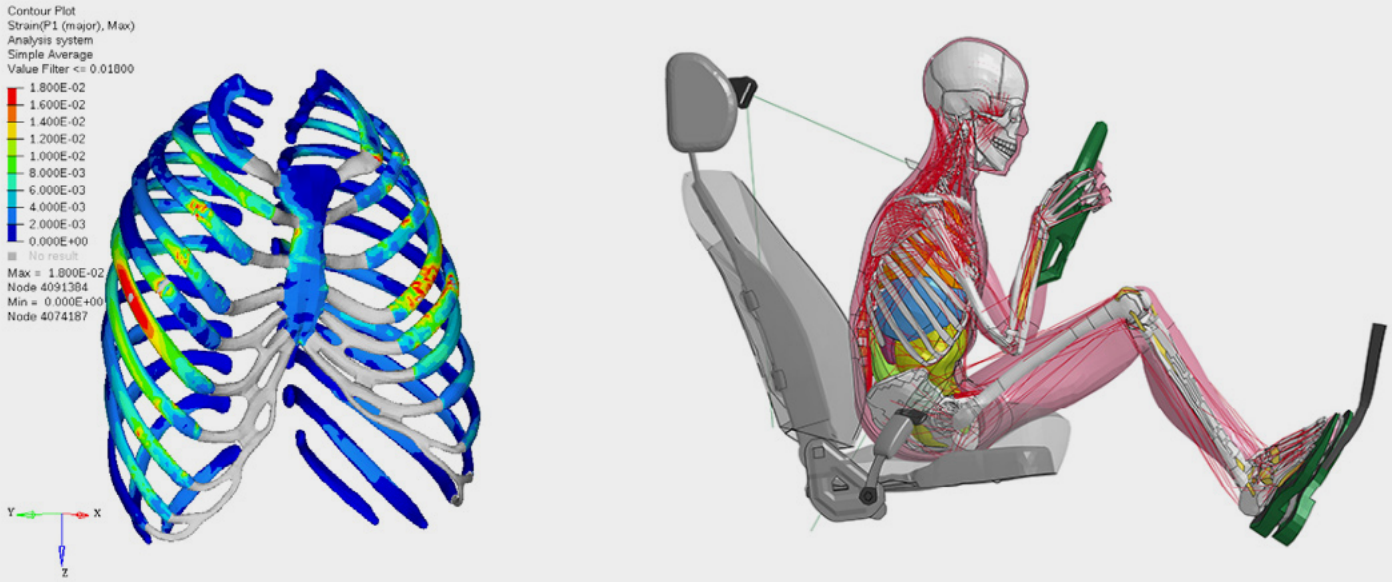
HEXAGON | MSC Software

Case study

Ludwig Maximilian University of Munich

SimManager provides CAE process quality control thanks to a harmonized and consistent simulation environment



SimManager's web-based functions ensure that simulation processes are repeatable thanks to the consistent management of all data and models. They also increase productivity through process automation and a reduction in the need for manual operations.

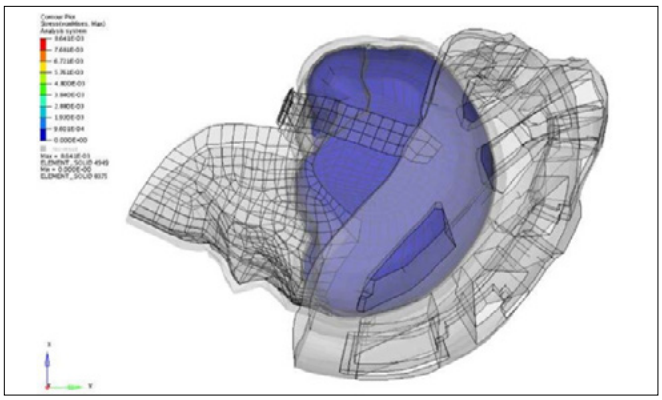
"We use a total of 13 different simulation systems for most of our programs, sometimes in combination. Also, for each of these systems, we use the latest version of the software as well as the current stable version, to ensure our results are correct. To ensure we stay organized, and we are working in a consistent software environment, we have introduced SimManager from MSC Software. This portal provides lots of options for managing the simulation data from all the solvers on one platform. Everyone on the team knows who has run and uploaded which tasks, and how."

