Editorial

Lihui Wang

Integrated Manufacturing Technologies Institute
National Research Council of Canada
800 Collip Circle, London, Ontario N6G 4X8, Canada
E-mail: lihui.wang@nrc.gc.ca

Biographical notes: Dr. Lihui Wang is Senior Research Officer of the Integrated Manufacturing Technologies Institute at National Research Council (NRC) of Canada. He received his PhD and MESc from Kobe University, Japan in 1993 and 1990, respectively, and his BSc from China in 1982. He worked for two years at Kobe University and two years at Toyohashi University of Technology (Japan) as an Assistant Professor prior to joining NRC. Dr. Wang has over 100 papers published in scientific journals and conference proceedings. He has also published one book and edited seven proceedings and journal special issues. His research interests are currently focused on manufacturing process planning, planning and scheduling integration, agent technology, real-time monitoring and control, Java and web-based systems. He is a registered Professional Engineer, a senior member of SME, a member of ASME and an Adjunct Professor at the University of Western Ontario, Canada.

Manufacturing has been one of the key areas that support and influence a nation's economy since the 18th century. Being the primary driving force in economic growth, manufacturing constantly serves as the foundation and contributes to other industries such as construction, transportation and information technologies. The products of manufacturing range from heavy-duty trucks, automobiles, trains and airplanes to computers, camera phones and hi-tech home electronics. Despite the various revolutionary changes in the past century (*e.g.*, high-speed computing, the internet and e-'everything') that significantly advanced manufacturing, we are still facing new challenges when striving to achieve greater success in winning global competitions. Today, distributed and collaborative manufacturing is unforeseeably coming into being due to recent business decentralisation and manufacturing outsourcing. Understanding the current status and mastering new technologies become crucial for manufacturing engineers and researchers to effectively solve problems in manufacturing. This special issue on Innovative Technologies in Manufacturing is put together in an attempt to address some of the important issues that challenge today's manufacturing.

The purpose of this special issue is to provide a forum for researchers and practitioners to review past achievements on manufacturing and to identify possible research directions in future manufacturing. Nine papers have been carefully selected for inclusion in this special issue. It is hoped that this special issue will stimulate more interests in the field of advanced manufacturing research.

As mother machines, Computer Numerically Controlled (CNC) machine tools play important roles in modern manufacturing. Based on the review and analysis of current technologies of advanced CNC machine tools, the first paper provides unique perspectives of future intelligent machine tools and possible technological developments on autonomous machining. An evolutional architecture called digital copy milling is introduced. This digital copy milling hopes to achieve autonomous milling operations that are uninstructed by Numerical Control (NC) programs. The key issues of autonomous planning and decision-making technologies, as well as process monitoring and control, are also discussed in this paper.

Within the context of intelligent machining, an approach to determining nonconstant feed rates for high-performance CNC pocketing and contouring is proposed in the second paper. Usually, the feed rate during machining is not optimal but fixed at a conservative rate. This fixed rate causes longer machining time or shorter tool life. To achieve less machining time, high part quality and long tool life, this paper introduces a fuzzy rule-based system to predict the cutting force at every cutter location according to the effective radial depth of cut, the feed rate and the axial depth of cut. The feed rate is then adjusted to compensate for the effective radial depth of cut at different locations to boost performance.

An alternative to machining processes optimisation is by simulation in virtual manufacturing. The third paper presents a framework and an object-oriented prototype for virtual manufacturing of milling processes. The 3D visualisation based on geometric model, kinematic model and animation model allows the user to experiment with different values of tool path parameters in order to select the most suitable ones. With simulation in virtual manufacturing, it assures a correct machined part the first time, with minimum machining trial and error.

Aligned with virtual manufacturing, virtual assembly is an efficient tool to optimise assembly planning and evaluation using the concept of Virtual Reality (VR). In the fourth paper, a VR-based assembly planning and training system is introduced. Using a CAD assembly model as input, the system can output one or several good assembly sequences with the application of an intelligent bionic algorithm. It is based on the precedence constraints between parts. An ant colony optimisation algorithm is then applied to acquire an optimal assembly sequence. This sequence is evaluated through iterations by assembly simulation in virtual environment to verify whether the sequence is the best assembly sequence.

Manufacturing management is another focus of this special issue. This kind of management has been studied both along manufacturing chains and across manufacturing enterprises. In the fifth paper, a quota-constrained, speed control problem in production scheduling is formulated into an integer programming problem. This problem is then solved using Lagrangian relaxation and the minimum cost, linear network flow techniques. In semiconductor manufacturing, the speed of a lot can be dynamically changed or adjusted. The higher the speed, the shorter the cycle time. As there are only limited resources at a time, a quota for each speed level is specified. The reported methodology can generate near-optimal schedules and is claimed to be efficient in the application to realistic problems.

In the area of collaborative manufacturing, effective knowledge exchange and efficient resource sharing are crucial to business success. The latest technologies of web services and intelligent software agents open new opportunities for collaborative manufacturing. The sixth paper proposes a component called ‘Agent-based Web Service’

(AWS) to provide manufacturing scheduling services for enterprise collaboration, where the scheduling process of an order is orchestrated on the internet through the negotiations among AWSs. This paper also reports on a prototype system for AWS-based manufacturing scheduling that is implemented and connected to a back end multi-agent dynamic manufacturing scheduling system.

At the enterprise level, independent companies especially Small and Medium-sized Enterprises (SMEs) can form a dynamic and temporal network or a Virtual Enterprise (VE). This will allow them to stay competitive in global market. Targeting this research area, the seventh paper presents an inter-operability framework and a virtual integration infrastructure for SMEs, which enable the collaborative demand forecasting and production planning within the VE environment. It also reviews the major industry standards for implementation of inter-operable systems and examines the decision factors for selecting the appropriate inter-operability specifications. The focus is on business connectivity, system scalability and information security.

Another important issue in collaborative manufacturing and virtual enterprises is data exchange across heterogeneous systems from design through process planning to manufacturing. Although STandard for the Exchange of Product (STEP) model data is recommended by the ISO as a new standard, Initial Graphics Exchange Specification (IGES) remains popular among industries and academia regarding the area of data exchange. In the eighth paper, a set of algorithms are proposed to extract both simple and concatenated features for prismatic parts directly from IGES files. The final results are a set of manufacturing features that can be used for process planning, NC programming and cutter path generation. Details are explained with examples.

The last paper is dedicated to manufacturing education with focus on simulation-aided optimisation of manufacturing processes. It is of vital importance that students are equipped with the right knowledge and tools (while at universities) for future manufacturing advancement. This paper demonstrates how the complex manufacturing processes can become comprehensive in university education by using simulation models.

These papers cover a broad area ranging from machining at the shop level to resource sharing at the enterprise level. This range is typical in today's manufacturing. I hope this special issue is timely in delivering the latest R&D achievements to the research community.

As the guest editor, I would like to take this opportunity to thank all the authors for the time and effort they spent in writing their paper, and for complying with referees' comments in revising their manuscripts. I would also like to express my heartfelt gratitude to the referees who reviewed the papers and made valuable comments for improving the quality of the manuscripts.

Finally, I would like to gratefully acknowledge the trust and support provided by Dr. Mohammed Dorgham, Editor-in-Chief of the IJMTM journal, for collating this special issue on Innovative Technologies for Manufacturing.