Additive Manufacturing in Construction
2nd funding period: The Opportunity for Large Impact

AMC TRR277

A07 Wire Arc Additive Manufacturing (WAAM) of High Strength and Individualized Steel Components

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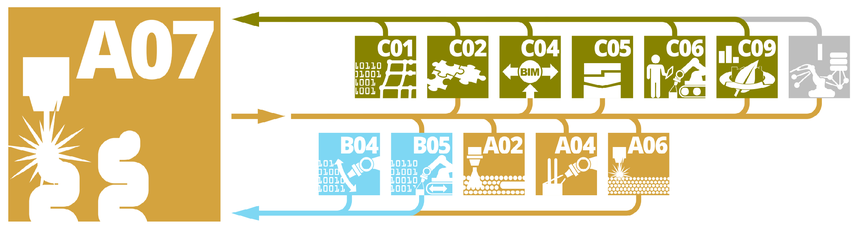
Project aims of 2nd funding period

- Investigations on WAAM, including large structures, on-site use, interaction of different materials, and applying manufacturing constraints using Holistic Design Framework (HDF).
- Learning-by-Printing: Improving the printing process through online decision making to address issues like geometric deviations, process irregularities, and heat accumulation during printing.
- Buckling behavior research: geometric imperfections, load-deformation, load-bearing cross sections, and ductility.
- Digital Twin with design, manufacturing, geometry, and performance data for virtual component testing.
- Investigation of the sustainability (Life Cycle Analysis) and improvement (Life Cycle Design) of the WAAM process.

Key collaborations in 2nd funding period



- C02: Implementation of manufacturing constraints in Holistic Design Framework
- B05: Exploration of on-site WAAM for local strengthening with mobile robots
- C04: Measuring routine for the location-related tracking of process data
- C09: Life Cycle Analysis and improvement of the environmental impact of the WAAM process

