Powering Innovation That Drives Human Advancement

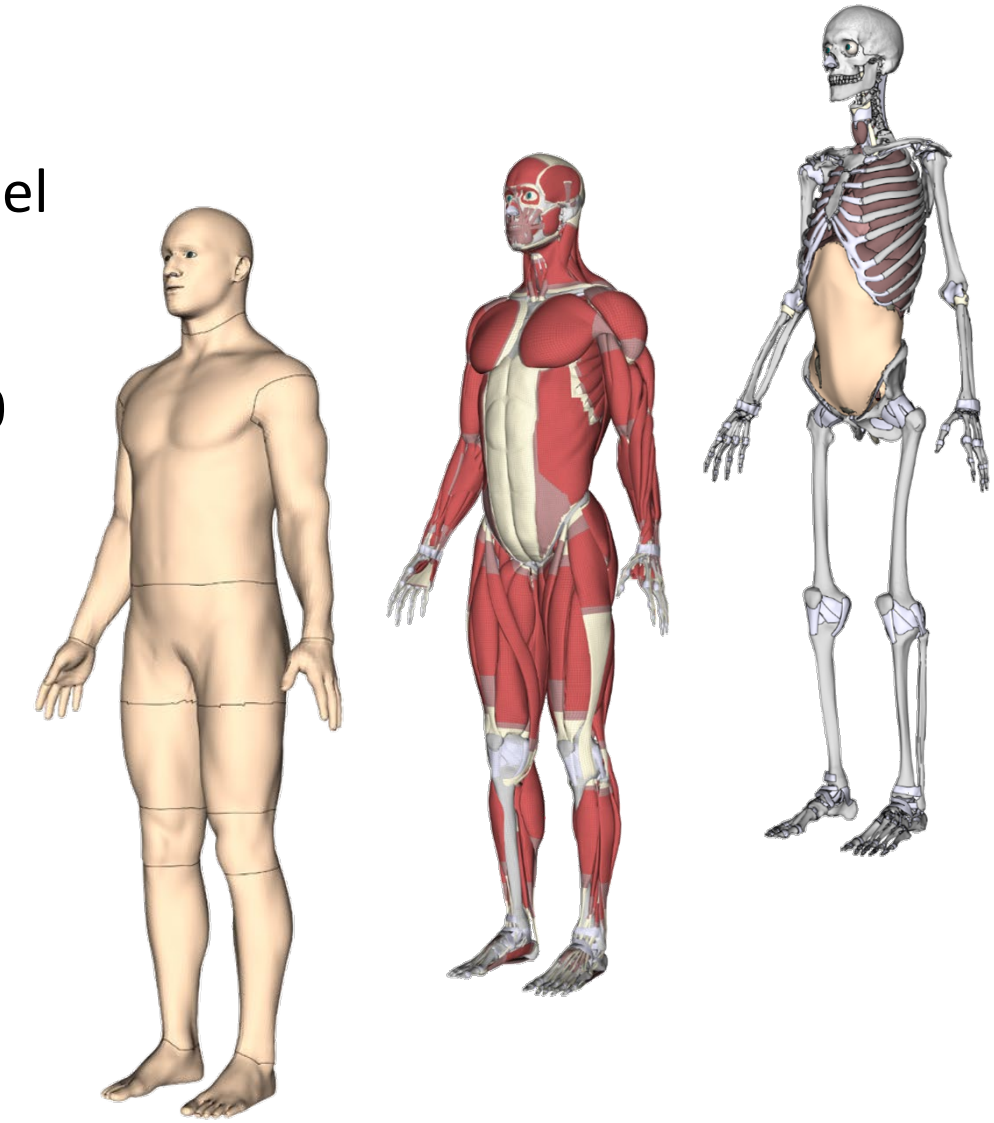
Hans – Human Body Model: EnHansments

LS-DYNA User Conference 2024

What – or better – Who is Hans?

- Hans is a high-fidelity LS-DYNA human body model
- Commercial model licensed separately
- Hans represents an average male person – AM50
- Our Vision:

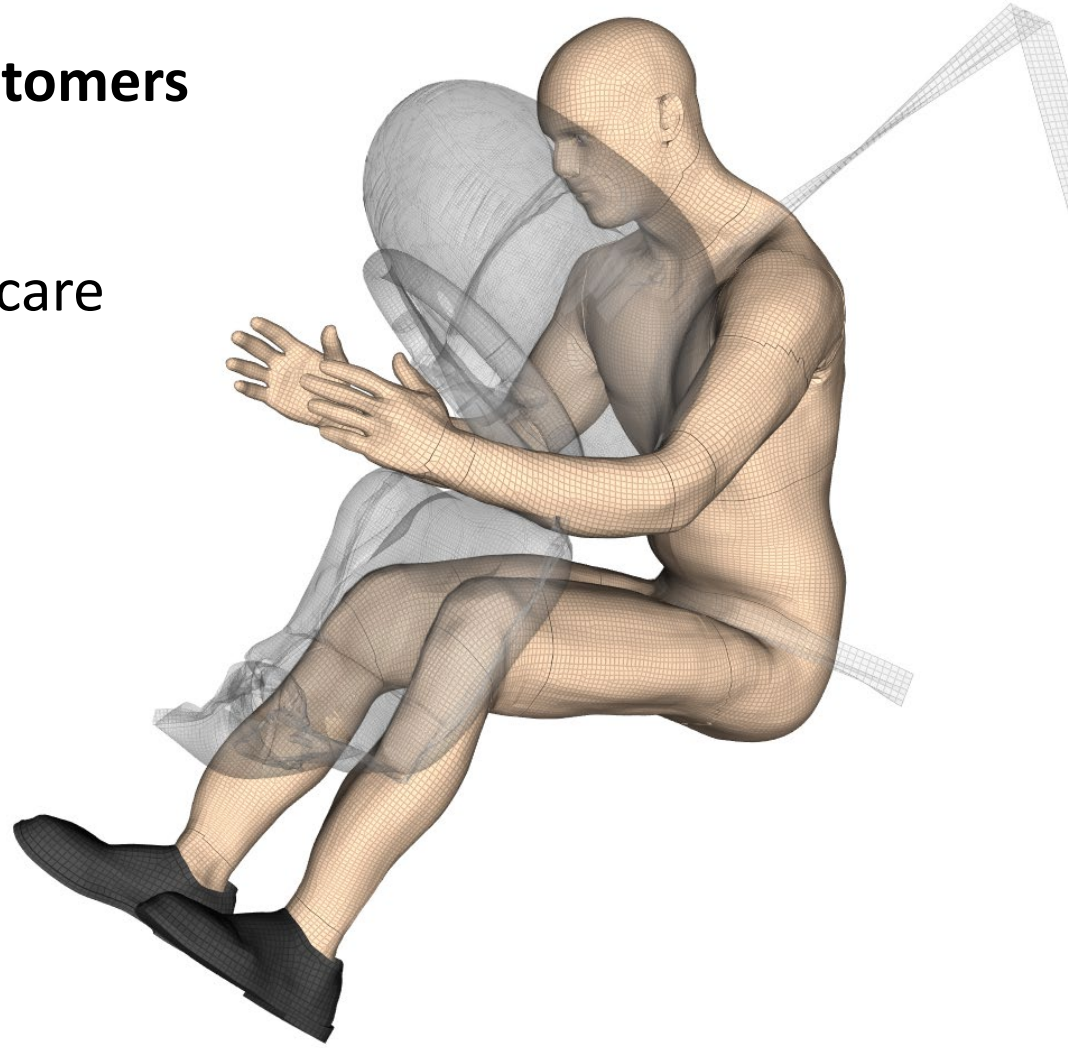
Structural HBM model
to support
advanced product development
in multiple industries



