THUMS User Community

Project Overview

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OUTLINES

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General Information

Coordinator:	University of Munich (LMU – Ludwig-Maximilians-Universität)
Duration of project:	3 years (12/2012 – 11/2015)
Financing:	yearly contribution to project budget by the partners
Project Partners:	Adam Opel AG Autoliv Daimler AG Toyota Motor Corporation AUDI AG BMW AG Porsche AG Volkswagen Aktiengesellschaft
Subcontractors:	DYNAmore, ESI, Simulia
Associated Partners:	Bundesanstalt für Straßenwesen (BASt) Partnership for Dummy Technology and Biomechanics (PDB) Virtual Vehicle (ViF)

Project Partners

Audi, Autoliv, BMW, DAIMLER, OPEL, PORSCHE, TOYOTA, VOLKSWAGEN AKTIENGESELLSCHAFT

Associated Partners

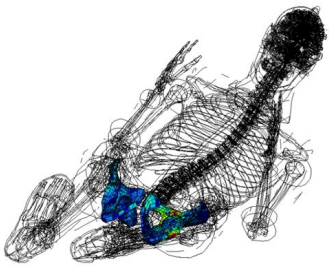
bast, pdb PARTNERSHIP FOR DUMMY TECHNOLOGY AND BIOMECHANICS, virtual vehicle

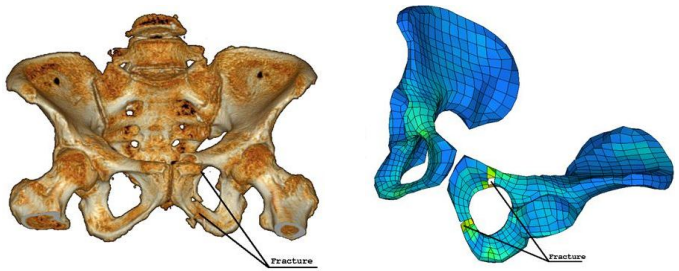
Subcontractor

esi get it right, DYNA MORE

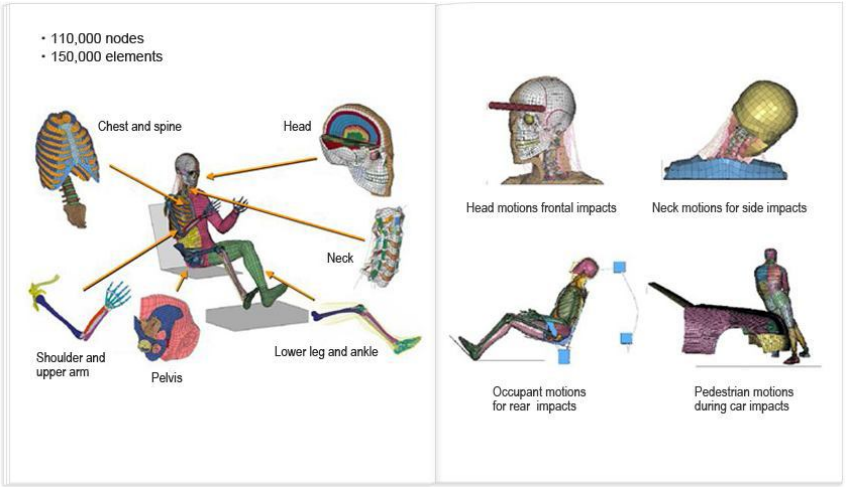
Background

- Numeric Human Body Models (HBMs) gain in importance in the field of passive safety
  - Several advantages of HBMs towards Dummies
    - High biofidelity
    - Simulation of stress distribution within tissues
    - Simulation of fractures
    - Influence of muscle activity
  - Evaluation of occupant kinematics and injury potential possible with HBMs

