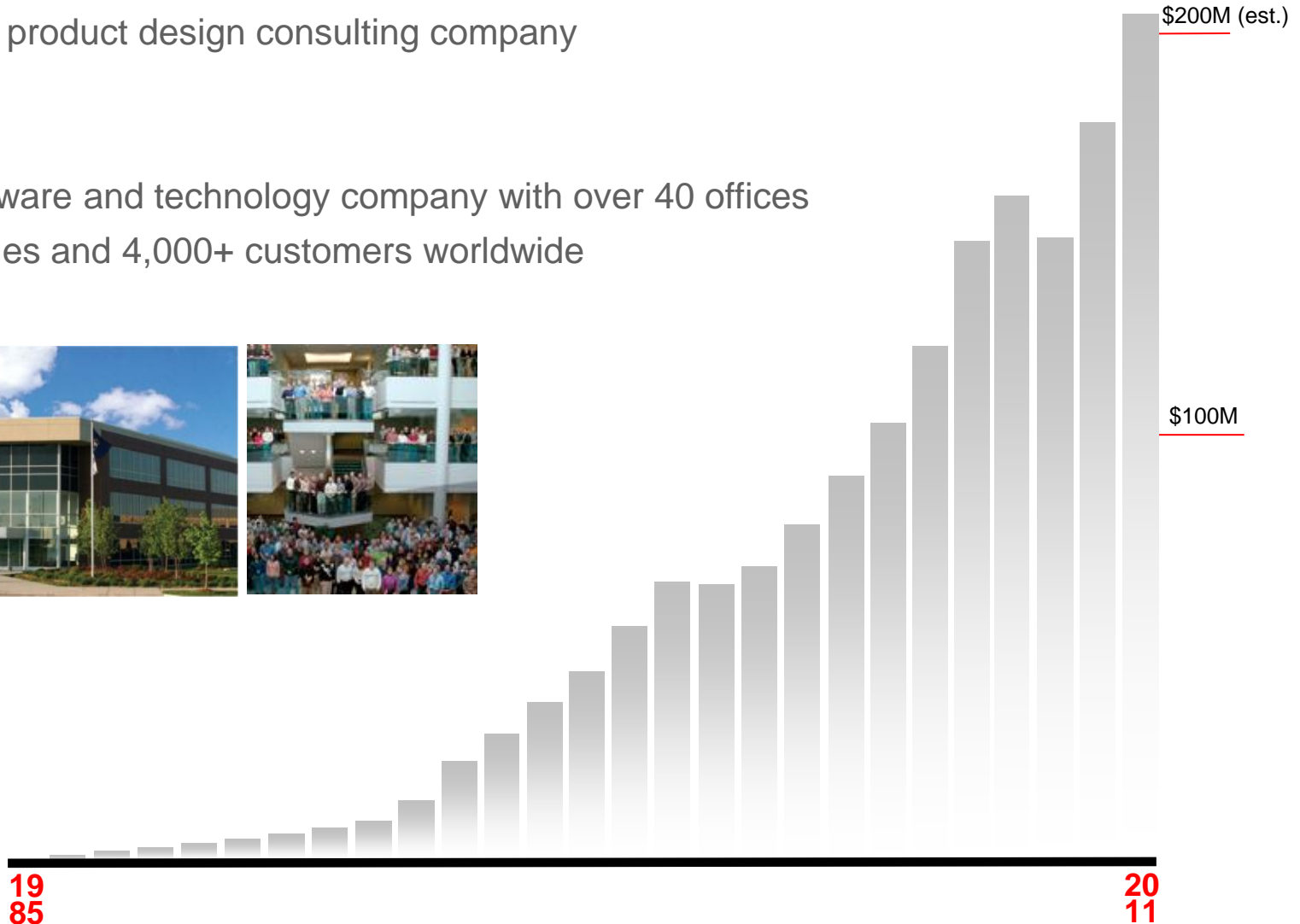
Innovation Intelligence®

ALTAIR - Overview

Founded ...

In 1985 as a product design consulting company

Today ...

A global software and technology company with over 40 offices
in 16 Countries and 4,000+ customers worldwide

$200M (est.)

$100M

**19
85**

**20
11**

Key Milestones in Aerospace

1993

OptiStruct released

1997

First OptiStruct sale in Aerospace (Boeing)

2002

Airbus A380 Leading Edge Wing Rib Optimization

2003

Boeing 787 Leading Edge Wing Rib Optimization

2005

Dedicated HyperMesh Development for Aerospace

2007

Boeing 787 Optimization Center Established

2008

Airbus Optimization Center Established

2009

Altair selected as Preferred Engineering Vendor at Boeing, Airbus, and ATK

2010

HyperStudy/Excel and HyperShape/Catia Approved for Use at Boeing

Airbus Presents Optimization Center Results at HyperWorks Technology Conference

Altair APAC Aero Market Grows by over 70%

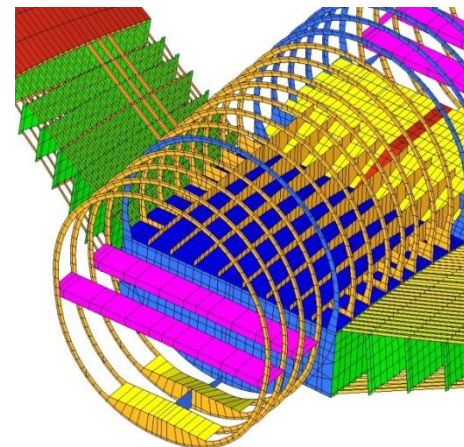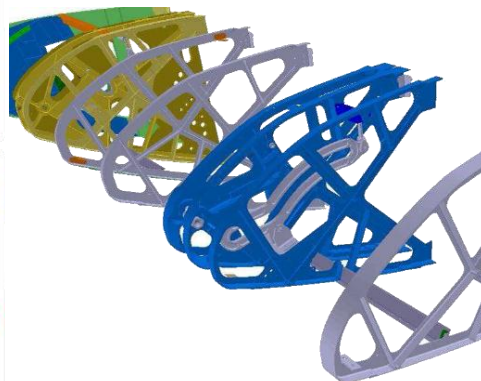Eurocopter, OHB, and MTU Aeroengines officially switch to HyperMesh

