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About HyperWorks®

Performance Simulation Technology

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

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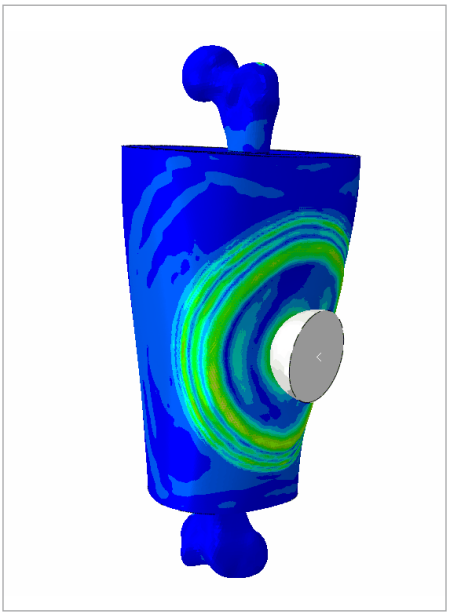
Loughborough University

Accurate Simulation Modelling of Sports Impact Scenarios using HyperWorks



Key Highlights

Industry
Research, Sports

Challenge
Generate complex human surrogate models to simulate impact scenarios

Altair Solution
HyperWorks used for its enhanced meshing capabilities in HyperMesh

Benefits
High quality meshes which provide a good description of the complex anatomical geometries

The Sports Technology Institute (STI) at Loughborough University was founded in 2007 and is a world leading research group in sports engineering, and the largest in the UK. The STI has many established links with a large range of leading global brands and strategic commercial partners in the sporting goods industry.

The facilities at STI are located on one site in state-of-the-art laboratories where the team can progress from initial concept through to finished product. The wide variety of equipment available allows them to design, develop, prototype, test and optimise a range of products. They also have the skills to create bespoke equipment designed to achieve the aims of a particular research project.

One of the key research activities within the institute is concerned with the development of enhanced human surrogate models for sports personal protective equipment (PPE) research. Impact surrogates are used to provide a representation of a living human which can then be impacted under injurious loading conditions such as a ball impacting the thigh to understand the response behaviour.

What is Personal Protective Equipment?

PPE serves an integral role in maintaining the safety of an athlete participating

Keywords: HyperWorks, HyperMesh, Personal Protective Equipment, FEA

Loughborough University Success Story

"The enhanced modelling capabilities of HyperWorks have enabled my student to discretise complex geometries and model impact scenarios more effectively and efficiently than with a generic FE solver."

Dr Sean Mitchell
Lecturer
Sports Technology Institute, Loughborough University

in sport. The human body is incredibly complex and consists of many interacting tissue structures and complex anatomical geometries.

When considering sports impact scenarios, it is beneficial to generate precise human surrogates in order to understand the behaviour of a living form.

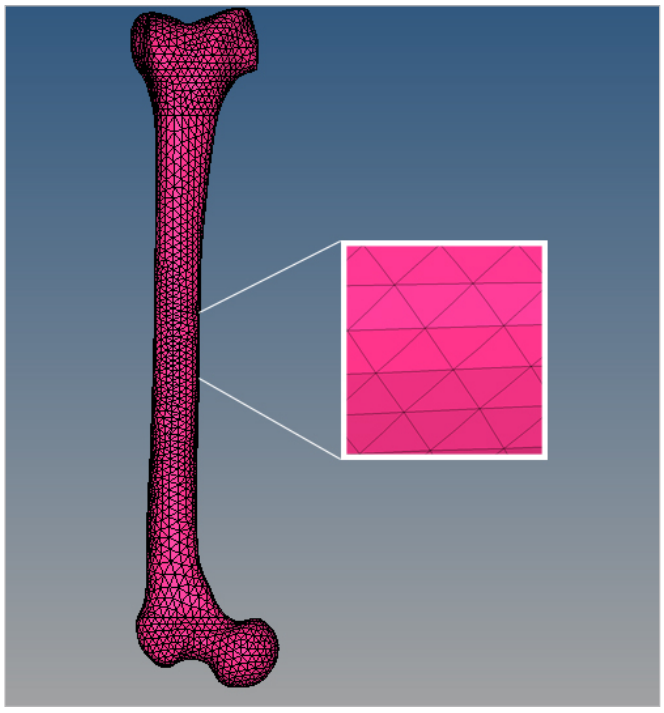
Development of Human Surrogates

Tom Payne, a PhD researcher within STI focused on the development of novel synthetic and virtual human surrogates for improved assessment of sports PPE. In order to develop sophisticated surrogates, capable of providing more accurate predictions of human response behaviour it is necessary to model these complicated structures. When modelling these structures, more powerful meshing capabilities are required beyond what is present in most generic finite element (FE) pre-processors or meshing tools - that's where HyperMesh comes into play.