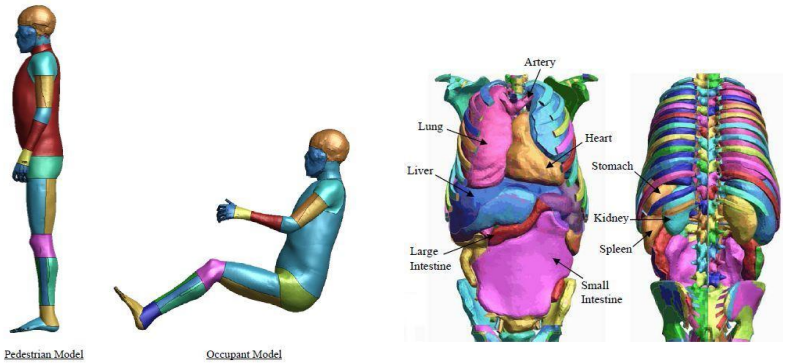




THUMS – Total HUman Model for Safety



THUMS version 3 (© JSOL Corporation)



THUMS version 4 (© JSOL Corporation)

- FE Human Model
- Developed by Toyota Motor Corporation and Toyota Central R&D Labs
- Human-like behaviour in crash
  - Human-like kinematics
  - Realistic loading representation in crash
- Representing American male body 50th percentile size (175cm, 77kg)
- Available in different versions

Injury Mode	Version 1	Version 3	Version 4
Fracture and Tendon rupture	Yes	Yes	Yes
Brain damage	No	Yes	Yes
Organ damage	No	No	Yes

Used within THUMS User Community

Motivation

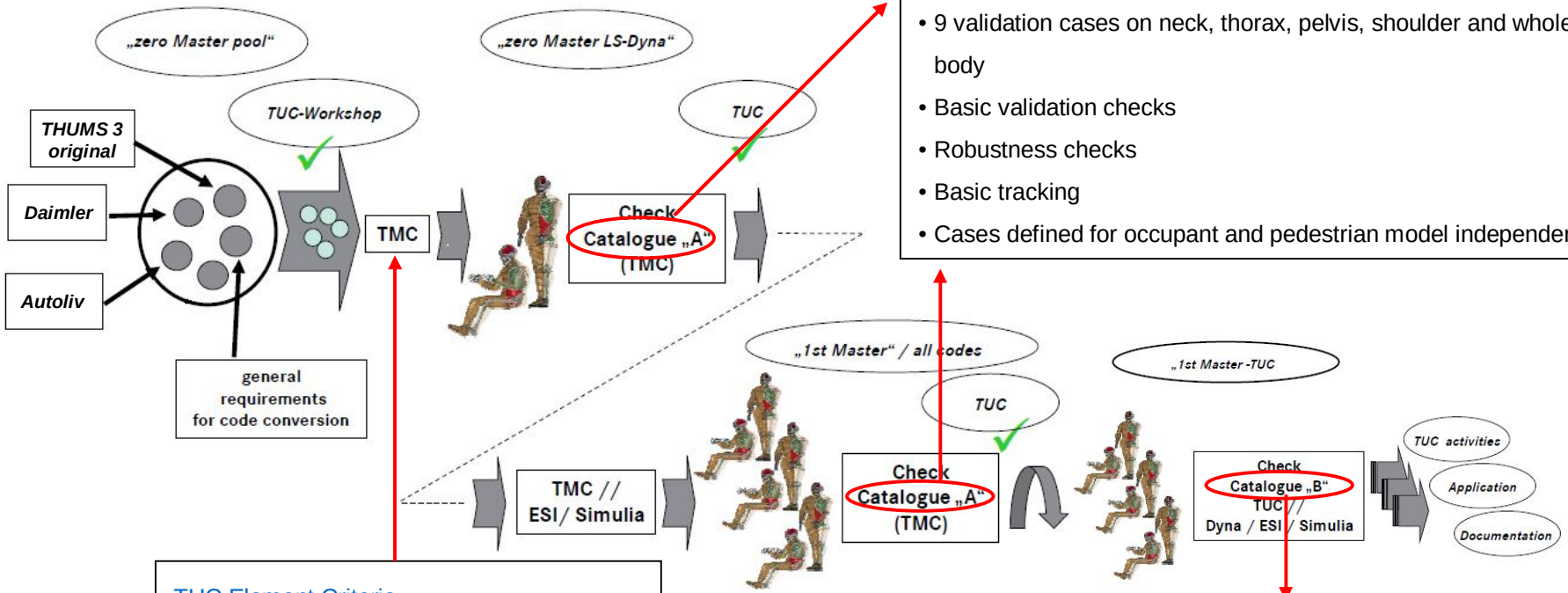
- Common motivation and interest of project partners to constantly improve vehicle and traffic safety
  - Implementation of HBMs as tool for the evaluation of passive safety systems
- Harmonisation, provision and maintenance of THUMS in 3 different codes (DYNA, Pam, Abaqus)
  - No uniform model available among project partners
    - THUMS was further developed by several project partners
      - Daimler: shoulder, improved mesh
      - Autoliv: thorax
    - No comparable results of crash simulations