2011

Altair Awarded Boeing Performance Excellence Award

Boeing and Airbus Optimization Centers Expand

HyperWorks 11.0 Released with Significant Aerospace Content

Bombardier adopts HyperMesh

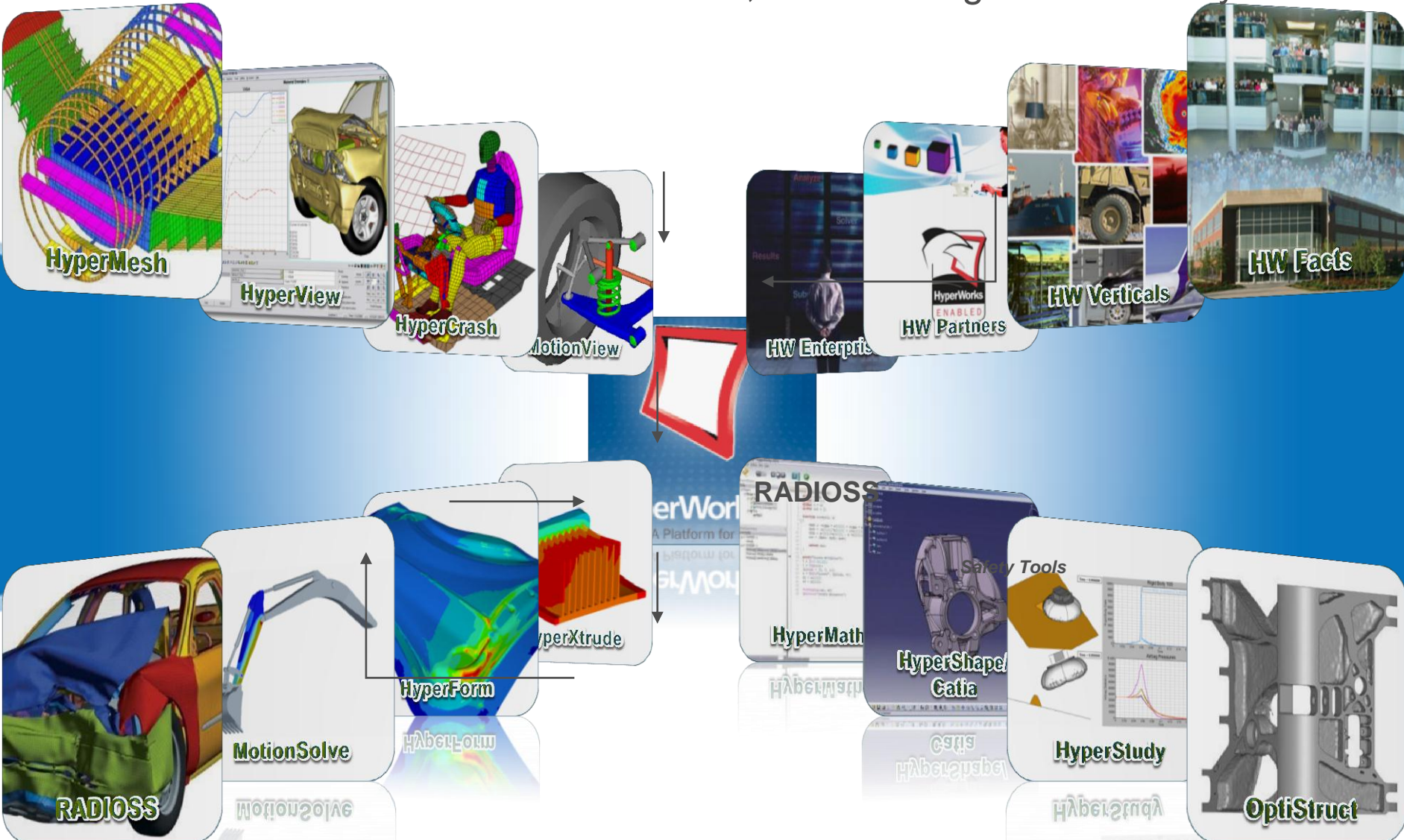**HyperWorks**

Engineering Simulation Platform

Altair **ProductDesign**

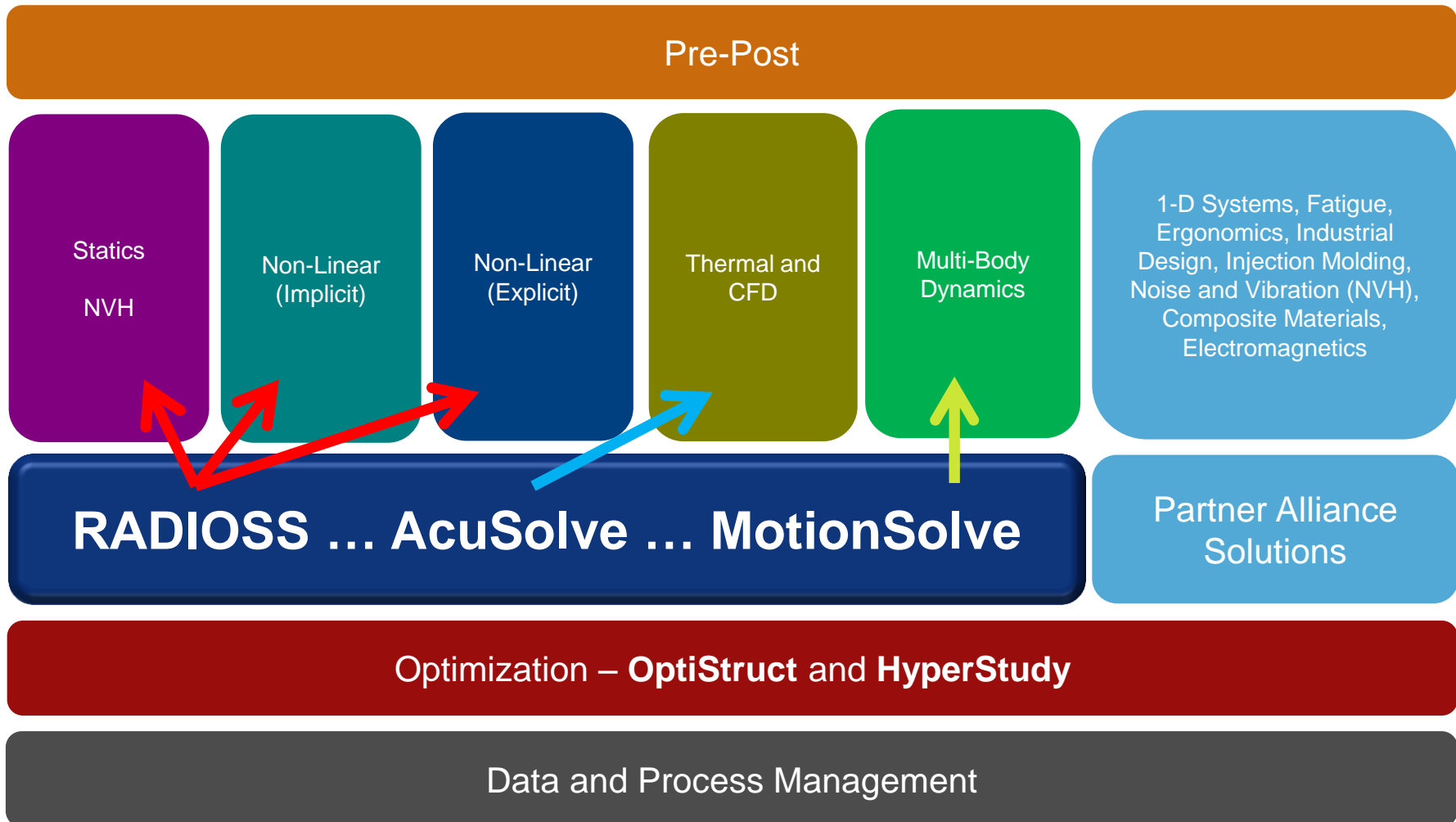**Product Innovation Consulting**

PBS Works

On-demand Computing Technology

Altair HyperWorks: A Platform for Innovation

HyperWorks®

Suite of software tools for CAE, Data Management & analytics

HyperMesh

HyperView

HyperCrash

MotionView

HW Enterprise

HW Partners

HW Verticals

HW Facts

RADIOSS

HyperXtrude

HyperMath

Safety Tools

HyperShape/Catia

HyperStudy

MotionSolve

HyperForm

RADIOSS

OptiStruct

HyperWorks - Software Platform for Inovation

HyperWorks

Pre-Post					
Statics NVH	Non-Linear (Implicit)	Non-Linear (Explicit)	Thermal and CFD	Multi-Body Dynamics	1-D Systems, Fatigue, Ergonomics, Industrial Design, Injection Molding, Noise and Vibration (NVH), Composite Materials, Electromagnetics

RADIOSS … AcuSolve … MotionSolve

Partner Alliance Solutions

Optimization – **OptiStruct** and **HyperStudy**

Data and Process Management

Safety Models: Dummies

- **Frontal impact dummies**
  - Hybrid II (50th percentile) rigid dummy for aeronautics applications
  - Hybrid III (5 and 95th percentile) rigid dummies
  - FTSS Express Hybrid III 50th, & 5th percentile dummy
  - FTSS Hybrid III 50th, 95th & 5th percentile dummies
- **Side impact dummies**
  - ES2 & ES2-re
  - FTSS SID-IIs SBL C & D
  - US SID
  - SIDHIII
  - WorldSID 50%
  - WorldSID 5%
- **Rear Impact Dummies**
  - BIORID IIg

- •Child dummies
  - Hybrid 3 and 6 years, 10 years
  - P series 3, 6 and 10 years
  - P 18 months
  - Q series 3 years, 1 year, 1.5 & 6 years
  - CRABI

- •Pedestrian impactors and standing dummy
  - Head (EEVC adults and Child, FMVSS 201)
  - Pedestrian Head forms EEVC
  - Lower leg EEVC impactor
  - Upper leg EEVC impactor
  - Standing HIII 50th rigid dummy
  - Standing HIII child 6 years rigid dummy
  - Autoliv-Chalmers standing dummy
  - FlexPLI

- **Human models:**
  - HUMOS
  - LBA Leg
  - 10 Years Child

HII Aero Dummy

Hybrid II RB Aero 50th dummy
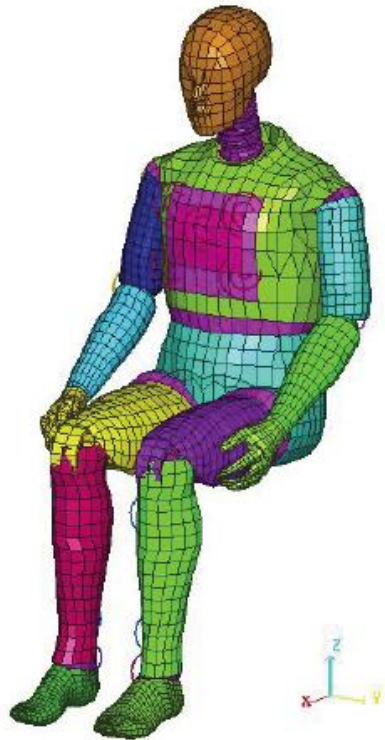
General features :

5630 nodes
5003 shells elements
230 bricks
41 springs
42 parts

Time step = 5.3 μs
Total mass = 74.06 kg.