The ability to discretise complex geometries is a key challenge associated with this type of research. The quality of a mesh is one of the most significant factors affecting model behaviour. Given the importance of an accurate surrogate response, particularly when validating synthetic surrogates, the ability to mesh intricate geometries is integral to the research.

FE models are used as an integral diagnostic tool to inform the predicted behaviour of human surrogates and inform development of more complex synthetic surrogates without the need for expensive and time consuming prototyping. Using FE modelling it is possible to measure many loading phenomena which cannot be

Scanned femur



Meshed femur

Tom Payne using the state-of-the-art laboratories at STI

Developing initial concept to finished product

measured to the same detail in a synthetic model without creating artificial stress concentrations compromising the biofidelity.

Generating High Quality Models Efficiently

With the help of online tutorials and the experience of his colleagues, who attended free training sessions with Altair, Tom used HyperMesh primarily to clean up the scan geometries and provide a high quality mesh.

The geometry editing tools enable an efficient clean-up of any inconsistencies introduced when a scanned geometry is imported. This is important as all human structures used in surrogate evaluations are non-standardised shapes and as such often embody some missing detail. The diagnostic capabilities of the software is also extremely useful particularly with regards to evaluating the quality and consistency of meshes.

When considering sports impact scenarios, there are inevitably areas which experience localised high stresses and element deformations both as a function of features in the geometries (e.g. bony protrusions) or the impact location. Consequently, mesh biasing is often a necessity. The enhanced control over such features facilitated by HyperMesh makes mesh refinements far easier to conduct and manipulate for further iterations.

Overall, the software provides a tool from which it is possible to generate high quality meshes which provide a good description of the complex anatomical geometries in a computationally efficient manner.

Future Research with HyperWorks

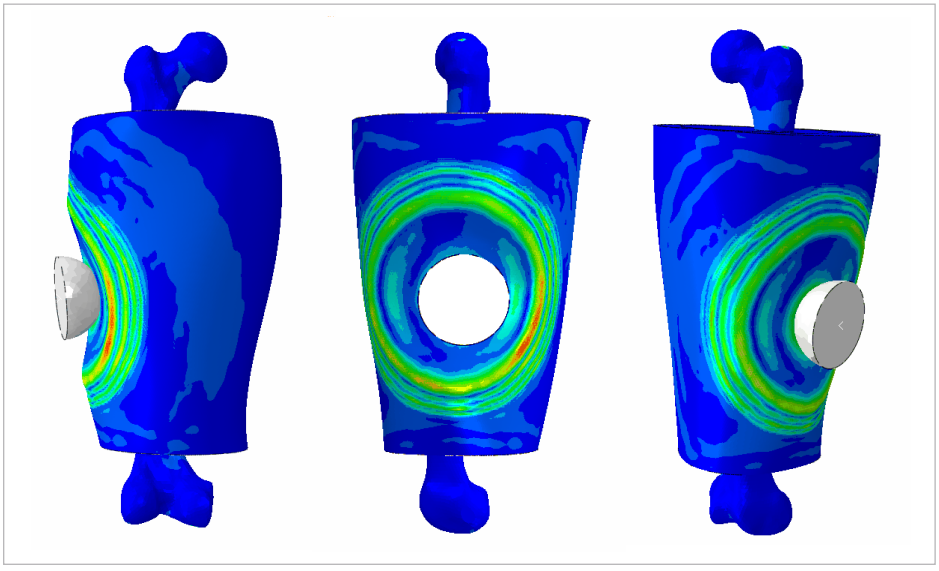
With STI carrying out a wide range of research including athletic footwear, technical apparel, protective equipment, balls, bats, clubs, rackets and fitness equipment, there is huge scope for the use of HyperWorks in their future projects.

Future research in this area will involve modelling increasingly complex geometries and impact scenarios from different regions of the body. HyperWorks will be integral to the future development of these FE models and will form a key component of the surrogate development cycle.

For more information on HyperWorks training courses email info@uk.altair.com.

To find out more about Altair University visit www.altairuniversity.com

To find out more about Loughborough University Sports Technology Institute visit sti.lboro.ac.uk.



Simulation of a cricket ball impacting the thigh