Preface

INTRODUCTION

Fast advances in information technology (RFID, sensor, Internet of things, and the Cloud) have led to a smarter world vision with ubiquitous interconnection and intelligence. Smart manufacturing refers to advanced manufacturing with wise adoption of information technologies throughout end-to-end product and service life cycles, capturing manufacturing intelligence for wise production and services. Smart manufacturing represents a field with intense competition in this century of national competitiveness.

Thus, it is the right time to have a book with innovative findings in advanced manufacturing research and development. The main intent is to promote an international knowledge exchange community involving multidisciplinary participation from researchers, practitioners, and academicians with insight addressing issues in real life problems towards smarter manufacturing, triggered, and facilitated by ubiquitous interconnection and intelligence, incubating manufacturing innovation, and transformation.

INNOVATION AND TRANSFORMATION

Manufacturing in recent decades has made amazing progress. At present, manufacturing has adopted and leveraged the latest achievements in materials, mechanics, physics, chemistry, and computer simulation technology, network technology, control technology, nanotechnology, biotechnology, and sensor technology. New manufacturing mechanisms, manufacturing tools, processes, and equipment continue to emerge. Manufacturing as a technology has developed into a new engineering science subject – Manufacturing Science. Cross-regional distribution of manufacturing resources in the era of economic globalization has forced manufacturing collaboration to become a daily necessary means. The networked collaborative tools and systems are also increasingly rich. Intelligent Manufacturing has been recognized as the direction of manufacturing technology innovation, the maturity of the related theories, and technologies will be one of the signs of the advent of knowledge economy.

Advanced manufacturing’s role as the backbone of a country has been re-recognized and has aroused wide attention of major developed and developing countries. These countries have already started a series of advanced manufacturing technology research programs. Europe and the United States proposed “re-industrialization” in recent years to seize the commanding control of global industrial technology, and to further capitalize on the high-end manufacturing. In the U.S., President Barack Obama has announced infrastructure and technology policy and steps to restore the center of manufacturing in the U.S. economy. In the face of fierce international competition in the 21st century, Chinese government has planned accordingly and launched a series of major and key projects, carrying out special studies in the frontier of advanced manufacturing technology and equipment.
INTERCONNECTION AND INTELLIGENCE

Development of the manufacturing industry so far has involved multi-disciplinary applications, adopting the latest achievement in materials, mechanics, physics, chemistry, and computer simulation technology, network technology, control technology, nanotechnology, biotechnology, and sensor technology. Fast advances in Internet/Internet of Things, and next generation of information technology will lead to industry revolution, promoting the manufacturing industry to shift from the traditional manufacturing towards industrial chain based manufacturing. The trend and requirements of digital manufacturing, service manufacturing, and intelligent manufacturing will become more apparent and prominent.

Pursuit of the consistency of business and customer goals is the eternal theme of service manufacturing. High quality, high efficient, and personalized manufacturing represents the most significant features of service manufacturing. Currently, the volatility of consumer demand is widening, so is financial volatility. Expectation on customer service and product quality is continuously higher and higher. Business models are also diversified. All of these present great challenges to manufacturing. Improving services, responding to consumers’ changing expectations, and demand patterns needs more and better resources and information. The development and application of Internet of Things and cloud computing in manufacturing provides powerful tools to achieve those. With Internet of Things application in the manufacturing sector deepening, it will give rise to new data, new technologies, new products, new applications, and new business models. Consequently, it will generate huge support and management needs. Cloud computing as a new computing paradigm is developing rapidly.

Intelligent manufacturing provides intelligent means for the optimal use of manufacturing resources, leveraging recycling economy theory and re-manufacturing concept for traditional industries to provide resource-saving, energy saving, environment-friendly technologies. It will also provide advanced technology and equipment for new energy, new materials, biomedicine, a new generation of information networks, smart grid, green means of delivery, eco-friendly, ocean and aviation, public security, and other strategic developments of emerging industries.

