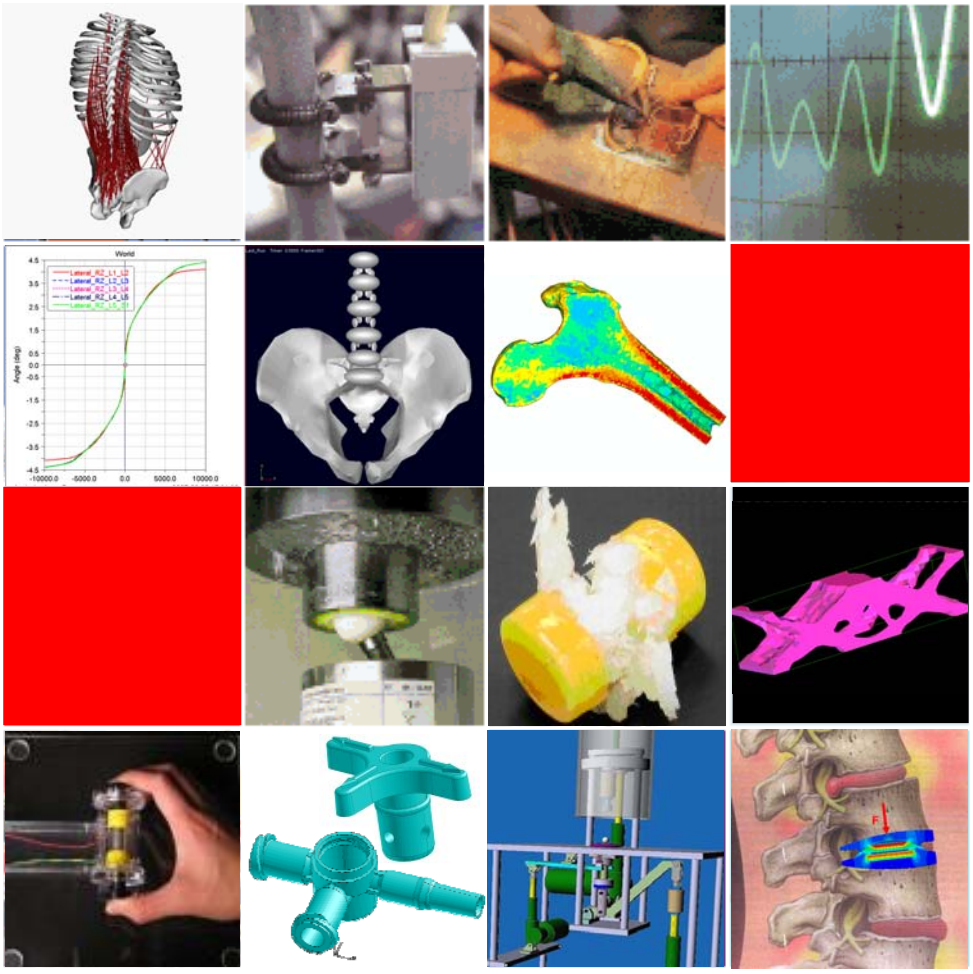
Empa

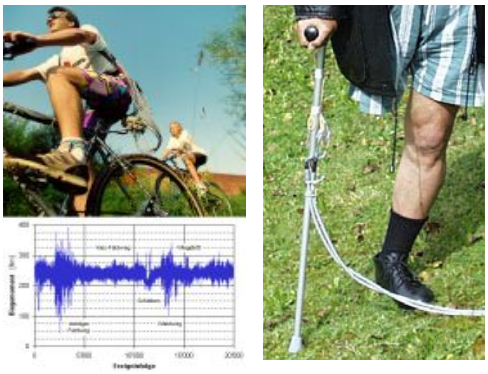
Materials Science and Technology

Biomedical Engineering



Research & Development activities of the Laboratory for *Mechanical Systems Engineering*

