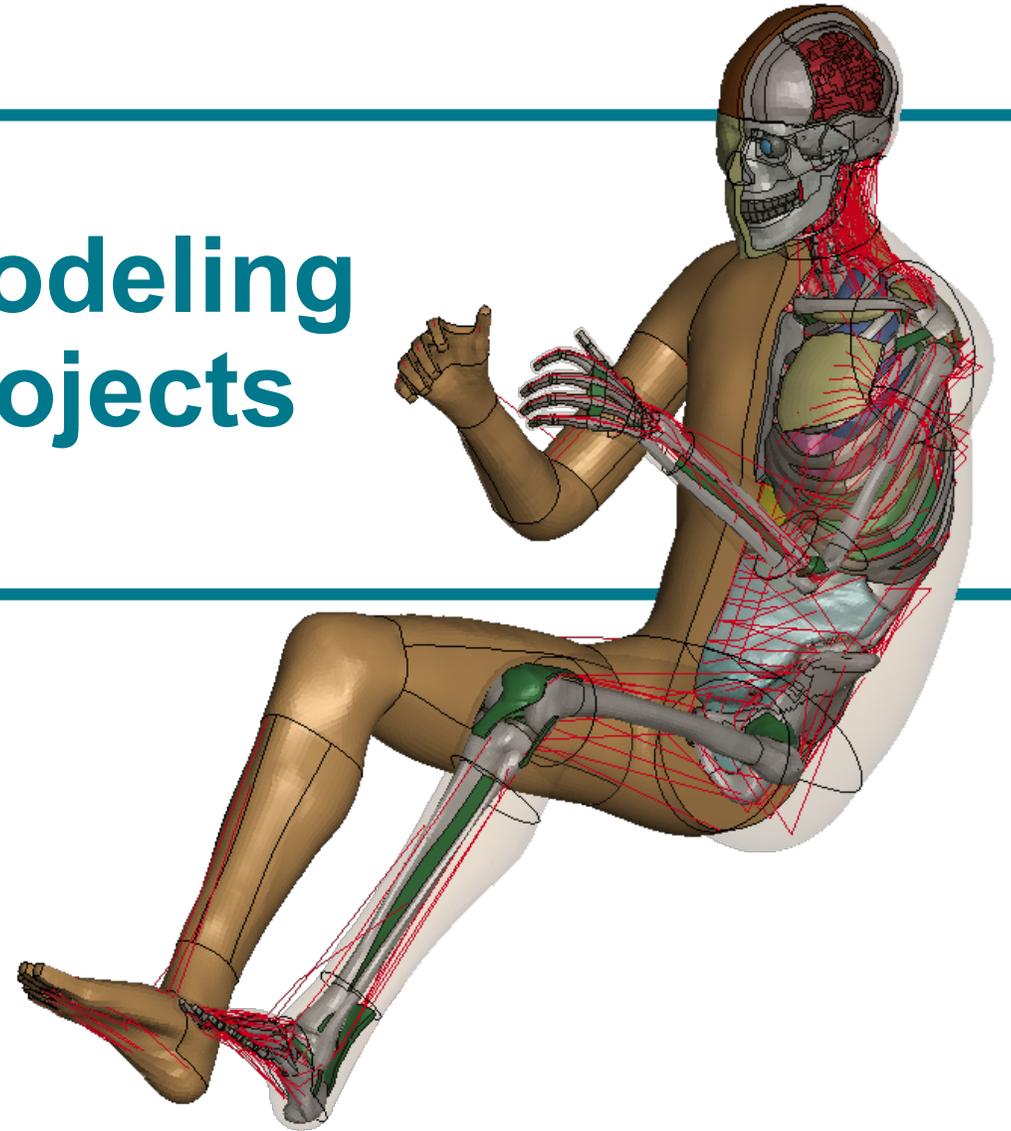


16 years of Human Body Modeling at DYNAmore and future projects



Alexander Gromer, DYNAmore GmbH
Dirk Fressmann, DYNAmore GmbH

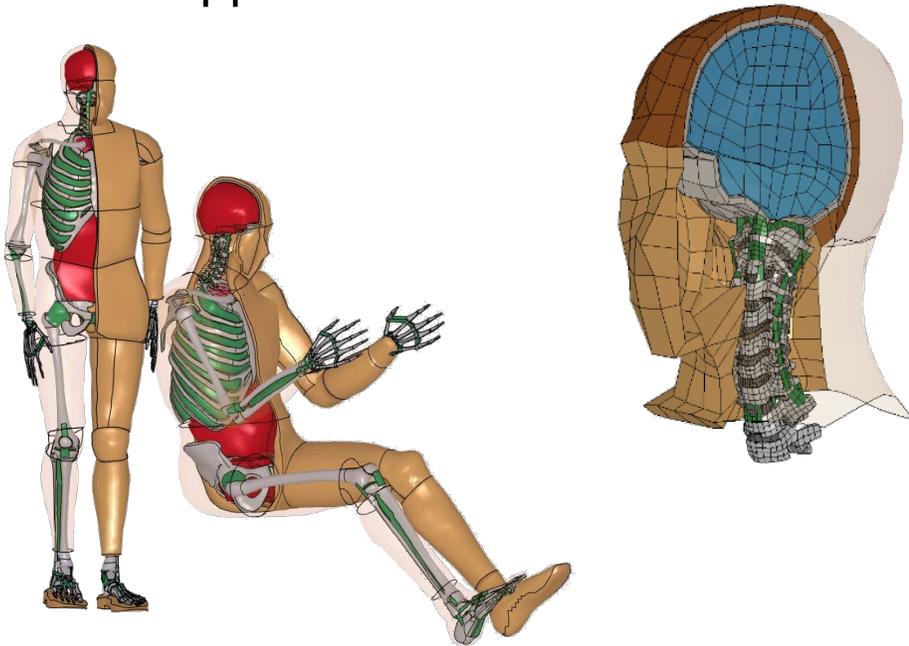
- History of Human Body Modeling at DYNAmore
 - THUMS Model History
 - extended Support Package
 - special topics: positioning, morphing, injury evaluations
- Our new project

