Project title:	DigiPEP – Digital Product developement process to design TFP-Preforms
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Mission Statement

Tailored textiles (TT), textile semi-finished products for the production of fibre-reinforced composites, offer potential for reducing component weight and material usage while simultaneously increasing component performance. They are thus a key to improved sustainability throughout the entire product life cycle of FRPs, as well as reduce costs during their manufacture. One textile manufacturing process for producing TT is tailored fibre placement (TFP). The process is a variant of technical embroidery, in which CNC-controlled variable-axis placement of reinforcing fibres produces semi-finished products with low waste. The reinforcing fibres can be aligned along the main stresses in the component in accordance with the stresses, thus avoiding oversizing (weight, costs, CO2 emissions). Despite the high level of technological maturity of TFP embroidery technology (Technology Readiness Level 9), TFP-optimized component design and embroidery pattern generation represent a hurdle for industrial application in small and medium-sized series. Due to the lack of comprehensive software solutions for the design of new products, a highly iterative and costly development process is currently not feasible for the efficient development of TFP components. The global optimum of TFP components with respect to the target parameters of cost, weight and performance cannot be efficiently achieved with today's classical development methods, since many iterations are necessary for an optimal component. In order to establish the method in SMEs, a holistic, digitally networked product development process (PDP) for TFP components is being developed and validated as part of the project.

Approach

The solution approach is based on the methodology of model-based systems engineering (MBSE). In this approach, the linked value chain is represented in the form of a system model, aggregated and composed of individual digital sub-models. The sub-models (Finite Elements

Analysis, load path determination, strength model, path planning and draping) are interlinked at the parameter level, generating complete digitization and continuity of data. To design the digital models of the individual process steps along the value chain, the relevant input and output parameters are first defined. Based on this, a model is developed for the structural-mechanical design, which enables an evaluation of concepts with regard to stiffness and strength. The investigation of production-related boundary conditions - in particular the deposition behaviour of different reinforcement fibre types - serves as input for the development of a model for automated, production-oriented web planning during embroidery pattern generation. In addition, the forming behaviour of TFP semi-finished products is mapped in a model. Thus, at the beginning of the product development process, a scientific pre-assessment for the profitability of the TFP technology can already be performed by the systematic approach. As a result, a digital and efficient PEP can be derived that maps all relevant process steps, from concept design to production-ready component design. The developed PEP is transferred into a separate user-friendly software solution with user interface (GUI) and validated on the basis of demonstrator components.

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