What Happened so far … What Happens Next?

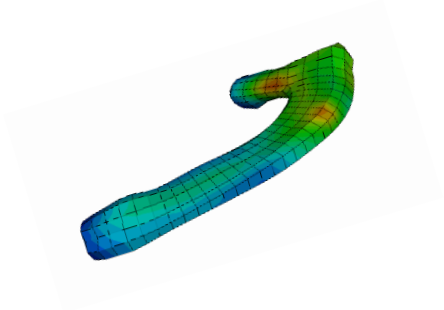
- Since spring 2024, testing of Hans V1.0 **by pilot customers**
  - Goal: acquiring customer feedback
- Industries involved: automotive, aerospace, healthcare
- First maintenance updates – currently V1.0.2

- Official product launch in Q4-24
- Release of **Hans – Human Body Model V1.2** in Q4-24 featuring the feedback from pilot customers and more

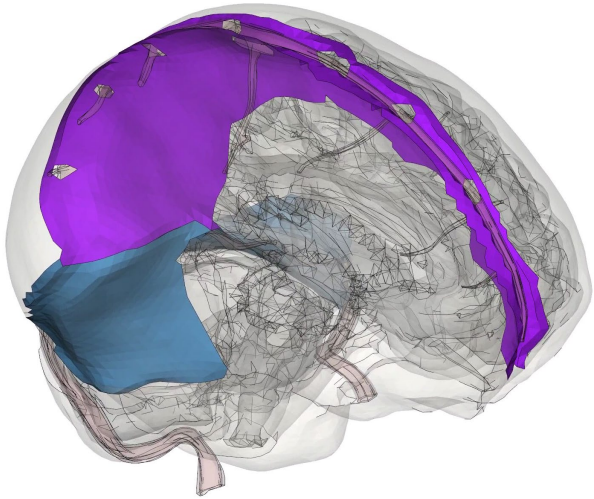


General Updates for V1.2

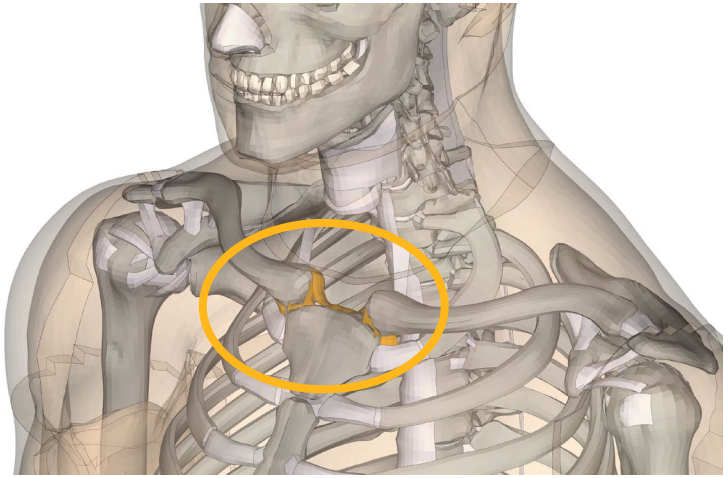
- Minor stability issues fixed
- Fixes for some energy issues
- Output definitions revised
- Corrected Thickness distribution of 1st rib



- Added more details to the brain
  - Added Falx Cerebri
  - Added Tentorium Cerebelli
- Improved brain tissue response

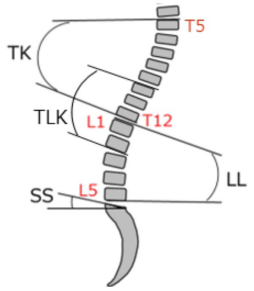


- Sternoclavicular Joint
  - Correction of the ligaments
  - Improved shoulder kinematics

