3DWoodWind Research Prototype

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The 3DWoodWind Research Prototype demonstrates a new generation of additive technologies in wood construction: three-dimensional robotic winding processes for material-efficient hollow profile lightweight components. An AI-driven design logic enables the intelligent combination and design of the modular components into multi-story structures, which can serve as a substitute for concrete or steel systems in the future due to their high performance.

Background

The research structure 3DWoodWind is the winner of the departmental research project BBSR Research Prototype 2022 - realization competition for applied research in the interface from artificial intelligence and digital fabrication methods - from the innovation program Zukunft Bau. The 3DWoodWind team convinced the jury with its planning and development process as well as the innovative robotic winding process for material-efficient lightweight components made of veneer wood. With this research project, the scientific findings on new digital process structures in design, manufacturing and assembly will be made visible to the (trade) public in the pavilion structure that can be experienced in real life at the digitalBAU 2022 trade fair (Hall 5-2, Stand 117).

Interdisciplinary team

The design of the BBSR Research Prototype realization competition is based on a robot-based construction technique in the interaction of sustainability and supporting structure with machine learning methods. For this purpose, an association of three partners was formed, which ideally combines the competences on architecture and digital fabrication (Prof. Philipp Eversmann), machine learning as a design tool for sustainability (Prof. Dr.-Ing. Philipp Geyer), and structural design and ma-terial-efficient optimization (Prof. Dr.-Ing. Julian Lienhard).

Additive manufacturing in timber construction

Resource-efficient construction methods are increasingly in demand in the construction industry. The 3DWoodWind research project funded by Zukunft Bau is investigating additive application methods of continuous veneer wood strips to enable new types of lightweight construction. These three-di-mensional winding processes have a high innovation potential, as hollow components made of ve-neer wood with adapted structural properties can be developed. For this purpose, the natural fiber direction of the wood is exploited and structurally optimized, resulting not only in high-performance components, but also in extremely material-efficient and sustainable use of the currently increasingly scarce resource wood. Within the research project, questions regarding a suitable material system in relation to automated process technology, resulting surface quality, scalability and component preci-sion, possible component shapes, as well as general possibilities and limitations of this manufac-turing technology are investigated.

Machine learning as a sustainable design tool

To support resource-efficient construction, parametric digital modeling and AI are brought to bear in the 3DWoodWind project. These methods form an analysis and recommendation system that is available as an assistance in the design and enables the development of particularly efficient variants. For the analysis of performance, AI models for performance in terms of structure, energy, comfort and light are developed on the basis of simulation data, which can be integrated into design processes in real time. This is the basis for a recommendation system that makes suggestions in the design according to the selected boundary conditions with above-average performance based on multifactor optimization. The integration as a recommendation system makes the incorporation of optimization in the design and the corresponding exploitation of the efficiency potential possible.