ABOUT SMART MANUFACTURING

This book on smart manufacturing focuses on innovation and transformation from the perspective of interconnection and intelligence leading to manufacturing sustainability. The whole book consists of five sections: 1) Introduction to Smart Manufacturing, 2) Smart Manufacturing Optimization Techniques, 3) Smart Manufacturing Enabling Technologies, 4) Smart Manufacturing Interconnection, and 5) Smart Manufacturing Sustainability.

Section 1, “Introduction to Smart Manufacturing,” includes one chapter:

- Chapter 1: “Introduction to Smart Manufacturing: Value Chain Perspective for Innovation and Transformation” by Zongwei Luo

In chapter 1, an introduction to smart manufacturing innovation and transformation is presented. An example is used to illustrate what is happening in China’s manufacturing industry, with insights about China’s strategy of advanced manufacturing research and development. Emphasis is laid upon the value chain analysis for setting smart manufacturing strategies. A case study is conducted in detail.
Section 2, “Smart Manufacturing Optimization,” includes the following four chapters:

- **Chapter 2**: “Robust Optimization for Smart Manufacturing Planning and Supply Chain Design in Chemical Industry” by Tianxin Cai

- **Chapter 3**: “Meta-Heuristic Structure for Multiobjective Optimization Case Study: Green Sand Mould System” by T. Ganesan, I. Elamvazuthi, K. Z. KuShaari, and P. Vasant

- **Chapter 4**: “Hybrid Evolutionary Optimization Algorithms: A Case Study in Manufacturing Industry” by Pandian Vasant

- **Chapter 5**: “A Framework for the Modeling and Optimisation of a Lean Assembly System Design with Multiple Objectives” by Atiya Al-Zuheri, Lee Luong, and Ke Xing

In chapter 2, a novel methodology is developed for robust optimization for manufacturing planning and supply chain design in the chemical industry, which includes four stages of work. First, the network of chemical supply chain needs to be characterized, where the capacity, quantity, and availability of various chemical sources are determined. Second, the initial situation under steady conditions needs to be identified. Then, the optimization is conducted based on a developed MILP (Mixed-Integer Linear Programming) model in the third stage. Finally, the sensitivity of the manufacturing and transportation planning with respect to uncertainty parameters is characterized by partitioning the entire space of uncertainty parameters into multiple subspaces. The efficacy of the developed methodology is demonstrated via a case study with in-depth discussions.

Chapter 3 focuses on “Meta-Heuristic Structure for Multiobjective Optimization Case Study: Green Sand Mould System.” In engineering optimization, it is often that one encounters scenarios that are Multi-Objective (MO), where each of the objectives covers different aspects of the problem. It is, hence, critical for the engineer to have multiple solution choices before selecting the best solution. In this chapter, an approach that merges meta-heuristic algorithms with the weighted sum method is introduced. Analysis on the solution set produced by these algorithms was carried out using performance metrics.

Chapter 4 focuses on “Hybrid Evolutionary Optimization Algorithms: A Case Study in Manufacturing Industry.” The novel industrial manufacturing sector inevitably faces problems of uncertainty in various aspects such as raw material availability, human resource availability, processing capability and constraints, and limitations imposed by marketing department. This problem has to be solved by a methodology, which takes care of such unexpected information. As the analyst faces manmade chaotic and due to natural disaster problems, the decision maker and the implementer have to work collaboratively with the analyst for taking up a decision on an innovative strategy for implementation. Such complex and hard problems of vagueness and uncertainty can be handled by the hybrid evolutionary intelligence algorithms.

Chapter 5 focuses on a framework for the modeling and optimization of a lean assembly system design with multiple objectives. The newest assembly system is lean assembly, which is specifically designed to respond quickly and economically to the fluctuating nature of the market demands. Successful designs for these systems must be capable of satisfying the strategic objectives of a management in manufacturing company. An example of such systems is the so-called Walking Worker Assembly Line (WWAL), in which each cross-trained worker travels along the line to carry out all tasks required to complete a job. Design approaches for this system have not been investigated in depth, both of significant role in
manual assembly process design, productivity, and ergonomics. Therefore, these approaches have had limited success in actual applications. This chapter presents an innovative and integrated framework, which offers significant potential improvement for productivity and ergonomics requirements in WWAL design. It establishes a systematic approach clearly demonstrating the implementation of a developed framework based on the simultaneous application of mathematical and meta-heuristic techniques.

