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GUEST EDITORIAL

Design Computing and Cognition (DCC'14)

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Design is one of the most fundamental human activities that we perform. Understanding the process of design, and the development of computational tools to aid in that process, is therefore a highly significant area for research. This Special Issue on design computing and cognition focuses on research that combines artificial intelligence, cognitive science, and computational theories. It also explores topics ranging from the computational representation of shape and concept to overcoming human cognitive issues like design fixation and the recognition of wicked problems.

The papers in this Special Issue comprise a selection of research drawn from the Sixth International Conference on Design Computing and Cognition (DCC'14), held at University College London on June 23–25, 2014 (Gero & Hanna, 2015). A total of 131 full papers were submitted to the conference, from which 38 were accepted after a process of peer review. Conference attendees who had presented these at the conference itself were invited to submit substantially revised and expanded versions of their work, which were then submitted to a separate process of peer review for journal publication. Out of this group, the 6 papers in this issue were selected for their quality and for their representation of important themes.

The first article, by Ehud Kroll and Lauri Koskela, "Explicating Concepts in Reasoning From Function to Form by Two-Step Innovative Abductions," is perhaps the most firmly grounded in the classic domain of artificial intelligence, and discusses the important issue of how a function is transformed into a form. It presents the notion of the concept as an intermediate stage between a function, as would be specified in a design brief, and the final form that is the product. Their method makes the concept explicit symbolically, both to follow a process of design to manage or educate designers and to build a logical, computational model of design.

In the second article, "A Graph-Theoretic Implementation of the Rabo-De-Bacalhau Transformation Grammar," Tiemen Strobbe, Sara Eloy, Pieter Pauwels, Ruben Verstraeten, Ronald De Meyer, and Jan Van Campenhout present a computational implementation of a shape grammar based on a graph representation. Shape grammars have always appeared to suggest a computational process, but some of their most important features, such as the detection and manipulation of emergent shapes, have most often proved to be particularly difficult to implement. The use of a graph as an intermediate representation between the designer's image and the machine's symbols is shown here to be a potential solution. In showing how an existing grammar can be effectively encoded, the authors also argue that this can increase the designer's knowledge of the grammar itself.

Biological models offer constant and rich sources of ideas for designers, and much has been made of the value of the innovative qualities of biologically inspired design. The typical understanding is of analogy: a good concept found in nature can be used, or copied, in a designed piece, as the common term *biomimesis* suggests. However, where this suggests a straightforward one-to-one mapping, Camila Freitas Salqueiredo and Armand Hatchuel present the process of biological inspiration as a generator of multiple new concepts that expand the knowledge base itself. This third article, "Beyond Analogy: A Model of Bioinspiration for Creative Design," uses concepts and knowledge theory to trace the design process involved in two cases where biological examples yielded novel engineering solutions. This suggests a picture of the design process that does not simply transfer knowledge from one domain to another, but is rather more intricate and valuable.

The tendency for designers to become fixated is an important aspect of the creative process, currently seen as highly relevant for research. Thought to be productive on some occasions, it is more commonly seen as a barrier to innovation. Two separate articles address this issue from different directions, but yield conclusions that appear to agree. In "A Study on the Effects of Example Familiarity and Modality on Design Fixation," Vimal Viswanathan, Megan Tomko, and Julie Linsey look at the potential causes of fixation, in terms of how ideas are represented and whether familiar ideas encourage greater fixation than unfamiliar ones. In the work presented, they observed participants undertaking a controlled design task, in which initial examples were given as either conceptual sketches or working prototypes, containing both familiar and unfamiliar ideas. This revealed that designers appear to fixate on familiar features, and

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suggest a crucial property of prototypes over sketches: they are more likely not only to cause fixation but also to provide a means by which designers overcome it.

In the fifth article, "Overcoming Design Fixation: Design by Analogy Studies and Nonintuitive Findings," Diana Moreno Grandas, Luciënne Blessing, Maria Yang, Alberto Hernandez Luna, and Kerstin Wood investigate methods for how fixation may be overcome. Here, they focus specifically on the formation of design analogies, by testing two methods for creating them, and propose a fixation metric by which their effectiveness can be measured. The surprising findings suggest that the method that was less effective at overcoming fixation was more effective in generating novel ideas. The counterintuitive results of this and the previous paper both point toward a notion of fixation that is not simply opposed to innovation, but an independent and more complex phenomenon.

The final article, "Untangling Wicked Problems," tackles the broad and crucial question of what makes some design so difficult. Raymond McCall and Janet Burge revisit Rittel and Webber's 40-year-old theory of wicked problems, examining the claims and arguments made for each of their 10 descriptions of a "wicked problem" in turn. Considering the original in the light of more recent theory and practice, they come to some different conclusions. Where Rittel suggested each design problem be treated in isolation, McCall and Burge allow learning from previous projects. They emphasize the ongoing iterative process of trial and error, accepting the importance of precedent in actual design practice. In the end, they propose a picture of design that may serve to improve the computational tools for designers, by integrating rationale management into tools that designers actually use.

REFERENCE

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