Human Body Modeling History

Where did it start?

2006

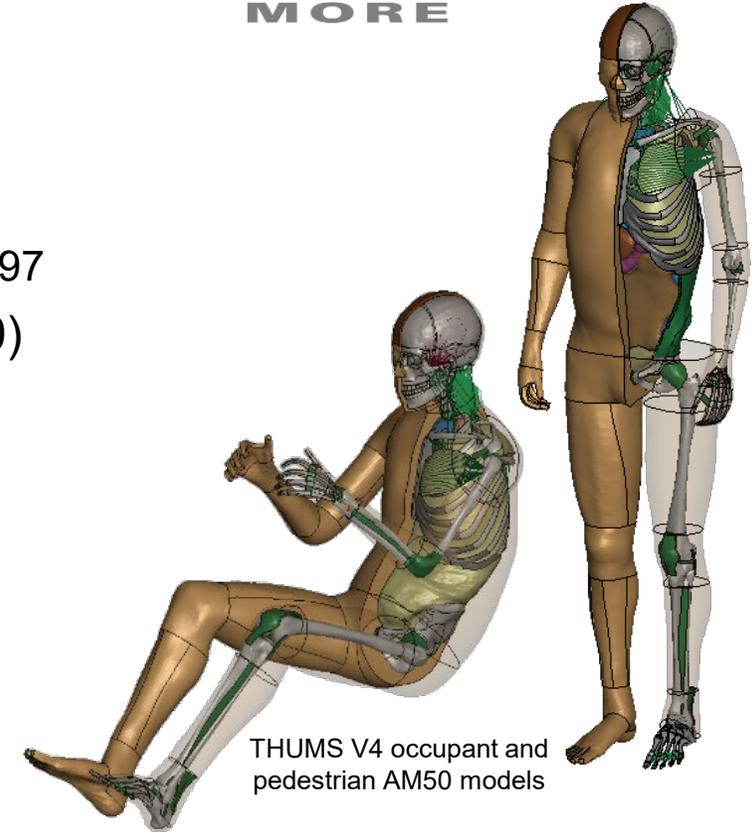
- Toyota THUMS is the only available model in the LS-DYNA world
- Only a few customers/users
- Industrial application starts



The THUMS Human Body Model at DYNAmore

HBM Activities

- THUMS – Total HUMAN Model for Safety
 - developed by *Toyota Motor Corporation* and *Toyota Central R&D Labs INC.* since 1997
- DYNAmore distributed the THUMS human models for 15 years (until end 2020)
- involved in various consultant and project activities for car manufacturers and research projects
 - model optimization, positioning and scaling/morphing procedures
 - investigation of new restraint concepts, e.g. inflatable belts, new airbag concepts
 - OOP and fully reclined seating positions
 - ... and many more
- development partner in the THUMS Users Community (TUC)
- active in various projects
 - research projects: OM4IS, ROSETTA, INVITER, ...
 - current project: ATTENTION



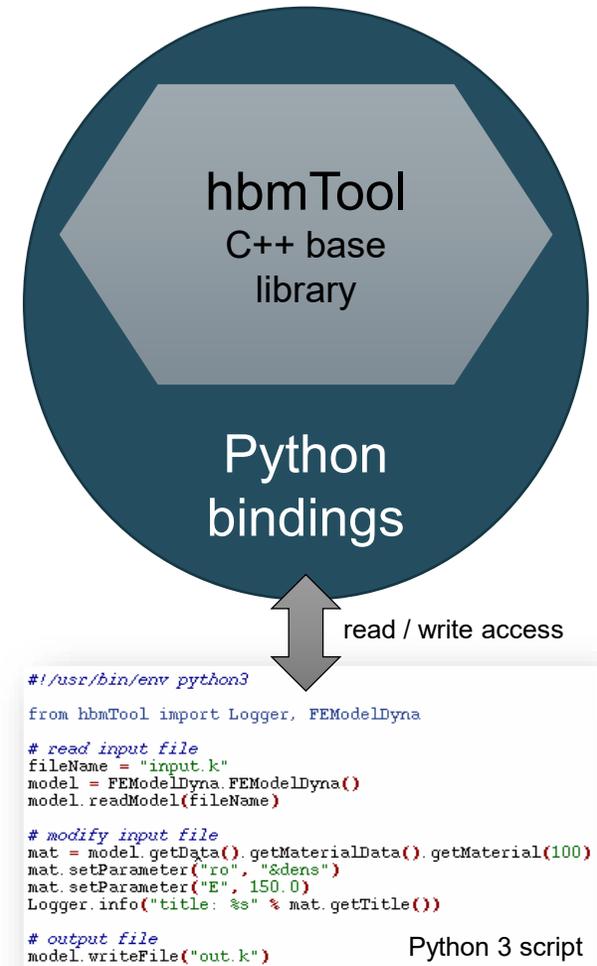
THUMS V4 occupant and pedestrian AM50 models



