Medical Engineering
Use Cases of Endo- and Exoprosthetics

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Motivation

Prosthetics are typical representatives for components where classical engineering (polymeric engineering) and medical (orthopedics) fields come together. On a very basic level a distinction between endo- and exoprosthetic is made. The former is, as the name indicates, used as a direct implantation into the human body to replace damaged or worn out bones, joints or soft body tissues like in total knee arthroplasty (TKA). The second type, exoprosthetics, are intended for external body usage with the aim to support the human body in different situations, tasks or motions to protect the user from harm and fatigue. Classical examples are the so called (partial) exoskeletons.

Endoprosthetics

Analysis and optimization of different parts of a TKA (femoral part, tibia insert, tibia tray) acc. to
- Contact mechanics
- Wear analysis
- Basic/daily motions
  - Gait analysis
  - Deep squat
  - Chair raise
  - ….

Based on real world computer tomography (CT) and motion/loading data.
The project is carried out in cooperation with the University Clinic of Orthopedics and Traumatology Linz.
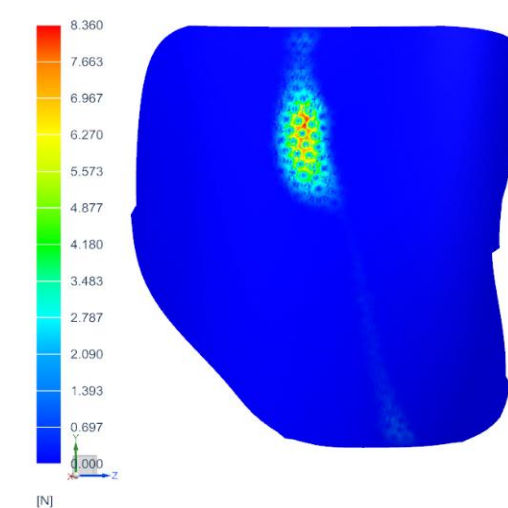
Geometry generated from CT-Data
Forces during Chair Raise

Model generated from inputs (1D)
Results – Chair Raise
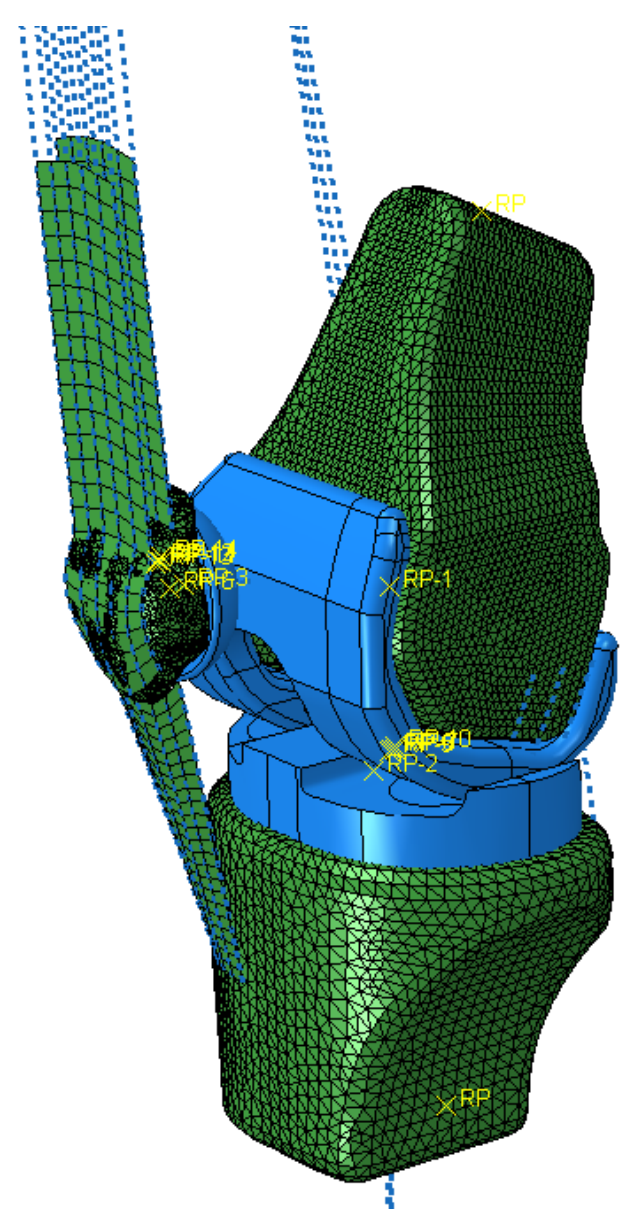
Motion and Interactions

