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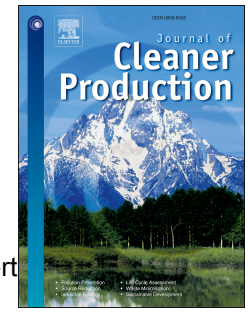


Potential benefits of digital fabrication for complex structures: Environmental assessment of a robotically fabricated concrete wall

Isolda Agustí-Juan, Florian Müller, Norman Hack, Timothy Wangler, Guillaume Habert

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# Potential benefits of digital fabrication for complex structures: Environmental assessment of a robotically fabricated concrete wall

Isolda Agustí-Juan [a]*, Florian Müller [a], Norman Hack [b], Timothy Wangler [c], Guillaume Habert [a]

[a] Chair of Sustainable Construction, IBI, ETH Zürich, Stefano-Franscini-Platz 5, 8093 Zürich, Switzerland.

[b] Chair of Architecture and Digital Fabrication, ITA, ETH Zürich, Stefano-Franscini-Platz 5, 8093 Zürich, Switzerland.

[c] Physical Chemistry of Building Materials group, IfB, ETH Zürich, Schafmattstrasse 6, 8093 Zürich, Switzerland.

* Corresponding author. E-mail address: agusti@ibi.baug.ethz.ch (Isolda Agustí-Juan).

**Abstract**

Digital fabrication represents innovative, computer-controlled processes and technologies with the potential to expand the boundaries of conventional construction. Their use in construction is currently restricted to complex and iconic structures, but the growth potential is large. This paper aims to investigate the environmental opportunities of digital fabrication methods, particularly when applied to complex concrete geometries. A case study of a novel robotic additive process that is applied to a wall structure is evaluated with the Life Cycle Assessment (LCA) method. The results of the assessment demonstrate that digital fabrication provides environmental benefits when applied to complex structures. The results also confirm that additional complexity is achieved through digital fabrication without additional environmental costs. This study provides a quantitative argument to position digital fabrication at the beginning of a new era, which is often called the Digital Age in many other disciplines.

**Keywords**

Digital fabrication, LCA, complexity, concrete, robotic construction, sustainability.

## 1 Introduction

The construction sector is responsible for significant environmental impacts, such as 40% of the energy consumption and greenhouse gas emissions worldwide (UNEP, 2012). But these extremely large impacts represent also opportunities for improvement, and buildings are seen by the main international agencies (UNEP, IPCC) as a key player for carbon mitigation actions (IPCC, 2014). This potential is foreseen as occurring through the implementation of new technologies, such as digital technologies (McKinsey&Company, 2016). Digital technologies are broadly used in the manufacturing industry and the direct production of elements from design information (e.g., 3D printing) has become an essential component of modern product development (Chen et al., 2015). However, digital fabrication in construction is still in its early stage, probably because the construction industry is a highly fragmented, risk-averse sector (Arora et al., 2014). Most construction firms are small, so few of them have the ability to exploit new technologies, which rely on specific knowledge. Learning is done on a project-to-project basis with professionals to develop perceptions and skills from their individual