HBM Toolbox Library

In general

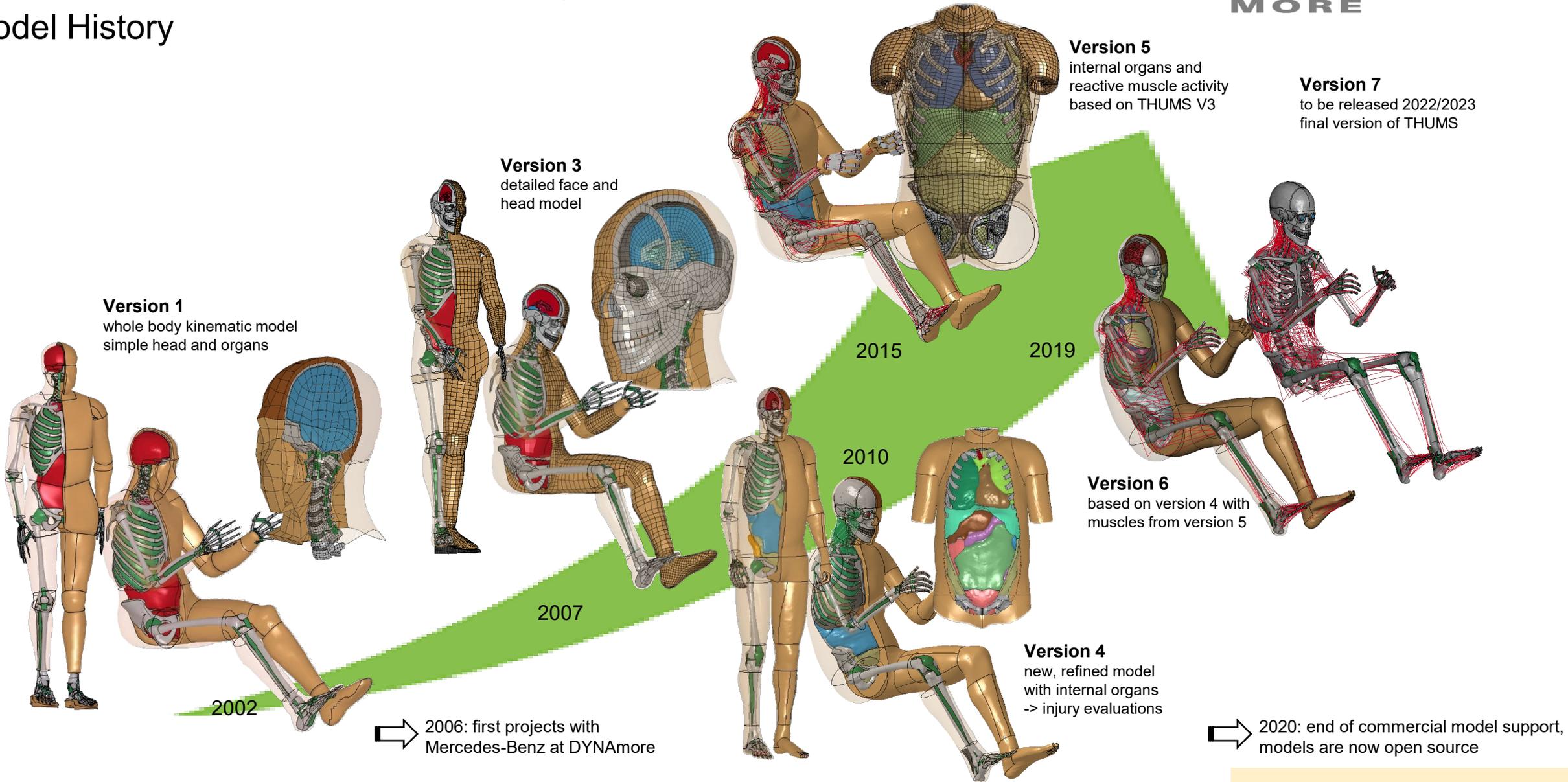
- development of an HBM toolbox library
 - C++ based library with complete Python bindings
 - Implement core methods in C++ for performance reasons
 - Use library from Python programming language for simplicity
- allows DYNAmore to quickly setup special-purpose positioning, mesh morphing or injury evaluation methods
 - currently inhouse use only
 - compiled scripts can be distributed to customers



The THUMS Human Body Model at DYNAmore



Model History



The THUMS Human Body Model at DYNAmore

Model Support Package

- new: enhanced THUMS Support package
 - support customers in all areas of HBM modelling
 - pre-processing: model positioning, special-purpose positioning methods, model instrumentation, etc.
 - solver: debugging, bug hunting, model optimizations, etc.
 - post-processing: result extraction, injury evaluations, etc.
 - model integration into software/simulation environment
 - training
- can be individually adapted
- more info on webpage

You are here: Home / Products / Models / Human Models / Extended DYNAmore support package

Extended DYNAmore support package

DYNAmore offers a comprehensive support package around all areas of the THUMS human model.