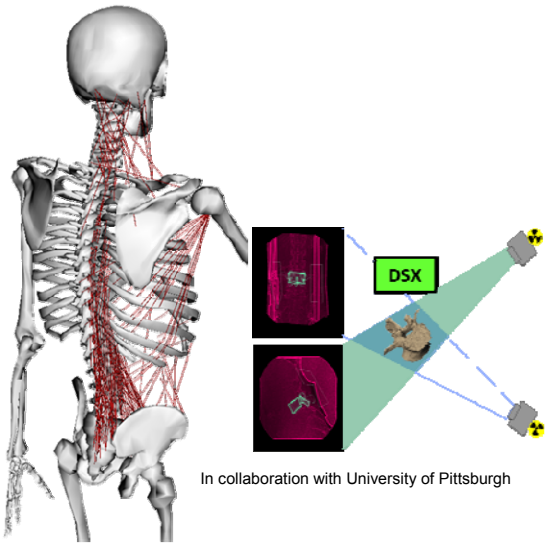
- **Measurement of service loads** on sport goods (e.g. bicycles, skis, kickboards) or rehabilitation accessories (e.g. crutch, wheel chair).



- **Rigid body simulation** of the musculoskeletal system to predict muscle and reaction forces in the body for a given movement.

  The figure shows the model of a full human with added muscles on the right upper thorso and the used method (DSX - Dynamic Stereo-X-ray Imaging) capturing 3D in vivo kinematics. The model is used to study the kinematics of the lumbar spine during flexion and lifting tasks (the vertebras are connected with linear elastic joints).

  Used software: OpenSim®.

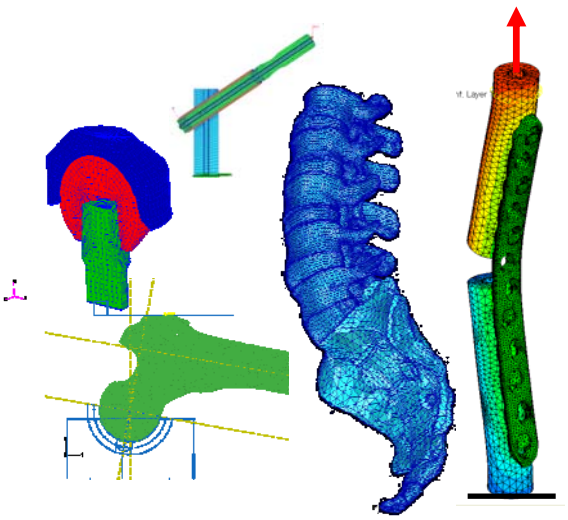


In collaboration with University of Pittsburgh

- **Finite Element analysis** (FEA) of trauma implants, instruments, joint replacements, dental implants, bones and soft tissues.

  Geometrical (contact with friction) and material non-linearities can be considered. The results of the FEA are stress and strain distributions, deformations and contact forces.

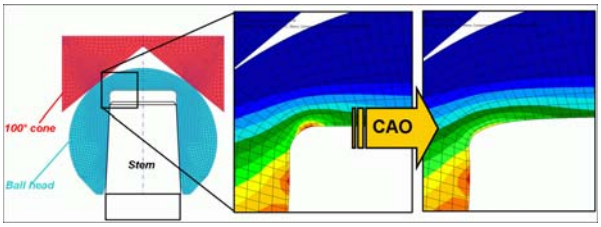
  Used software: Abaqus®.



- **Topology and shape optimisation** of medical devices.

  The figure shows the optimized shape of the chamfer between the conical bore and the bottom of the bore hole of a hip joint ball head.

  Used software: CAO by Mattheck.

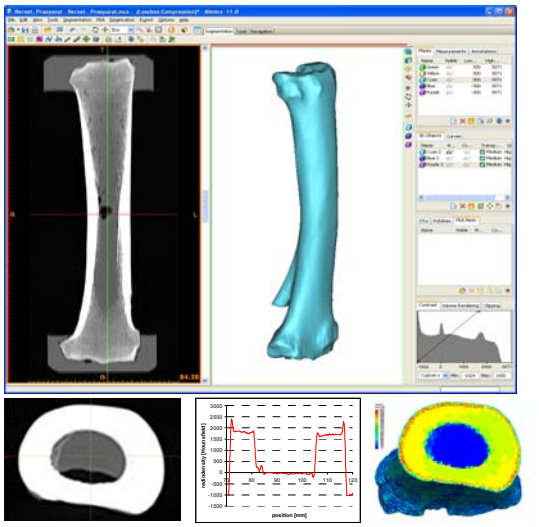


► **3D-Modeling** based on Computed Tomography (CT) scan of bones.

The upper figure shows the lateral image of a long bone (equine radius) and the surface model of the bone based on gray values for bone material density.

