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



## Tooling

## Innovation, quality and ecology for composites

## Motivation

The design of molding tools has a major influence on the quality, reproducibility and economy of the products manufactured with them. This results in numerous requirements and problems at

## Goals

Many development steps end in the tool or start from the resulting part, which involves many stakeholders. For this reason, a high value is put on the exchange of experience and **knowledge transfer** in the research. It maintains a **competence** network with other topics and industrial partners. The wealth of experience and the creativity potential of the participating disciplines result in more robust, cheaper and smart tools as well as **new tool concepts** for hybrid and additive processes.

the beginning of a tool development, which the user has to decide on. The research area helps to master this challenge efficiently in order to arrive at a solution optimized for the respective application. The research is oriented to the tool development cycle outlined below.

Material and process definition + part geometry	How can we influence the the the the the the the the the th	Account for anisotropic properties and take advantage of them during	Tool
Tool material	advantage?	path planning	Part Part 300K 45
Thermomechanical properties	How can we achieve an optimal tool surface?	technologies like milling, thermal smoothing	
Surface quality	How can the longevity of sharp edges in composite tooling be	Resistance to wear can be increased significantly by ensuring that fibers reach into the edges while using	
Resistance to wear	increased?	highly elastic resin	
Tool production method	How can tools be designed for robust CFRP processing under high pressures and temperatures?	Thermal expansion and conductivity, surface treatment and dimensional stability must be taken into account.	

Conventional machining	How can we achieve series maturity in 3D-printed (3DP) tooling?		Best practices for tool design, surface post-processing necessary, account for warping etc.
Additive manufacturing	How can part geometry in the presence of warpage be ensured without trial and error?		Perform process simulation in order to compensate for PIDs in the tool design
Tool geometry and cavity			acoign
Fluid guidance	How can undercuts be realized in high-pressure processes, if no retractable cores are possible?		Water-soluble, fiber-reinforced salt cores for high-pressure die casting made by wet compression molding
Cavities within the desired part	How can sealing be guaranteed while protecting tools from		Development of processes using polymer or silicone films as barrier
Sealing concepts	contamination?		Self-healing matrix for tool material t reduce leakage by aging in RTM
Tool peripheral devices	How do we achieve short cycle times for processing CFRP at up to 400 °C?		Design of heating & cooling capacity in alignment with thermal simulation
Handling of inserts and preforms	How can we compensate for the high thermal mass of 3DP tools?		Fluid channels in 3DP mold for temperature management







without cooling

with cooling

cesses using films as barrier for tool material to aging in RTM