Based on the extensive experience, resulting from the long-lasting distribution and support services of the THUMS human body models, DYNAmore offers a support package, which covers the areas of model preprocessing, simulation/solver and postprocessing. This support package can be individually adapted and might include the following points

- preprocessing
 - support with model positioning, e.g. using the Primer software approach
 - implementation of special-purpose positioning scripts which can account for special data structures or formats and implementation into available process chains
 - model instrumentation, e.g. definition of reference points, cutting planes, required for the result extraction
- solver/simulation
 - model optimization and -debugging, incl. error search, model stabilization, etc.
- postprocessing
 - creation of templates for the evaluation of kinematical results
 - support evaluation of relevant model-based injury criteria, e.g. the *JSOL Injury Risk Visualization Tool* or the implementation of special-purpose and adapted injury evaluation tools

For further information, any questions or an individual offer and please don't hesitate to [contact DYNAmore](#).



<https://www.dynamore.de/en/products/models/human-models/extended-dynamore-support-package>

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Support

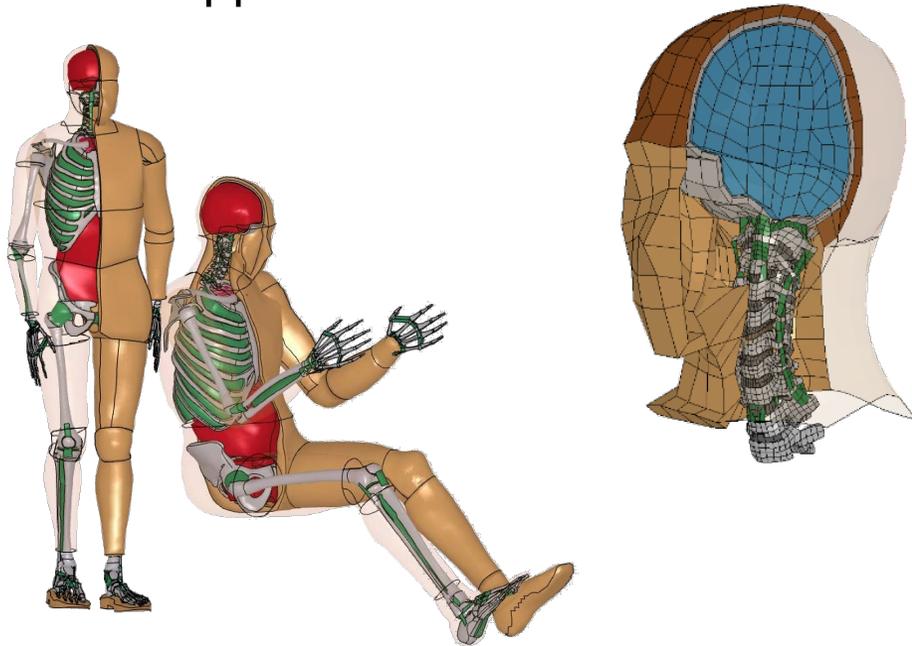
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Human Body Modeling History

Where did it start – Where are we now?

2006

- Toyota THUMS is the only available model in the LS-DYNA world
- Only a few customers/users
- Industrial application starts