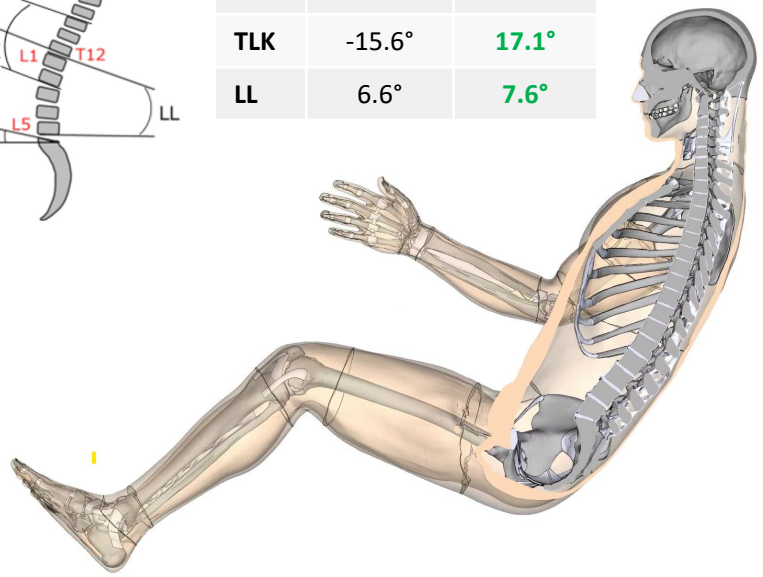


Improved Delivery Positions

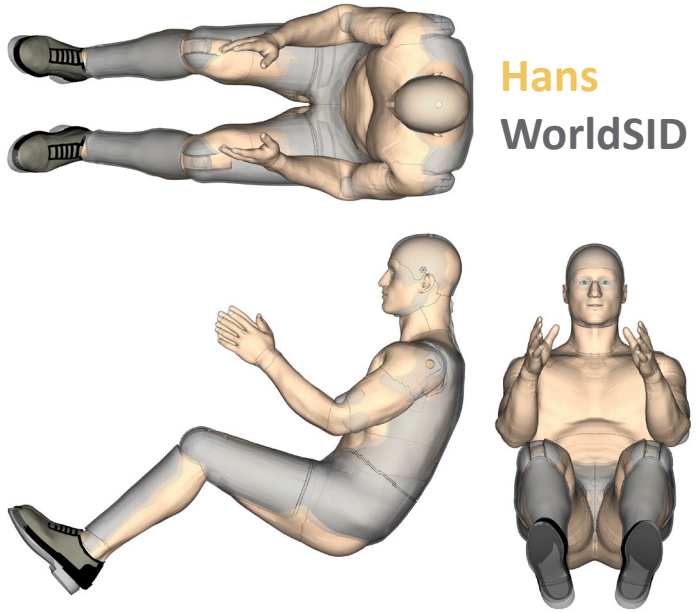
- Occupant delivery position modified based on *Rieger et al (2023)*
- Spine angle measurements from volunteer scans in car seats



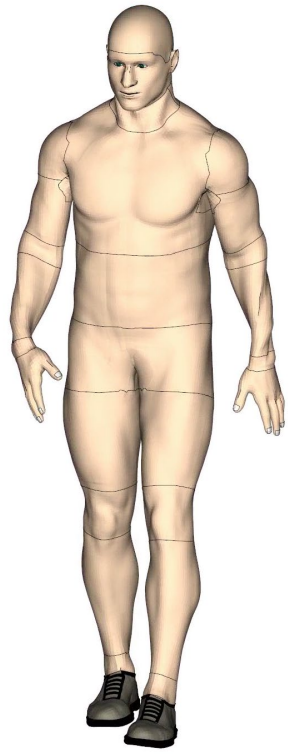
	Target Angle	Hans Angle
TK	-16.8°	**16.9°**
TLK	-15.6°	**17.1°**
LL	6.6°	**7.6°**



- Given the **same H-Point** location, the posture of Hans is close to the postures of **WorldSID50M** and **THOR-50M**
- Hans delivery position is aligned with Dummy model positions



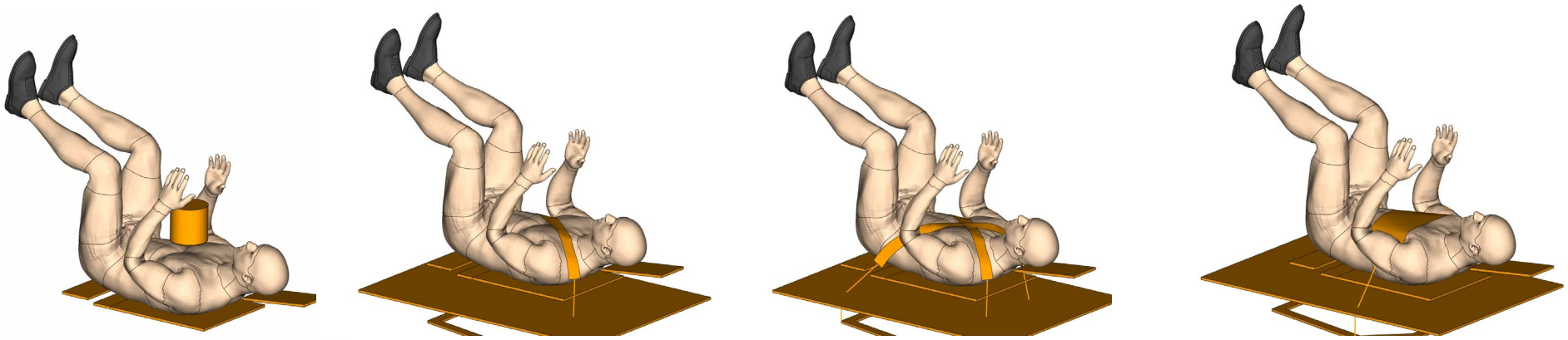
- The Pedestrian Position completely fulfils the EuroNCAP TB024 requirements



AM50		
	Check	Deviation
934	OK	3,5%
698	OK	-3,1%
24	OK	-1,2%
782	OK	-2°
96	OK	-3°
871	OK	-1°
514	OK	-3°
106	OK	-1°
101	OK	1°
329	OK	3°
908	OK	3°
518	OK	-2°
935	OK	-3°
792	OK	-1mm
931	OK	-0,2%
		-100,0%
	OK	2,4%

