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





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

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Project summary

CO4 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.



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

Project status - DDSS

Knowledge base formalisation



+hasBoundaryCondition	+setConstraint
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+hasParameter +hasParameter +	-hasParameter

Key collaborations in 1st funding period



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



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



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

Project status – FIM and digital twin

FIM framework and data structure

- Based on the BIM exchange format IFC
- Intermediate layer between
- Streamlined BIM to FIM process
- Data structures for data





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

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

Prototypical implementation of DDSS with robot simulation

Image: State of the state	Evaluation Evaluate the feasibility of AM methods for selected by	uilding co	nponents.				(o) Retrieve Info
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	Method_Shotcrete_TRR277	Concre	te Gantry	RoboticArmSystem	Articul	atedRobot	4.0-3.0
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	Method_Shotcrete_TRR277						
	Method_Shotcrete_TRR277					App	licability ~

digital design and fabrication

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"



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



• Enables capturing of Digital Twin data

Large scale demonstrator

 FIM design for the "Marriage of Materials" Demonstrator







