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GUEST EDITORIAL

Design Computing and Cognition (DCC'10)

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This Special Issue of *AI EDAM* presents selected revised and updated papers presented at the Fourth International Conference on Design Computing and Cognition (DCC'10), which was held July 12–14, 2010, at the University of Stuttgart in Stuttgart, Germany. The main conference was preceded by eight workshops from July 10 to 11, 2010, which focused on the following topics:

- Assessing the Impact of Complexity Science in Design
- Design Communication
- Understanding Functions
- Computational Design Synthesis: Knowledge Representation
- Conceptual Computational Design Tools: Bridging the Gap Between Abstract Requirements and Concrete Implementation Strategies
- Design Creativity
- Shape Grammar Implementation: From Theory to Useable Software
- Research Methods for Design Cognition

The DCC'10 workshops and the DCC'10 conference were hosted by the Institute for Statics and Dynamics of Aerospace Structures (ISD) of the University of Stuttgart. The team of local organizers, the "Similarity Mechanics Group" headed by Dr. Stephan Rudolph of ISD, made every effort to make around 120 participants "feel good" during the event. A welcome reception, the conference dinner, and a visit to the famous "Stuttgart TV-Tower" were the evening highlights put in place to enable and enhance the social interaction and scientific networking of the participants during the conference.

The conference proceedings were published by Springer (Gero, 2010) as a book. According to a longstanding tradition, a call for papers was open to all accepted papers of the conference for this Special Issue of *AI EDAM*. Out of the 38 papers accepted for the proceedings of the conference, a total 16 papers were submitted. The review process was coordinated by the three guest editors, and each paper was reviewed by at least three reviewers. Finally, 6 papers were selected for publication.

In their paper, "Variations in Functional Decomposition for an Existing Product: Experimental Results," Claudia Eckert, Anne Ruckpaul, Thomas Alink, and Albert Albers present the results of an experimental study of a set of 20 design engineers analyzing their process and understanding of the function and functional breakdown of a given hydraulic pump. Starting with a discussion of the notion of "function" in design, the paper provides empirical evidence for the relevance of the ongoing debate on the nature of functions, which arrears to be crucial for the purpose of design analysis.

Reinhard Koenig and Sven Schneider describe methods for the automated generation of two-dimensional layouts, as seen in architectural floor plans, in their paper "Hierarchical Structuring of Layout Problems in an Interactive Evolutionary Layout System." This is an inspiring paper that conveys the really difficult issues associated with automatic generation and illustrates it well with convergence diagrams and some puzzling initial layouts. They base their algorithms on the work of Lawson "How designers think." We think we would all like to know and interpret this!

It is always nice to have some concrete output from a workshop, which is what we have here. Alison McKay, Scott Chase, Kristina Shea, and Hau Hing Chau, a truly international team, present in their paper "Spatial Grammar Implementation: From Theory to Useable Software" a review of seven systems of the recent shape and spatial grammar implementations. The critical thing here is that they focus on spatial not shape grammars. They begin by describing the needs of conceptual design and the desired characteristics of spatial grammar implementations, provide a short characterization of the history of past implementations, and plunge into the descriptions of the seven systems. They are then able to distill five key recommendations for future research areas and developments.

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"Concept generation and synthesis is perhaps the most exciting, important, and challenging step of engineering design" is the opening sentence of the conclusions of "A Computational Approach to Biologically Inspired Design," by Jacquelyn Nagel and Robert Stone. It is hard not to agree, and in this paper the authors describe their approach and computational framework for systematic development of biologically inspired designs. The framework incorporates the functional basis tool for functional modeling and utilizing their engineering to biology thesaurus, the MEMIC concept generation software, their Design Repository, and their organized search tool. The list of decompositions and interpretations that are the bedrock of this approach are well described and usefully listed in detail in the paper. The authors use this framework to "create, filter, and inspire concept variants." They illustrate their approach and framework with a smart flooring example.

Carl Schultz and Mehul Bhatt present "Multimodal Spatial Data Access for Architecture Design Assistance," a framework for a design assistance system intended for spatial decision support and analysis in architectural design. This paper links in well with the work of Koenig and Schneider and gets across the complexity of the issues of supporting spatial layout generation and understanding. They describe their spatial analysis capabilities for representing and reasoning about hierarchical spatial models, visibility, route, sequence, and illumination graphs. They have as their underlying philosophy design support and assistance for decision making. They illustrate their approach with an analysis of a museum floor plan and building model. The paper brings basic architectural analysis into the environment of the industry foundation classes and building information model.

It is always reassuring when authors state that they are "applying a proven coding scheme to formulate a theoretical comparative base that used the qualitative findings gained from previous research as hypotheses to test." Thus, in "Re-examining the Relationship Between Design Performance and the Design Process Using Reflection in Action," H.H. Tang, Y.Y. Lee, and W.Z. Chen present their results of an experimental study of 10 design teams engaged in a design competition, with two-person design teams working on a 1-h design task. The design activities were recorded, encoded, and subsequently analyzed. The paper includes considerable detail of the data that were collected and how they were analyzed; you have a feeling that people reading this paper could get close to replicating it.

REFERENCE

Gero, J.S. (Ed.). (2010). *Proc. 4th International Conference on Design Computing and Cognition*. Berlin: Springer.

Stephan Rudolph is the Head of the Similarity Mechanics Group in ISD at the University of Stuttgart, Germany. His research interests include engineering design methodology, design and manufacturing automation, the digital factory, graph-based design languages, and design evaluation methods, as well as applications of similarity methods in engineering and artificial intelligence. Within the research for a universal engineering design language, his main focus lies on the automatic design synthesis and manufacturing issues for complex products such as satellites, space stations, airplanes, and cars, as well as on dimensionless similarity analysis methods for a consistent and objective design evaluation.

Jeff Heisserman is an Associate Technical Fellow in Boeing Information Technology, Flight Systems. He joined Boeing in 1991, conducting research on formal design methods. He was the architect and principal investigator of Boeing's Genesis/KIRTS system for aircraft systems design and developed the high speed, parallel interference analysis capability within Boeing's FlyThru® CAD visualization system. From 2000 to 2003, he led the 3D Applications Group at Terabeam, developing tools for designing, analyzing, and visualizing free space optical networks in the context of vast three-dimensional city models. He holds degrees in architecture and computer science from the University of Washington, Seattle, and a PhD in architecture/computer-aided design from Carnegie Mellon University. He is currently developing interactive and automated tools for conceptual and preliminary aircraft design, analysis, and optimization.

Steve Culley is a Professor and Head of Design in the Department of Mechanical Engineering at Bath University. He has researched in the engineering design field for many years. In particular, this has included the provision of information and knowledge to support engineering designers. He pioneered work into the introduction and use of the electronic catalogue for standard engineering components and has extended this work to deal with systems and assemblies. He is a member of the EPSRC funded Innovative Manufacturing Research Centre (IMRC) at Bath University, where he leads the Design Information and Knowledge (DIAK) theme. He is a Fellow of the Institution of Mechanical Engineers.