Special issue on: Collaborative and Multi-disciplinary Product Design

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Special issue on: Collaborative and Multi-disciplinary Product Design

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Collaborative and multi-disciplinary design can be defined as a process to coherently exploit the synergy of mutually interacting disciplinary expertise to optimize complex and large-scale product development. Due to the product complexity and the disciplinary backgrounds of engineers, the organization and management of the process remains as a challenge. Some difficulties include: there is no effective collaborative and multi-discipline development platform; efficient ways for knowledge and information exchange across domains do not exist; collaborative engineering needs sophisticated and optimized strategies to solve conflicts and to achieve better system performance; more research is required to provide designers with better understanding and more efficient approaches on the integration of conceptual design and detailed design to achieve the overall optimization, etc. To find effective solutions, many organizations, including academic, research-oriented, governmental, industrial and commercial ones, have recently started a number of research initiatives. In this special issue, seven papers are included to update the latest progress in this significant research area. The majority of the papers are the extended and peer-reviewed versions of those selected from the 2008 International Conference of Advances on Product Development and Reliability (PDR'2008), Chengdu, China, in which more than 100 papers were presented. The topics covered by this special issue are: unified product models to support lifecycle knowledge sharing, interoperability in collaborative engineering across design, manufacturing, operation, maintenance, and end-of-life stages, multi-disciplinary optimization models to support collaborative conceptual design, systematic and collaborative methodologies to generate innovative design from product requirements, and the development of software platforms and tools to support collaborative design processes and information retrieval.

The first paper by Ding et al. presents a unified and XML-based product model to support lifecycle information and knowledge exchange. The model offers the potential to enable designers to revisit and retrieve the information throughout the lifecycle of machine design and build processes dynamically. An industrial case study for cleaning tank design has been used to demonstrate the effectiveness of the operation of the model.

The second paper by Ma investigates the interoperability in collaborative engineering across design, manufacturing, operation, maintenance, and end-of-life stages with an expanded generic feature paradigm. A unified and consistent interoperable semantic scheme has been proposed to support an open and flexible knowledge realization system. The scheme and system have been applied to the oil production industry, and three design cases for grating layout, oil tank scaffolding and the piping system during an oil rig design process have been discussed.

The third paper by Chu et al. addresses the uncertainty issue in collaborative and multi-disciplinary conceptual design. Based on the summary of uncertainties in conceptual design, a systematic tool based on the rough set theory and advanced kriging model has been developed to represent the approximate relationships between major design parameters. With the approximate relationships, designers can adjust design parameters and evaluate the impact of the changes to the overall performance of the design so as to facilitate decision making in the conceptual design stage.

The fourth paper by Tang et al. proposes a new design process model based on Axiomatic Design (AD) and Design Structure Matrix (DSM). Both AD and DSM are design process management methods but applicable to different stages of design. The rationale of this research work is to combine the two models to take their

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full potentials and support lifecycle collaborative design. A case study on the design of a friction drive conveyor has been investigated to validate the proposed research.

The fifth paper by Li et al. details a software tool to manage the collaborative processes of aircraft design and tooling design. The collaborative processes have been modeled based on the similar working principle of a natural neuron-endocrine-immunity system, which is self-adaptive and self-responsive and able to work in a dynamic design and manufacturing environment. The model has been implemented using the multi-agent and Product Data Management (PDM) technologies, and successfully applied to a practical aircraft design and development project.

The sixth paper by Hwang et al. developed a neutral reference model as a new medium for the sharing and propagation of engineering change information among collaborating companies. The neutral reference model, which consists of a neutral skeleton model and an external reference model, enables design collaboration on different PDM/computer-aided design systems and protect intellectual properties.

The last paper by Liang et al. reports the preliminary research on developing an Ontology- and Multi-agent-based Mechanical Design Intelligent Document management system enabling intelligent document searching in collaborative product development projects. The system can manage heterogeneous and distributed design documents. Annotation strategies and the corresponding knowledge utilizers have been designed to ensure the requested documents approachable by designers in an efficient means.

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