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Preface to the special issue on Intelligent Construction and Automation

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DOI
10.1007/s44150-023-00093-w

Publication date
2023

Document Version
Final published version

Published in
Architecture, Structures and Construction

Citation (APA)
Figueiredo, B., Popescu, M., & Louter, C. (2023). Preface to the special issue on Intelligent Construction and Automation. *Architecture, Structures and Construction*, *3*(2), 143-144. https://doi.org/10.1007/s44150-023-00093-w

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Architecture, Structures and Construction (2023) 3:143–144
https://doi.org/10.1007/s44150-023-00093-w

EDITORIAL

Preface to the special issue on Intelligent Construction and Automation

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Published online: 31 May 2023
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We are delighted to present you the special issue on *Intelligent Construction and Automation* as part of the *Architecture, Structures and Construction* journal. This issue covers a diverse range of topics related to the design, conception, and realisation of architectural structures and components, showcasing some of the latest developments in the broad field of *Construction and Automation*. The 10 papers collected over the past year focus on additive manufacturing (AM), robotic fabrication and assembly, computational design, and large-scale printing technologies. Process automation and 3D printing have been used to explore material and functional behaviour, design paradigms for AM, fabrication processes, and lightweight composite systems. Although *Construction and Automation* goes beyond 3D printing, these publications clearly demonstrate that additive manufacturing techniques currently hold a prominent place in the field. Moreover, with Artificial Intelligence (AI) gaining interest in the AEC industry, we expect it to appear prominently in future special issues of the Architecture, Structures and Construction journal.

The first paper of this special issue focuses on the development of a mobile and on-site robotic plaster spraying process that enables the realisation of bespoke plasterwork. The additive process includes an adaptive spray-based printing technique by which thin layers of plasterwork are incrementally applied on a building structure to create an articulated plasterwork without the need for additional formwork. A projection-based augmented reality interface allows users to design the plasterwork interactively, taking the building structure, the as-built state of the ongoing fabrication and the material behaviour into account.

The second paper addresses the need for more sustainable construction materials and presents a systematic testing of natural fibres such as cellulose and lignin-based materials for the additive manufacturing of building components. By means of these material tests, the authors are able to infer optimal mixtures under different extrusion conditions. In addition, prototypes of a window frame and a structural node are presented as initial proof of the applicability of the findings in a real context.

The subsequent set of three contributions focus on the exploration of AM to enhance functional issues of building components. As such, the third paper of this issue deals with the enhancement of AM in viscous materials, such as clay, by presenting methodologies that foresee the use of sensing for real-time tuneable grading structures processes in accordance to functional goals. The system includes a depth sensor, a manipulator, and a controlled extruder that can transition between a precise and a locally uncontrolled deposition process. Complementary to this process, the fourth paper describes a method for designing and manufacturing 3D printed light screens using clay with plastic deformation to create porous geometries that mediate light. The apertures are defined by a graded structure that is achieved by customised printing path variations. The research demonstrates that material behaviour challenges can act as a creative basis for novel fabrication methods. The fifth paper discusses the design and performance of compact resonant absorber panels for low frequencies that take advantage of AM. The paper analyses the acoustic behaviour of a prototype wall, consisting of panels with embedded tubular shapes that were produced by Selective Laser Sintering (SLS) using Polyamide (PA12) as a material.

Then, a set of two contributions focus on the use of AM and robotic fabrication for the achievement of non-regular

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geometries, either by using temporary external supports or performing as formwork. As such, the sixth paper of this issue investigates a fabrication method of architectural structures on pneumatic formwork. The proposed PneuPrint technique allows for complex non-planar 3D printing without relying on costly support structures. It involves computational simulation, 3D scanning and the toolpath planning and robotic fabrication in order to significantly improve the printing quality. Five experiments are presented demonstrating a high potential for building freeform double curvature elements for architectural applications. The seventh paper describes a computational modelling framework for developing 3D polyhedral structures, which addresses some of the challenges of designing and fabricating such structures. The approach supports the exploration of design cases at different scales, favours pre-production modelling, and increases cost-efficiency. The combination of the modelling framework with Additive Formwork Manufacturing (AFM) enables the creation of complex, high-precision concrete structures that can be efficiently assembled, disassembled, and relocated. The detailed description and illustration of the production and assembly of a fully-functional physical prototype is presented.

Subsequently, the eighth paper presents a novel fabrication method for creating non-standard, materially-efficient, lightweight concrete elements using mineral foam 3D printing (F3DP). Two experimental case studies explore the potential weight savings (in concrete) of non-standard structures and offer a competitive alternative to standardised solutions like hollow core slabs.

The last two contributions of this special issue employ automation and digital fabrication for the realisation of lightweight components. As such, the ninth paper combines 3D-printed polymer cores with thin glass sheets bonded on both sides to create rigid yet lightweight composite facade components. The paper illustrates the process starting from the digital design and the parameters involved, to the digital fabrication of such thin glass composite panels. Additionally, the structural performance of a prototype panel is explored through a physical lab test and FE-analysis. The tenth paper employs aerogel concrete technology for the realisation of lightweight insulating wall panels by means of an automated production process. The panels consist of two nano-optimised Ultra High Performance Concrete (UHPC) face layers and a highly insulating, load-bearing lightweight concrete core. The study targets an automated production process that allows for individualised standardisation so that panel properties can be adapted to project-specific requirements. The process enables the production of material efficient panels and is complemented by further sustainable measures such as material recycling and optimised logistics through on-site (mobile) production.

We would like to thank the authors for their excellent contributions and the reviewers for their valuable feedback. Acknowledgements also go to the editors-in-chief, Paulo Jorge de Sousa Cruz and João Paulo Correia Rodrigues, for providing us the opportunity to compile this special issue.

Enjoy reading!

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