Additive Manufacturing in Construction
1st funding period: The Challenge of Large Scale

AMC TRR277

C04

Integrating Digital Design and Additive Manufacturing through BIM-Based Decision Support and Digital Twin Methods

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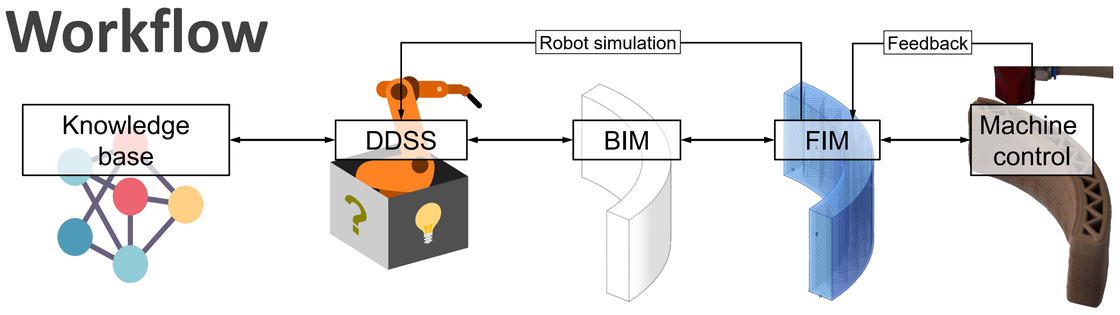
Project summary

C04 aims to (1) provide a **Design Decision Support System (DDSS)** guiding architects and engineers in choosing optimal Additive Manufacturing (AM) methods; (2) develop the **Fabrication Information Modeling (FIM)** methodology and data structures based on the Industry Foundation Classes (IFC) for generating AM information and representing digital twin data.

Workflow



Main outcomes of 1st funding period

Design Decision Support System (DDSS)
- Formalisation of AM knowledge using Semantic Web technologies
- Integration of formalised AM knowledge into BIM
- Prototype of DDSS with feedback for design adaptations

Fabrication Information Modeling (FIM) framework
- Data structures for managing fabrication information in a BIM context
- Direct interface to robot control enabling real-time data access
- Implementation of a streamlined simulation methodology
- Integration of feedback methods to capture digital twin data

Key collaborations in 1st funding period

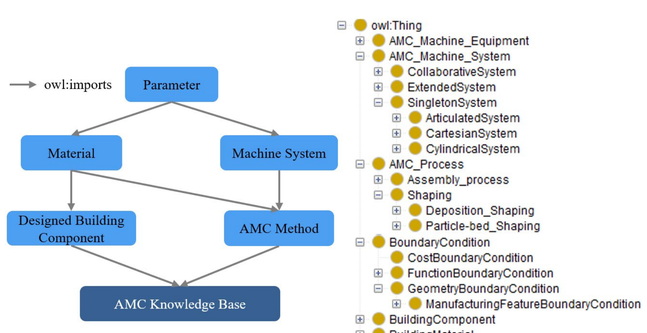
C01 — Close collaboration with **C01** regarding the integration of simulation tools into the FIM framework

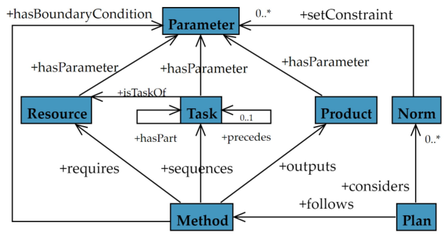
C06 — Close collaboration with **C06** regarding construction planning during early design stages and digital twin data capturing and fusion under the FIM framework

A03 — Close collaboration with **A03** for path planning and robot simulation of the demonstrator

Project status - DDSS

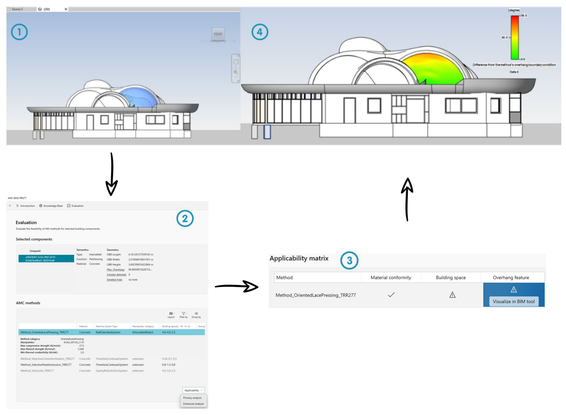
Knowledge base formalisation





Metrics

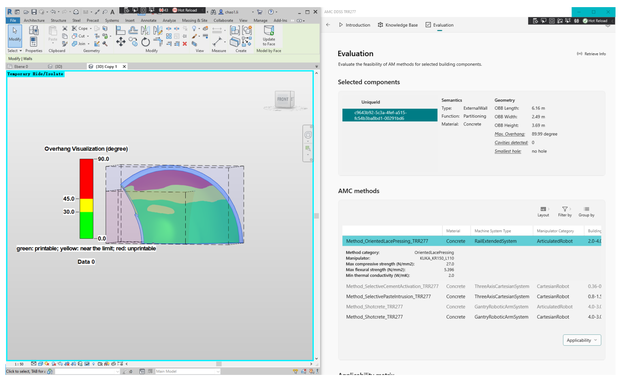
Axiom	2911
Logical axiom count	1797
Declaration axioms count	939
Class count	376
Object property count	126
Data property count	5
Individual count	419
Annotation Property count	19