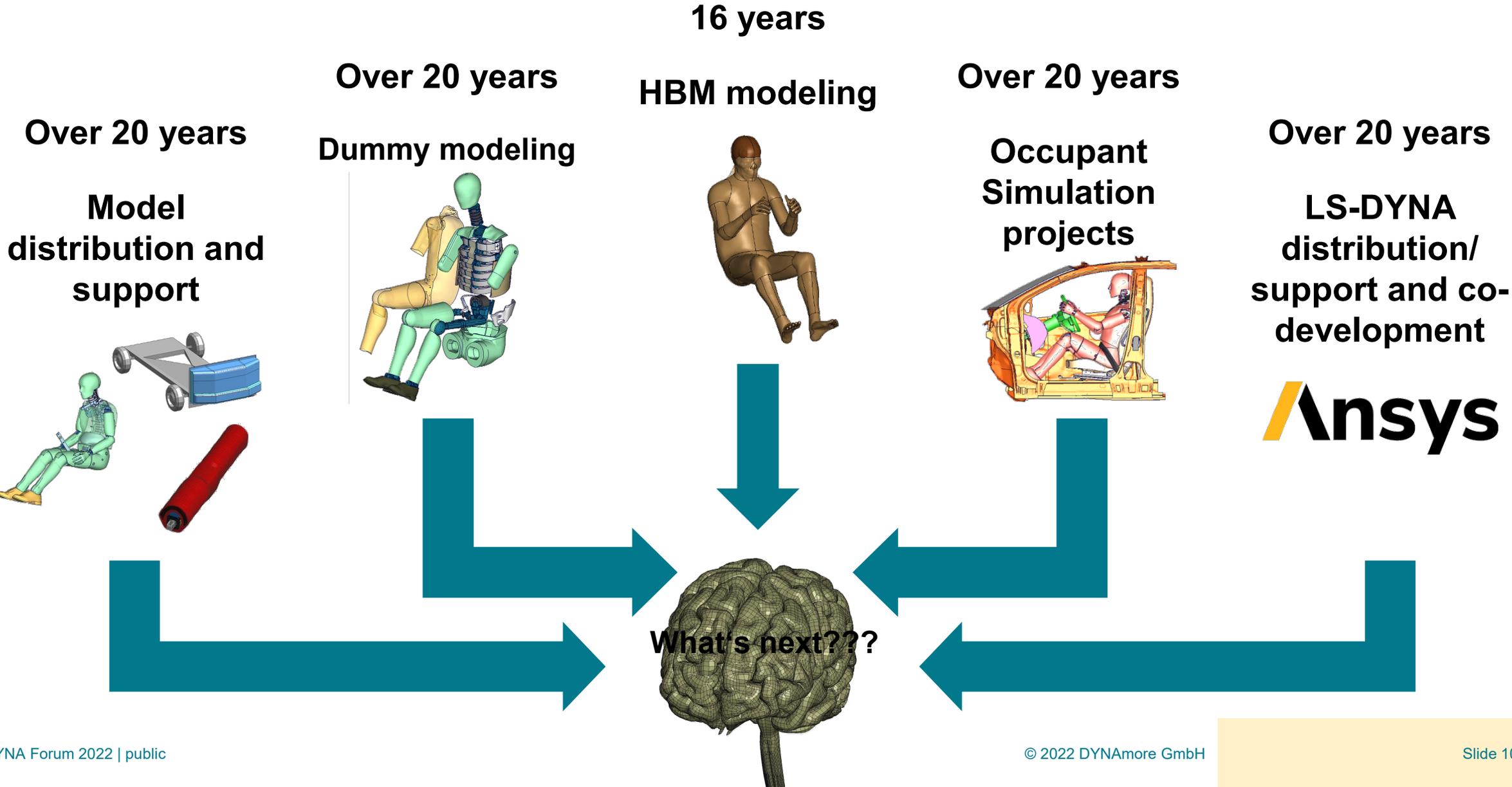
2022

- Several Human Body models are available
 - different resolution/model sizes/complexities
- Considerate community of HBM users has evolved
- Industrial application has established as a standard
- Consumer tests as well as regulations are actively working on virtual test procedures using HBMs



- Virtual testing including HBMs expected to be introduced 2nd half of this decade

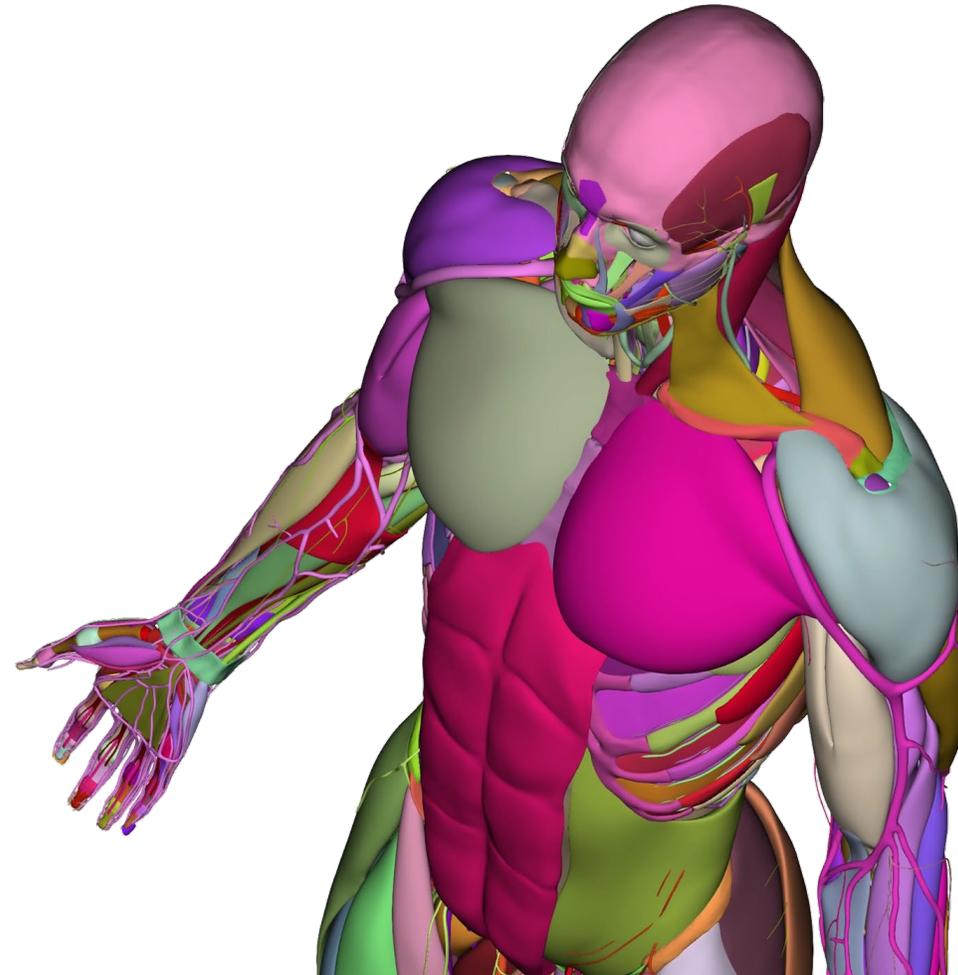
Future HBM work at DYNAmore



Our all-new Human Body model

For now, we call him HANS ...

