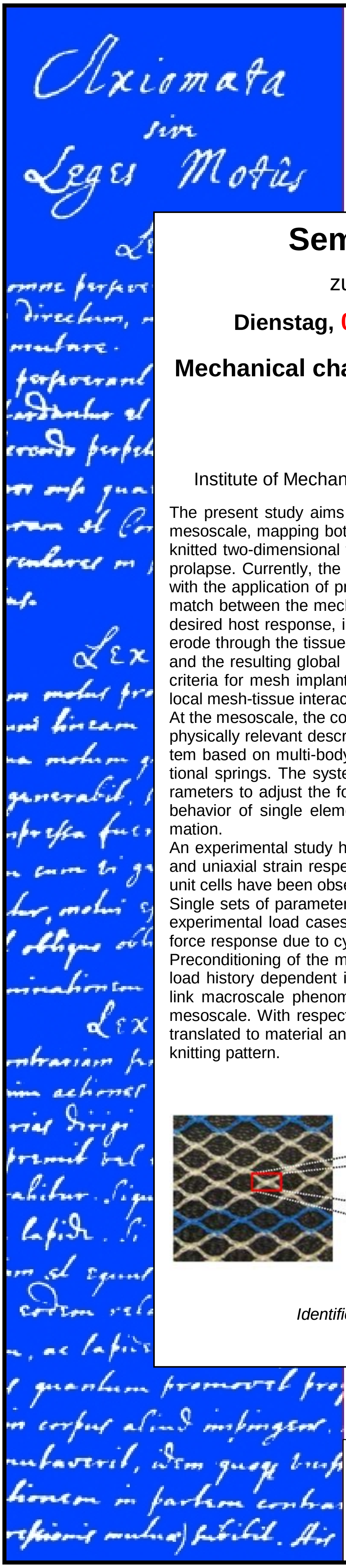

Seminar über Fragen der Mechanik

zu folgendem Vortrag wird herzlich eingeladen

Dienstag, 05.06.2012, 16:00 Uhr, Egerlandstr. 5, Raum 0.044

Mechanical characterization and modeling of prosthetic meshes at different length scales

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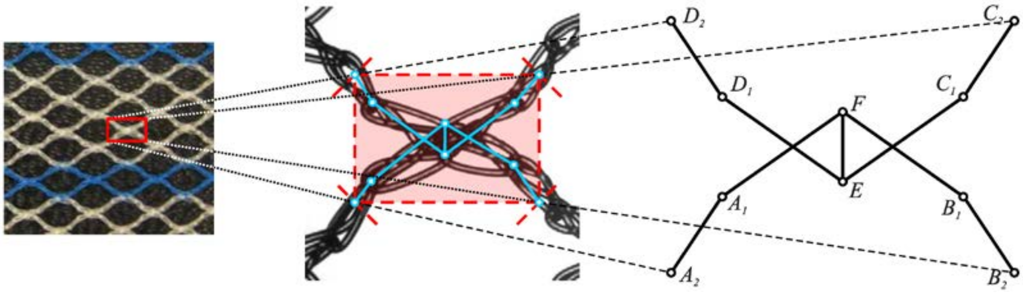
The present study aims at developing a physically based mechanical model for prosthetic meshes at the mesoscale, mapping both local deformation patterns and the global force response. Prosthetic meshes are knitted two-dimensional fiber-networks used for soft body tissue support, such as in case of a pelvic organ prolapse. Currently, the FDA issued a health notification, warning against severe complications associated with the application of prosthetic meshes in prolapse repair. Next to chemical and biological factors, a mismatch between the mechanical behavior of the mesh and the underlying tissue is assumed to incite an undesired host response, impairing the integration of the implant. Instead, it might reposition, wrinkle or even erode through the tissue. This study is motivated by understanding the interplay between local deformations and the resulting global anisotropic (orthotropic), nonlinear force response. It is expected to provide design criteria for mesh implant optimization, not only accounting for the global mechanical behavior but also for local mesh-tissue interactions.

At the mesoscale, the complex mesh geometry and its local kinematics are mapped in an abstracted, but still physically relevant description (figure). A representative unit cell is modeled as a 20 degree of freedom system based on multi-body theory. It is composed of discrete force elements, such as translational and rotational springs. The system equations are the (static) projected Newton-Euler equations. There are 21 parameters to adjust the force laws of the whole model. These parameters can be related to the mechanical behavior of single elements at the micro-scale, representing stiffness values or limiting ranges of deformation.

An experimental study has been conducted subjecting the dry mesh to cyclic load cases of uniaxial stress and uniaxial strain respectively, in the two preferred material directions. Moreover, the kinematics of single unit cells have been observed with great magnification, providing local deformation patterns.

Single sets of parameters can be found simulating the global force and local kinematic response of all four experimental load cases in an appropriate way. Moreover, preconditioning effects, i.e. an alteration of the force response due to cyclic loading are adequately described based on an altered reference configuration. Preconditioning of the meshes is thus interpreted as a mainly geometry related phenomenon, caused by a load history dependent inelastic deformation of each unit cell. Analysis at different length scales allows to link macroscale phenomena of prosthetic meshes to mechanical contributions of single elements at the mesoscale. With respect to mesh design control, the mechanical properties of these elements have to be translated to material and structural properties at the microscale, such as filament material and diameter or knitting pattern.



Identification and abstraction of a unit cell from the mesh implant material

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