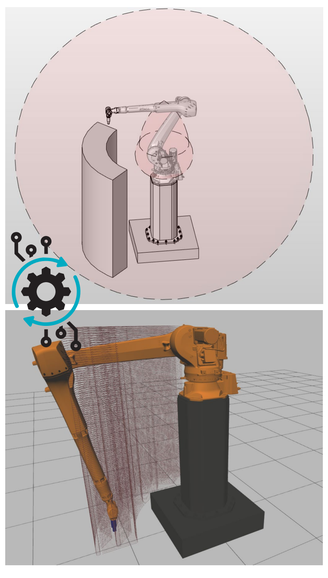


Integration of AM knowledge
Inference: driven by the knowledge base and built-in Description Logic-based reasoner

- Information retrieval
- Feature detection
- Browsing and evaluation
- Feedback for adaptation

Prototypical implementation of DDSS with robot simulation



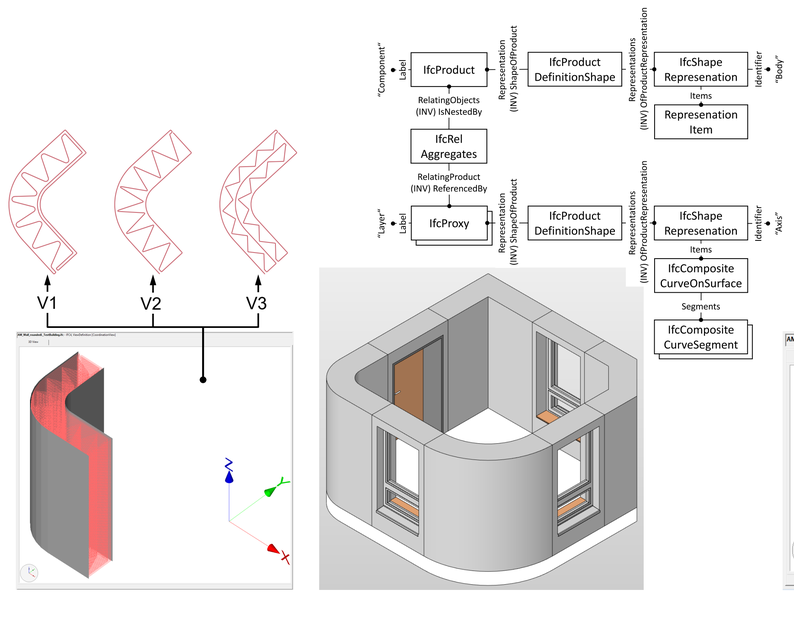


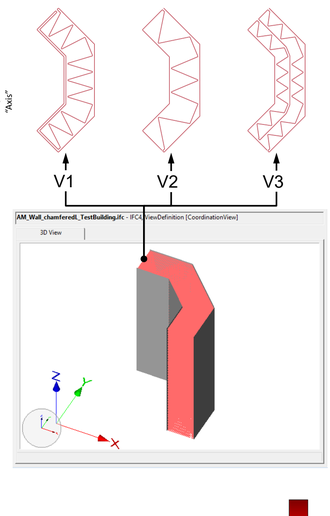
- Remote procedure call between DDSS and BIM modelling tool
- Robot simulation using the FIM model
- Closed feedback loop from design to fabrication

Project status – FIM and digital twin

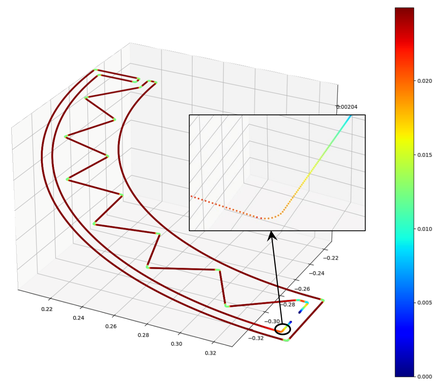
FIM framework and data structure

- Based on the BIM exchange format IFC
- Intermediate layer between digital design and fabrication
- Streamlined BIM to FIM process
- Data structures for data feedback (Digital Twin)



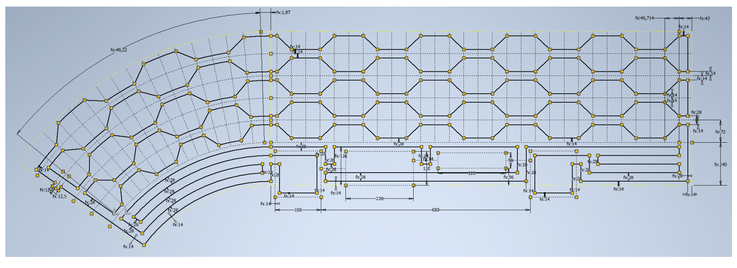


IFC-based trajectory generation
- IFC data can be utilized directly for robot control
- Enabling refined velocity profiles suitable for concrete 3D printing
- Allows modifications of the fabrication information during “print time”
- Enables capturing of Digital Twin data



Large scale demonstrator

- FIM design for the “Marriage of Materials” Demonstrator



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