Latest version : AERO_HYB250_RG_V110A (Q1- 2011)
- Radioss V11 model.
- Updates (Elements formulation ,contact definition, …) based on NIAR tests data

HII Aero Dummy Instrumentation

HyperWorks
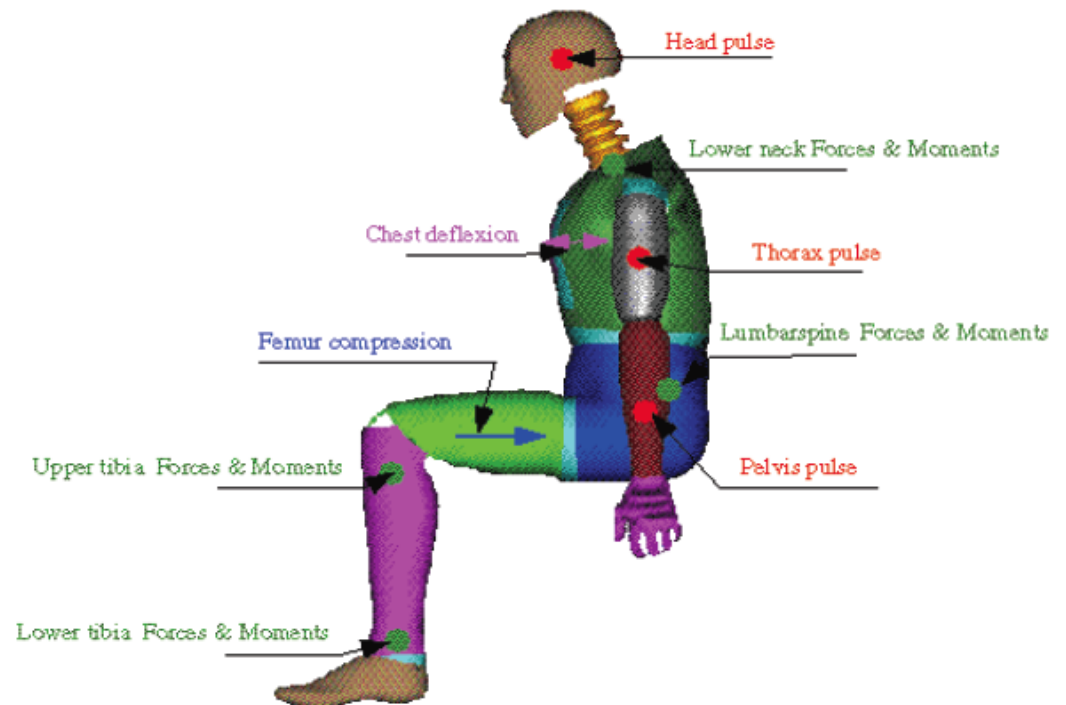
Hybrid II Instrumentation

- Accelerometers
    - Head
    - Chest
    - Pelvis

- Force and moment sensors
    - Lower & Upper neck
    - Lower & Upper lumbar spine
    - Left and right femur
    - Left and right upper tibia
    - Left and right lower tibia

- Deflection sensors
    - Chest deflection

HII Aero Dummy – Validations

- **NIAR Test: 60° pitch test with 2 points belt & 14g acceleration**
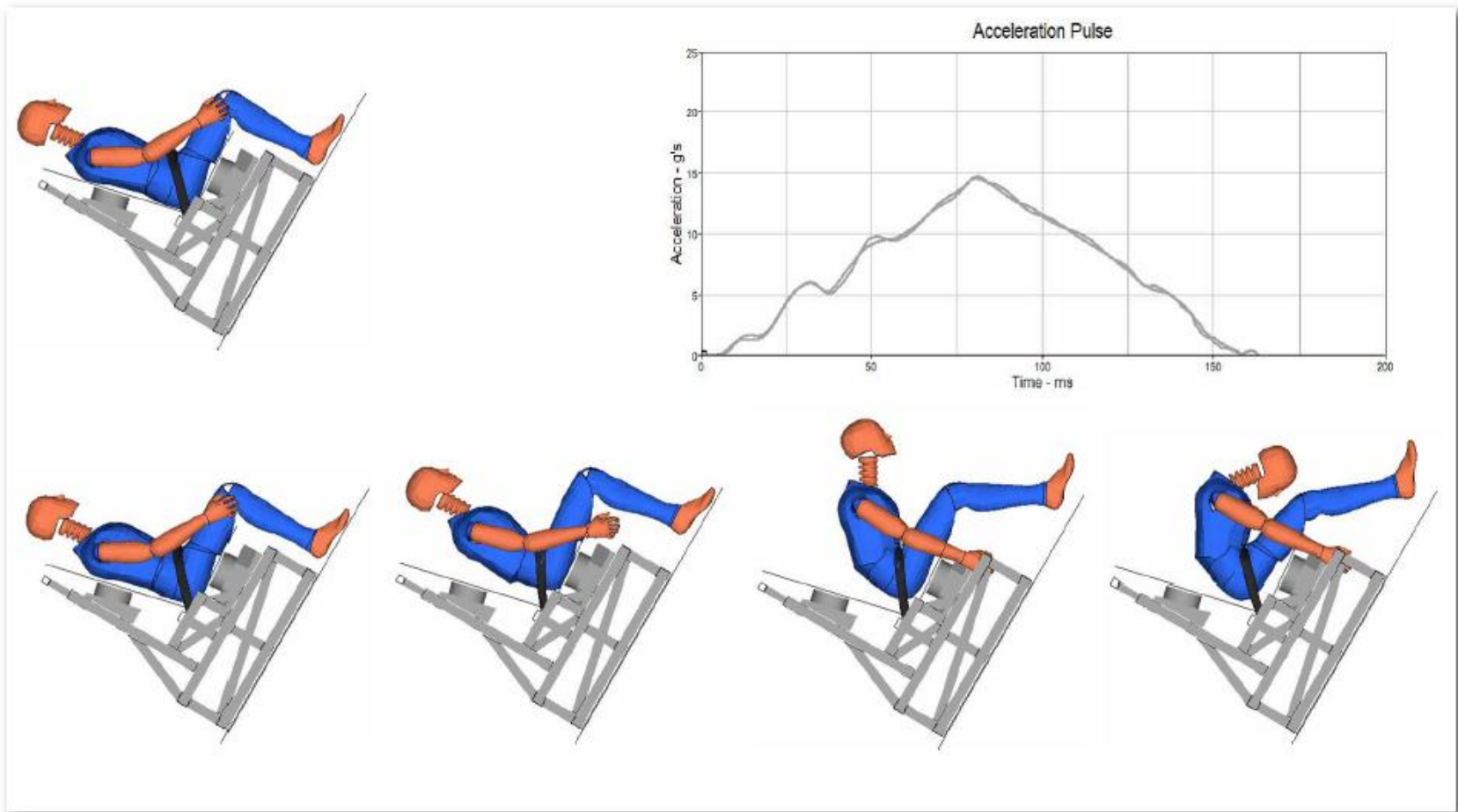
HII Aero Dummy – NIAR 60° 2PB 14g

