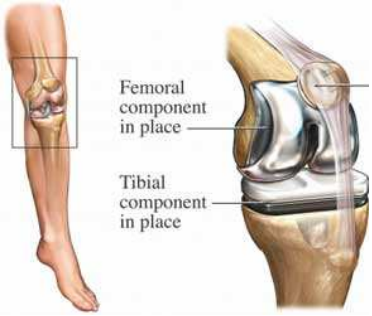

Fachhochschule Amberg-Weiden

CASE STUDY

HyperWorks Helps Create Accurate Finite-Element Models from CT Scans of Artificial Knee Joints

Overview

Using Altair HyperMesh, the HyperWorks finite-element (FE) pre-processor, researchers at the University of Applied Sciences in Amberg-Weiden, Germany, created an efficient process to create FE meshes of an artificial knee joint from supplied computed tomography (CT) scans. The team, led by Professor Franz Magerl, deployed HyperMesh's re-meshing capabilities to convert STL data to a high fidelity tetrahedral-based FE model and investigated the effect of imperfections induced by the manufacturing process on part strength.

Business Profile

The University of Applied Sciences, Amberg-Weiden is a leading German university in the field of product development, rapid prototyping, simulation and materials science. Its Industrial Engineering faculty educates more than 350 students in these various technical disciplines.

Challenge

In order to predict the structural performance of prostheses, such as artificial knee joints (Fig. 1), engineers perform FE simulations based on ideal CAD models of the implant. In reality, however, various imperfections exist. For example, the manufactured joint can show geometrical deviations, non-homogeneous material distribution, internal cavities, inclusions or delamination. To investigate the effect of the imperfections on performance, the manufactured component is scanned in a computer tomograph. In the past, it was very difficult to create high-quality FE meshes based on CT data, because of the size and the level of detail in a CT model. A good FE mesh is needed to obtain accurate results from the simulation.

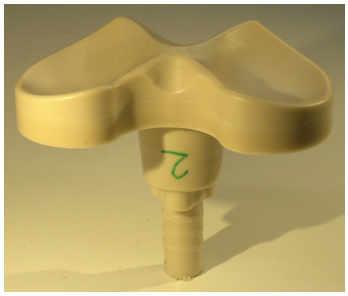

Figure 1
Tibial component of an artificial knee joint

"HyperMesh is a very helpful tool to generate high-quality STL data based finite-element meshes."

Prof. Franz Magerl /M. Hofmann
University of Applied Sciences
Amberg-Weiden, Germany

Solution

The CT scan of the knee joint, available as triangulated surfaces data, is imported into HyperMesh. However, the STL mesh cannot be used for simulations because of poor element quality. HyperMesh includes a function that re-meshes existing meshes, such as a STL model, without underlying analytical geometry information (e.g. IGES data) to improve mesh quality. The software creates surface approximations in the background and generates a shell mesh based on that approximation. As a result, small geometric details inside the artificial knee joint such as a bubble inclusion can be captured with a high fidelity mesh (Fig. 2). In a second step, a tetrahedral-based model is created from the shell mesh and boundary conditions are applied. In the case of the specific knee joint, the simulation reveals non-critical stresses in the area of the bubble (Fig. 3), so there is no need to improve the manufacturing process.

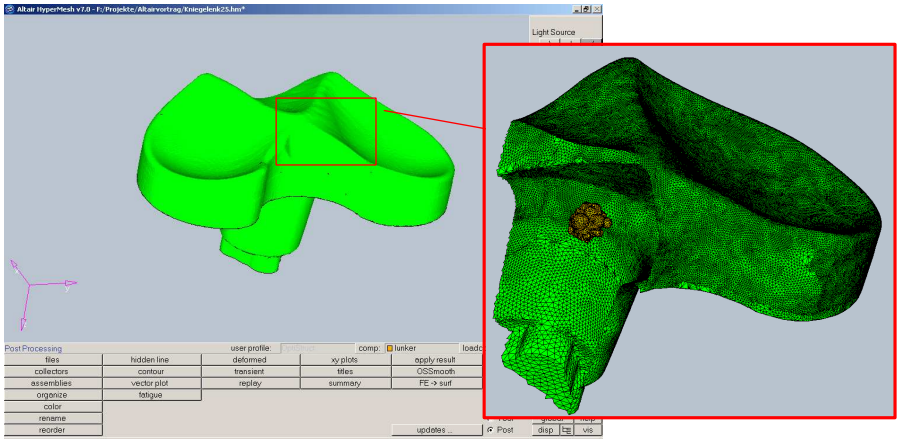

Figure 2
Re-meshed STL mesh with inclusions (grey)

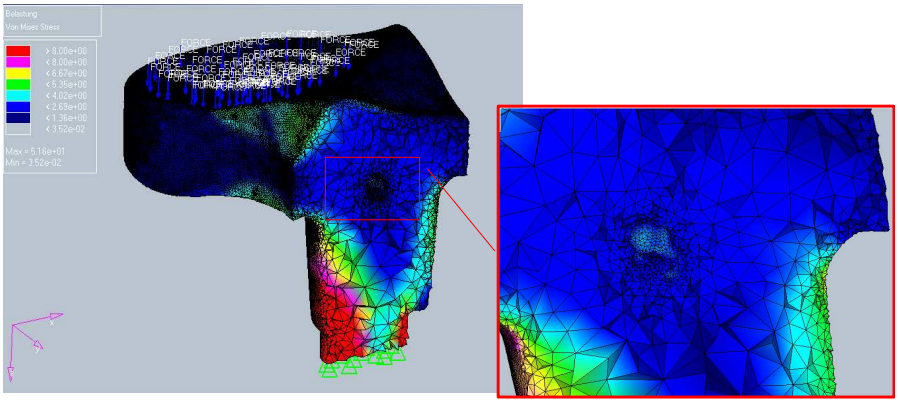

Figure 3
Von Mises stresses in the vicinity of the bubble

Benefits

- Creation of FE models based on CT scans without the need for underlying CAD data
- Processes can be adopted to similar problems
- Better product quality through consideration of internal material flaws