Contact Analysis and Wear (Metal – UHMWPE contact)

Exoprosthetics / -orthotics

Design and development of lightweight lower limb exoskeleton parts by using state of the art manufacturing processes (additive manufacturing, AM) and materials (continuous carbon fiber reinforced polymers, c-cfrp). This work was part of the **LIT EROS** project in 2019, in cooperation with the Institute of Robotics at the Johannes Kepler University Linz.
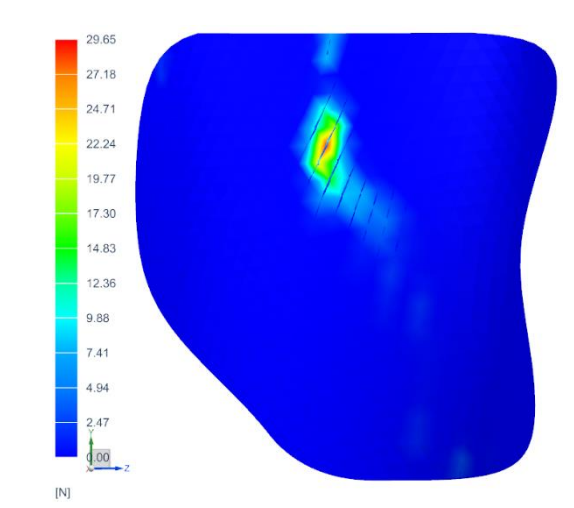
Hip Shells

- Optimized for an even contact pressure distribution
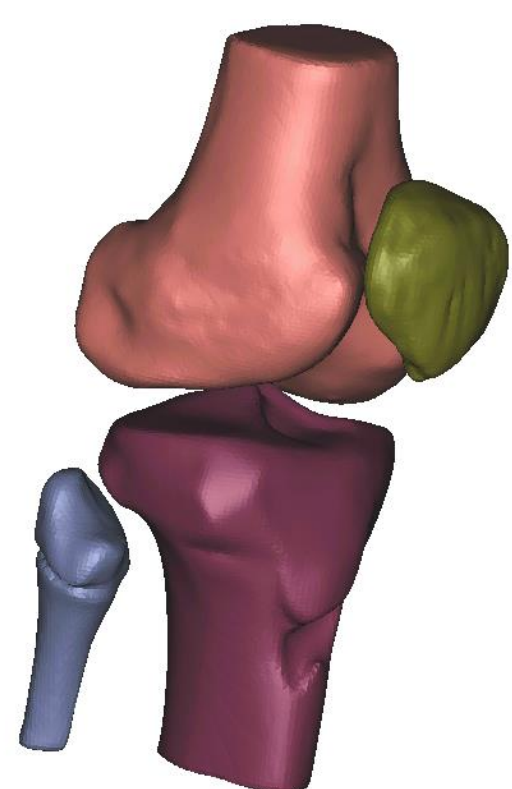- Different materials and material models (hyperelastic, viscoelastic, …)