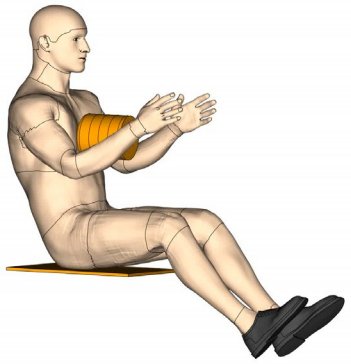
Performance Updates: HBM4VT Load Cases

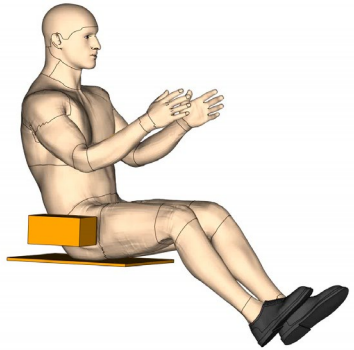
- The HBM4VT Workgroup engages in building a HBM qualification procedure for upcoming EuroNCAP Virtual Testing load cases.
  - DYNAmore/ANSYS is member of the group.
  - In total more than 20 load cases have been added to the Hans calibration repository.
- Qualification Protocol finished by end of Q1-25
- Focus on chest impacts



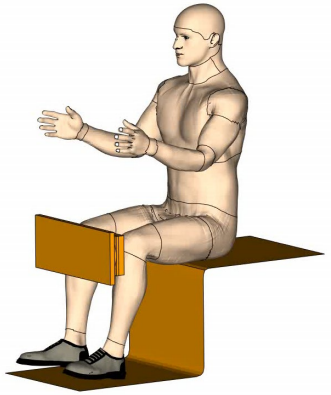
Kent et al 2004

Performance Updates: HBM4VT Load Cases

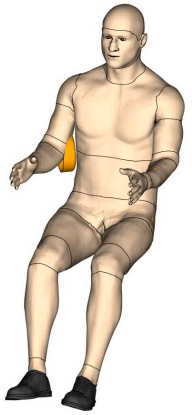