- **Torso Acceleration**

HII Aero Dummy – NIAR 60° 2PB 14g

HyperWorks
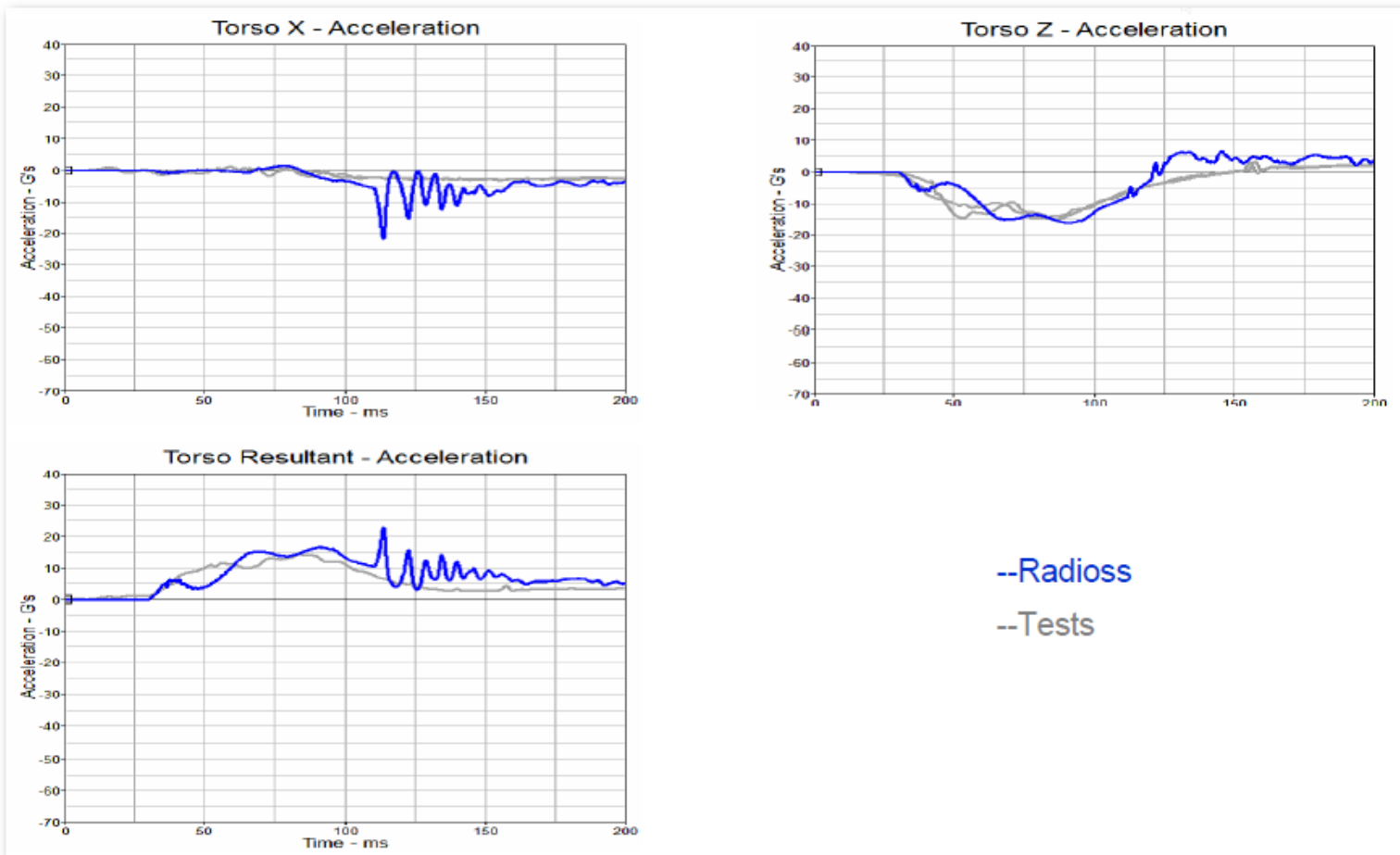
- **Pelvis Acceleration**
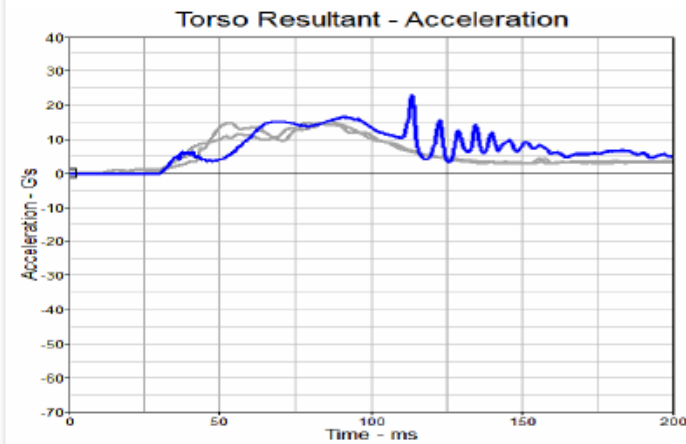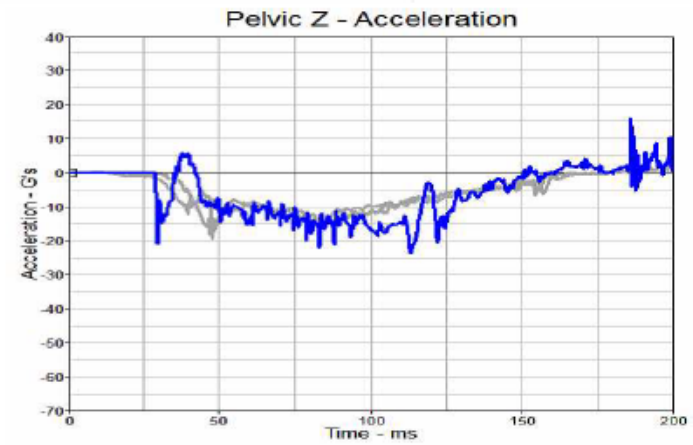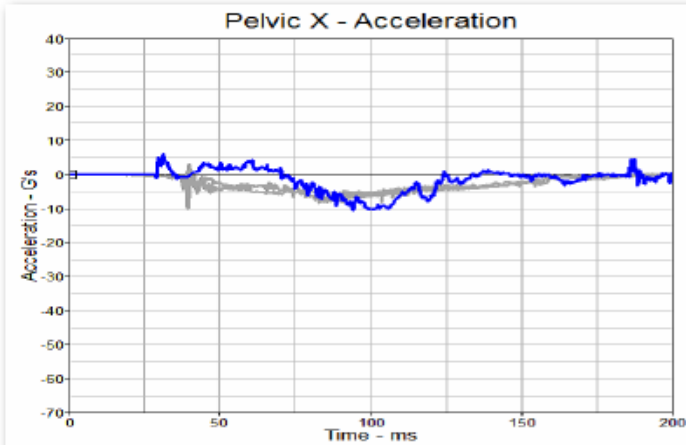
--Radioss