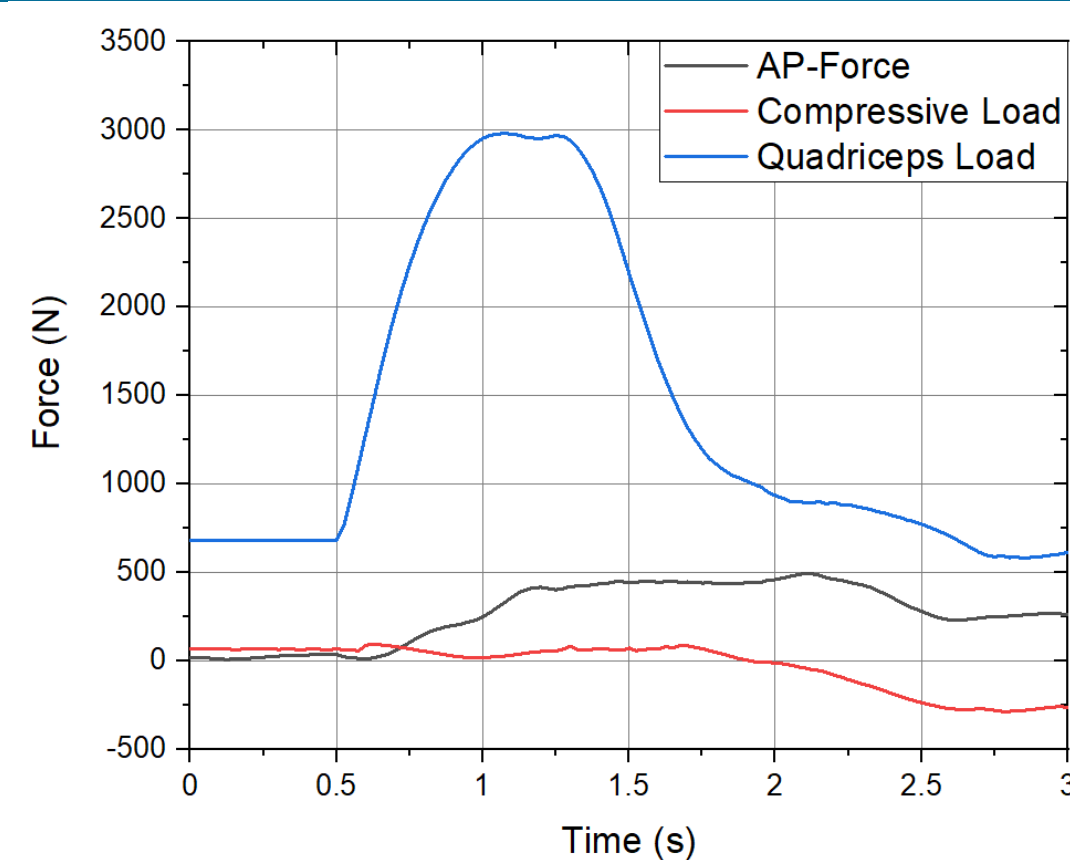**Pressure Distribution without Padding**