Section 3, “Smart Manufacturing Enabling Technologies,” includes the following three chapters:

- **Chapter 6:** “Design of Anti-Metallic RFID for Applications in Smart Manufacturing” by Bo Tao, Hu Sun, Jixuan Zhu, and Zhouping Yin
- **Chapter 7:** “Towards Smart Manufacturing Techniques using Incremental Sheet Forming” by J.B. Sá de Farias, S. Marabuto, M.A.B.E. Martins, J.A.F Ferreira, A. Andrade Campos, and R.J. Alves de Sousa
- **Chapter 8:** “Software Development Tools to Automate CAD/CAM Systems” by N.A. Fountas, A.A. Krimpenis, and N.M. Vaxevanidis

Chapter 6 is focused on “Design of Anti-Metallic RFID for Applications in Smart Manufacturing.” A novel long range passive anti-metallic RFID tag fabrication method is proposed in this chapter, in which a multi-strip High Impedence Surface (HIS) with a feeding loop is designed as the antenna radiator. Firstly, the bandwidth enhancement methods for passive RFID tags based on micro strips are discussed. Then, a RFID tag design based on multi-strip antenna is proposed and its radiation efficiency is analyzed. After that, some key parameters of the RFID antenna proposed are optimized from the viewpoint of radiation efficiency and impedance match performance. Targeted for manufacturing plants with heavy metallic interfering, the proposed RFID tag can significantly enhance the radiation efficiency to improve the reading range as well as the bandwidth.

Chapter 7 is focused on smart manufacturing techniques to produce components cheaper and faster. In this sense, the importance of smart manufacturing techniques, proper articulation between CAD/CAM techniques, and integrated design and assessment becomes critical. Concerning components obtained after sheet metal forming operations, like in the automotive industry, it is mandatory to shorten even more products’ lifetime cycle, especially for small batches or rapid prototyping. Considering the technological viewpoint but also economical competitiveness, the Single Point Incremental Forming (SPIF) process represents a breakpoint with traditional forming processes, and possibly a new era in the small batches production or customized parts, being already used by automotive industry for light components. In this chapter, an overview is given on the techniques currently being employed to optimize the process feasibility. Conclusions are made about the future trends in process development, integrating CAD, CAM, and optimization techniques aiming to improve geometrical accuracy and mechanical reliability.

Chapter 8 focuses on automation and customization of engineering software using programming. In today’s modern manufacturing, software automation is a crucial element for leveraging novel methodologies and integrating various engineering software environments such as Computer-Aided Design (CAD), Computer-Aided Process Planning (CAPP), or Computer-Aided Manufacturing (CAM) with programming modules with a common and a comprehensive interface, creating solutions to cope with repetitive tasks or allow argument passing for data exchange. This chapter discusses several approaches concerning engineering software automation and customization by employing programming methods. Main interest is given to design, process planning, and manufacturing, since these phases are of paramount importance when it comes to product lifecycle management. Thereby, case studies concerning
software automation and problem definition for the aforementioned platforms are presented, mentioning the benefits of programming when guided by successful computational thinking and problem mapping. Section 4, “Smart Manufacturing Interconnection,” includes the following three chapters:

- **Chapter 9:** “The Interaction between Design Research and Technological Research in Manufacturing Firm” by Satoru Goto, Shuichi Ishida, Kiminori Gemba, and Kazar Yaegashi
- **Chapter 10:** “The Role of Brand Loyalty on CRM Performance: An Innovative Framework for Smart Manufacturing” by Kijopkin Kasemsap
- **Chapter 11:** “Smart, Innovate, and Intelligent Technologies Used in Drug Design” by S. Deshpande, S.K. Basu, X.P. Li, and X. Chen

Chapter 9 is focused on the interaction between design research and technological research in manufacturing firms. Design has significantly affected innovation, and the discipline of design management focuses on meanings that it brings about a drastic change in the lifestyle of consumers. Although the relationship between design and technology is one of the important issues for the innovation of meanings, there were only a few studies suggesting the comprehensive model that includes design and technology. This chapter shows that an augmenting of both researches may create effectively radical meanings or technologies, and an integration of both researches may create radical meanings and technologies concurrently. The case study of FPD industry examines how some companies create competitive advantages by both researches and the commoditization of technology may cause the transition to the design research from the technological research as source of the competitive advantages. Additionally, the strategic and organizational issues are suggested for conducting the design research and the technological research interactively in the discussion section.

Chapter 10 focuses on “The Role of Brand Loyalty on CRM Performance: An Innovative Framework for Smart Manufacturing.” This chapter introduces the framework and causal model of customer value, customer satisfaction, brand loyalty, and customer relationship management performance in terms of the innovative manufacturing and marketing solutions. It argues that dimensions of customer value, customer satisfaction, and brand loyalty have mediated positive effect on customer relationship management performance. Furthermore, brand loyalty positively mediates the relationships between customer value and customer relationship management performance and between customer satisfaction and customer relationship management performance.

Chapter 11 focuses on “Smart, Innovative, and Intelligent Technologies used in Drug Designing.” Smart and intelligent computational methods are essential nowadays for designing, manufacturing, and optimizing new drugs. New and innovative computational tools and algorithms are consistently developed and applied for the development of novel therapeutic compounds in many research projects. Rapid developments in the architecture of computers have also provided complex calculations to be performed in a smart, intelligent, and timely manner for desired quality outputs. Research groups worldwide are developing drug discovery platforms and innovative tools following smart manufacturing ideas using highly advanced biophysical, statistical, and mathematical methods for accelerated discovery and analysis of smaller molecules.

Section 5, “Smart Manufacturing Sustainability,” includes the following two chapters:

- **Chapter 12:** “Fair Share of Supply Chain Responsibility for Low Carbon Manufacturing” by Yumei Wong
Chapter 12 is focused on “Fair Share of Supply Chain Responsibility for Low Carbon Manufacturing.” A large amount of carbon emissions is emitted, and pollution is generated during the manufacturing process for consumer goods. Low carbon manufacturing has been increasingly asked about or required by stakeholders. However, international trade blurs the responsibility for carbon emissions reduction and raises the questions of responsibility allocation among producers and consumers. Scholars have been examining the nexus of producer versus consumer responsibility among supply chain, and recently, there are discussions on the share of producer and consumer responsibility. Producer or consumer responsibility approach has intrinsic shortcomings and is ineffective in curbing the rise of carbon emissions in supply chains. Shared responsibility based on the equity principle attempts to address these issues. A case study of carbon impact on China’s export and economy with scenarios shows that the benefits of carbon reduction taken by the producers can be trickled down along the supply chain and the motivation of the sharing responsibility can be created under certain circumstances. The share of producer and consumer responsibility for low carbon manufacturing can be enabled when embodied carbon emissions in goods and services are priced and such accurate information is available. A mechanism engaging global participation is recommended. The author calls for further research on the system pricing embodied carbon emission, the universal standard to calculate the embodied carbon emissions and to disclose the information, and the way to secure global cooperation and participation.

Chapter 13 focuses on “Antecedents of Green Manufacturing Practices: A Journey towards Manufacturing Sustainability.” The purpose of this chapter is to explore manufacturing practices that help firms to achieve better environmental and business performance. In short, it can be termed as antecedents “green manufacturing” practices that enhance firm performance. In this chapter, the authors have adopted a secondary literature survey approach to identify variables and identify research gaps. Based on the constructs and items identified through the literature survey, the researchers have developed a structured questionnaire, which was pretested before use as the final survey.

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