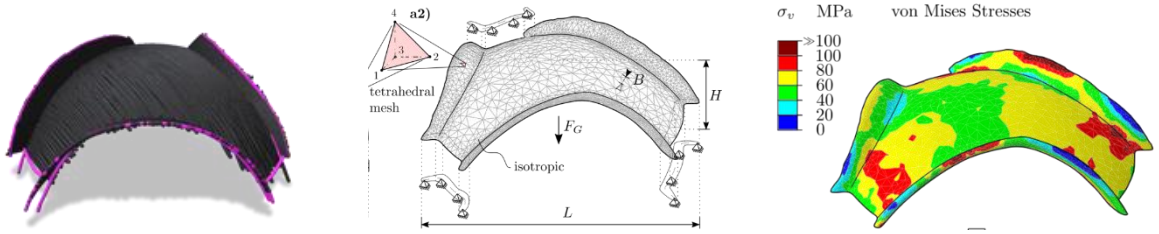
Technische Universität Wien
Institut für Mechanik der Werkstoffe und Strukturen

Master's Thesis

Developing of structural analysis module for material-informed architectural design

State-of-the-art workflows within Architecture, Engineering, and Construction industry are still caught in sequential planning processes. Advanced digital design tools allow for more interactive communication between different domains and offer rapid feedback regarding design implications. This work targets a novel **integrative design framework** based on a recently developed sketching module *MR.Sketch*, which allows for drawing—using a stylus and tablet—in 3D space. The sketching tool incorporates a *Geometric Modelling* module, which utilizes machine learning-aided mesh generation, a *Material Modelling* module which predicts the anisotropic mechanical properties of sustainable biocomposites, and a *Structural Analysis* module which assesses the mechanical performance of the meshed structure using finite element simulations. Virtual and augmented reality applications are currently developed in parallel to provide both visual and haptic feedback.

The **goal of the master's thesis** is to develop an efficient **finite element (FE) code** for linear elastic structural analysis and implement it in the digital design tool *MR.Sketch*. The existing **user interface** should be enriched to allow for assigning loads, bearings and materials in an intuitive way. Moreover, the work involves the implementation of an existing code for biocomposite homogenization, which provides input for the FE Code. The designer will then be able to analyze the structural performance of the design and adjust, if necessary, geometry or material to improve the overall quality of the structure, right from the very start of the design process.



(a) (b) (c)

Structural analysis of pavilion structure: (a) sketch based on 3D strokes drawn using stylus pen and tablet, (b) geometrically processed structure with tetrahedral mesh, loads, and boundary conditions, (c) stress results from structural analysis

Research project

This master's thesis is performed in the framework of a large research project entitled: **"***Advanced Computational Design***".** The project addresses the research question of how to advance design tools and processes through multi- and interdisciplinary basic research in the areas of digital architecture, integrated building design, computer graphics and virtual reality, discrete and applied geometry, and computational mechanics. For more information, please see https://acd.tuwien.ac.at/

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