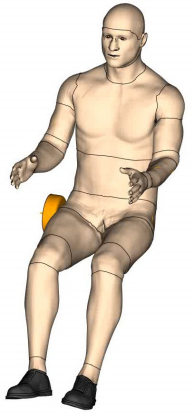


Bouquet et al 1994

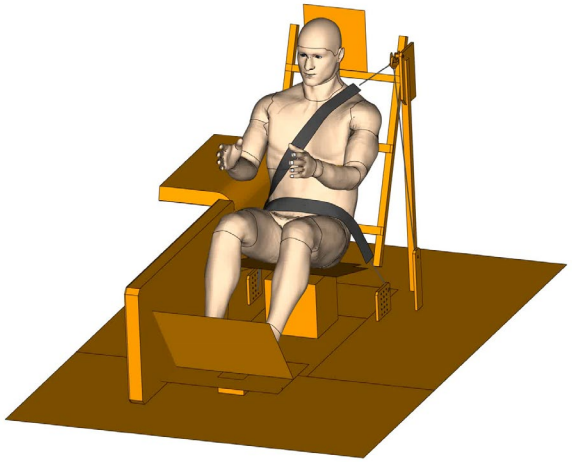


Rupp et al 2015

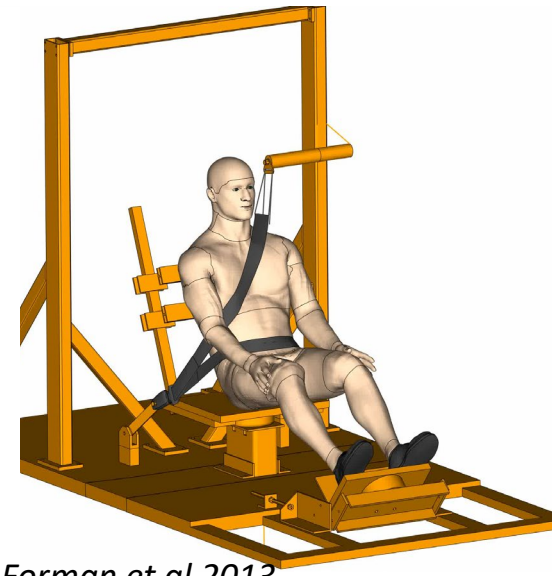




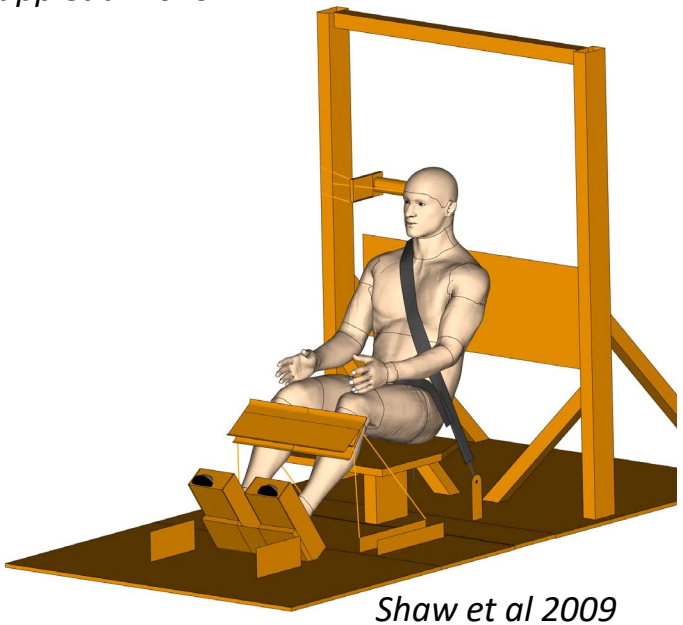
Viano 1998



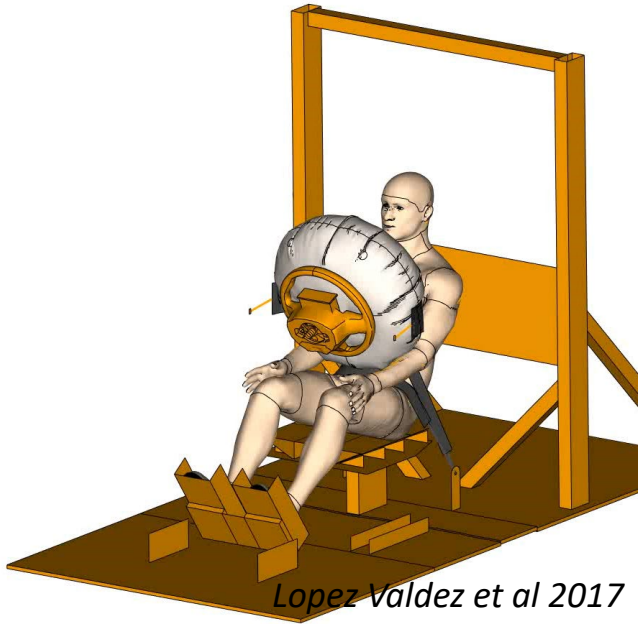
Petit et al 2019



Forman et al 2013



Shaw et al 2009

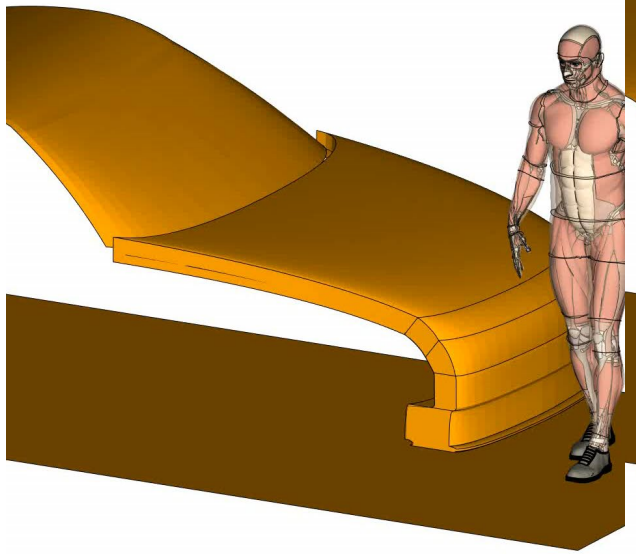


Lopez Valdez et al 2017

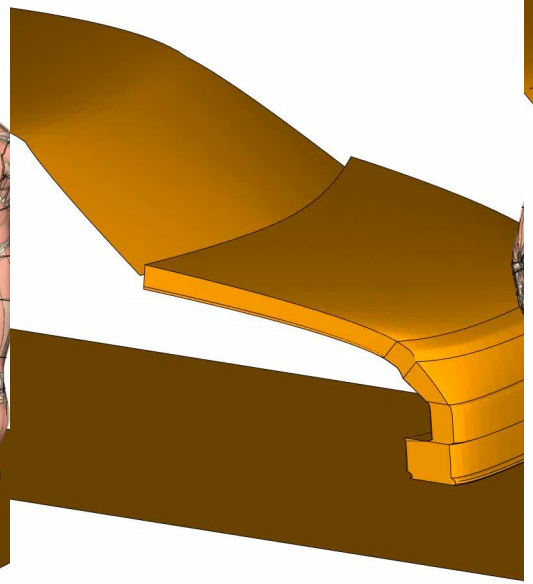
Vulnerable Road Users (VRUs) – EuroNCAP TB024

- Qualification model included in the delivery package
- In total 9 (3 generic vehicles x 3 impact speeds) are carried out for qualification