The lower figures show a CT scan slice - diaphysis (1), the corresponding density profile measured along a path from the left to the right (2) and a longitudinal section of the FE model using Young's modulus distribution derivated from the density profile (3).

Used software: Mimics® Base / FEA Modul.

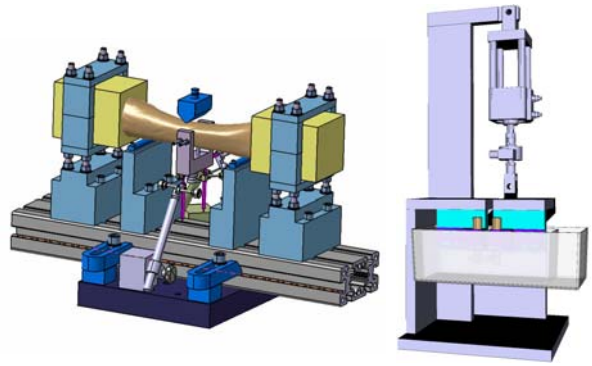


► **Static, creep, wear and fatigue tests** as well as durability tests using variable load levels. The laboratory performs these tests with up to 4 channels simultaneously.

The Laboratory has long time experience in performing mechanical experiments on structures using force, displacement and strain measurement sensors (strain gage or contact-free like laser or video extensometer). Implants may be tested in physiological solution at 37°C in order to simulate real in vivo conditions.

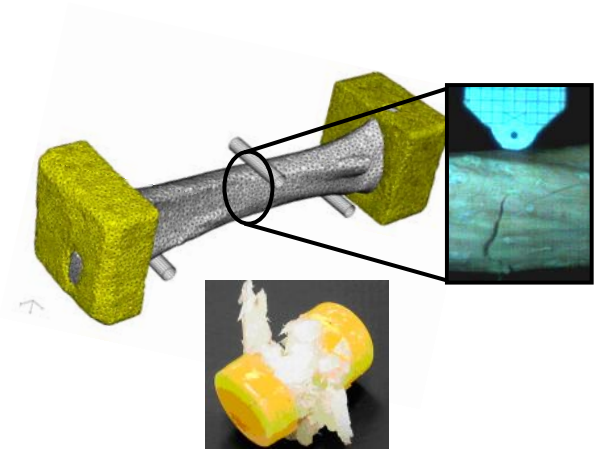
The laboratory is accredited in accordance with DIN EN ISO/IEC 17025: Mechanical testing of metallic materials, structural components and constructions (STS0053). All used test machines and devices are categorized in precision class 1.

► **Test simulators** are developed to allow specific loadings and motions according to customer specifications. A Design/Workshop Group at Empa provides support in preparing drawings and manufacturing devices.



► **Tests with special requirements.** The laboratory possesses test facilities for impact characterisation with optional recording possibility by high-speed video camera and subsequent video tracking.

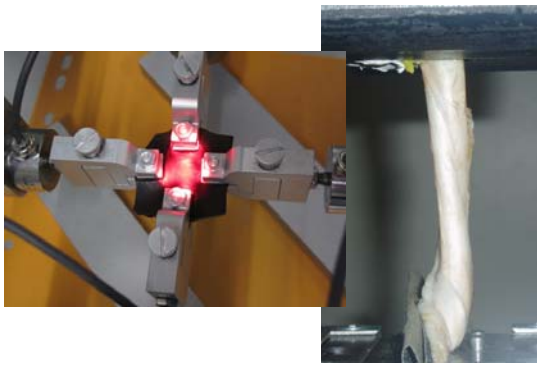
The figures show a high-speed video image of the crack propagation in a long bone which was loaded by an impact and a biopolymer augmented bone specimen used for compression test in the range of a few Newtons.



► **Mechanical properties of soft tissues**

The left figure shows the biaxial testing of an elastomer membrane in order to determine the hyperelastic material properties. Different grip systems allow to fix also soft tissues like cell membranes or scaffolds.

The right figure shows a tension test on a sheep calcaneus tendon. The grips were optimized to assure the muscular side fixation.



The **Laboratory for Mechanical Systems Engineering** is perfoming contract assignments and Research & Development cooperations with medical technology companies, academic institutions or foundations. Should you have any further questions or wish to have quotation for services, please do not hesitate to contact us.

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