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Guest Editorial

Special Issue: Highlights From ASME CIE 2018

The 38th American Society of Mechanical Engineers (ASME) Computers and Information in Engineering (CIE) Conference was held in Quebec City, QC, Canada, Aug. 26–29, 2018, in conjunction with the International Design Engineering Technical Conferences (IDETC). The ASME CIE annual conference is the flagship conference of the ASME's CIE division, which is organized by four technical committees, including Advanced Modeling and Simulation (AMS), Computer Aided Product and Process Development (CAPPD), Systems Engineering, Information and Knowledge Management (SEIKM), and Virtual Environments and Systems (VES).

This special issue contains a selection of papers as the best representatives for a total of 102 papers presented during the conference. They were nominated by the four technical committees based on the conference paper review results. All nominated papers further went through the regular JCISE journal review process, and 15 of them were finally accepted and published in this special issue.

The AMS technical committee focuses on advances in modeling and simulation in engineering with emphasis on topics such as novel numerical techniques, inverse problems, computational multiphysics modeling, and uncertainty quantification. The three representative AMS papers are introduced as follows.

Simulating the multiphysics phenomena in complex additive manufacturing processes is computationally very expensive. In the paper by Steuben, Birnbaum, Iliopoulos, and Michopoulos, titled "Toward Feedback Control for Additive Manufacturing Processes via Enriched Analytical Solutions," a semi-analytic approach is taken to predict the temperature distribution in the laser-based powder bed fusion process, where temperature-dependent material properties and geometry changes are incorporated. It is demonstrated that this simplified approach has similar predictions as the traditional finite element method.

With the increasing adoption of cloud-based design and manufacturing, security is becoming an increasingly important concern. In their paper titled "sFEA: A Secure Finite Element Analysis Technique," Chaduvula, Atallah, and Panchal show how security can be integrated as part of distributed engineering analysis algorithms. They present a technique that enables engineers to perform simulations, such as FEA computations, without the need for revealing their information to anyone, including their design collaborators.

To better understand the temperature distribution in the laser-hardening process, Fakir, Barka, and Brousseau present a numerical model for controlling the process for steels in their paper titled "Servo-Control Applied to the Parameters of the Laser Hardening Process for a Regular Case Depth of 4340 Steel Cylindrical Specimen." The numerical model is based on a study of surface temperature variation and the adjustment of this temperature by a control of the heat treatment laser power. The authors show the feasibility of achieving a uniform case depth by controlling the laser parameters to homogenize the distribution of the maximum temperature reached on the surface.

The CAPPD technical committee emphasizes fundamental research and computational tool development to support product and process realization. It encompasses all aspects of product and process design, such as analysis, optimization, process planning, and inspection. The research topics include geometric modeling, feature-based design, tolerance analysis, and product-service systems design, as well as emerging topics such as emotional engineering, human modeling for engineering design, and multimodal interfaces. The following six CAPPD papers are included in this issue.

Traditional additive manufacturing approach based on planar layers faces challenges of efficiency and quality in building complex geometries or with composite materials. In the paper by Shembekar, Yoon, Kanyuck, and Gupta, titled "Generating Robot Trajectories for Conformal Three-Dimensional Printing Using Nonplanar Layers," a six-degrees-of-freedom robotic arm is used for 3D printing of nonplanar layers. Trajectory planning algorithms are developed with the considerations of reacheability and collision. Experiments demonstrate that nonplanar printing can significantly reduce the build time compared to the planar printing, while surface roughness can be greatly improved.

The problem of developing product configurations and layouts is challenging, because it involves both discrete and continuous mathematical processes. In their paper titled "A Product Family Design Method for Configuration and Spatial Layout Requirements," Hansen and Rosen present a method for product family design that solves the combinatorial problem related to generating platforms and products, and the geometric layout problem related to the placement of components in each product. The method is demonstrated using an automotive interior design case study.

To tackle the challenge of trade-offs between functionalities in product development, in their paper titled "Formal Process to Support Resolution of Functional Trade-Offs in Complex Product Development", Oizumi, Ishida, Tai, and Aoyama propose a method to build appropriate models for the trade-off problem by integrating different types of models, including function-based, physics-based, and cognition-based models. The method is validated by a case study of continuously variable transmissions.

To deliver external variety and internal commonality, Williamsson, Sellgren, and Söderberg present a designing strategy of modular product architectures in their paper titled "Product Architecture Transition in a Modular Cyber-Physical Truck." The authors propose a clustering-based method for product modularization that integrates product complexity and company business strategies. The proposed method is verified by an industrial case study of a heavy truck driveline.

