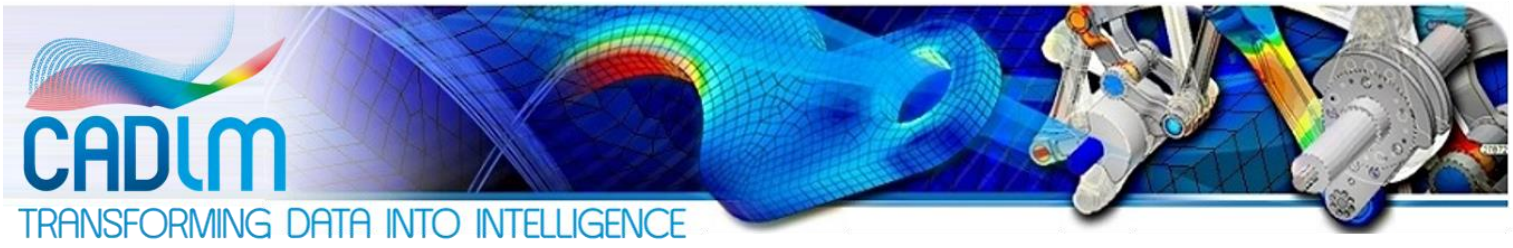


Case study – Biomechanical human model for defense application

Abstract

Many biomechanical humans models has been developed. Usually a human, financial cost and develop time are very high.
CADLM and partners have proved the capacity to make a human model for a reasonable cost and in a relatively short time.
This progress would allow a customization of these models for both human subjects and application domain.

Applications	**Defence, pedestrian protection**
Position	**Standing**
Mass	**39 kg**
Parts	**192**
Nodes	**449 556**
Elements	**627 786**
Calculation time	**≈ 1 h of calculation / 5ms of simulation (4 CPU Intel® Xeon® E5645 @ 2.40GHz)**
Total time on project	**3 months**

The following model is without upper and lower limbs. LS-DYNA software has been used for all calculations. Half of the skin has been hidden.

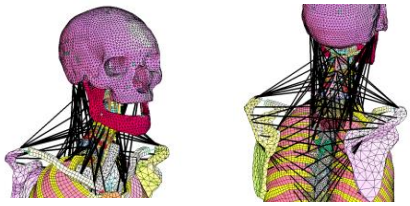
Production process

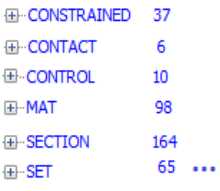
Production of a geometrical model (LBA-Ifsttar Partner):

Body CT Scan → Semi-automatic segmentation → 3D parts checking

Production of a FEM model (CADLM):

Meshing parts → Adding muscles and joints → Adding materials, contacts..





CADLM company

With our 25 years of experience, CADLM is specialized in modelling, numerical simulation, optimization and decision support systems using machine learning techniques. Our modelling expertise allows our customers to improve their development process with methods of optimal and robust design, enhanced via the techniques of Machine Learning, Data Mining, Pattern recognition, prediction of behavior in real time, creation of business model using automatic learning.

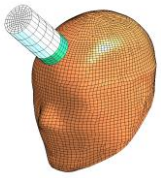
Know-how exclusive

CALM has developed advanced proprietary techniques in:

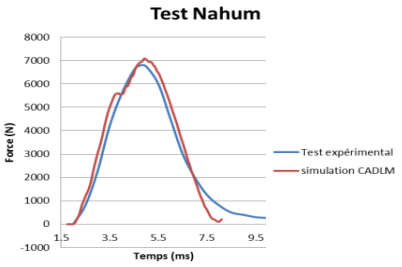
· Optimization of complex systems
· Reduced models for crash / safety applications
· Reduced Complexity Based Robust Optimization
· Early warning systems for real time risk analysis

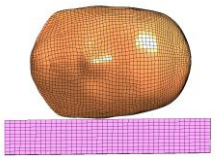
Model Validation

Experimental test Low Corridor — CADLM FE model — Experimental test Up Corridor

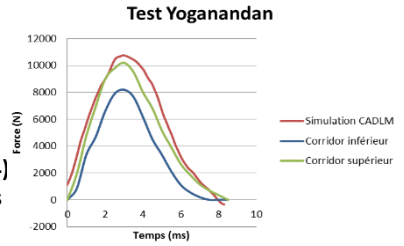


Test of Nahum et al. (1977):
- **Impactor mass: 5.6 kg**
- **Impcator velocity: 6.3 m/s**

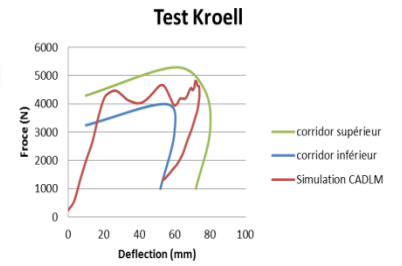


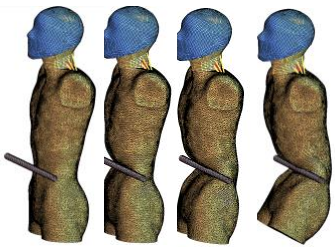


Test of Yoganandan et al. (2004)
- **Head impact velocity: 6 m/s**

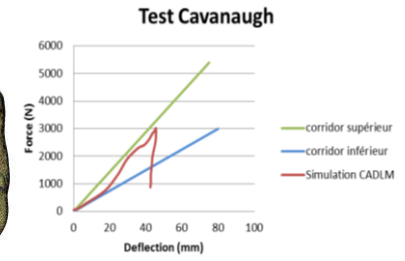


Test of Kroell et al. (1974):
- **Impactor mass: 23 kg**
- **Impactor velocity: 6.9 m/s**





Test of Cavanaugh et al. (1986):
- **Impactor mass: 32 kg**
- **Impactor velocity: 6.1 m/s**



Remark : Cavanaugh's test corridor is valid in driving position (sitting). Thus, Cavanaugh's results are given for information.

Conclusion

The results obtained at the validation tests have a good quality and show the possibility to build a biomechanical human model in a relatively short time. Thus, companies will be able to customize their biomechanical human models.

This model is commercialized by **CADLM**. For further information, please contact : sales@cadlm.com

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