

## **Design Computing and Cognition: An Introduction**

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The Third International Conference on Design Computing and Cognition was held at Georgia Institute of Technology in Atlanta, USA, on June 23-25, 2008. The main conference was preceded by seven workshops, including the Second Design Creativity Workshop organized by the Design Society's Special Interest Group on Design Creativity, and a Doctoral Student Symposium sponsored by the US National Science Foundation. The conference proceedings were published by Springer (Gero & Goel 2008). This special issue of the *International Journal of Artificial Intelligence for Engineering Design, Analysis and Manufacturing* is based on papers presented at the conference and related workshops and symposia.

As Gero & Goel write in the preface to the *Proceedings of the Third International Conference on Design Computing and Cognition*:

“There are now three sources for design research: design computing, design cognition and human-centered information technology. The foundation for much of design computing remains artificial intelligence with its focus on ways of representation and on processes that support simulation and generation. Artificial

intelligence continues to provide an environmentally rich paradigm within which design research based on computational constructions can be carried out. Design cognition is founded on concepts from cognitive science, an even newer area than artificial intelligence. It provides tools and methods to study human designers in both laboratory and practice settings. It is beginning to allow us to test the claims being made about the effects of the introduction of novel technologies into the design processes in addition to helping us understand the act of designing itself. Human-centered information technology, the newest of the three areas, is concerned with the use of information technologies in communities of practice.”

All three of the above perspectives are represented in the six papers in this special issue.

The first paper, “Integration of Knowledge-Based and Generative Systems for Building Characterization and Prediction,” by Ajla Aksamija, Kui Yue, Hyunjoo Kim, Francois Grobler & Ramesh Krishnamurti, describes a novel integration of generative design based on shape grammars and knowledge-based methods for making complex inferences. It uses shape grammars to generate the spatial layouts of buildings and knowledge-based methods for controlling the application of shape grammar rules according to building requirements. It also presents an initial case study of applying this technique to the design of a spatial layout of a building.

In “From Handicraft Prototypes to Limited Serial Productions: Exploiting Knowledge Artifacts to Support the Industrial Design of High Quality Products,” Stefania Bandini & Fabio Sartori review research on engineering ontologies and describe a detailed application of

ontology in manufacturing. Their work may also have pedagogical value and could be useful in design education.

Yan Jin & Mathieu Geslin address the issue of arguments in computer-supported collaborative design in “A Study of Argumentation Based Negotiation in Collaborative Design.” They describe an empirical study of student designers engaged in a machine layout problem, both with and without a computational tool for supporting formal negotiations. The results indicate that computer-supported argumentation and explanation may lead to deeper exploration of the design problem space.

The fourth paper “Automating the Conceptual Design Process: “From Black-box to Component Selection,” by Tolga Kurtoglu, Albert Swantner & Matthew I. Campbell, suggests that it may be possible to automate much of the process of conceptual design. They describe a case study in which multiple computational tools together automate the conceptual design of electromechanical devices.

Somwrita Sarkar, Andy Dong & John S Gero present a novel method for automatic acquisition of specific kinds of semantic knowledge from the syntax of specific design representations in “Learning Symbolic Formulations in Design: Syntax, Semantics, Knowledge Reification.” Their method uses the numerical technique of Single Value Decomposition and potentially results in the reformulation of the design problem.

Finally, in “Evaluation of the Functional Basis using an Information Theoretic Approach,” Chiradeep Sen, Benjamin W. Caldwell, Joshua D. Summers & Gregory M.

Mocko address the issue of measuring the information content of functional models of mechanical designs. They describe a formal functional representation and a rigorous method for evaluating the information content in the formal representation.

These six papers were selected for this special issue after two rounds of review. In the first round, all submitted papers were peer-reviewed by multiple reviewers; in the second the guest editors briefly reviewed the revised manuscripts. We thank the authors of all sixteen submissions to this special issue for their contributions. We also thank the nearly fifty reviewers for their hard work. We thank Prof. David Brown, the Editor-in-Chief of this journal, and Prof. John Gero, the General Chair of The Third International Conference on Design Computing and Cognition, for their encouragement and support throughout this process. We believe that this special issue suggests a bright future for research, development, integration and application in design computing and cognition.

**References:**

John S. Gero & Ashok K. Goel. (editors) Proceedings of the Third International Conference on Design Computing and Cognition, Atlanta, June 23-25, 2008. Berlin: Springer.

**Bios:**

Ashok K. Goel is an Associate Professor of Computer Science and Cognitive Science at Georgia Institute of Technology, Director of the Design & Intelligence Laboratory in Georgia Tech's College of Computing, and a Co-Director of Georgia Tech's Center for Biologically Inspired Design. He is an Associate Editor of IEEE Intelligent Systems and

of ASME Transactions: Journal of Computing and Information Science in Engineering. Dr. Goel conducts research at the intersection of intelligence and design: he uses techniques from computer science, artificial intelligence, cognitive science to address problems in design, and design problems as sources for developing computational techniques for analogical reasoning, visual reasoning and meta-reasoning. His current research on design focuses on creativity, cognition and computing in biologically inspired design.

Ellen Yi-Luen Do is an associate professor of design computing and design cognition at Georgia Institute of Technology, with joint appointments in the College of Architecture and the School of Interactive Computing in the College of Computing, also an affiliate faculty member at the Health Systems Institute, GVU Center and the Center for Music Technology. She is interested in building better tools for people, from understanding the human intelligence involved in the design process and leading to the improvement of the interface with computers and the build environment. Her research explores new interaction modalities as well as the physical and virtual worlds that push the current boundaries of computing environments for design and happy healthy living. She now works on making things that think, spaces that sense, and places that play.