Aims of the project

Harmonisation, provision and maintenance of a FE – Human Body Model for vehicle and traffic safety application

- Safeguarding effective and robust usability of THUMS by implementation of a dedicated tool management, support and documentation.
- Initiation of further research activities to improve biomechanical model quality and validity.
- Exchange and documentation of research results and / or agreed initiation of further research activities to push on with appropriate further development in terms of continuous validation of biomechanical model quality and application oriented improvement of an anatomic representation of the human.
- Set up a platform to share and exchange pre-competitive know-how and experience with the application of THUMS.
- Discuss and formulate framework requirements to establish a permanent institution by the end of this project to continue this platform approach.
- Gain new members contributing to the project

Process to TUC Master Model



Validation Catalogue A

- 9 validation cases on neck, thorax, pelvis, shoulder and whole body
- Basic validation checks
- Robustness checks
- Basic tracking
- Cases defined for occupant and pedestrian model independently

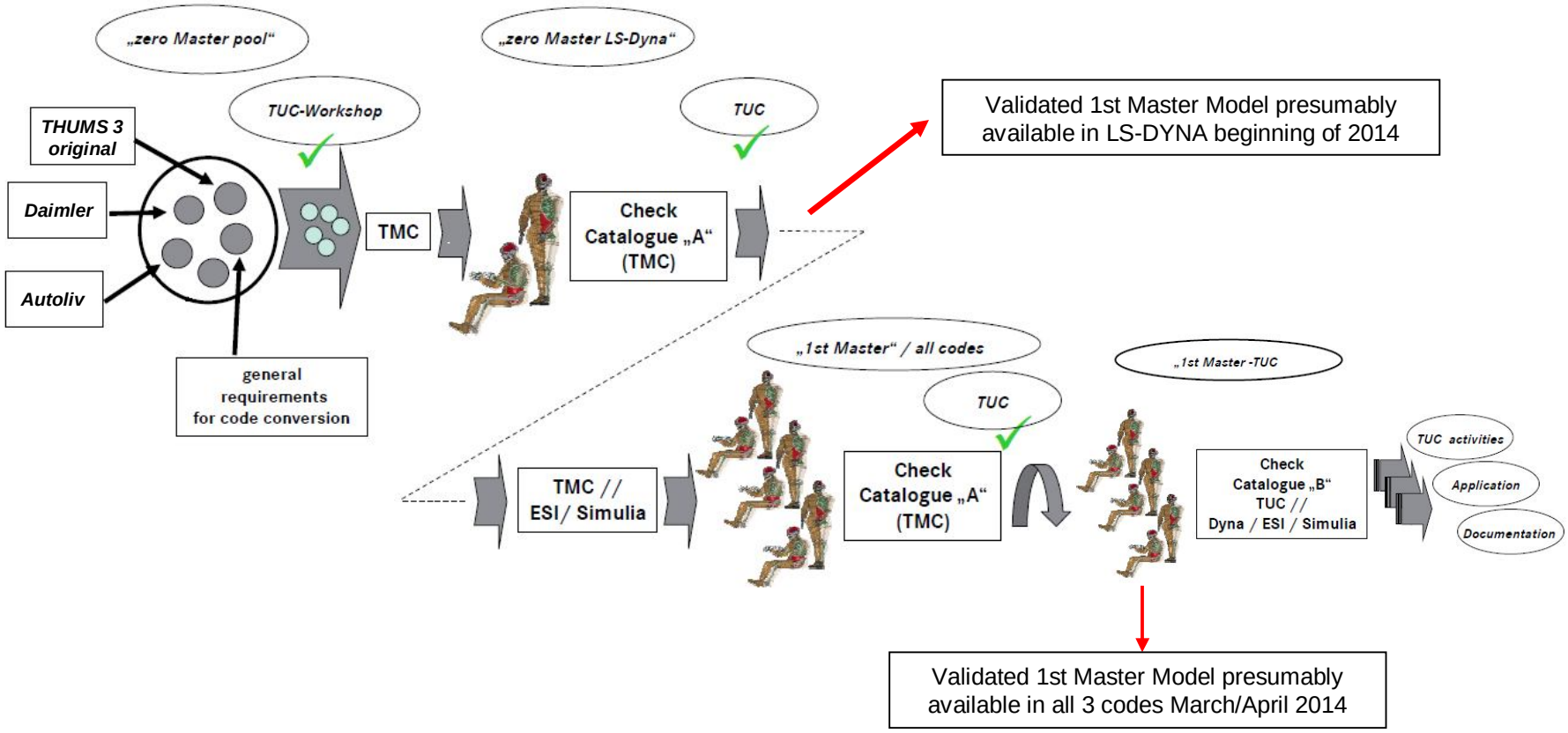
TUC Element Criteria

- Check of the assembled Master Model by commonly defined element criteria

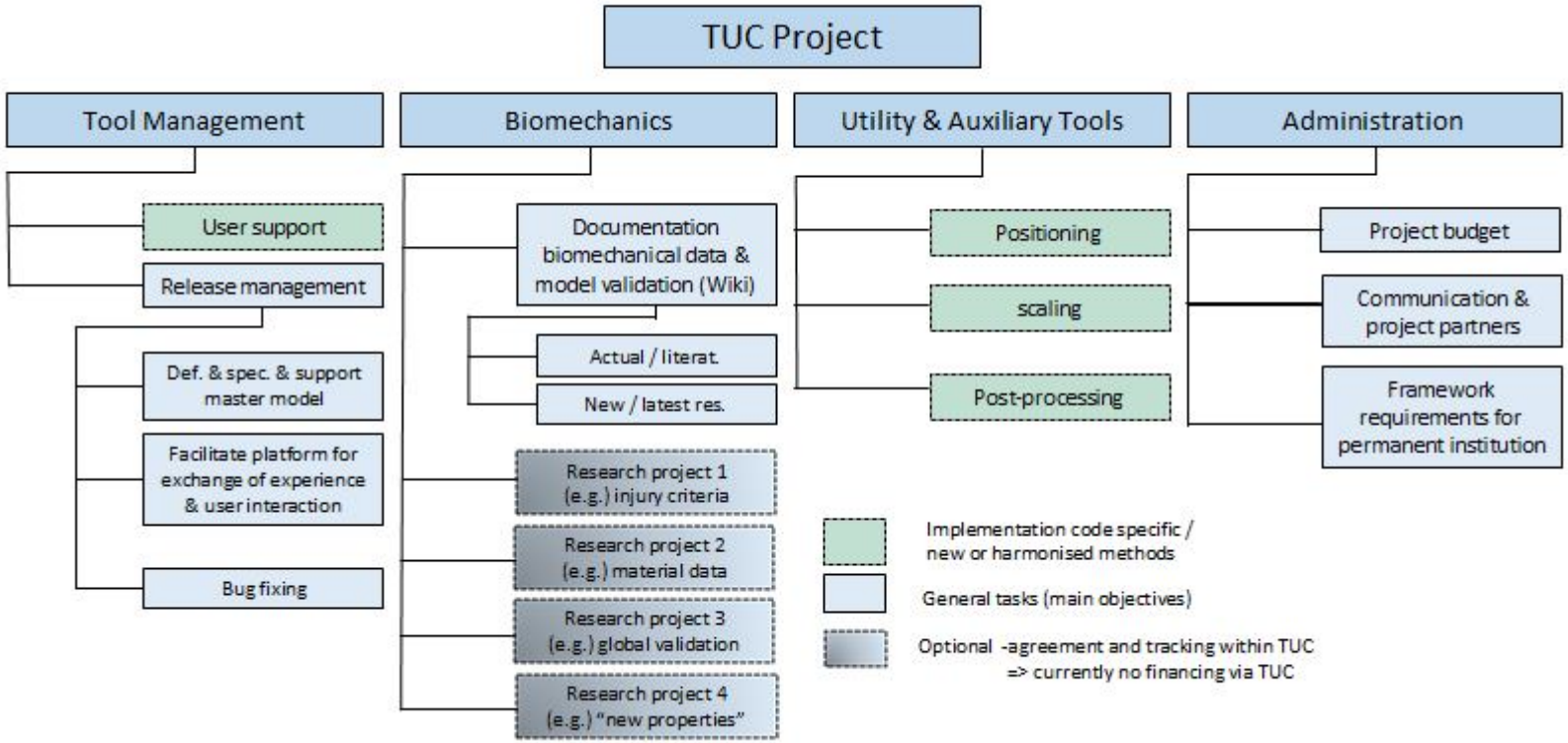
Validation Catalogue B / C

- List of validation cases for biomechanical assessment
- Cases defined for occupant and pedestrian model independently

Process to TUC Master Model



Activities



Status

1. Tool Management: Process to first Master

   - New model (occupant) assembled
   - Validations running – finished beginning of next year
   - Master model available in DYNA as occupant and pedestrian presumably beginning of next year
   - Translation into Pam and Abaqus starting 2014

2. Biomechanics

   – Project with University of Coventry anticipated (OOP with airbag)

3. Utility and Auxiliary Tools

   – Development of a TUC positioning and scaling tool - started
   – Development of TUC post-processing and biomechanical assessment tool - planned

4. Administration

   – TUC website www.tuc-project.org
   – TUC newsletter (please subscribe at the homepage!)

Validation of neck under compression

- Validation of neck under compression necessary for the evaluation of new pedestrian safety systems
  - Windscreen airbags
  - Active bonnet

