THOMO

Development of a finite element model of the human thorax and upper extremities

Funding: European (7th RTD Framework Programme)
Duration: Jan 2009 - Oct 2012
Status: Complete with results
Total project cost: €2,655,175
EU contribution: €2,065,269

Call for proposal: FP7-SST-2007-RTD-1
CORDIS RCN: 90090

Background & policy context:

In 2004, in the European Union, there were 42193 road fatalities and 1213300 accidents involving injuries. The socio-economic cost of road crashes to the EU 15 is twice the EU's annual budget. The number of casualties is so important that it shall be reduced by all the available ways. Presently, the vehicle safety devices used as prevention tools shall be improved, since they were developed in an outdated context, for a mean person and a limited area of application. Numerical human body models could be used instead of anthropomorphic dummies to assess injury risks in different accident scenarios, to adapt accordingly vehicles and then regulations. The present project proposes to give to passive safety players a tool capable of assessing real safety. It aims to create and maintain biofidelic finite element models of the human thorax including upper extremities based on the research, development, and validation of the models for the 5th, 50th, and 95th percentile of each gender.

Objectives:

The current project proposes to give to passive safety players a tool capable of assessing real safety. It aims to improve finite element models of the human thorax including upper extremities based on the research, development, and validation of the models for the 5th, 50th, and 95th percentile of each gender. This project interacts with a worldwide project, called Global Human Body Model, which aims to create and maintain the world's most biofidelic human body models.

1. Development and maintenance of a biomechanical database focused on the thoracic segment.
2. Improvement of the knowledge of the geometrical and mechanical properties of the rib cage.
3. Development of numerical models, focusing on the validation of rib strain fields, in order to exhibit the rib fracture mechanisms.
4. The 5th, 50th and 95th percentile thorax models are considered, with help of scaling methods.
5. Mechanical and injury validation of the thorax models with tests coming from the literature or performed during the project. Use of personalisation methods and optimization process to validate matched thorax models.

Main goals: definition of acceptable values for soft tissue material properties and improvement of mainly used scaling methods for biomechanical results.

Methodology:

It is based on the following steps:

- development and maintenance of a biomechanical database of post-mortem human subject tests at the segment (thorax) and organ (heart, lungs, aorta) levels with the necessity to define the mechanical validation criteria of the model and to improve the knowledge of the mechanical behaviour of the organs and of the mechanical and geometrical properties of the rib cage;
- development of numerical models from the CAD data with the necessity to personalize these data,
to define a model architecture allowing its validation at the mechanical and injury levels and to quantify the numerical and mechanical consequences at the fracture level;
- mechanical and injury validation of the thorax and of the upper extremities with tests coming from the literature or performed during the project.

This project fits into a worldwide project, called Global Human Body Model, which aims to create and maintain the world's most biofidelic human body models.

Related Projects:

This project is part of a worldwide project, called Global Human Body Model, whose aim is to create and maintain the world's most biofidelic human body models.

To realise the targets for the future road safety, THOMO is part of a bundle of FP7 projects in the field of crash biomechanics (COVER, CASPER, EPOCh and THORAX) brought together by COVER.

Parent Programmes:

**FP7-TRANSPORT -- Transport (Including Aeronautics) -- Horizontal activities for implementation of the transport programme (TPT)**

Institute type: Public institution  
Institute name: The European Commission  
Funding type: Public (EU)

Lead Organisation:

Centre Europeen D'etudes De Securite Et D'analyse Des Risques e.e.s.a.r.et D'analyse Des Risques  
Address: Rue Des Suisses  
92000 Nanterre  
France  
Organisation Website:  
http://www.ceesar.fr/  
EU Contribution: €1,410,053

Partner Organisations:

Universite Polytechnique Hauts-De-France  
Address: Le Mont Houy  
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France  
EU Contribution: €294,330

Politechnika Warszawska  
Address: Plac Politechniki 1  
00 661 Warszawa  
Poland  
Organisation Website:  
http://www.pw.edu.pl  
EU Contribution: €200,482

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Key Results:

The project performed dynamic tests on the complete thorax with different loadings and acquisition of geometrical ribcage data using CT-scans and μ-CT scans. The new data can be used in order to improve the knowledge of the mechanical behavior of the ribcage and rib fracture mechanisms. Up to now, twelve tests were performed with success on the 50th percentile male (including three tests for the THORAX project) and analysed in order to understand the rib fracture mechanisms and define rib strain patterns, depending on the loading direction and violence.

THOMO used, in addition, three different acquisition devices to measure the whole geometry of the skeleton in order to determine relevant parameters of the human ribcage to be incorporated in a refine finite-element model. The three datasets were merged to build a geometrical thorax model in a multilevel scale approach (thorax, rib, bone structure) and a finite element model was developed. Using this approach, the project linked together medical imaging, 3D reconstruction and Finite Element modelling providing a personalised, biofidelic, CPU-time efficient model, which takes into account the entire geometry and bone distribution.

Innovation aspects

THOMO is a R&D project, developing a research direction in the field of safety, accelerating the deployment of vehicle safety technologies based on research findings and the know-how, together with related projects, in the form of numerical and experimental tools.

Strategy targets

An efficient and integrated mobility system: Acting on transport safety - saving thousands of lives

Documents:

- Newsletter #1 THOMO (Other project deliverable)

STRIA Roadmaps:

- Vehicle design and manufacturing, Other
  - specified

Transport mode: Road transport

Transport sectors: Passenger transport

Transport policies: Safety/Security

Geo-spatial type: Other