Info | 1375539 | Management in the Built Environment
Lab | Business Models for Robots in Construction
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TU Delft

Graduation presentation

The Barriers to 3D Construction Printing a Cementitious Outer Wall

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Outline

30 min. presentation

- What topic?
- The main idea
- What main research question?
- What did I contribute?
- Why did I?
- Important issues?
- Main conditions
- How did I conduct my research?
- Interview major findings
- Questionnaire results
- Conclusions
- Recommendations

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What topic?

The barriers to 3-d construction printing a cementitious outer wall in the reign of digital fabrication

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The main idea

There are potential new materials, there are barriers and I research the way how barriers can be discovered and potentially be overcome in the domain of digital fabrication, focusing on cementitious 3-d construction printing.

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What main research question?

"What are the barriers to 3-d construction printing a cementitious outer wall in the construction industry?".

Image credits: Author

What did I contribute?

Encourage the use of evolving technology in solving fundamental socio-economic and environmental issues within the built environment.

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Why did I?

Learn how to research a technology that could potentially contribute to the resolving of important issues.

- Undergraduate degree in Architecture
- Robotics (Digital Manufacturing)
- Desire to expand the feasibility and scalability of standardised forms of construction

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Important issues?

3 large problems:

- Climate change
- Depletion of natural Resources
- Socio-economic factor

Image credits: Freepick; author

Main conditions

- Contribute to the resolving of important issues
- Adoption
- Commercially viable and scalable

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How did I conduct my research?

- Literature review
- Questionnaire
- Interviews

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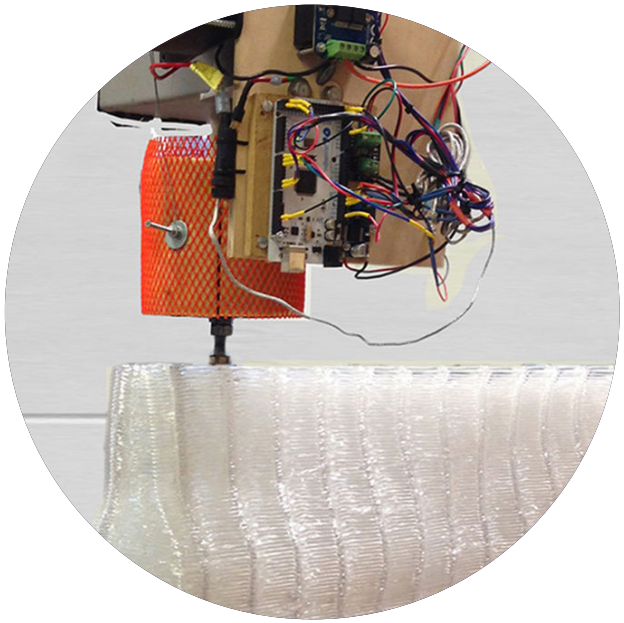
Interview major findings

• Scalability of Fungus Like Adhesive Material (FLAM)
• Innovative capacities of 3-d construction printing
• Business model shifts and first movers finding the ‘sweet spot’.
• Knowledge gap
• Lack of proper standardisation
• Innteruption risks
• Willingness to increase information
• Shifts in roles and value chain
• The scalability to 3-d construction printing and materials
• The chasm



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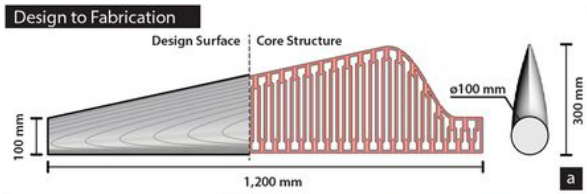
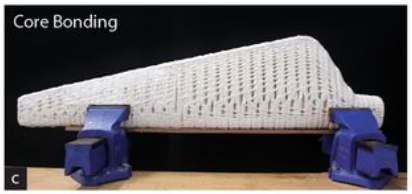
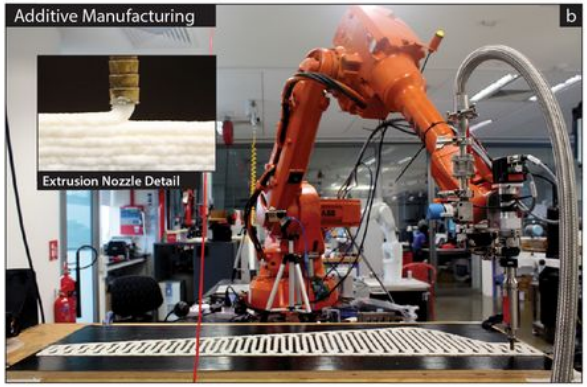
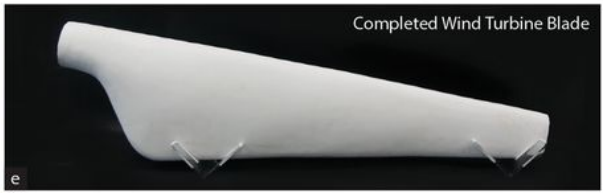
Fungus Like Adhesive Material (FLAM)