At LMU's Institute for Forensic Medicine, Professor Dr. Peldschus leads an interdisciplinary working group that specializes in injury mechanics, accident research and forensic biomechanics. The team consists of specialists from the fields of medicine, biology, anthropometry, engineering, and simulation. This expert team makes use of 13 different simulation software packages from a range of disciplines and manufacturers, which can be quite complicated to keep organized.

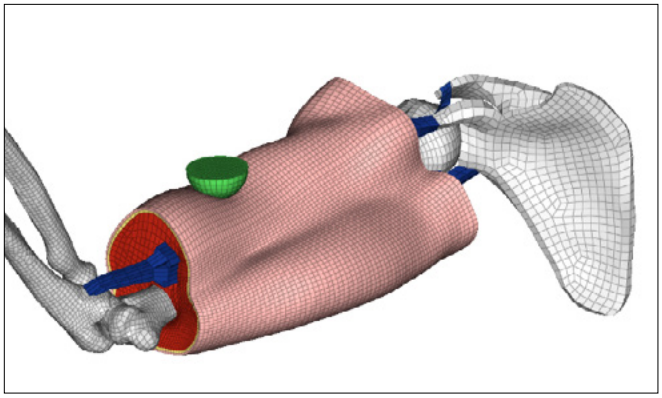
For over a year now, MSC Software's SimManager software has handled the central simulation data and process management for all these solutions. The simulation environment has been harmonized, and this new level of consistency has contributed in a large way to quality control in the CAE process.

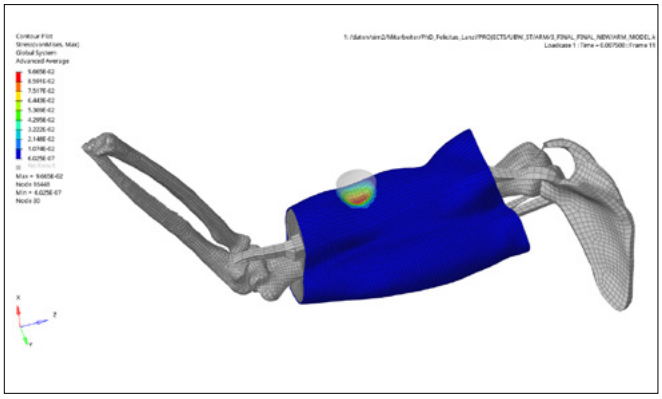
Challenge

The human body is a complicated structure to simulate using computer software. LMU's team of specialists covers a wide range of topics in this arena, including reconstruction of real traffic accidents, the protective effects of motorbike clothing and bicycle helmets, the changes in risk of injury due to the new seating positions of occupants in autonomous vehicles, the validation of human simulation models based on experimental studies, and the mechanics of injury to different types of tissue such as skin, fat, muscle, and bone. The interdisciplinary team of experts use a wide spectrum of simulation software to do these tasks; THUMS (Total Human Model for Safety) and GHBM (Global Human Body Model) are simulated using the finite element method (FEM) and various other solvers such as LS-Dyna, VPS (Pamcrash) and ABAQUS. When it comes to accident research, MADYMO is also used to calculate multibody models. All this simulation work creates a massive amount of data, in multiple formats – which makes file organization key – but also, requires a "virtual line" for computer solving time, and has a lot of opportunities for potential human error.



A bicycle helmet simulation, showing the protective effects that a bicycle helmet has on the human brain – which leads to better bicycle helmet designs over time.





A simulation showing the deformation of soft tissues at different impact velocities. The EFG (element-free Galerkin) simulation method comprises a study of more than 25 separate simulations – SimManager can automate the calculation process, thus saving time.

