Chair of Carbon Composites
TUM School of Engineering and Design
Technical University of Munich

Design and Application

Bundle the Research Fields and Bring Them to Application Using Virtual Methods

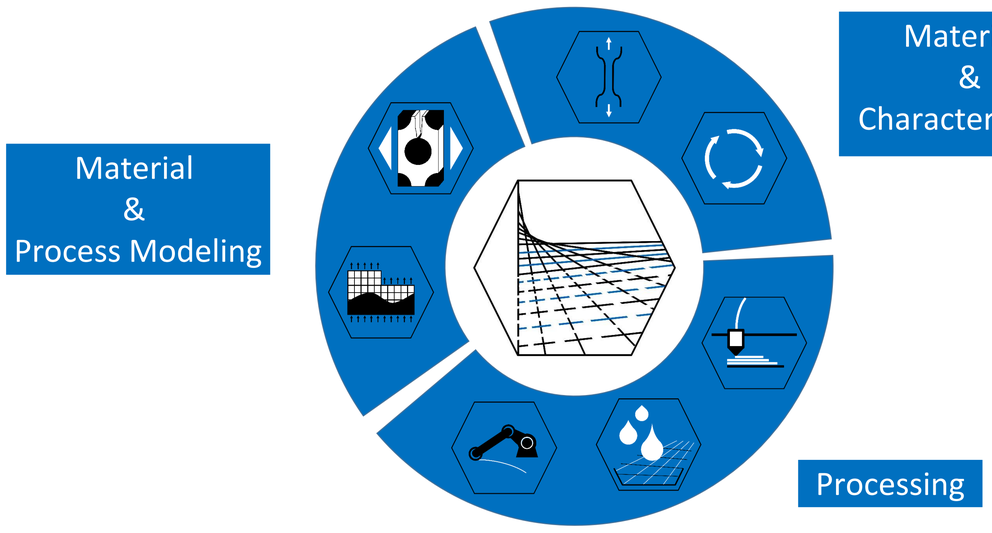

Fig. 1: Overview of the interdisciplinary design process

Design Studies

Part design starts with an idea and ends with the definition of physical parameters of a part. Along the composite part design path, multiple steps may be taken, from studies comparing part interfaces, material combinations and production processes to the development of the part geometry and fiber composite layup, to the simulation of physical properties (mechanical, thermal) of the part. Depending on the scope of a project, the different steps are regarded with varying levels of detail.

Material Modeling and Structural Analysis

The entire design process is accompanied by the application of analytical and virtual calculation methods. These range from implicit schemes for stiffness analysis to the use of non-linear explicit models for crash and impact design. In addition to a high prediction quality of the models, the focus is on runtime efficient and automated simulation processes, which is crucial for large-scale applications. Material and structure modeling is closely linked to the areas of material characterization and process development at the chair.

Optimization

The full exploitation of the advantageous properties of composite materials requires a material-specific design and layout instead of black metal design. Depending on the application and the type of composite material, different methods are used to optimize load paths, the topology or the laminate layup. This can be for example a metamodel based parameter optimization of a crash structure to reach a high energy absorption while keeping the maximum forces on the occupant low. Another example is the use of multibody dynamics simulation for deriving forces acting on a lower-limb exoskeleton frame structure followed by optimization of laminate layup and steering of the continuous fibers to reduce local stress concentration in the carbon frame.

Motivation

The development of high-quality composite parts requires a holistic approach where design, analysis and manufacturing are interconnected. A comprehensive use of virtual methods such as FEA and CAD is mandatory for that. The key points for successfully introducing composites into the application are:

- Production-oriented development / Design for manufacturing
- Efficient modeling of the structural behavior
- Optimization of target variables through the use of composites