--Tests

HII Aero Dummy – NIAR 60° 2PB 14g

HyperWorks

- **Lumbar Spine Load**
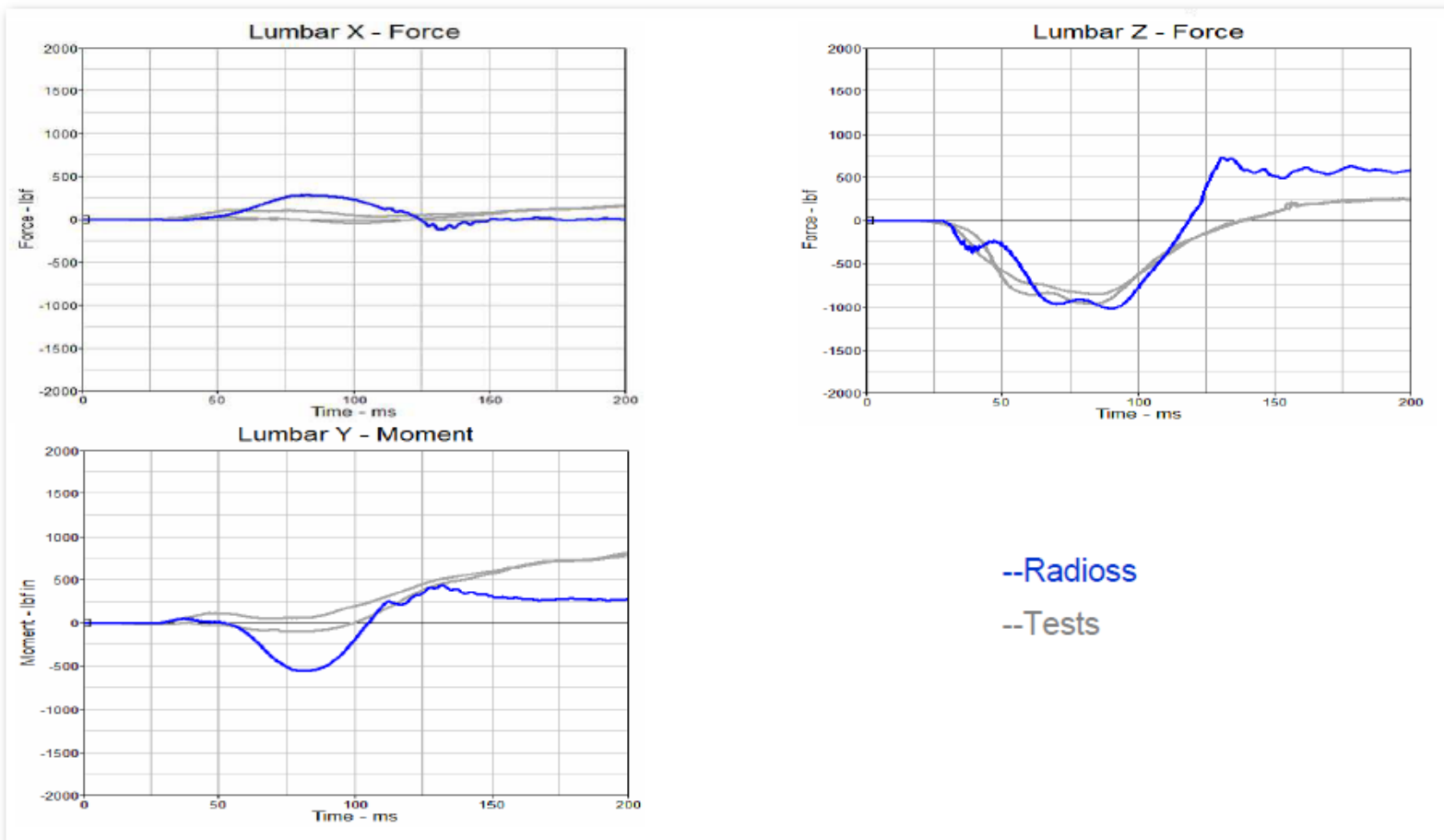
Seat Positioning – MotionSolve MBD solution
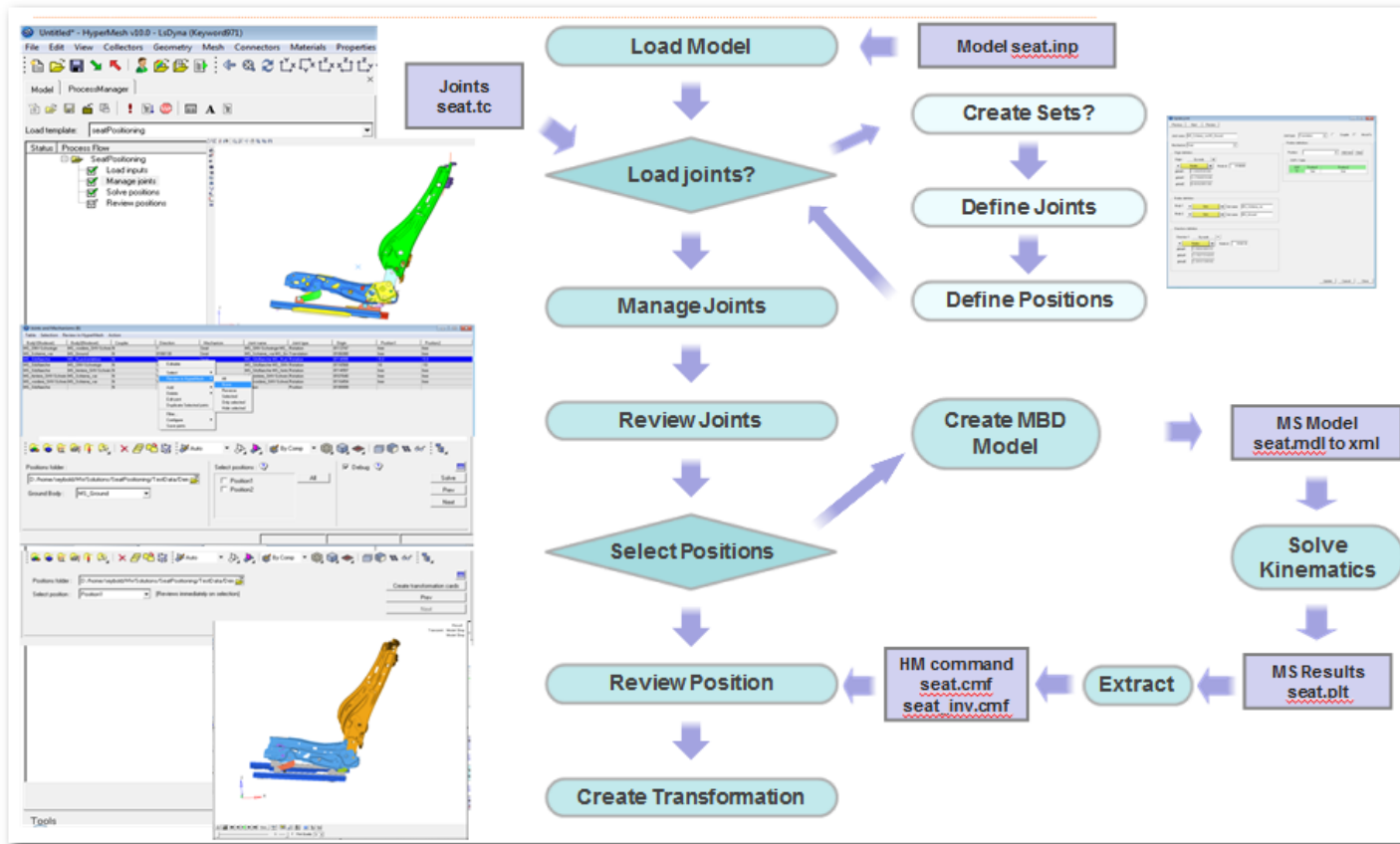
The models obtained after transformations are available then in HM to finish the input data setup.
Pitch and Roll are resolved thru simulations

HyperCrash : Safety pre-processor

HyperWorks®

Connections

Quality

Multi Solver

Load Cases

Mass Balance

Mesh Tools

System Swap

Graphic **U**ser **I**nterface

Safety

- Dummy Positioning

- Seatbelt Routing

- Seat Deformer

- Airbag Folding

- Safety Library Database

- FTSS Partnership

HyperCrash – Positionning of all the Radioss dummies

HyperWorks®
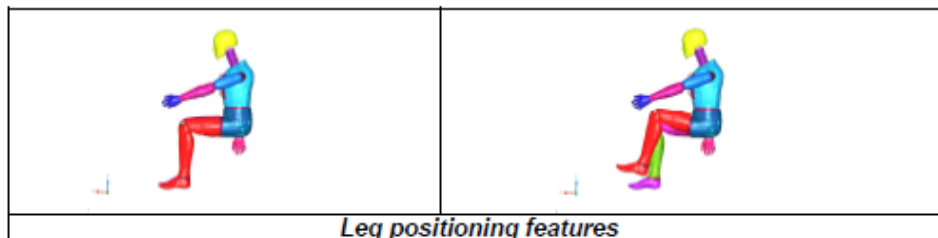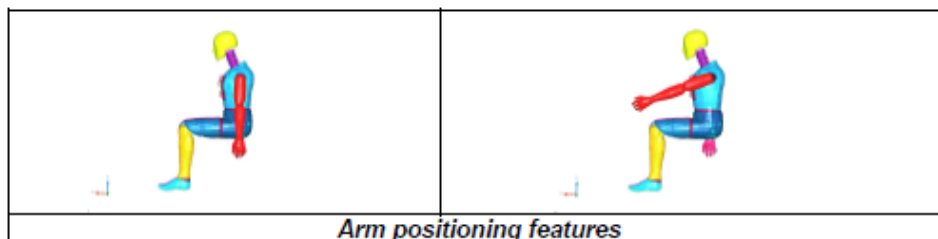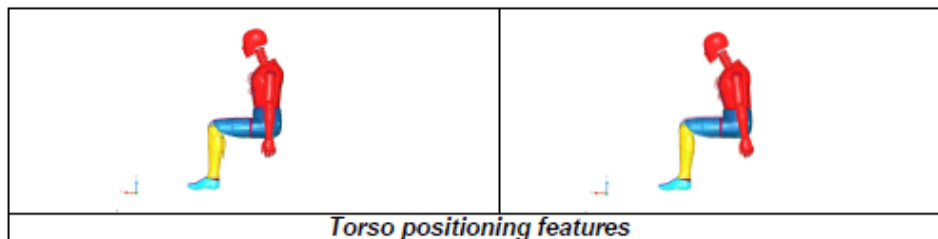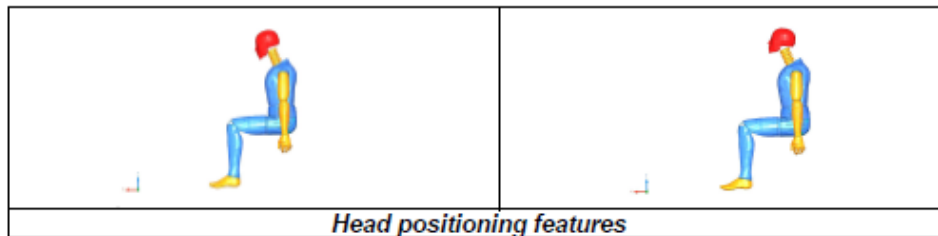
Advanced review for joint position

