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Guest Editorial

Special Issue: Data Science-Enhanced Manufacturing

GE described in a 2012 white paper how manufacturing companies have been collecting a massive amount of data about the production processes and operating conditions from a variety of manufacturing machines, devices, and applications. For example, a consumer packaged goods (CPG) company can collect over 13 billion data samples per day, and data volumes are trending higher. In addition to large data volumes, increasing variety, complexity, and uncertainty have also contributed to the increasing and ubiquitous challenge posed by data. Deeply embedded in the data is temporal and spatial information that underlies the physical mechanisms used to make a product. Therefore, effective extraction and use of information embedded in the data have become the next frontier to drive innovation, competitiveness, and growth in manufacturing, as highlighted by McKinsey in a series of studies.

The exponential growth of data has provided new opportunities for the manufacturing community to leverage data science and advance the state of manufacturing. This necessitates research into advanced data analytics, such as compressive sensing, stochastic modeling, deep belief networks, and nonlinear optimization. Such tools enable manufacturers to effectively and efficiently identify patterns and context hidden in raw data sets, in order to provide a deeper understanding of process physics and derive new knowledge for process and quality control. Beyond individual machines and processes, actionable information generated by data science can further improve the system-level operations of manufacturing enterprises, for example, by increasing the accuracy and reliability in predicting equipment failure rates and remaining useful life for preventative maintenance; integrating data across various work units to create transparency and enable holistic, enterprise optimization; exposing variability in inventories and individual performance for robust operation planning; streamlining inventory management to leverage energy-efficient components; optimizing factory floor space utilization; and improving decision-making through automated, data-driven decision evaluation.

This Special Issue aims to provide a platform for researchers and practitioners to disseminate research findings and innovative practices that leverage data analytics to complement physical science for enhancing manufacturing processes and systems. Through a rigorous peer-review process, 11 submissions were selected for inclusion in this Special Issue. These papers cover a wide range of topics in various manufacturing scenarios, for example, multiobjective optimization for minimizing deviations in the geometric dimensioning and tolerance of additively manufactured parts; dynamic sampling for characterizing the spatiotemporal processes in manufacturing; multiphysics data decomposition to quantify contributions from different sensors for predicting product quality in injection molding; image processing for analyzing and predicting electrical resistance of traces produced by aerosol jet printing; bootstrap aggregation with support vector regression to guide the design of weldment and selection of welding condition; optimization of fixture locator points to minimize part deformation and dimensional variation in sheet metal assembly; nonlinear time–frequency analysis for instantaneous frequency extraction in vibration signals in motors and other rotating machines; and sparse representation with minimum entropy deconvolution to improve incipient fault detection in rolling bearings.

We would like to thank Dr. Y. Lawrence Yao, Editor-in-Chief of JMSE, for supporting the idea of exploring data science for enhancing manufacturing. We also appreciate the support from Emily R. Bosco, Editorial Assistant, throughout the paper review and production process. This Special Issue would not have become a reality without the enthusiastic response from the community to the call for papers. Last but not least, we are indebted to the reviewers whose time and effort have ensured the timely publication of this Special Issue. It is our sincere hope that the readers find this collection of papers informative in illustrating the value of data science and assisting their research toward improved manufacturing processes and product quality control.

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