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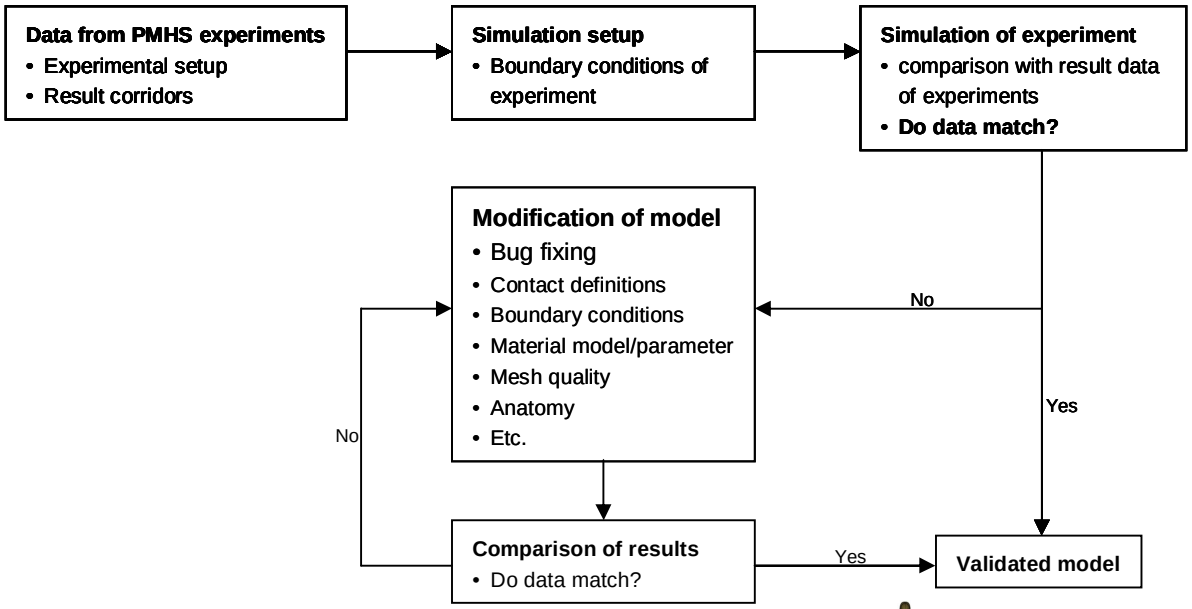
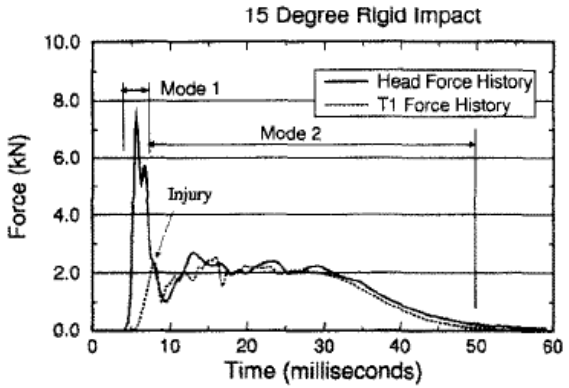
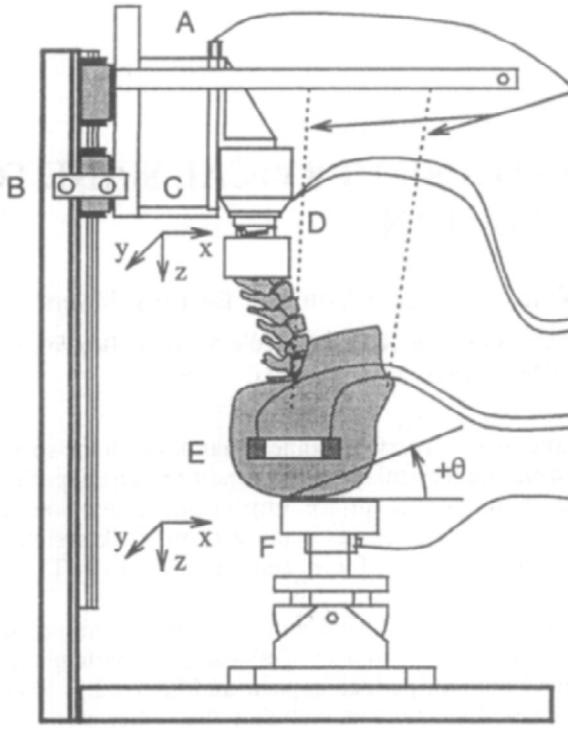


Validation of neck under compression

- Validation against experiments of W. Nightingale, H. McElhaney (Duke University, USA, 1995)
  - PMHS compression tests
  - Head-neck cut free under T1
  - Removal of muscular tissue, conservation of ligaments
  - Different angles of impact plate (-15°, 0°, 15°, 30°)
  - Impact velocity: 3.2 m/s
  - Torso mass: 16kg
  - Forces:
    - Contact force between head and impact plate
    - T1 force