H-point control area

Head positioning features

Torso positioning features

Arm positioning features

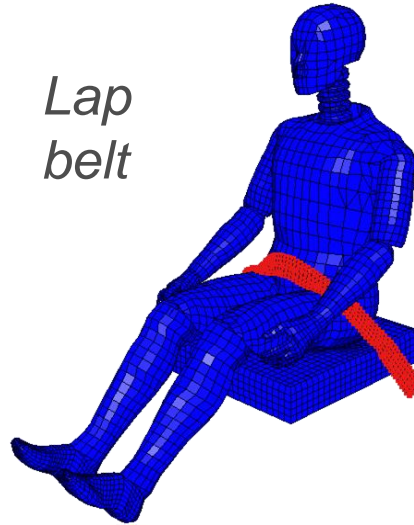Leg positioning features

...s dummies ...structures

HyperCrash – seatbelt creation & seat deformer

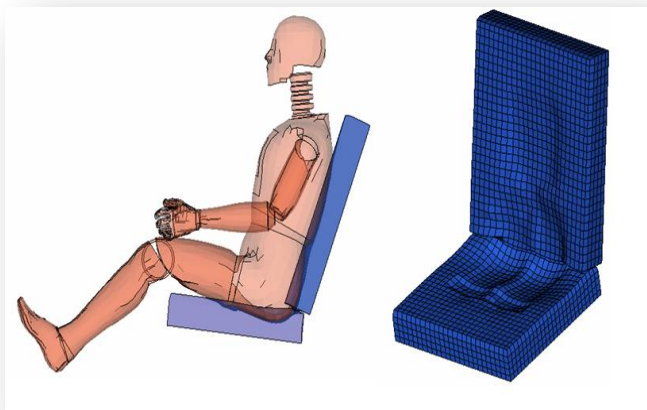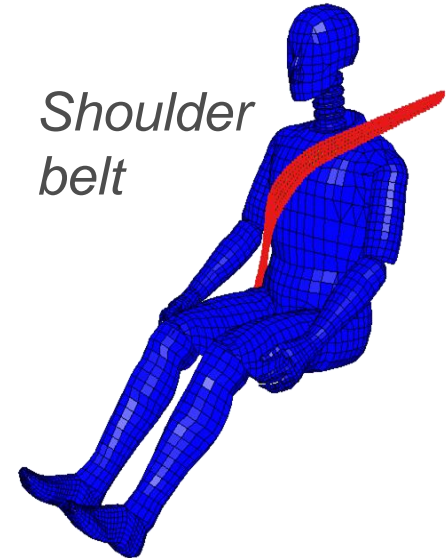• Belt creation
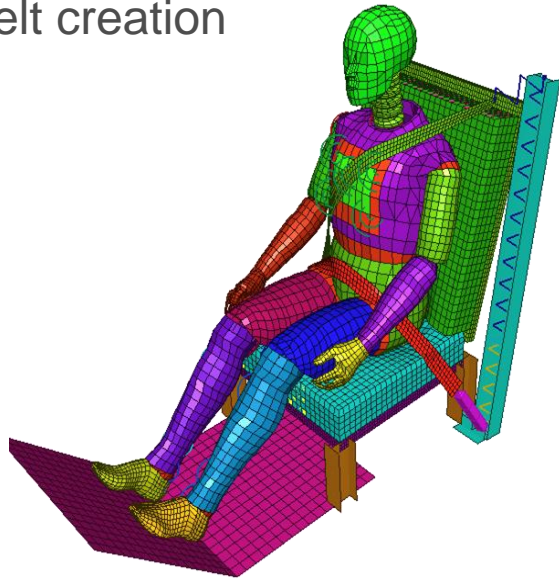
Lap belt

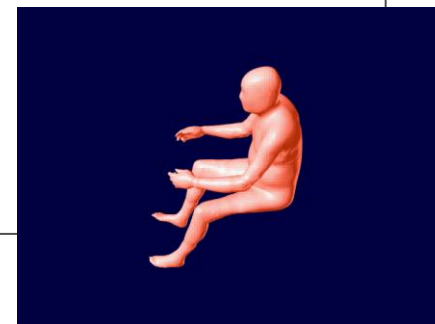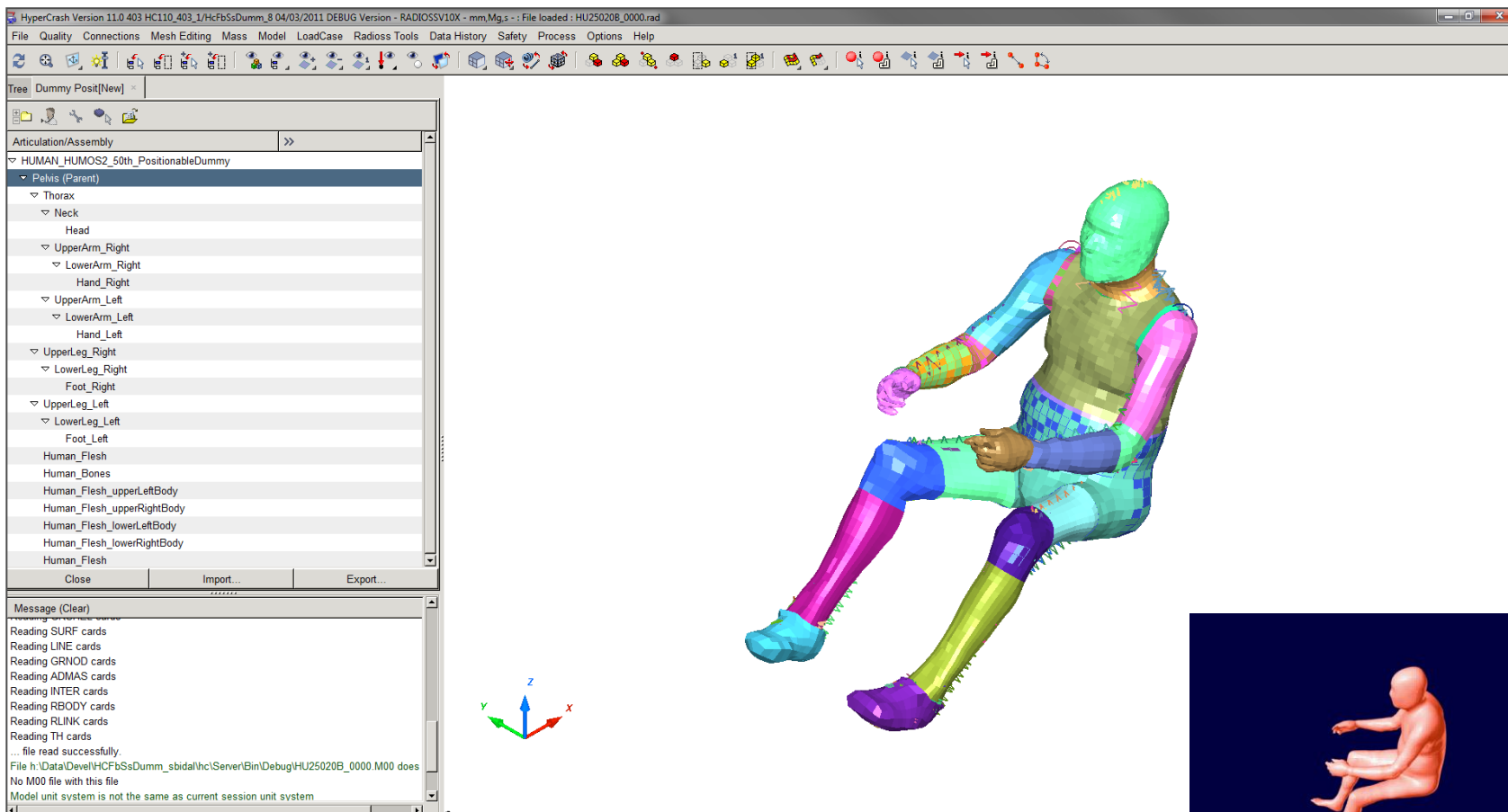*Shoulder belt*

•Seat Deformer Function

The function morphs dummy back surface to seat foam.

➜ Stress in seat foam can be preserved as initial stress for crash.

HyperCrash : HUMOS 2 positioning

HUMOS 2 can be set in position in HyperCrash like all the other dummies

It's base on a positions data base

HUman MOdel for Safety (HUMOS)

HyperWorks

- History

    HUMOS 1 & 2 projects (HUman MOdel for Safety) –
    supported by the European Community

    HUMOS 1 model - 50th percentile male model

    HUMOS 2 models is a family of human models (5th
    female, improved 50th male, 95th male models,
    standing 50th male)

- Includes skeleton, muscles, organs,

    ligaments…

- Accurate 3D finite element model of the

    real human body, geometry based on a

    PMHS

<u>61000 Nodes / 102000 Elements</u>

HUMOS 2

- **European Program on Advanced PROtection SYStems (APROSYS) Automotive and motorbike safety 2004-2009**

- **European Program on MotorcYclists and MOped driver SAfety (MYMOSA) 2007 – 2010**

- **PROMOTO project : airbag jacket design & real accident analysis**

- **Applications in Defense**

HUMOS 2 for Aircraft Seat Certification

HyperWorks
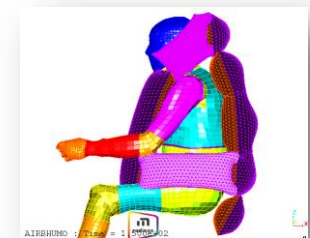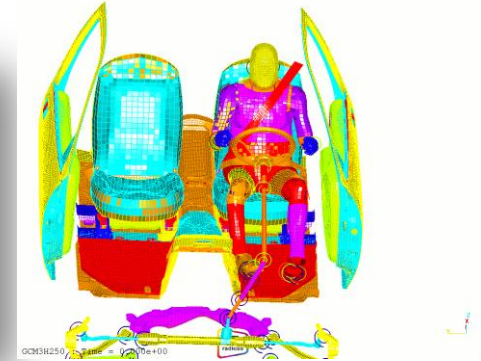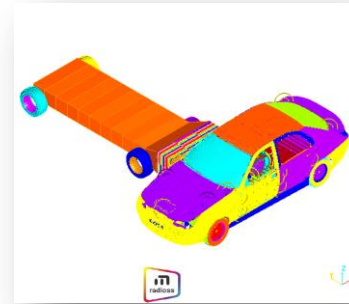
Common R&D work between NIAR and Altair Development France

- **NIAR Wichita State University**

    - Gerardo Olivares, Ph.D

        Sr. Research Scientist & Director,
        Crash Dynamics & Computational Mechanics Laboratory

    - Luis Manuel Gomez

        Research Engineer
        Comp. Mechanics/Crash Dynamics Laboratory

- **Altair Development France**

    - Franck Njilie

        Safety Development team manager

    - Jerome Kerrien

        Internship student
        Ecole Centrale de Nantes

HUMOS 2 for Aircraft Seat Certification

HyperWorks

Objectives

In Automotive industry, human models are getting more and more used for crashworthiness purpose. => better understanding of injury mechanisms leading to effective design of injury countermeasures.

"Emergency landing dynamic conditions" => Hybrid II and/or FAA-Hybrid III anthropomorphic test devices (ATDs)

Do dummy measures provide accurate and wide information on potential injuries occurring on aircraft seat occupant in case of survivable crash even ?

This work is done with the believe that there is a need to enhance the knowledge of injury mechanism within the aircraft survivable crash event.

Aim :

- ✓ Adapt the Radioss automotive human model (Humos 2) to aircraft seating posture
- ✓ Validate Humos 2 within the aircraft crash scenarios (horizontal-vertical load cases…)
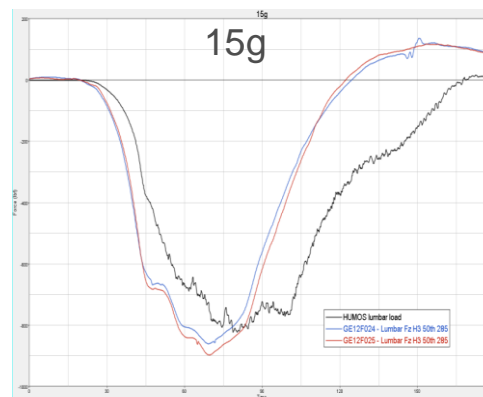- ✓ Use the validated Humos 2 model to enhance injury biomechanical knowledge in aircraft crash scenario

HUMOS 2 for Aircraft Seat Certification

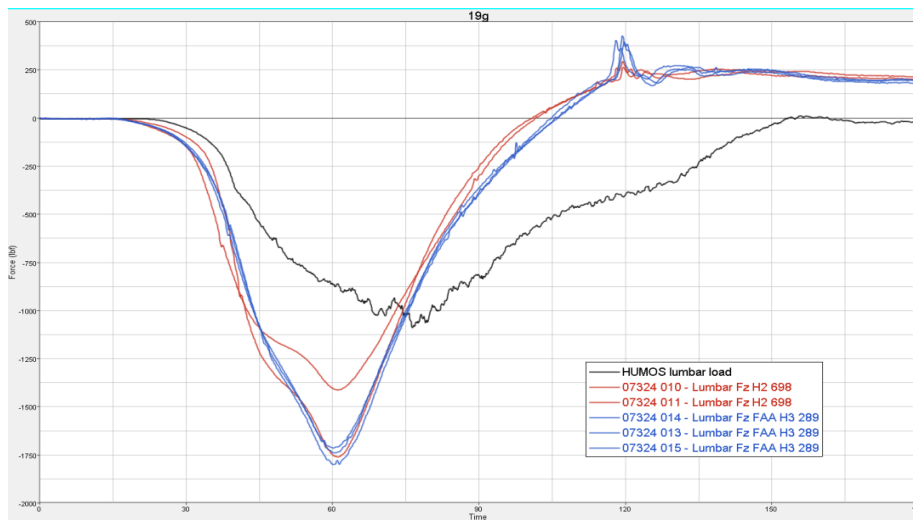## 1. HUMOS 2 versus standard HIII in aero sled tests

t = 0ms   t = 100ms   t = 180ms

14g

15g
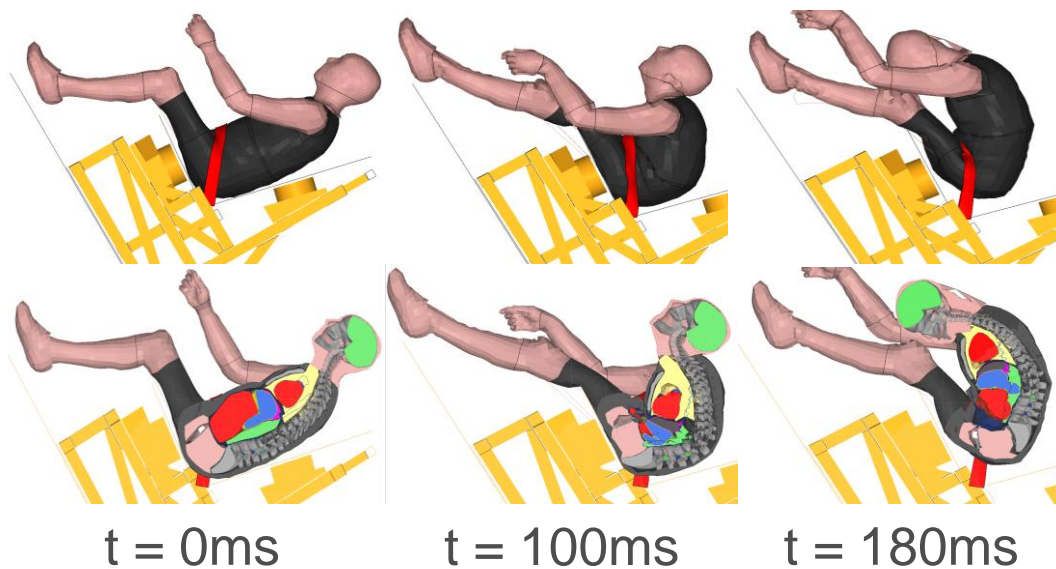
Spine loads

HUMOS 2 for Aircraft Seat Certification
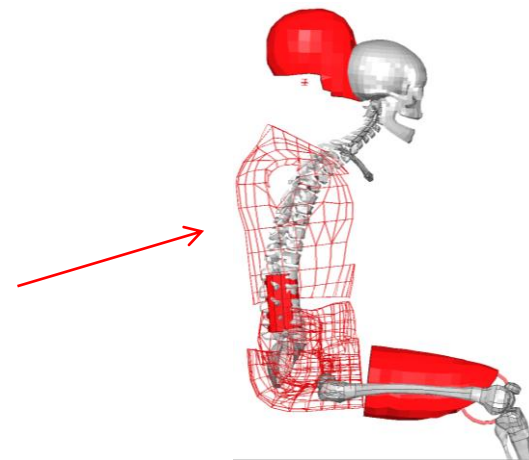
HyperWorks®

