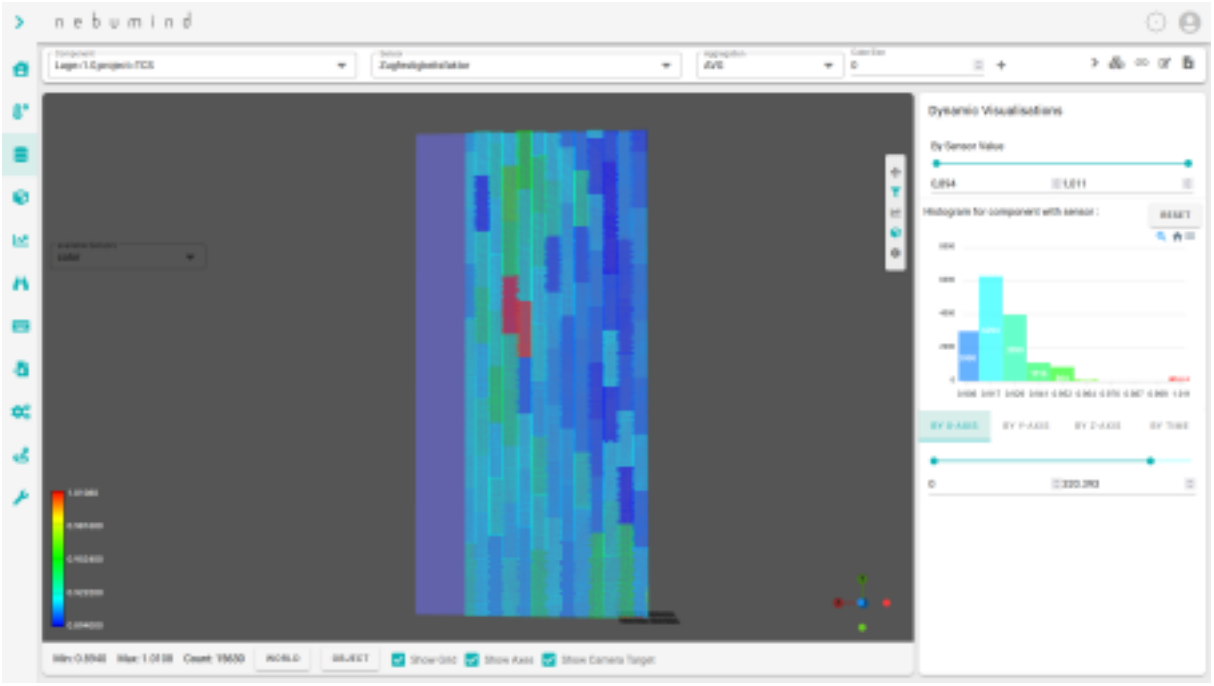
Optimising tape laying: Sensory testing ensures the quality of fibre composite plastics

About this project



TapeCheckSim

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Markets:

Material: Thermoplastics, Yarns, rovings, Others (UD tapes), Carbon-fiber reinforced plastics (CFRP)

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

Technology Transfer Program Leichtbau

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Context

Tape laying is a production technology for the automated manufacture of fibre-reinforced plastics. Robots lay continuous fibre tapes directly onto a mould or tool surface. Layer by layer, fibre-reinforced plastic components are produced in almost final form.

Thermoplastic prepreg tapes are pre-impregnated and therefore enable even material distribution and high strength. However, they often show deviations in width, thickness and fibre volume content. These material deviations lead to gaps, overlaps and folds in the composite, which reduce the strength and rigidity by up to 27%.

Existing inspection systems only recognise defects after they have been deposited, which results in long inspection cycles and costly reworking. The resulting material waste and inefficient troubleshooting also have a negative impact on the carbon footprint of production.

Purpose

In the TapeCheckSim research project, the team wants to actively rule out material-related defects before the tape laying process. The researchers measure the quality of the tapes directly on the reel and create a digital twin. This records precise surface roughness, geometric parameters and internal defects such as porosity, fibre breaks and fibre distribution.

A pre-build simulation model is used to predict how individual tape sections will behave in the component. The model uses artificial neural networks to calculate defect-related reduction factors and checks whether a defect leads to critical mechanical impairments. If the system recognises a critical influence, it automatically cuts out the affected section. In this way, the project team aims to avoid production downtimes, reduce rework and optimise the use of materials.

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Procedure

The researchers are integrating modern sensor technology into the production process. Optical cameras and laser sensors precisely measure the surface quality, width and thickness of the tapes. They are also developing eddy current sensors to determine fibre breaks and fibre distribution as well as to detect porosity, as thermoplastic tapes are more susceptible to internal defects. The recorded data flows into the digital web planning of the tape laying system. A simulative approach, supported by neural networks, links the quality data with the exact position in the component.

Before the laying process begins, the system simulates the mechanical behaviour and identifies critical sections. It then cuts these out in a targeted manner so that only qualitatively flawless tape sections are processed. This procedure ensures component quality and significantly shortens production times.

Funding duration:

Funding sign:	03LB5001	**Funding amount:**	EUR 1 million

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB5001A - TapeCheckSim in the federal funding catalogue

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Project coordination

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Lightweighting classification

	Realisation
Offer	
Products Machines and plants, Materials	✓
Services & consulting Engineering, Validation, Simulation	✓
Field of technology	
Design & layout Others	✓
Functional integration Sensor technology	✓
Measuring and testing technology Component and part analysis, Materials analysis, Non-destructive analysis	✓
Modelling and simulation Processes, Materials	✓
Plant construction & automation Plant construction	✓
Recycling technologies Material separation, Others (Conservation of resources)	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Pre-preg processing, Others (Automated tape laying)	✓
Forming	
Joining	
Material property alteration	
Primary forming	
Processing and separating	
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Carbon-fiber reinforced plastics (CFRP)	✓
Fibres	
Functional materials	
Metals	
Plastics Thermoplastics	✓
Structural ceramics	
(Technical) textiles Yarns, rovings, Others (UD tapes)	✓