Journal of Manufacturing Science and Engineering

Guest Editorial

Special Issue: Sustainable Manufacturing

In Memoriam: David A. Dornfeld

We dedicate this special issue of the ASME *Journal of Manufacturing Science and Engineering* to David A. Dornfeld. Dave was the key architect and inspirational force behind this special issue. He was a recognized leader in the manufacturing community who devoted several decades of research contributing to many areas of advanced manufacturing science and engineering, including sustainable manufacturing. Our field lost a giant when Dave passed away on March 27, 2016.

Dave believed that sustainability was one significant driver of manufacturing innovation. He advocated leveraging sustainability to promote industrial competitiveness and worked tirelessly with industrial and academic partners to help develop the ideas and technologies to achieve this vision. His research work helped advance several areas of sustainable manufacturing, including lifecycle analysis methods and tools for manufacturing processes, systems, and supply chains; social sustainability; green material selection; and sustainable production technologies for emerging economies.

Dave was also an inspirational teacher passionate about educating others about sustainability. He was the founding faculty director of the Jacobs Institute for Design Innovation at the University of California, Berkeley, and he wrote a Green Manufacturing blog where he regularly discussed the state-of-the-art in sustainable manufacturing research with the larger manufacturing community. As a faculty member at Berkeley, he mentored 58 Ph.D. students, many of whom have gone on to become leaders in academia and industry.

Dave left us with a strong legacy of leadership and outstanding technical contributions. He was a friend, mentor, and colleague to many and will be dearly missed by those lucky enough to have known him.

Overview

This special issue of the ASME *Journal of Manufacturing Science and Engineering* is devoted to the broad field of Sustainable Manufacturing. Sustainable manufacturing requires simultaneous consideration of economic, environmental, and social aspects of the production and delivery of goods. It fundamentally relies on descriptive metrics, advanced decision making, and standard policies and practices for implementation and evaluation. Manufacturing it is a vital source of innovation to meet society's future needs by undertaking strategic activities focused on process- and system-level sustainability.

Our objective with this special issue was to collect papers that explore recent research into the concepts, methods, tools, and applications for sustainable manufacturing. We were pleased to receive many submissions from across the globe and from researchers representing many disciplines, as well as industry, academia, and government organizations. For the special issue, the review process was rapid and required hard decisions to decide which submissions could be accepted based on their quality of content and writing. This issue is comprised of 14 articles devoted to the topics of Design for Sustainable Manufacturing, Manufacturing Process Analysis, Manufacturing Systems Analysis, and Remanufacturing, as detailed below.

Design for Sustainable Manufacturing. There are three papers devoted to research directed at aiding design decision makers by providing more information about manufacturing processes and systems, as well as the attendant sustainable performance metrics. One paper extends Axiomatic Design Theory to ensure sustainable manufacturing systems. It develops a methodology for designing and implementing such systems, as well as defining the use of performance metrics and investment criteria to be applied for continuous improvement through systems engineering.

Another paper develops a method that extends process-based life-cycle assessment to parametrically model supply chain and manufacturing processes. The goal of such an approach is to aid design decision makers with more accurate information and more sensitive models for sustainability performance. The focus is on environmental and social impacts.

The final paper in this topic area reports the development of a standard approach through ASTM International for characterizing the environmental aspects of manufacturing processes to aid accurate process- and system-level performance evaluation. Use cases from the pulp and paper industry are presented and explored.

Manufacturing Process Analysis. There are six papers that focus on evaluation of a single manufacturing process from the sustainability perspective. Three papers investigate machining processes. One develops a generalized model for predicting machine tool energy use. Another investigates the effects of various lamellar-type solid lubricants in vegetable oil applied for use in minimum quantity lubrication (MQL) machining. The third paper conducts a review of sustainable machining literature over the past 15 years to synthesize the findings from the perspective of the triple bottom line (economy, ecology, and equity).

In addition, several papers look into additive processes. One develops a machine-learning based model of sintering. The model considers various parameters to more accurately predict process energy use. Another paper investigates a novel fast mask image projection stereolithography process for environmental impacts, and it determines that energy use is a key factor. A model is developed to predict energy use and environmental impacts of the process based on part design parameters. The final paper investigates the effects of several process parameters on deposition rate, process emissions, and wastes in atomic layer deposition. The key effects of process temperature, pulse time, purge time, and carrier gas flow rate are presented and discussed.

Manufacturing Systems Analysis. There are three papers that investigate sustainability issues consequential to manufacturing systems. One paper focuses on an automotive manufacturing

facility. Specifically, a layered temporal and organizational framework is developed to guide systematic energy modeling.

Two papers investigate symbiotic eco-industrial parks. In the first, closed-loop manufacturing is examined using principles for understanding food web structures. It is found that the cyclicity of industrial ecosystems is much lower than biological ecosystems, indicating the need for more material return loops. The second paper takes a reflective look at 19 existing eco-industrial parks based on bibliographic and empirical research to understand their development and management trends. It identifies dependencies between the development approach and coordination structure and, consequently, the influence of social context and cohabitation for public and private parks.

Remanufacturing. There are two papers that focus on strategies for improving sustainability through product, component, and material recovery and remanufacturing. One paper investigates recovery of waste electrical and electronic equipment. An agent-based simulation framework is developed to model the takeback and recovery system, as well as consumer sociodemographics. The model is demonstrated by using buyback price to control timing and quality of incoming used products. The second paper tackles the interrelated issues of disassembly sequence planning and prediction of the number of products to be disassembled to meet demand. It develops and applies a genetic algorithm-based simulation optimization approach to simultaneously aid such disassembly sequence and disassembly-to-order decisions.

Summary

Sustainable manufacturing involves more than simply implementing isolated solutions aimed at improving energy efficiency or reducing environmental impact, as an example. It requires that the manufacturing enterprise comprehensively adopts broader, system-level sustainability goals in decision-making when allocating its limited resources. Thus, the papers in this special issue provide the reader a foundation for understanding the complex interplay of environmental, economic, and social aspects, as well as corresponding analysis tools to achieve sustainable manufacturing.

David A. Dornfeld (Deceased)
Guest Editor
Department of Mechanical Engineering,
UC, Berkeley,
Berkeley, CA 94720

Jorge Arinez, Guest Editor
General Motors Co., R&D,
Warren, MI 48090

Karl Hapaala, Guest Editor
School of Mechanical, Industrial and Manufacturing Engineering,
Oregon State University,
Corvallis, OR 97331

Moneer Helu, Guest Editor
National Institute of Standards and Technology,
Gaithersburg, MD 20899