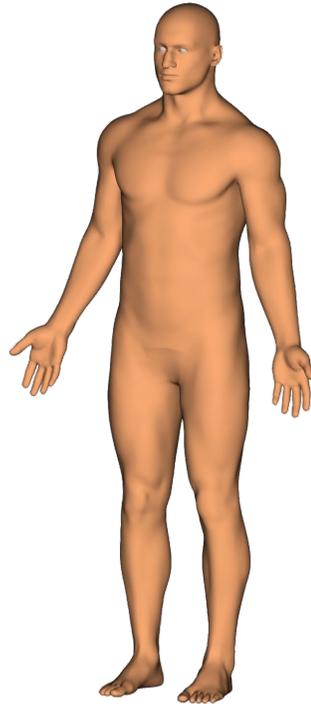
High Biofidelity/Accurate Kinematics
Great Usability
Robust
Efficient



Our all-new Human Body Model

Anatomy Background of 50% Male Model

- Partnership with Zygote
 - CAD data based on high resolution MRI and CT Scans of one individual
 - Scan in recumbent position – corrections applied for upright standing posture
- Body Specs of Individual
 - 79 kg – 176 cm – BMI 25.5
 - 21 years old
 - Athlete body shape

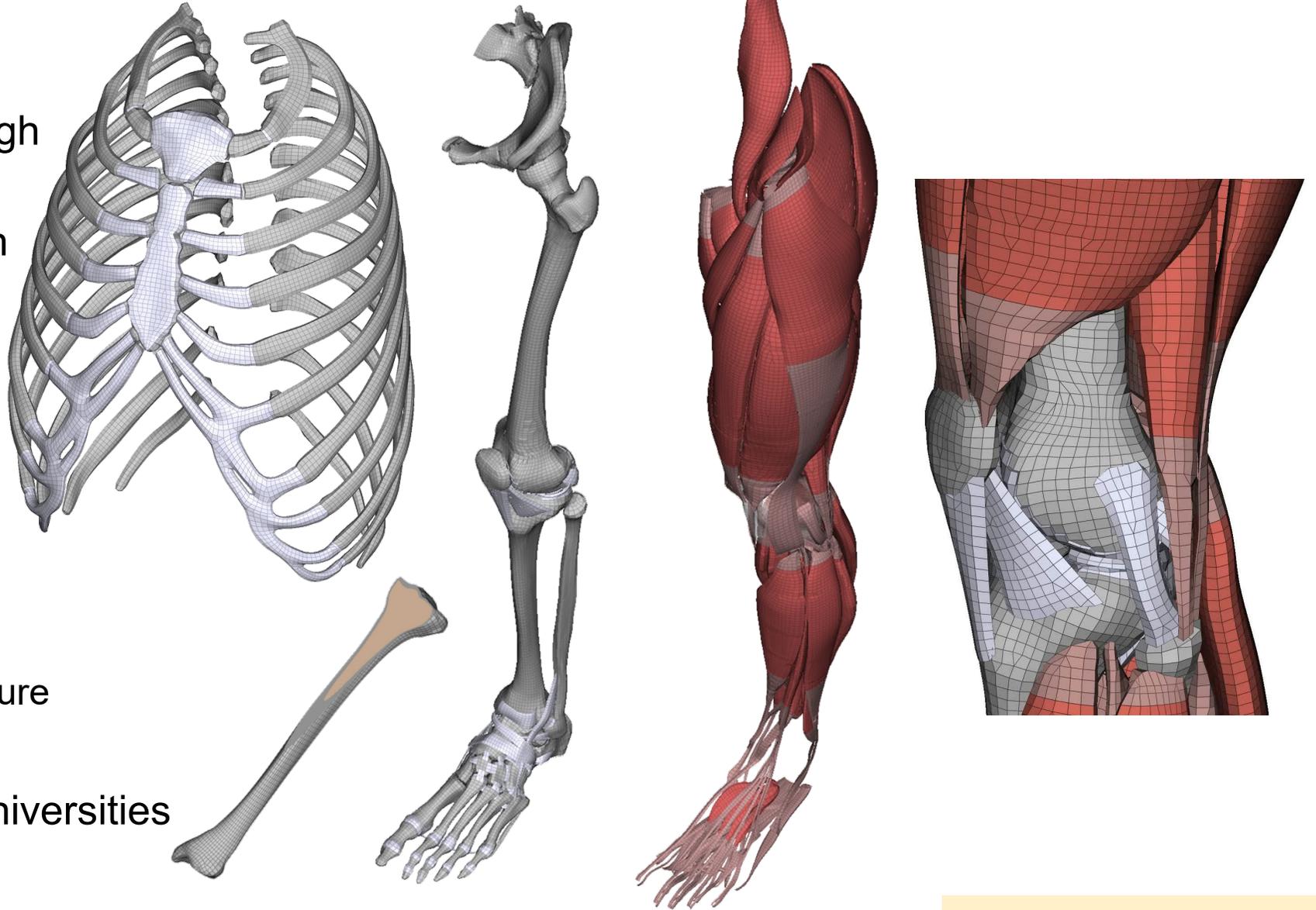


ZYGOTE

Our all-new Human Body Model

Biofidelity/Accurate Kinematics

- State-of-the-Art model with high biofidelity
 - High geometric resolution in
 - Skeleton
 - Soft tissues
 - Joints
 - Material models including
 - Nonlinear elasticity
 - Rate dependency
 - Hysteresis
 - Optional: damage based failure
- Consulting with anatomy and biomechanics experts from universities