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Questionnaire results

• Extrapolation was needed (bootstrap); small research group and small respondents group (9)

• Most of the barriers are still existent

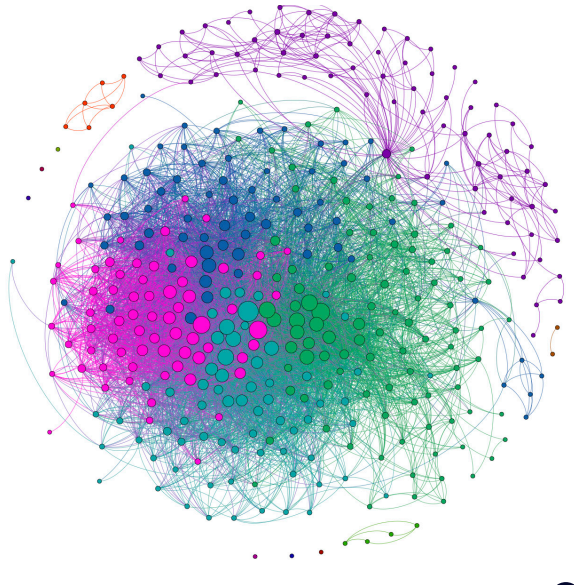
Image credits: ETH Zurich

Questionnaire results

Overarching barrier	Barriers		
Cost	High printer cost (B.S.)	High cost of printed structures	Need for expensive speciality materials
Market dynamics	Lack of commercial viability	Lack of customer support (B.S.)	Finding the right niche market
Limitations amongst partners or stakeholders	Architect / designer unreadiness	Immaturity of printing partners (B.S. Sort of correclation)	
Construction capacity	Inability to create larger structures		
On-site and off-site logistics	Difficulty of transporting printer		
3-d technology	Technology Interruption risk		
Law	Unclear regulatory implications		
Proof of concept	Insufficient successful examples		
Usability	Design practicality (is the wall itself, holistically practical)	Size of the 3-d printer	

Conclusions (1/6)

• **3-d printing** (in **combination** with the **integrated processes**) is an **innovative technology** with the capacity to transform the construction industry but only when the posed barriers can be overcome.



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Conclusions (2/6)

- The **barriers** that are slowing down the adoption of the technology **should be addressed for future success**.

- High printer costs, high costs of printed structures, lack of commercial viability among other factors are significant barriers towards the adoption of the technology.

Image credits: ETH Zurich

Conclusions (3/6)

• **Examples** given, where it **seems** already more
cost-effective or provide **other value propositions** which suggests there are already first movers

• **Statistical analysis;** most **barriers** are **still existent.**
• **interviews** showed there is **potential.**

• **Suggested; potential** can be **discovered** in the **combination** of the (3-d printing) **technologies**.

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Conclusions (4/6)

It is suggested that 3-d construction printing can become **scalable** if the proposed barriers and the undiscovered barriers in this thesis are overcome.

Undiscovered barriers can be found in:

- Social innovation
- Process innovation
- Technical innovation

Image credits: Apis Cor

Conclusions (5/6)

Lack of large groups of people who can commit themselves to push the technology forward.

- **Lack of financial incentive (risk to reward ratio)**
- **Innovators dilemma** of Christensen (1997) remains valid for the gross of the companies.

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Conclusions (6/6)

Only If these issues are overcome, then 3-d construction printing will assumedly contribute to the resolving of climate change, the depletion of natural resources and socio-economic factors (Moore, 2014).

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Recommendations (1/2)

- **Significant** and **non-significant barriers** that affect the adoption of 3-d printing in the construction industry should be **evaluated further** basing on findings of this study and a line of distinction created between the two for prioritization purposes.

- **Further research** should be conducted to provide **more insights and information** on how 3-d printing works and how it can be adopted in the construction industry with ease.

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Recommendations (2/2)

- **Stakeholders** in the construction industry should **collaborate** where possible to necessitate the success of adoption of 3-d printing technology in the sector.

- **Technological barriers** should be **addressed** to pave the way for effective adoption of 3-d printing in the construction sector.

- **More research** is needed to the **scalability** of **materials** and **3-d printing technologies** involved.

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Thank you for your attention

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