2. HUMOS 2 versus FAA HIII in aero sled tests

vertical load -19g pulse

$\Rightarrow$ Need to improve Humos 2 position
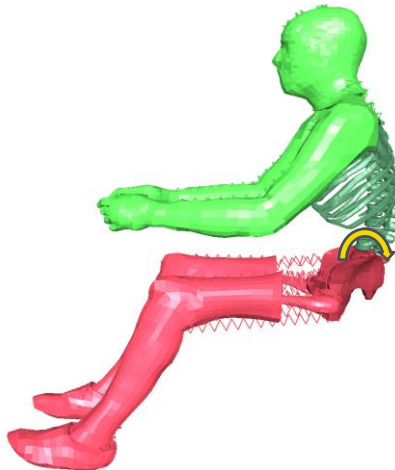to fulfill Aero test condition requirements

HyperWorks

3. HUMOS 2 seating posture updates
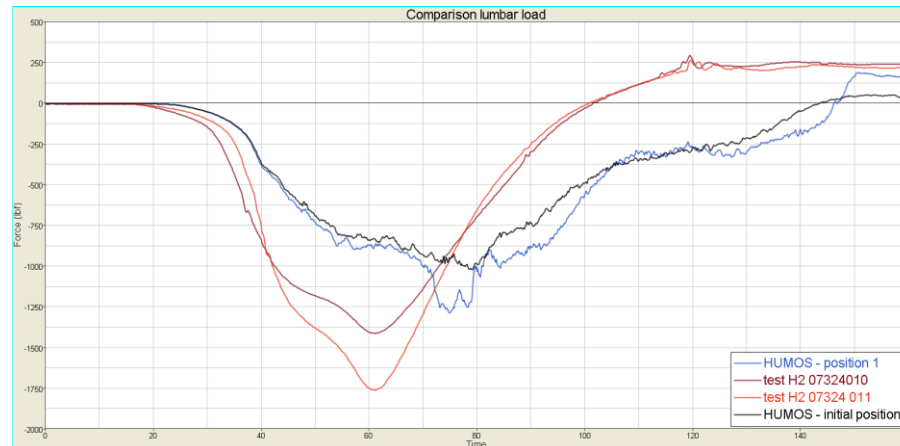
- Spine update

Positioning load description

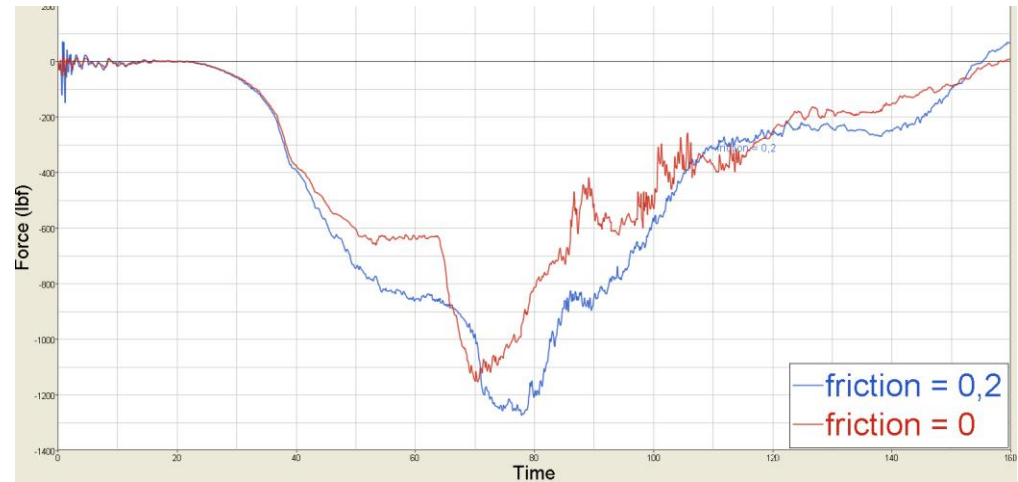initial automotive posture
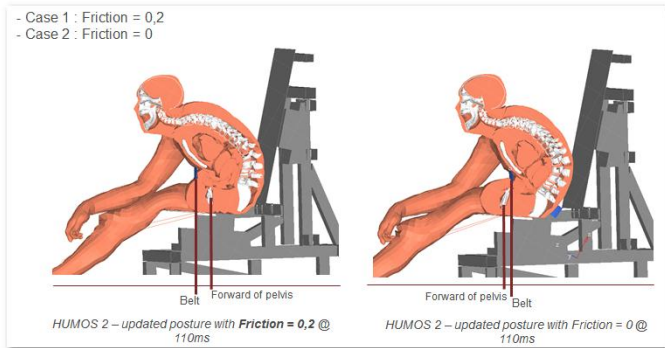
posture update 1

First update

HUMOS 2 for Aircraft Seat Certification

4. Effects of some parameters (dummy/seat friction, …)

- Submarining

Increase of the lumbar load with the increase of the friction

HUMOS 2 for Aircraft Seat Certification

5. HUMOS 2 aero position versus FAA HIII in aero sled tests

Added value due to a human model usage
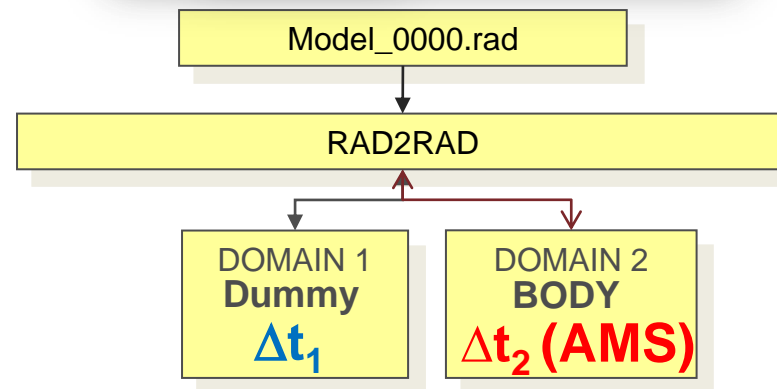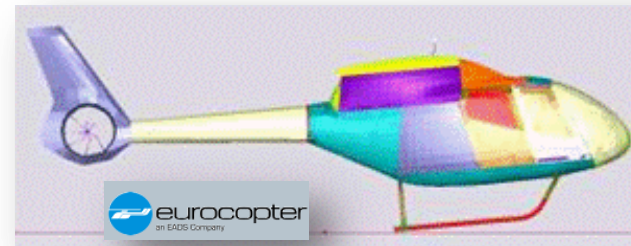
(to be done – Schedule end of September 2012))

- *Paper to be presented at the NIAR Aerospace Structural Impact Dynamics International Conference (Nov. 6th-9th 2012).*

Solution speed in Radioss

Multi-domains (improvement)

- **Single input file**
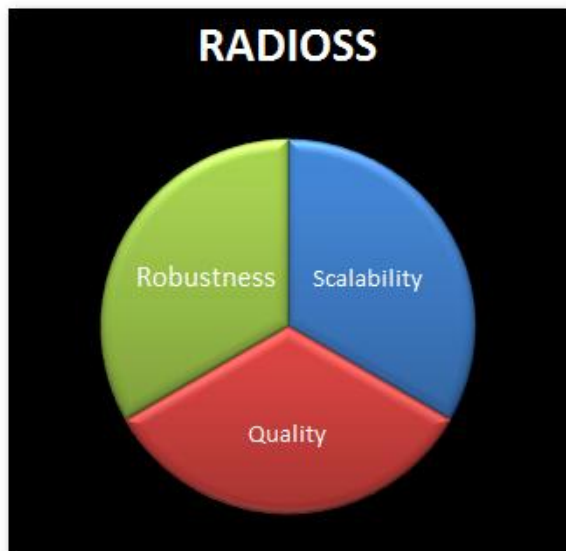
- **Solver Manager**

- **Compatibility with AMS domain**

Benefits

- **Speed-up**

- **High accuracy**

Model_0000.rad

RAD2RAD

| DOMAIN 1 **Dummy** Δt_1 | DOMAIN 2 **BODY** Δt_2 **(AMS)** |

Version Radioss 12+

HyperWorks tools for Seat Certification thru virtual Testing's △ Altair

Thank you for your attention !

Jean Michel TERRIER

Phone: +1 248 885 6806

E-Mail: jmterrier@altair.com