Work programme

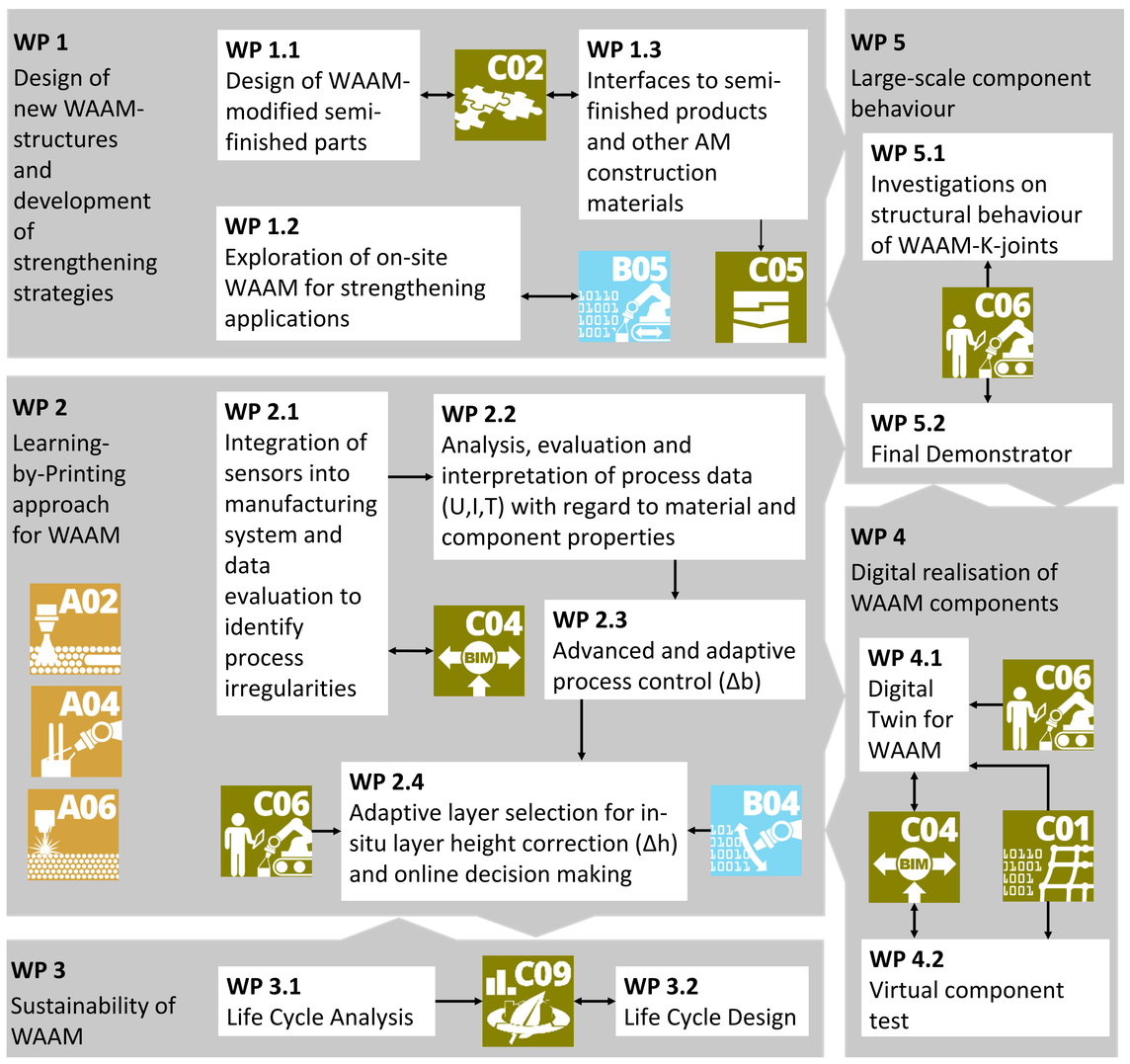


Fig 1: Interaction and work flow of work packages and collaboration with other projects

Methods

- HDF is adapted to incorporate manufacturing constraints and explore mobile robotic systems for strengthening parts.
- Interaction between WAAM and existing parts is studied by characterising the microstructure, residual stress states, and distortion.
- Learning-by-Printing: Correction of unforeseen deviations during WAAM and online decision making.
- Digital Twin used to evaluate the impact of process deviations on the mechanical properties.
- Simulations based on the Digital Twin data predict the behaviour of the component in a virtual component test.