Product usage data are very valuable to improve product design. Yet such usage data are not easy to collect. In the paper by van der Vegte, Kurt, and Kerem Şengöz, titled "Simulations Based on Product-Usage Information From Connected Products to Support Redesign for Improved Performance: Exploration of Practical Application to Domestic Fridge-Freezers," a simulation approach is taken to collect product performance data, and it is

demonstrated by fridge-freezers. The temperature and energy consumption data with load cycles are obtained through a fridge-freezer simulator implemented in SIMULINK.

Data fitting is an essential task in computational metrology. In the paper by Shakarji and Srinivasan, titled "On Algorithms and Heuristics for Constrained Least-Squares Fitting of Circles and Spheres to Support Standards," the least square-error fitting under the geometric constraints with respect to specific shapes is demonstrated, where data are required to inscribe or circumscribe circles and spheres in the fitting process.

The SEIKM technical committee promotes research on design informatics, ontology engineering, information discovery, agent-based systems, knowledge and function representation, systems engineering, model-based design, as well as knowledge capture, reuse and management. In addition to these established areas, the recent emphasis is on emerging topics including smart manufacturing informatics, machine learning, factory of the future, and cyber-physical systems. Four representative SEIKM papers in this year's conference are as follows.

The assessment of failure risk, particularly in the early conceptual design, is challenging. In their paper titled "A Generative Human-in-the-Loop Approach for Conceptual Design Exploration Using Flow Failure Frequency in Functional Models," Arlitt and Van Bossuyt present a framework for exploring a space of functional models for human-in-the-loop decision-making and human-guided design. Based on graph-rewriting rules and a qualitative failure simulation framework that presents information to humans in an intuitive manner, this approach supports and helps systems engineers to understand how failures are likely to propagate.

Failure detection in systems is also the focus of the paper by Irshad, Ahmed, Demirel, and Tumer, titled "Computational Functional Failure Analysis to Identify Human Errors During Early Design Stages." The authors address the specific issue of identifying human errors during early design stages by extending the Functional Failure Identification and Propagation method to include human action and error propagation. This allows a systems designer to address the human errors using human factors engineering principals at early design stages.

Crowdsourcing design contest is an emerging mechanism for companies to quickly generate design concepts through contests instead of relying on in-house engineers. How to design the contest mechanisms and rules for good outcome however is largely unknown. In the paper by Sha, Chaudhari, and Panchal, titled "Modeling Participation Behaviors in Design Crowdsourcing Using A Bipartite Network-Based Approach," the contest participants' behaviors are studied. The relationships between multiple participants and multiple contests are modeled as bipartite networks. The participations are quantified with exponential random graph models, and can be predicted based on the characteristics of participants and contests.

During the design process, there is a risk of an idea or solution being incorrectly transferred and interpreted. In the paper titled "Evaluating the Impact of Idea Dissemination Methods on Information Loss," Zhao, Lopez, and Tucker explore the amount of relevant design information transmitted by different idea dissemination methods. Using an experiment with engineering and nonengineering participants, the authors found that the effectiveness of the methods in conveying information depends on a receiver's familiarity with the ideas being transmitted. This knowledge can aid designers in selecting suitable dissemination methods.

The VES technical committee focuses on research issues involved in developing hardware and software for virtual environments, i.e., computer-generated immersive 3D worlds that facilitate the design of virtual products. The VES community addresses a number of emerging areas, including tangible user interfaces, multimodal user interfaces, multisensoral techniques, haptics, and alternative or combinatorial reality. The following two papers are included in this special issue.

While there is significant research on vision-based systems, the sense of smell has not yet been fully exploited in virtual reality applications. In their paper titled "An Olfactory Display to Study the Integration of Vision and Olfaction in a Virtual Reality Environment," Micaroni and co-authors present a Virtual Reality system that combines an olfactory display with a visual display. The paper is a significant step toward synchronizing the sense of sight with that of smell, in particular from the perceptual point of view.

Hand pose tracking has shown great promise in supporting design and manufacturing. Zhang and co-authors present a proof-of-concept instrumented glove with only a few strain gauge sensors and a microcontroller that continuously tracks and records the hand configuration during actual use, in their paper titled "High Degree of Freedom Hand Pose Tracking Using Limited Strain Sensing and Optical Training." The glove is capable of predicting 14 joint angles on a hand using as few as four strain gauges, and can be trained in short as 3 min, making the proposed system viable in real manufacturing settings.

The goal of this special issue is to provide a quick overview of the CIE 2018 conference as well as the latest development in a wide variety of CIE-related areas. We would like to thank all contributing authors for their efforts to continuously improve the quality of their papers during the review process and are particularly grateful to the anonymous reviewers for their time and efforts to maintain the high quality standard of JCISE. We look forward to more conference participation from researchers in our community and another special issue from next year's IDETC-CIE conference.

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