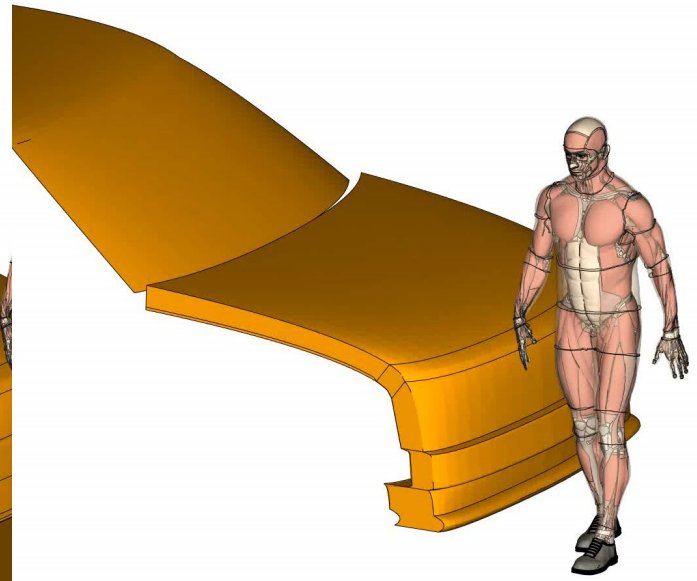
Roadster 50kph



Family Car 50kph

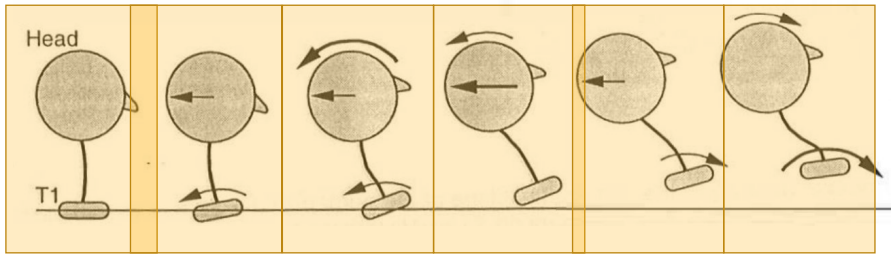


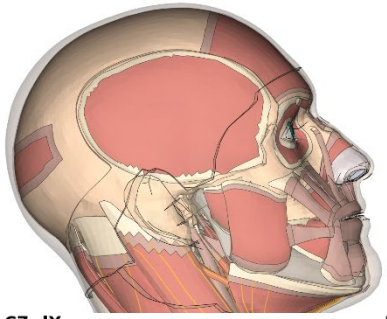
SUV 50kph

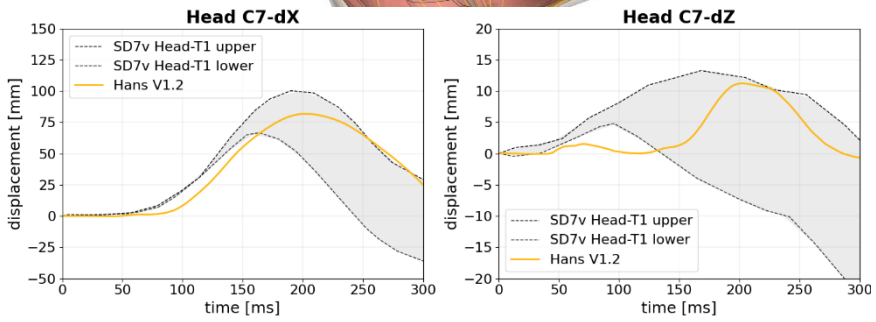


Neck Kinematics During low Energy Impacts

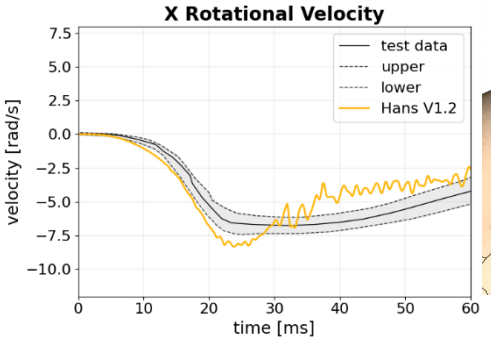
- Low speed rear crash Δ7kph (*Davidsson et al 1998)*

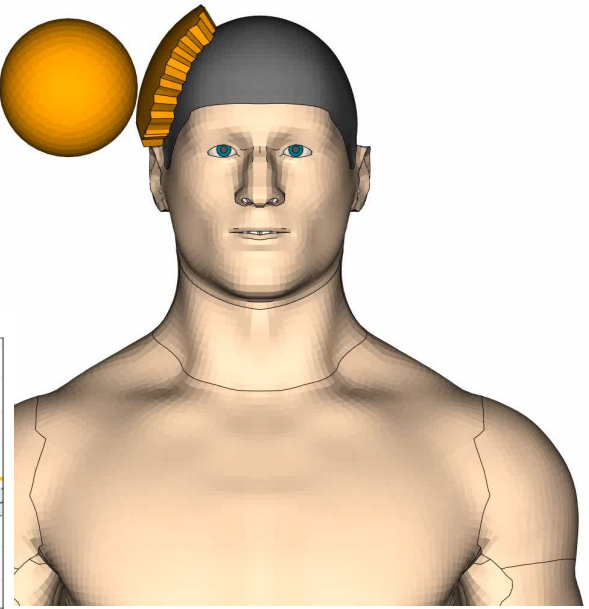






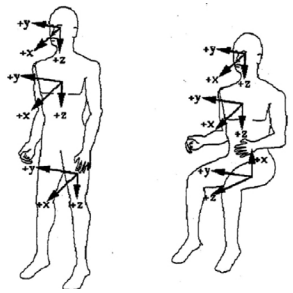
- Non-injurious load case by volunteers (*Reynier et al 2020*)
- Foam padded steel ball hitting foam padded head at 2m/s



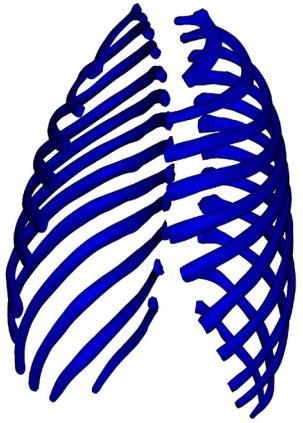


Hans - Outputs

- All output is written in **SAE-J211**



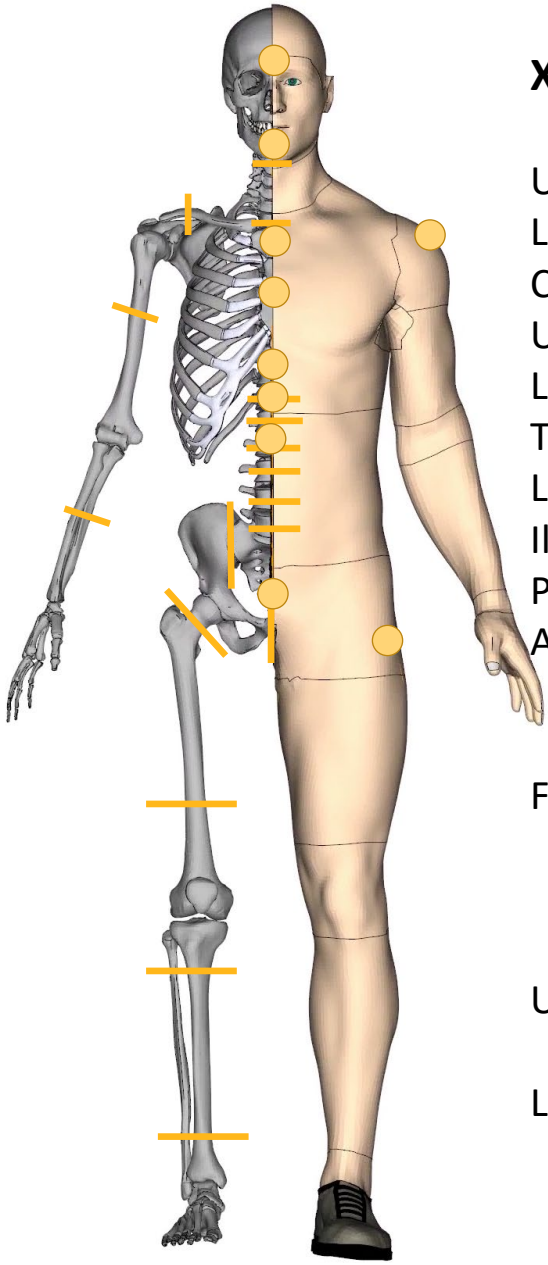
- Nodal outputs are available **global and local**
- Load cells are modeled by X-Section cutting through the bones
- Extra outputs in d3parts including cortical bone parts of the ribs for injury risk calculation



Nodal Outputs

Head CoG
C1

C7
Acromion
T1
T4
T8
T12
L2
AC
H-Point
Gt Trochanter



X-Sections

Upper Neck C2
Lower Neck C7
Clavicle
Upper Arm
Lower Arm
T1, T2, T8, T12 Vertebra
Lumbar Spine Vertebrae
Iliac Wing
Pubic Symphysis
Acetabulum

