Guest Editorial

Engineering Design Informatics

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Engineering design informatics is the creation, development and application of advanced computing, information and communication technologies in design, and has long been a topic of central importance in design practice and research. It has for many years involved techniques for the modelling of the designed artefact and evaluation of its through-life performance, for exploration of the design space, for the capture, organisation and delivery of information and knowledge relating to the artefact [does AIEDAM use UK spelling?] and the design process, and for support of the designer and design team including in the generation of new and improved design solutions. In recent years a strong emphasis has emerged on techniques to handle large sets of data and information-rich digital objects. In this special issue devoted to engineering design informatics, insights are presented into its theoretical and methodological basis and application from leading research teams around the globe.

Engineering design informatics impacts the consideration of all stages of the artefact life cycle, from requirements planning and formulation through concept generation, embodiment and detail design, manufacture and use to end of life. Recent developments in the subject in these contexts have drawn extensively on developments in formal representations, as may be seen in the first two papers in this special issue, presenting "An Ontological Approach to Engineering Requirement Representation and Analysis" and "A Formal Functional Representation Methodology for Conceptual Design of Material Flows-Processing Devices". The first paper, by Mukhopadhyay and Ameeri, presents and evaluates a formal ontology for standard representation of engineering requirements, using explicit semantics to make the ontology amenable to automated reasoning. It demonstrates services for analysis and evaluation in design based on the ontology. The second paper, by Chen, Zhou, Liu and Xie, again uses an ontology-based approach, this time for representing desired material flow-processing functions in a formal and unambiguous manner in order to support a simulation-based retrieval approach to enable search for suitable solution principles for desired material flow-processing functions. In contrast, "Automatic Derivation of Design Schemata and Subsequent Generation of Designs" by Reed and Gillies, describes an approach that explores a design space by building a schema as a list of rules that describe an area of the design space that will produce a design (a chair) with a particular property. The approach uses properties such as comfort and stability to define the spaces and, through a combination of multiple schemata and using decision trees to learn the schemata use machine learning to deal with discontinuous design spaces. The fourth paper, "Product Lifecycle Management Approach for Integration of Engineering Design and Lifecycle Engineering" by Penciuc, Le Duigou, Daaboul, Vallet and Eynard, is also concerned with approaches that can be used in the early phases of product design, but in this case to provides a method for decision-support by integrating through-life sustainability assessment into product lifecycle management. The paper demonstrates how an informatics approach can pull together the viewpoints of multiple disciplines in the re-engineering of a traditional process.

The topics of decision support and ontologies come together in the next paper, "Ontology-Based Executable Design Decision Template Representation and Reuse" by Ming, Yan, Wang, Panchal, Goh, Allen and Mistree, which presents an ontology-based tool to support the designer in decision-making. The authors emphasise in their paper the distinction between a decision-support construct in their ontology providing an analytical tool or approach in which decisions are mathematically formulated and rationally made and an information perspective through templates in a frame -based ontology. Together these facilitate reuse, consistency-maintaining and rapid execution in multi -objective design decision making. Design decisions are also an important element in design rationale – capture of the options considered in a design process and of the reasoning behind the choices that are made. Once captured, design rationale can be an effective basis for the reuse of design knowledge. The next paper, **"**Enhanced SPARQL Based Design Rationale Retrieval", by Li, Qin, Gao and Liu presents a retrieval approach for design rationale, again drawing heavily on ontological techniques in its ontology-based semantic model of design rationale using an extended IBIS-based design rationale representation. SPARQL query generation methods are used to query a database of ontology-based design rationale from natural language and design rationale record based queries.

As noted, techniques to handle sets of data and information-rich digital objects have emerged strongly in recent years, and the final three papers in the issue illustrate well the potential of such techniques to assist the designer or to give insights useful for design. "Automatic Generation of Design Structure Matrices through the Evolution of Product Models" by Gopsill, Snider, McMahon and Hicks, explores how an automated and continuously evolving Design Structure Matrix (DSM) representation of component and data interactions and dependencies (together with other indicators of product architecture dependency) can be generated by monitoring the changes in the digital models (such as computer-aided design or finite element models) that represent the product. The next paper, **"**Discourse Analysis Based Segregation of Relevant Document Segments for Knowledge Acquisition", by Madhusudanan and Gurumoorthy, shows how segments of the text of documents relevant to aircraft assembly can be automatically identified prior to processing for knowledge extraction as a first step in an automated knowledge acquisition process. The approach uses methods of discourse analysis to obtain a list of discourse entities and the difference in discourse entities between sentences is used to distinguish between text segments. Finally, **"**Safety-Informed Design: Using Subgraph Analysis to Elicit Hazardous Emergent Failure Behavior in Complex Systems" by McIntyre, Hoyle and Jensen, shows how a function failure reasoning tool can be applied to a functional model of a complex system to simulate qualitative failure scenarios and in so doing to identify hazardous scenarios, especially those representing unknown hazards. The feasibility of the work is applied to a functional model of an electrical power system with positive results.

Daniel McAdams is a Professor of Mechanical Engineering in the Department of Mechanical Engineering and Graduate Program Director at Texas A&M University. He joined Texas A&M in 2008 after serving as an Associate and Assistant Professor of Mechanical Engineering at the Missouri University of Science and Technology. He received his Ph.D. from the University of Texas at Austin in 1999. He teaches undergraduate courses in design methods, biologically inspired design, and machine element design and graduate courses in product design and dynamics. His research interests are in the area of design theory and methodology with specific focus on functional modeling [UK or US spelling?]; innovation in concept synthesis; biologically inspired design methods; inclusive design; and technology evolution as applied to product design. He has published over 120 scholarly articles in these areas. He has edited a book on biologically inspired design**.** Dr. McAdams has served in various leadership positions in The American Society of Mechanical Engineers Design Theory and Methodology technical committee.

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