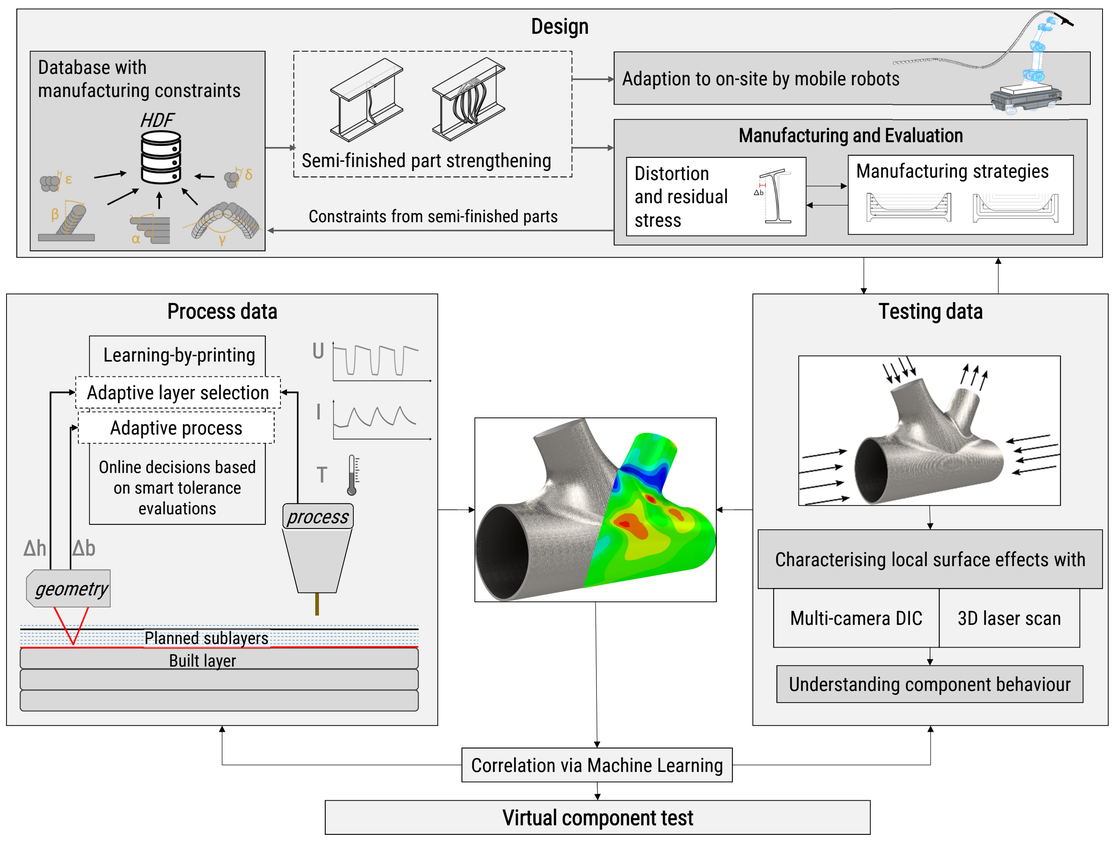


Fig 6: Work package flowchart

Methods

Learning-by-Printing

Fig 2: Y-Node sliced with horizontal planes

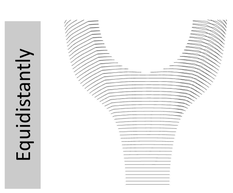


Fig 3: Y-Node sliced with equidistant layers

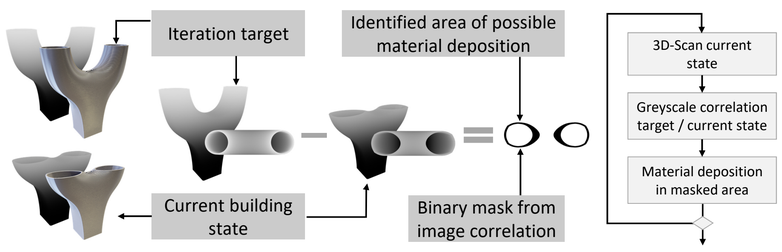


Fig 4: Adaptive path planning based on iterative greyscale correlation and identification of unfinished areas

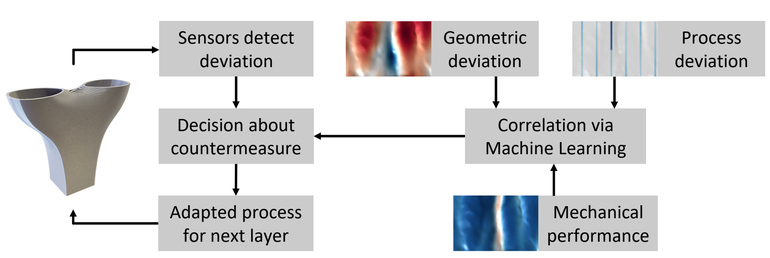


Fig 5: Adaptive deviation correction based on the correlation of process data and mechanical performance

Outlook 3rd funding period

In the 3rd funding period, the focus will be laid on large-scale component behaviour under cyclic loading. Additionally the potential of graded materials will be investigated.

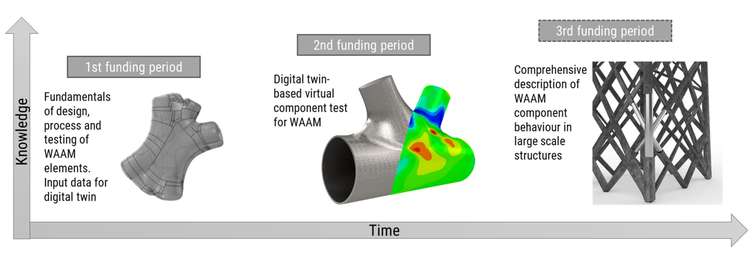


Fig 7: Fundamental research objectives for the 1st & 2nd funding period and perspectives for the further research programme in a 3rd funding period

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