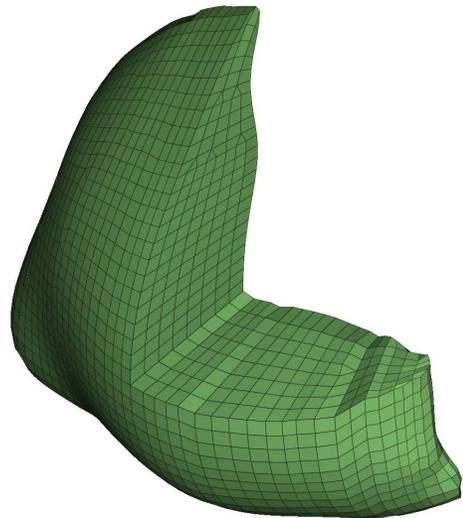


DYNA
MORE

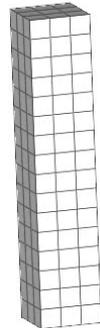
Our all-new Human Body Model

Robustness

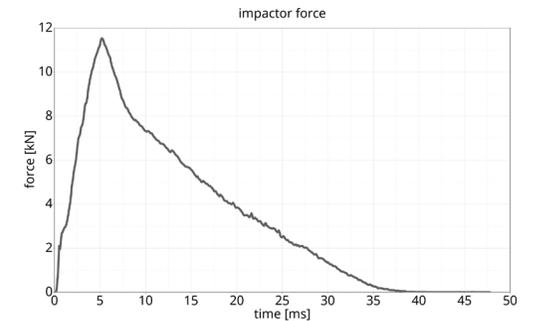
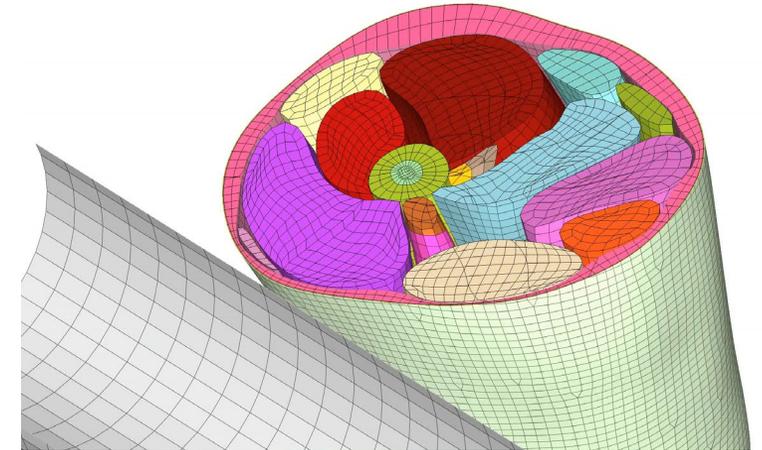
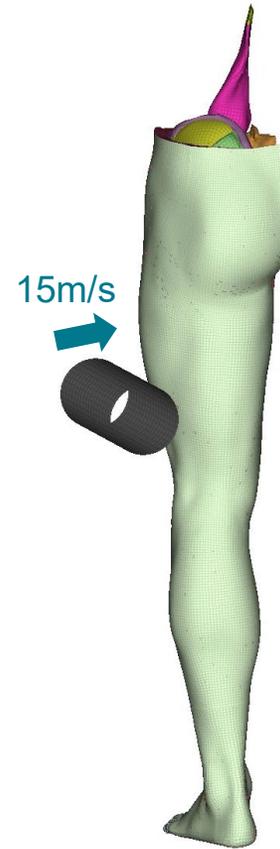
- High Robustness through
 - Best possible element/mesh quality
 - material models
 - Contact parameter