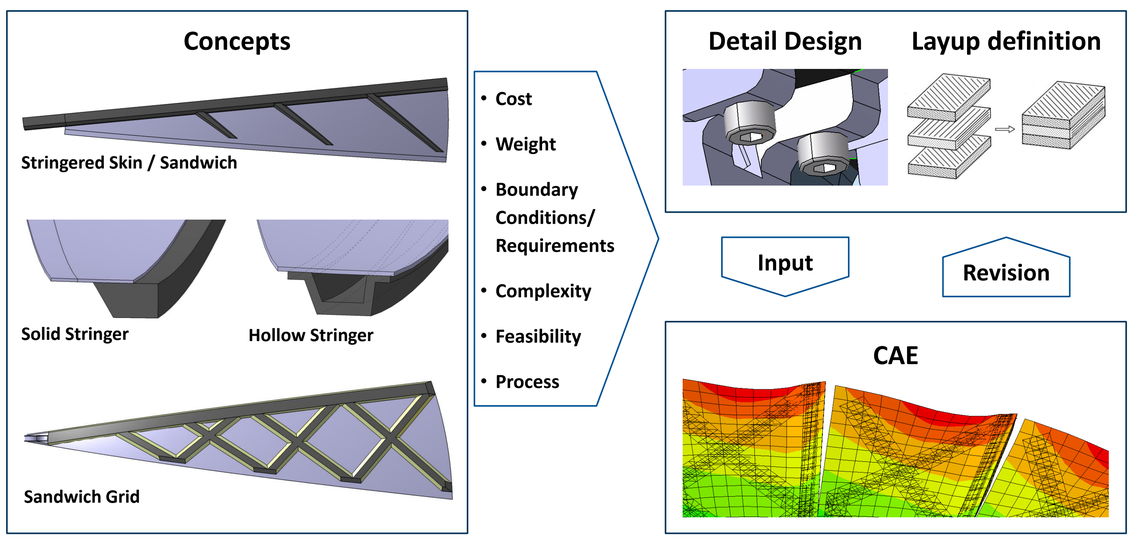

Fig. 2: From concept to design

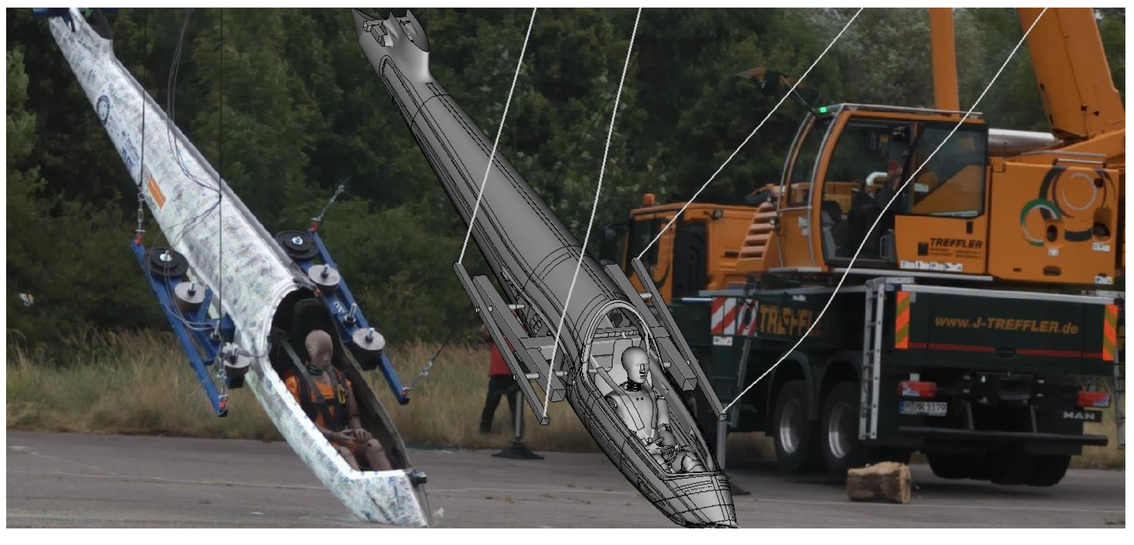

Fig. 3: Sailplane crash test and simulation [Thesis Hofmann 2022]

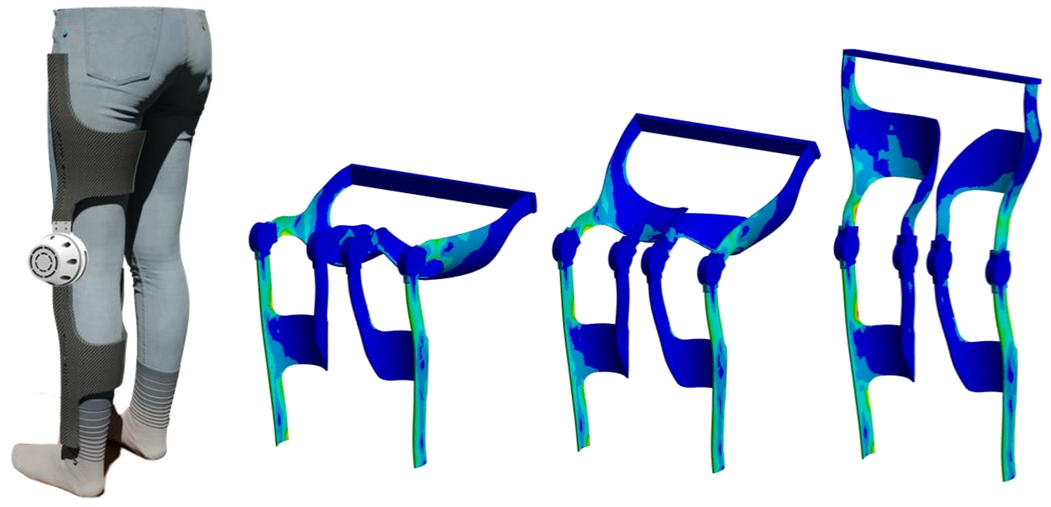

Fig. 4: Multibody dynamics simulation of an exoskeleton structure

More information and contacts: