Preface

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 of and contributes to other industries with products ranging from heavy-duty machinery to hi-tech home electronics. In past centuries, manufacturing contributed significantly to modern civilisation and created momentum that is used to drive today's economy. Despite various revolutionary changes and innovations in the 20th century that contributed to manufacturing advancements, we are continuously facing new challenges when striving to achieve greater success in beating the global competition.

Today, manufacturers are competing in a dynamic marketplace that demands short time-to-market and agility in production. In the 21st century, manufacturing is gradually shifting to a distributed environment with increasing dynamism. In order to win a competition, locally or globally, customer satisfaction is treated with the highest priority. This has led to mass customisation and even more complex manufacturing processes, from shop floor to every level along the manufacturing supply chain. At the same time, outsourcing has forged a multi-tier supplier structure involving numerous small-to-medium-sized enterprises, where highly-mixed products in small batch sizes are handled simultaneously in manufacturing operations. Moreover, unpredictable issues like job delay, urgent-order insertion, fixture shortage, missing tools, and even machine breakdown are challenging manufacturing companies, and adding high uncertainty to the fluctuating environment. Engineers often find themselves in a situation that demands adaptive planning and scheduling capability in dealing with daily operations in such a dynamic manufacturing environment.

Targeting the uncertainty issue in manufacturing, research efforts have shifted to improving the adaptability and responsiveness of manufacturing operations in the so-called digital manufacturing environment. The digital manufacturing approach offers manufacturers the ability to digitally represent entire operations on their computers, aiming at producing products safely, ergonomically, efficiently, and right the first time. Digital manufacturing supports a variety of day-to-day activities from collaborative product design to manufacturing execution control. It is further facilitated by advanced information technology (IT) and artificial intelligence (AI) tools in dealing with complex and dynamic issues in the distributed environment, targeting manufacturing uncertainty.

Thanks to recent advancements in AI and IT, manufacturing research has progressed to a new level in adaptive decision making and trouble shooting, in order

to address those problems encountered in today's manufacturing with increasing globalisation and outsourcing. While research and development efforts have been translated into a large volume of publications and impacted the present and future practices in manufacturing, there exists a gap in the literature for a focused collection of works that are dedicated to the collaborative design and planning for digital manufacturing. To bridge such a gap and present the state of the art to a broad readership, from academic researchers to practising engineers, is the primary motivation for this book.

Targeting digital manufacturing, Chapter 1 presents a systematic approach in designing and deploying various computing tools with a scalable hardware/software platform. A toolbox dubbed Watchdog Agent® consisting of modularised embedded algorithms for signal processing and feature extraction, performance assessment, diagnostics and prognostics for machinery prognostic applications, is introduced. Focusing on collaborative design, Chapter 2 reports on a design framework that allows efficient flow of design and manufacturing information across mechanical and electrical domains for the development of mechatronic systems. Constraints between mechanical and electrical design domains are classified, modelled, and bi-directionally propagated to provide automated feedback to designers of both engineering domains. The cross-discipline information sharing is further extended in Chapter 3, where a unified feature scheme is proposed to support entity associations and propagation of modifications across a product's lifecycle. For collaborative product design and development in today's decentralised environment, integration of suppliers into the process chain of an OEM (original equipment manufacturer) is investigated in Chapter 4. A web-based tool called CyberStamping is developed to realise the collaborative supplier integration for automotive product development. Extending the design scope to system level, Chapter 5 introduces a method for designing the structure of reconfigurable manufacturing systems for a contract manufacturer based on the use of co-operative co-evolutionary agents. The aim is to determine the structure of a reconfigurable manufacturing system that can be converted from one configuration to another to manufacture the different products of the customers of the contract manufacturer. With customer satisfaction in mind, Chapter 6 describes a conceptual framework of a web-based platform for supporting collaborative product review and customisation within a virtual/augmented reality environment. It can also be used to demonstrate the product to end users.

Linking to collaborative planning, Chapter 7 introduces a reference model of manufacturing process planning for extended enterprises. It represents a workflow modelling strategy and a reference architecture that enable collaborative process management. Furthermore, Chapter 8 proposes an adaptive setup planning approach for solving uncertainty issues in job-shop operations. It loosely integrates scheduling functions during setup planning, and utilises a two-step decision-making strategy for generating machine-neutral and machine-specific setup plans at each stage. In order to allocate operations on machines, Chapter 9 uses an auction-based heuristic with dual objectives of minimising the make span and maximising the system throughput. It is supported by an agent-oriented architecture.

Extending the scope to collaborative product development, Chapter 10 presents a web-based rapid prototyping system. The workflow and overall system architecture are described in detail. Adopting a multi-agent approach, Chapter 11 describes the

methodology towards a desktop assembly factory, including 3D representation of individual physical agents, assembly features, and clustering algorithms. Within the context, the physical agents are empowered by intelligent software agents.

Information sharing is crucial for collaborations in digital manufacturing, and can offer added value in achieving global optimisation. Chapter 12 addresses this issue using STEP and XML for information sharing between different systems with standard data accessing interfaces. Moreover, in Chapter 13, a web-based Kanban system in various environments, from manufacturing cells to virtual enterprises, is developed. It allows decision makers to plan and manage production flows of a virtual enterprise more effectively.

In order to achieve real-time traceability, visibility and interoperability in shop floor planning and control, Chapter 14 proposes to use workflow management as a mechanism to facilitate an RFID-enabled real-time reconfigurable manufacturing system, whereas the workflow of production processes is modelled as a network and agents are used to wrap web services. Similarly, Chapter 15 reports on a web-based approach for manufacturing management and control. The proposed methodology integrates engineering and manufacturing management through an ERP software tool. Finally, in Chapter 16, performance measures of distributed manufacturing systems are investigated. These measures would help enterprises evaluate alternative configurations/architectures of a particular distributed manufacturing system and choose the one to meet their goal.

Altogether, the sixteen chapters provide an overview of some recent research efforts towards collaborative design, planning, execution control and manufacturing management for digital manufacturing in the 21st century. They are believed to make significant contributions to the literature. With the rapid advancement of information and communication technologies, we believe that the subject area of this book will continue to be a very active research field for many years to come.

Taking this opportunity, the editors would like to express their deep appreciation to all the authors for their significant contributions to this book. Their commitment, enthusiasm, and technical expertise are what made this book possible. We are also grateful to the publisher for supporting this project, and would especially like to thank Mr Anthony Doyle, Senior Editor for Engineering, for his assistance and earnest co-operation, both with the publishing venture in general and the editorial details. We hope that readers will find this book informative and useful.

London, Canada — *Lihui Wang*
Singapore — *Andrew Y.C. Nee*
October 2008

http://www.springer.com/978-1-84882-286-3

Collaborative Design and Planning for Digital Manufacturing

Wang, L.; Nee, A.Y.C. (Eds.)
2009, XX, 413 p., Hardcover
ISBN: 978-1-84882-286-3