Gluteus Maximus



Tendon strap



Upper leg impact test

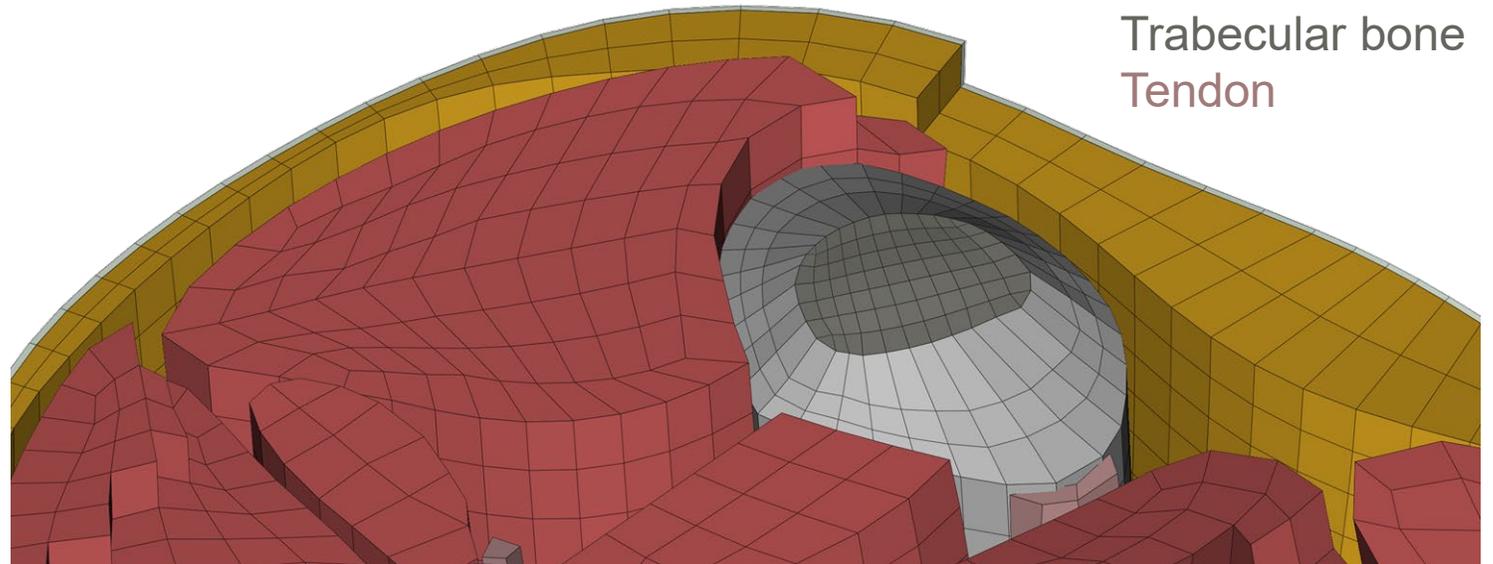
Our all-new Human Body Model

Efficiency



- Maxing out efficiency
 - Target time step of $0.5\mu\text{sec}$
 - Pre-dominant time step of current customer crash models
 - Moderate element count
 - Adapted mesh density for individual model layers
- Efficient material models
 - A single expensive material model can slow down the whole analysis
- Contacts
 - Thoughtful use of expensive features

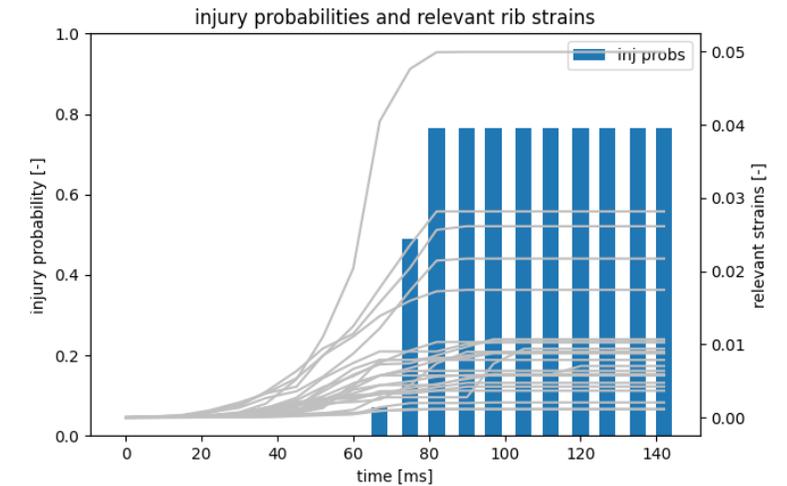
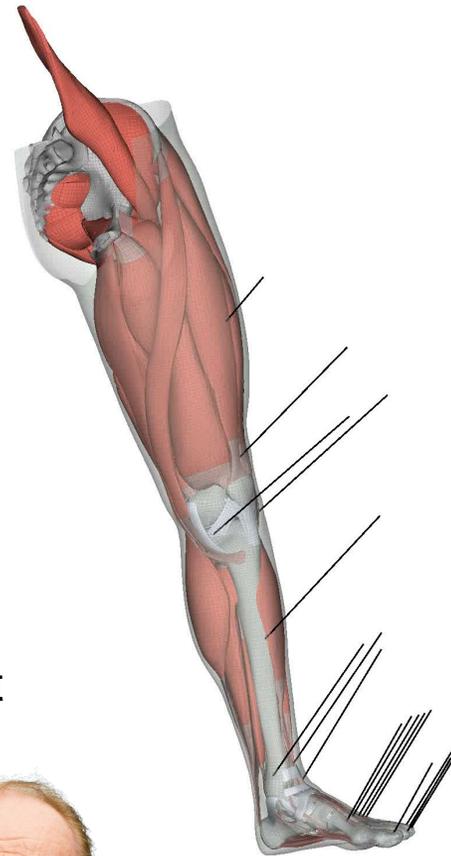
Skin
Adipose tissue
Muscle
Cortical bone
Trabecular bone
Tendon



Our all-new Human Body Model

Usability

- Best usability through optimized
 - Pre-processing
 - Rethinking the model articulation process
 - ... more to come shortly
 - Post-processing workflow
 - Scripted injury assessment
 - Standalone
 - Integrated solution to customers environment
 - Model support by HBM expert engineers

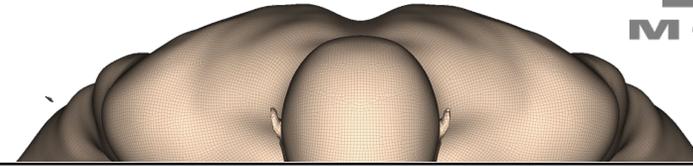


rib injury probability AIS2+ for a 25yo and relevant rib strains (probabilistic rib injury criterion, Forman 2012)

Our all-new Human Body Model

Roadmap

- Model build in progress
- First stability test successfully conducted
- Feedback appreciated!
- Coming soon:
mailing list for updates on the model.
- DYNAmore HBM Info Day in February



Meet me virtually in person Summer 2023!



Thank You

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