Pressure Distribution with Padding
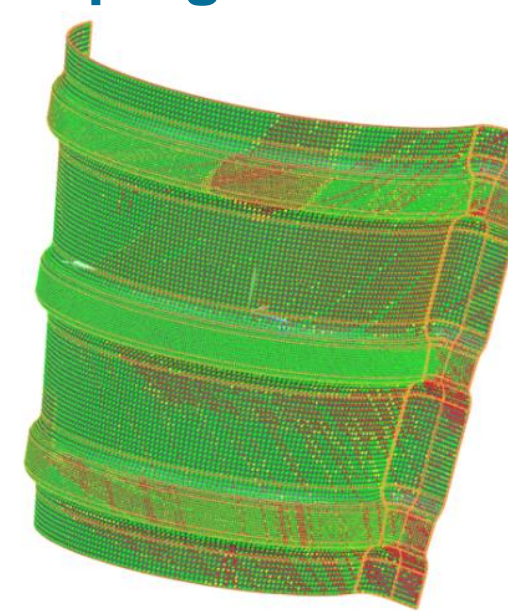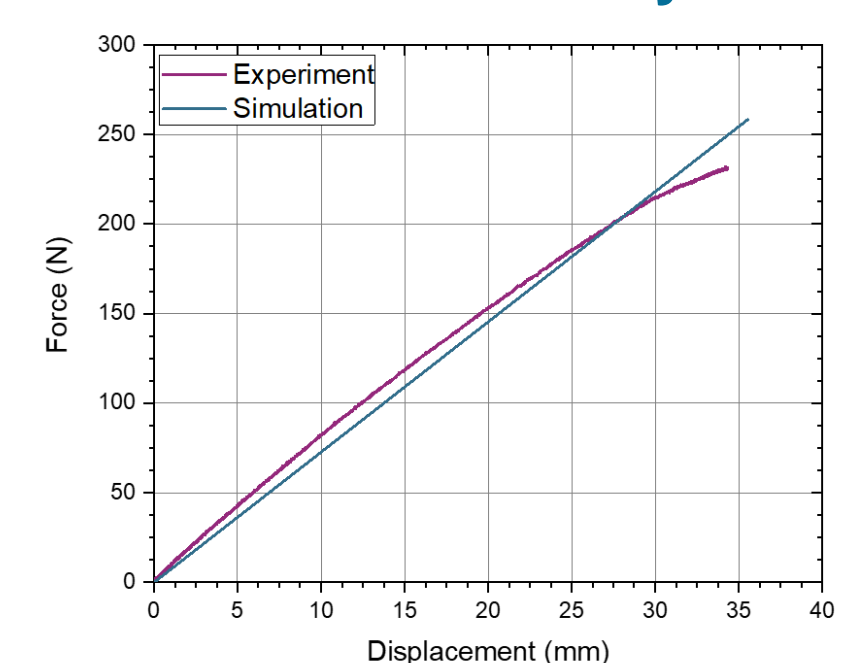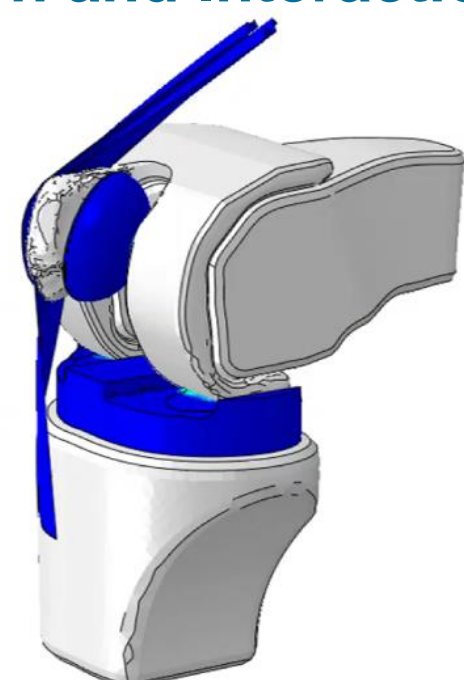

Upper Leg Shells

- Draping simulations and structural analysis for a minimum weight
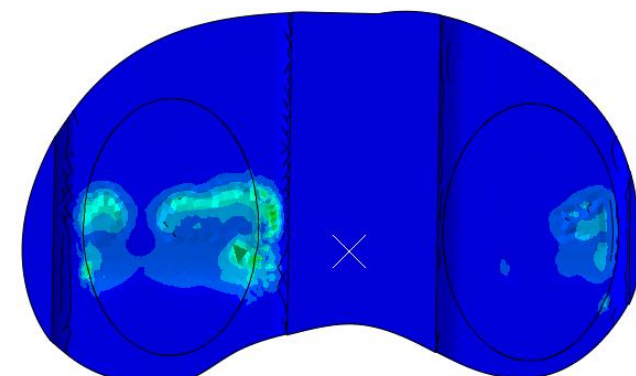
Draping Simulation

Structural Analysis

Lower Limb Exoskeleton

Parts based on conventional and thermoplastic cfrp are efficiently combined with actuators and motors in a complex & dynamic mechatronical system.

Hip Shells
Actuator
Motion Wing
Upper Leg Shell

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