

Interwoven reinforced concrete structures: Integration of design and fabrication drivers through parametric design processes



Elif Erdine and Alexandros Kallegias, Architectural Association School of Architecture, 36 Bedford Square, London, WC1B 3ES, UK

This paper addresses techniques directed towards the integration of form, structure, and composite material systems through a series of computational tools acting in correlation with digital fabrication processes for the realization of one-to-one scale, reinforced concrete architectural prototypes, designed and produced during the Architectural Association Summer DLAB Visiting Schools 2014 and 2016. The case studies investigate concrete and its inherent fluid materiality through generative form-finding methods, Finite Element Analysis, and various digital fabrication processes including robotic fabrication protocols. The paper highlights the integration of parametric design techniques with basic and advanced techniques of construction, moving away from conventional hierarchies prescribed by design, analysis, and fabrication as a linear model towards a unified model of design and production.

© 2017 Elsevier Ltd. All rights reserved.

Keywords: design research, design tools, prototypes, science of design, simulation

Advancements in computational processes and digital fabrication techniques enable seamless workflows for architects in order to enhance decision making procedures throughout the entire design, fabrication, and assembly processes. In the 21st century, it is a well-known fact that architects and designers need to be equipped with the necessary knowledge and tool-building capacity towards the conceptualization and realization of innovative architectonic spaces and spatial experiences. One of the constituents of this process entails re-inventing the capacity and behaviour of material systems which have long been employed in construction. In this respect, concrete has proven to capture the attention of architects for many decades due to its fluid materiality, durability, and strength.

The research presented in this paper is part of an ongoing series of investigations on the design and fabrication techniques with a composite material system, reinforced concrete, by coupling custom-made parametric tools in conjunction with innovative modes of digital fabrication processes. The major aim of the research is the formulation of innovative strategies to design and construct three-dimensionally interwoven concrete structures. In this

Corresponding author:
Elif Erdine
elif.erdine@aaschool.ac.uk



www.elsevier.com/locate/destud
0142-694X *Design Studies* 52 (2017) 198–220
<http://dx.doi.org/10.1016/j.destud.2017.06.002>
© 2017 Elsevier Ltd. All rights reserved.

framework, research objectives focus on the evaluation and interpretation of traditional fabrication processes towards their advancement within the domain of advanced digital fabrication methods. The case studies described in the paper have been conducted during the Architectural Association (AA) Summer DLAB Visiting Schools in 2014 and 2016.

The research investigates methods of realizing computationally generated interwoven geometrical systems on a one-to-one scale with the employment of a composite material system, reinforced concrete. The design brief for both case studies entails the design and construction of a one-to-one scale pavilion made from concrete in a forest located in AA's Hooke Park premises in Dorset, United Kingdom, within a limited time frame, three weeks. The objectives of the research are two-fold. While the digital workflow is built upon the integration of various parametric design and analysis tools in order to embed real-world constraints into the conceptual design phase, the strong correlations between the digital paradigm and physical materiality during design and fabrication processes are investigated and analysed with a critical approach.

The theoretical framework of the research situates itself within biomimicry, whereby rules abstracted and extracted from natural systems serve to formulate guidelines for an integrated approach to design and fabrication. In nature, form, structure and material perform as an integrated system, whose behaviour cannot be predicted by the analysis of any one single system individually (Hensel, Menges, & Weinstock, 2010), since they are highly linked at every level of the biological system during self-organization. In this process, all of the lower-level systems and material organizations carry equal amount of vitality for the survival of the natural system. Nature does not favour specific materials, systems or functions over others; on the contrary, self-organization takes place by the co-evolution and co-adaptation of all the inter-related systems. The genetic code of the natural system bears information for the self-generation of its form in relation to the environment, pointing to the fact that the processes necessary for the material organizations to carry on distinct functions at once is inherent in the encoding of the natural system itself (Hensel et al., 2010).

The complexity that is observed in natural systems provides inspiration and methods for the integration of form, material, and structure in architecture through the rigorous implementation of innovative design and fabrication techniques. These methods can comprise mapping of careful correlations between the various parameters pertaining to the performance of each system, followed by the formulation of an integration synthesis in order to design and evaluate the performance of the global system. Biomimetic strategies that integrate form, material, and structure into a single process have implications not only on design methods and strategies, but also on the optimization

Download English Version:

<https://daneshyari.com/en/article/4914069>

Download Persian Version:

<https://daneshyari.com/article/4914069>

[Daneshyari.com](https://daneshyari.com)