Solution

For forensic biomechanics, Felicitas Lanzl's area of expertise, the programming language FORTRAN is used to set user-defined material models for skin, fat and muscle tissue, and then paired with an FE solver to replicate injury behavior and analyze injury mechanics.

"We use a total of 13 different simulation systems for most of our programs, sometimes in combination," reports Felicitas Lanzl. "Also, for each of these systems, we use the latest version of the software as well as the current stable version, to ensure our results are correct. To ensure we stay organized, and we are working in a consistent software environment, we have introduced SimManager from MSC Software. This portal provides lots of options for managing the simulation data from all the solvers on one platform. Everyone on the team knows who has run and uploaded which tasks, and how."

For all this to operate smoothly, SimManager was implemented so that each individual simulation program could work together, and the floating licenses that were installed ensured that students could contribute their work without any issues. SimManager then automatically sent the calculation tasks from all the programs to the queuing system based on their priority in the queue. "This means we could set calculation tasks for a desired number of nodes and have them run over the weekend," explains Felicitas Lanzl.

Results

Recently, the team at LMU was called upon to simulate a forensics scenario – and SimManager was able to provide real value to their simulation process. One of the mechanical engineering graduate researchers who specialized in blunt force trauma was required to study biological tissues under dynamic loading using explicit FEM.

“The skin and superficial soft tissue are the first layers of the body to be impacted,” explains Felicitas Lanzl. “If the skin is not realistically modelled, then the stresses and strains acting on deeper tissues, such as muscles and bones, will not be accurate either.”

Research was carried out on different material models in forensic medicine so that in the future, the progression of events during accidents can be further evaluated using simulations, in order to properly understand what happened. During Oktoberfest in Munich, for example, there are beer-fueled brawls that lead to serious injuries. Lawyers need to know for certain whether an attack was potentially fatal or not. In the future, FEM simulations will be able to contribute towards providing conclusive answers to situations like this – but only if the underlying material models are consistent with reality.

To determine the relevant parameters for the material models, Felicitas Lanzl carried out physical experiments on soft tissue. In addition to tensile and compression tests, the effects of blunt force were simulated with drop tests from different heights. The results were compared with the corresponding finite element simulations. “Soft tissue behaves in a very complex way, so an iterative process is needed in order to adjust the various material parameters,” says Lanzl.

With SimManager, Lanzl can partially automate her parameter studies by specifying value ranges and intervals for the corresponding parameters, which are then processed individually. Felicitas Lanzl’s work has become significantly easier now, thanks to SimManager. “The lower error rate saves a huge amount of time. When everything is entered manually it is easy for a simulation to be forgotten or for incorrect values to be entered.”

Another challenge is the high deformation of soft tissue, which quickly leads to instability in traditional FEM. SimManager displays important data such as time increments and energy balance instantaneously as a graph. “This means we can compare results at a glance and eliminate simulations that are not giving plausible outcomes.”

Conclusion

Simulations generate larger quantities of data than any other construction process. This data needs to be managed efficiently so that the input parameters are traceable and reliable. SimManager’s web-based functions ensure that simulation processes are repeatable thanks to the consistent management of all data and models. They also increase productivity through process automation and a reduction in the need for manual operations.

For LMU, the value of SimManager is the ability to handle large quantities of data in a clear and transparent way – it is as easy to locate and single-out individual calculations from an entire series of tests. “I can find the entire audit trail for each parameter and display the results clearly,” says Felicitas Lanzl, pleased. “Overall, we benefit from the easy exchange of data, from the time saved through process automation, and from the traceability of the entire simulation process.”

About Ludwig Maximilian University of Munich

Ludwig Maximilian University of Munich is a public research university located in Munich, Germany. The University of Munich is Germany’s sixth-oldest university in continuous operation. The Biomechanics and Accident Research / Forensic Epidemiology team is led by Professor Dr. Steffen Peldschus, along with forensic biomechanics specialist Felicitas Lanzl.

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