Editorial

New Trends in Manufacturing Systems Research

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Research on manufacturing systems is further enriched and becomes stronger at the 47th North American Manufacturing Research Conference (NAMRC 47) at Penn State University, The Behrend College, Erie, Pennsylvania USA. Advancing manufacturing systems is quickly evolving within the framework of Industry 4.0 environment. Advanced process and system monitoring through delocalized sensors determines the creation of a huge amount of data which has to be properly managed in order to give effective feedback on the actual production. In this way, data analytics is experiencing a growing importance in the manufacturing systems research in order to get smart and lean solution for production.

Moreover, most recent manufacturing technologies are introduced in the production shop floor and often specific innovative solutions must be introduced at the production system level in order to get excellence in quality and effectiveness of products, agility in production, short response time to market evolutions, and profitable margins. This special issue titled “New Trends in Manufacturing Systems Research” brings to readers the state-of-the-art and the latest achievements highlighted at NAMRC 47. Five quality papers are selected from NAMRC 47 for inclusion in this special issue and their synopses are provided below.

In the first paper titled “Error qualification for multi-axis BC-type machine tools” kinematic equations of motion for a BC-style machine tool are derived while incorporating the 8 distinct kinematic error constants associated with a 5-axis machine tool. A method is presented to derive these kinematic error constants from eccentricity values obtained using 3-axis simultaneous tests for table-table style 5-axis machine tools. To validate this method, error constants were input into the kinematic simulation. Eccentricity values were then output from the simulation and error constants were derived and compared to the input values. It was shown that if the procedure is followed, the error constants can be correctly derived and compensated. This method was then implemented and tested on a BC-style machine tool.

The second paper titled “Reconfiguration of manufacturing supply chains considering outsourcing decisions and supply chain risks” proposes a graph-based cost model to optimize the configuration of manufacturing supply chain networks to support reconfiguration decision-making. An optimization model is formulated to minimize the total cost of the manufacturing enterprise with the consideration of operating cost and reconfiguration cost. To effectively quantify the reconfiguration cost, a graph-based cost model is developed to characterize the relationship between the graphical similarity of two supply chain networks and the reconfiguration cost. Outsourcing decisions and supply chain risks are also considered in the proposed model. A case study on a supply chain for laptop computer assembly is presented to demonstrate the effectiveness of the proposed method.

The third paper titled “CAD-Based Design and Pre-processing Tools for Additive Manufacturing” discusses a set of geometry based computational pre-processing algorithms developed for Powder Bed Fusion Additive Manufacturing (PBFAM) processes. An automatic support structure generation module generates customized CAD-based support structures for a given part build orientation. A set of stand-alone computational geometry-based algorithms are developed for calculating support structure parameters. An algorithm is developed, evaluating ease of removing supports during the post-processing phase and suggesting the optimum number of setups needed to remove support structures. Finally, Producibility Index, which is a weighted optimization scheme, brings together the quantified outputs of the Design for

Additive Manufacturing analysis, support structure parameters and accessibility and suggests the best build orientations for the given part geometry.

The fourth paper titled “A Manufacturing Process Design for Producing a Membrane-based Energy Recovery Ventilator with High Aspect Ratio Support Ribs” proposes and validates a manufacturing process design for channel lamination based on surface mount adhesives capable of meeting the process requirements of a membrane-based ventilator. In particular, the device requires rib supports with height-to-width aspect ratios greater than one. The proposed manufacturing process design is capable of meeting this process requirement by stretching the adhesive after initial adhesive tacking. A manufacturing process flow diagram, a machine tool specification and a cost model are proposed for meeting process requirements. A set of design constraints are developed detailing the adhesive requirements necessary for meeting requirements. The cost model is validated by building a sub-scale mesochannel array demonstrating the ability to meet process requirements.

The fifth paper titled “Knowledge Based Design Advisory System for Multi-Material Joining” is a knowledge-based advisory system to help structural designers at the early design phase to select the potential joining methods. A concept map is organized collecting data derived through data mining on various joining methods through any available sources, such as experts from academia and industry, handbooks, and vendors. The data are arranged into several categories according to their characteristics which include joinable materials, mechanical and design requirements, geometry, and so on. A database using a general tree structure is created to be fed into the advisory system. Searching algorithm using SQL query is implemented to navigate through the database to find the joining methods that match the requirements defined by the user. Two test cases are generated to validate the function of the knowledge-based system.

Finally, we wish to take this opportunity to thank all the authors for their scientific contributions to this special issue, and for complying with referees’ comments in revising their manuscripts. Through this special issue, we would like to shed some insight on the latest advancements in manufacturing systems research along with some of the accompanying challenges, and hope to open doors for new research ideas and achievements in the years to come.

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