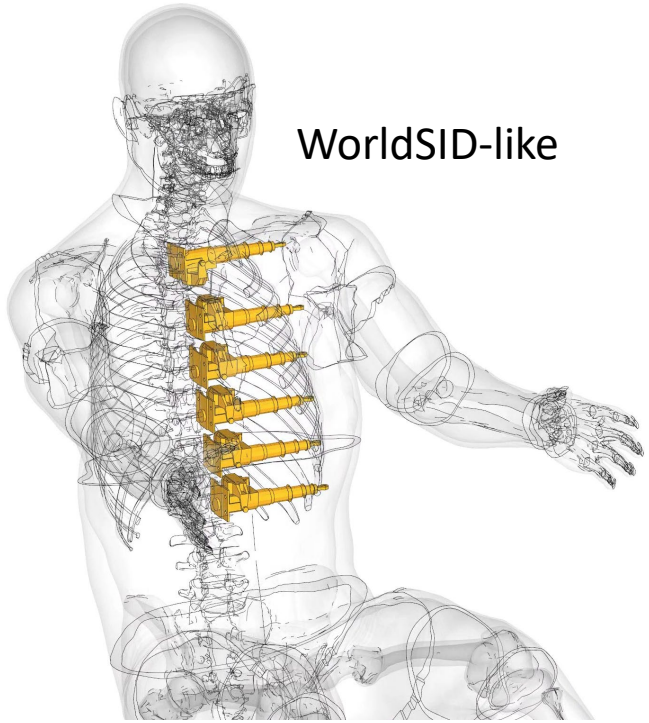
Femur

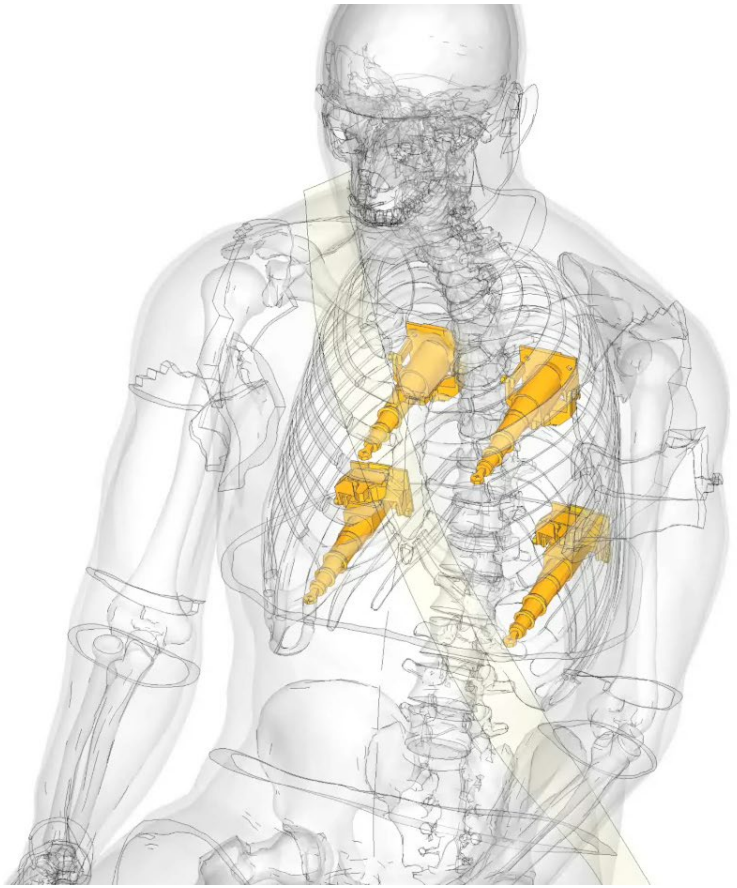
Upper Tibia

Lower Tibia Leg

Hans Featuring IR-TRACCs

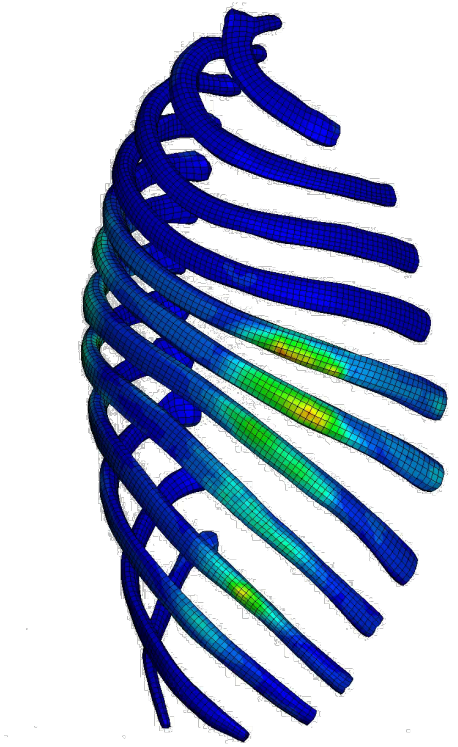
- Hans IR-TRACCs enable **similar outputs** to existing dummy models
- IR-TRACCs are **optional**: separate include

