

## Customized Care: Using Altair HyperWorks™ for Biomechanics Simulation in Orthopedics



Sports injuries, back pain, spinal stenosis, ruptured disks, hand injuries, and orthopedic trauma. These are some of the most common musculoskeletal conditions that can occur at any age. The pain and discomfort associated with musculoskeletal conditions can stop us in our tracks – strongly impacting the quality of life. Orthopedic surgery is practiced in cases of serious trauma and pathologies of bone or joint structures. A certain percentage of these surgeries is followed by complications that require one or more other surgeries, called revision. In the United States, in 2012, the cost of knee replacement revision surgeries was growing at an estimated \$2.7 billion (source: PMID 23239930). Analyzing the biomechanics of the human body and bone-implant interactions in a personalized way is critical in reducing the complications of mechanical causes (number or size of implants, length of surgery, level of bone resection, etc.). Digital simulation is a state-of-the-art technology that can understand and predict the deformities and fracture risks of biological tissue when subjected to external forces. This technology is in the process of being recognized and supervised by the Food and Drug Administration (FDA) for the design and approval of medical devices.

Surgical techniques are currently undergoing a major transformation, as personalized medicine is becoming the standard of care. For orthopedic surgeries, this implies bone implants with shape and characteristics personalized to each patient. Biomechanical simulation using validated models and a certified process has a major role in enabling personalized implants to improve patient outcome.

Providing design, CAD and simulation services applicable to several industries, Canadian start-up company Philomec specializes in mechanical engineering services that helps companies design and optimize their products using mechanical and biomechanical FEM simulation. They bring together research engineers with expertise in world-class biomechanical simulation. Philomec has developed a series of human osteoarticular validated models used to decrease cost and accelerate design of orthopedic implant.



### Industry

Medical

### Challenge

Validating biomechanical models due to complexity of materials, scarcity of experimental data, and the lack of representation of variability

### Altair Solution

Application of Altair HyperWorks for explicit Multiphysics simulation of musculoskeletal models

### Benefits

High-level of confidence in the validity and stability of musculoskeletal models

Their creation of customized, validated biomechanical models, and the analysis of simulation results by experts allows surgeons to choose the model of an implant and adapt surgical maneuvers to a specific patient, thus reducing the number of implants used, as well as the risk of complications. Implant designers can also optimize the geometry of their products faster and more economically than with conventional design techniques.

### Validation of Biomechanical Models

The main challenge in biomechanical modeling is linked to the complexity of the contact conditions and of the materials that can be inhomogeneous, anisotropic, nonlinear, strain rate dependent, etc. It is thus very hard to validate a biomechanical model due to the scarcity of experimental data and the lack of representation of variability. In addition, the studied phenomena are highly multifactorial, and have biological and chemical parameters that influence the mechanical behavior.

### Biomechanical Simulation using Explicit Multi-Physics Simulation Tools

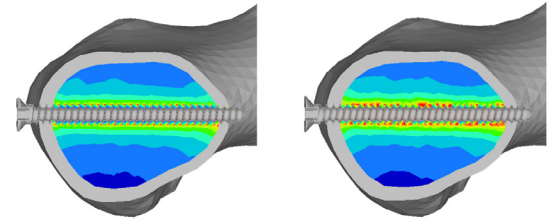
Dr. Léo Fradet, General Manager at Philomec believes that the company's expertise in simulation differentiates them, as a majority of consulting companies offer only implicit FEM simulation. "Altair offers us the credibility we need to be relevant for our clients. Having explicit dynamic non-linear simulation tools allows us to answer to some of our clients' most advanced problems. Also, Altair tools give us the opportunity to handle all aspects of the design and evaluation of a technological product."

With primary expertise in biomechanical simulation, one of Philomec engineers' main focus consists in calibrating and validating material properties that are very specific to biological tissues. The constitutive models available are not always adapted for such applications.

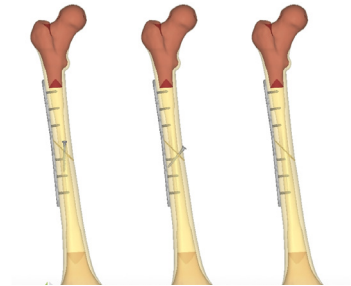
Dr. Fradet notes that Altair's hands-on, customizable, and highly versatile tools are what they need to tackle complex and specific problems of this nature.

"Altair's client support has helped to use control material laws in such a way that we are confident in the validity and stability of our musculoskeletal models. They have always been very helpful in finding solutions for atypical problems. We appreciate the 2-level use of Altair's products, with the efficiency and ease-of-use of Altair Inspire™ and the more technical in-depth control capabilities of the Altair HyperWorks™ software suite."

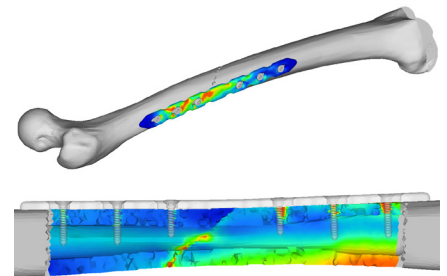
Dr. Léo Fradet, General Manager, Philomec



*Orthosis and Prosthesis optimization*



*Comparison of surgical approaches for femoral compression plate*



*Surgery simulation*