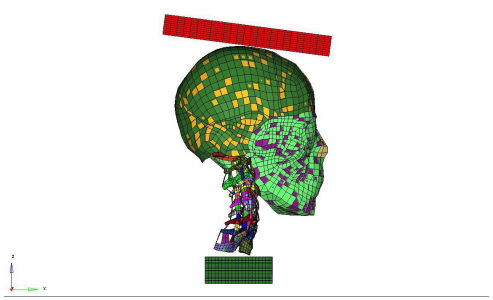
Nightingale et al., 1995



Nightingale et al., 1995

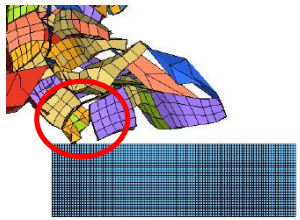
Validation of neck under compression

1. Experimental setup



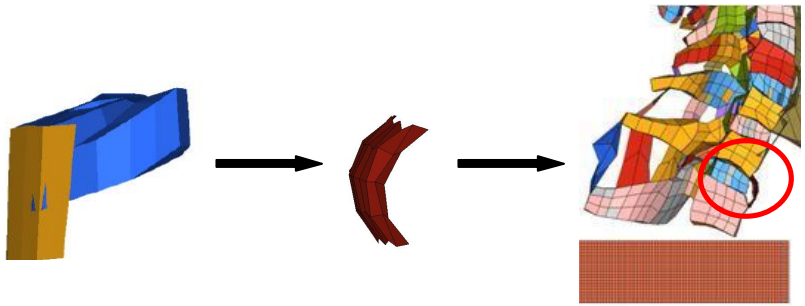
2. Bug fixing

- Neck penetrating into jaw
- Initial penetration of ALL (Anterior Longitudinal Ligament)
- Intervertebral disc sliding



3. Model modification

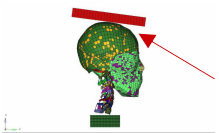
- Modification of material models and parameters
- Mesh refinement (disc and ALL)
- Extra shell part
- Contact definitions

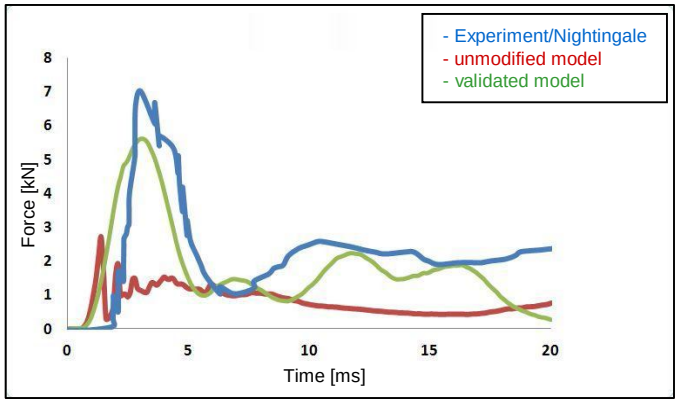


Validation of neck under compression

Results

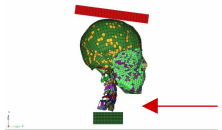
1. Head contact force

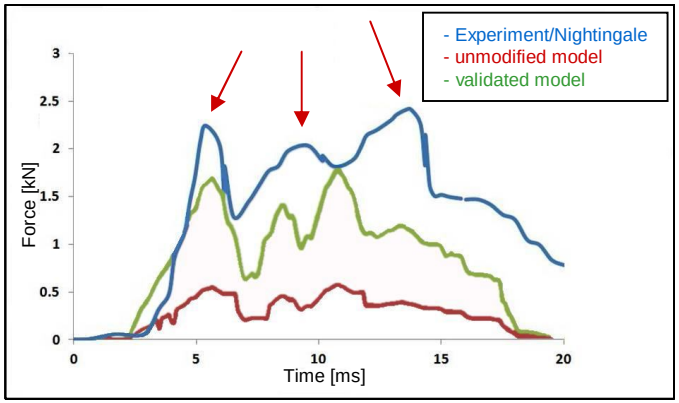




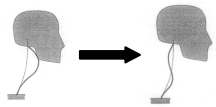
- Contact force between head and impact plate
- Successful validation: simulation results approximate experimental data (~80%)

2. T1 force





- Force at T1 vertebra
- Peaks:
  - Buckling modes



  - Fractures / dislocations (e.g. basilar skull fracture)

Contact

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Thank you for your attention.

Any questions?

www.tuc-project.org