

The Challenge of Large Scale Additive Manufacturing in Construction





Integration of Additive Manufacturing in the Construction Process

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The introduction of additive manufacturing in construction is expected to lead to fundamental changes along its entire value chain. While traditional construction processes are characterised by the fragmentation of construction knowledge, new digital tools allow the integration of all project participants already in early project phases. The prerequisite for this is a bi-directional flow of information into

a central building information model. The aim of this project is to investigate the bi-directional relationship between production and planning at the scale levels of component fabrication (using computer vision and machine learning for fabrication improvement), component assembly on-site (using mixed reality besides others) and on the industry scale (e.g. integrated project delivery).

Project Aims

- Multiple stakeholders **share and consolidate** their (fragmented) knowledge into a centralised BIM model
- Holistic process understanding allows **collecting data** before, during and after the fabrication and assembly process on site.
- Process Analysis and interpretation will form an Integrated construction delivery system
- Digital tools enable continuous and uninterrupted quality control throughout the entire construction process.
- Sensor feedback: Unforeseen issues during production and con-



struction that lead to deviations (as-built) from the design (asplanned) can be corrected instantly.

Exemplary Research Questions

- Which sensors and measurement methods are most suitable for capturing the current geometry and condition of an AM-component and comparing it to tolerances?
- What kinds of construction-related information and parameters must be tracked before, during and after the AM process until each component is completed?
- How does Mixed reality improve the on-site assembly of building components? Capabilities, challenges and limitations.
- How is it possible to trace the actual assembly information (location, time, process parameters) back to the BIM (update of digital twin)?
- What could a future value chain with an information flow and the early involvement of construction competence look like?

Logistics Logistics Production process redback-loop before production start (ex ante) Redback-loop after production start (ex post) All processes and their parameters are fully digitised and monitored. Real-time feedback-loops and data drops ensure matching of as-planned and as-built.

Permanent access to relevant information lead to profound decisions and enhanced quality.



Efficient process, maximum collaboration and minimum waste and enable sustainable projects.



Pre-studies

- A number of objects with varying specifications were printed using shotcrete 3D printing technology (SC3DP) at DBFL
- Laser scanning and vision based sensing were used to generate 3D representations (here: point clouds) of the objects



- Varying material curing states lead to different artefacts in the acquired data: need for investigations and new methods
- Need for fully automatic matching techniques
- First process analysis of shotcrete 3D printing



Process analysis of shotcrete printing on component scale.



3D designed model of the building component, TLS data acquisition and printed component colourised by C2C distance; Photogrammetric block around the fabricated component.



Typical defects form shotcrete printing and finishing process.

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