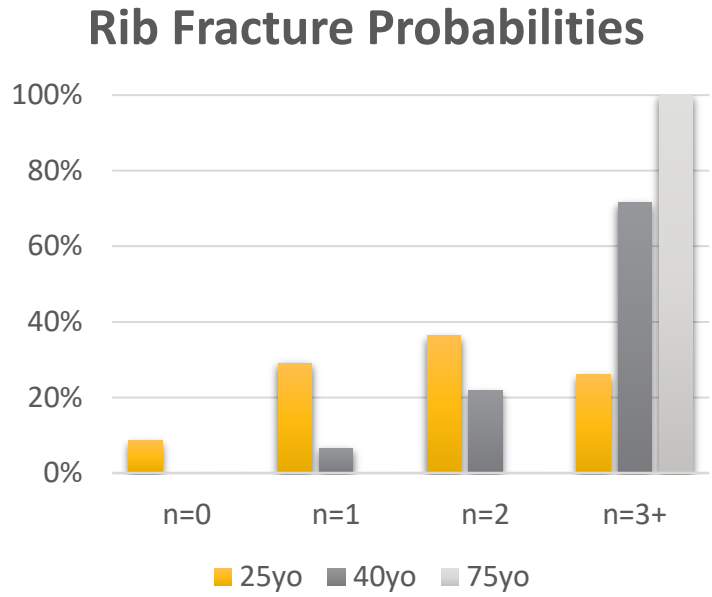




Injury Extraction: HBMScanner

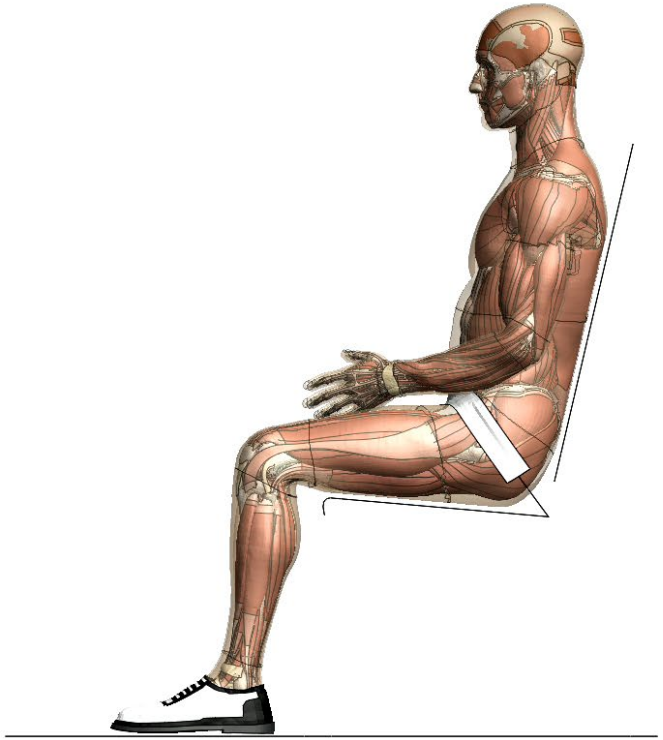
- Efficient **command line tool** to calculate **injury probabilities** from HBM simulation results
  - Extracts data from **binouts** and **plot** files
  - Suitable to incorporate in existing CAE processes
- Supported injury metrics
  - Rib fracture
    - Larsson 2021
  - Brain Injury
    - Cumulative Strain Damage Measures (CSDM)
  - More to come …
- Outputs ASCII data and graphs

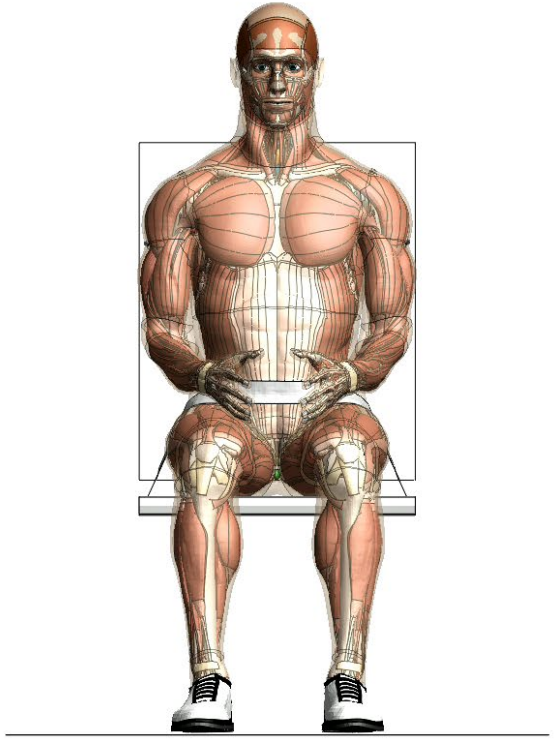




We did not Forget About Aviation and Aerospace

- Currently Hans is being tested and evaluated by aviation/aerospace pilot customers
- Main focus is on seated postures with high vertical loads
  - Ejection seats, …

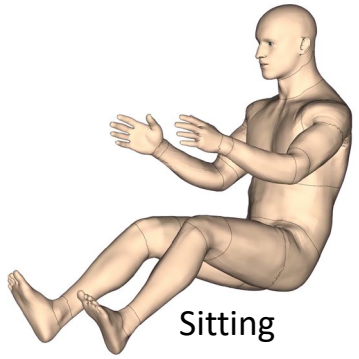




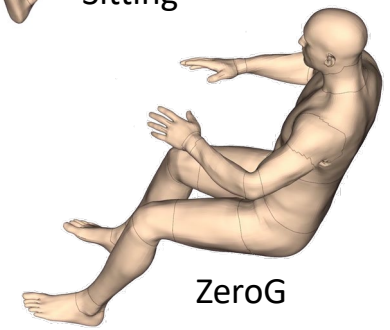
Courtesy of DLR

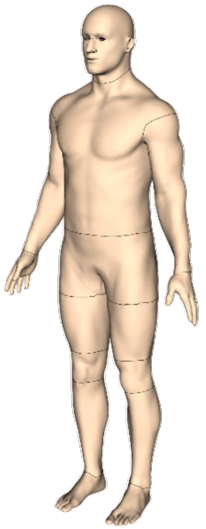
Summary

- Hans V1.2 comes with a lot of improvements for automotive customers in terms of usability and performance.
- The new release prepares the model for the upcoming/existing EuroNCAP requirements
- **R12.2** is the model development version and required to use Hans
- **Included to the delivery package:**
  - model in standing and sitting postures – **One Model**
  - Human Body Model in **three unit-systems, including parameterized renumbering**
  - Accessoires like shoes, ...
  - **Treefile for positioning** of the model in the commonly used pre-processing tools
  - Documentation/Correlation report
  - **1st class global expert support**


Sitting


TB024


ZeroG


Standing


Ansys