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S.C. Lenny Koh
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Enterprise Networks and Logistics for Agile Manufacturing

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Preface

Manufacturing has been one of the key areas that support and influence a nation's economy since the eighteenth century. As the primary driving force behind economic growth, manufacturing 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 has contributed significantly to modern civilisation and created the momentum that drives today's economy. Despite various revolutionary changes and innovations in the twentieth century that contributed to manufacturing advancement, we are constantly facing new challenges in the global marketplace.

Today, agile manufacturing has gained prominence due to recent business decentralisation and outsourcing. Manufacturing companies are competing in a dynamic marketplace that demands a short response time to changing markets and agility in production. In the twenty-first century, manufacturing is gradually shifting to a distributed environment with increasing dynamism. In order to win orders, locally or globally, customer satisfaction is treated as priority. This has led to mass customisation and ever more agile manufacturing processes, from the shop floor to every level of the manufacturing supply chain. At the same time, outsourcing has forged a multi-tier supplier structure with numerous small-to-medium-sized enterprises (SMEs) involved, where enterprise networks are formed and broken dynamically in order to deal with issues of logistics and supply chain management, effectively and efficiently. Moreover, environmental concerns have forced companies to address the recycling and re-manufacturing of end-of-life products, and this has created problems for both the reverse supply chain and reverse logistics. These issues constantly challenge manufacturing companies, and create a lot of uncertainty in agile manufacturing. Engineers across organisations often find themselves in situations that demand advanced planning and management capability when dealing with daily operations related to enterprise networks and logistics.

Targeting the uncertainty issues in agile manufacturing, over the past decade, research efforts have focused on improving the flexibility, adaptability, productivity, agility and leagility of manufacturing, particularly in supply chain management and logistics of decentralised enterprise networks. Various Web-based and artificial intelligence (AI) based tools have been developed to deal with these issues, and many research projects have been devoted to improving the throughput and efficiency of agile manufacturing. Thanks to recent advancements in information technology, research in supply chain management and logistics has progressed to a new level in adaptive decision making and trouble shooting, in order to address the problems encountered in today's enterprise network environment with increasing globalisation and outsourcing. While research and development efforts have resulted

in a large volume of publications and impacted both present and future practices in agile manufacturing, there still exists a gap in the literature for a focused collection of works dedicated to enterprise networks and logistics. To bridge this gap and present the state-of-the-art to a broad readership, from academic researchers to practicing engineers, is the primary motivation behind this book.

As a general overview, Chapter 1 begins with a clear definition of enterprise network, logistics, supply chain, supply network and value chains, and explains the contexts within which they differ. Based on a comparative analysis of the existing literature, this chapter provides a discussion on decentralised decision making and presents both the current status and potential future trends in enterprise networks and logistics within the context of agile manufacturing. The discussion of decentralised decision making is extended in Chapter 2. Particularly, it reviews the research and practices of the industrial networks of the future. This chapter also identifies the fundamental challenges of preparing for the industrial networks of 2020 and beyond. Chapter 3 then introduces a unique perspective showing where agile manufacturing can position itself in complex supply networks. Through a Co-OPERATE project, it aims to develop a Web-based system for improved coordination of manufacturing planning and control activities across a supply network.

Recognising the importance of structure versus operation of an organisation, Chapter 4 focuses its attention around enterprise architecture in order to determine how an organisation can most effectively achieve its current and future objectives. Assuming that a portion of the value of an enterprise architecture initiative is in the form of embedded options (or real options), this chapter proposes the use of real options that allow flexibility for architects to change plans, so that uncertainties can be resolved over time. In light of the current popularity of information and communication technologies (ICT), Chapter 5 reports on ICT standardisation, aiming at ensuring interoperability between the various systems of an enterprise network.

Chapter 6 highlights ways of collaborative demand planning, particularly when information is shared in the downstream supply chain between manufacturer and retailer. It regards information sharing concerning demand signals within supply chains as one of the keys to responding to retail demands with greater agility.

In the area of supply selection, Chapter 7 depicts an empirical analysis of value creation and supplier selection. This chapter also examines the criteria used in the suppliers' selection process and thereby in the supply chain. Continuing this theme, Chapter 8 utilises a fuzzy AHP (analytic hierarchy process) approach to address the supplier selection problem. When faced with incomplete information from experts, the fuzzy set theory is found to be useful to handle uncertainties.

These discussions are extended in Chapter 9 to include a sustainable green supply chain platform in a globally integrated supply chain network. Based on preliminary analyses, this chapter offers some suggestions to help manufacturers and logistics service providers to restructure their supply chain strategies.

The primary goal of a supply chain is to meet the varying demand of customers where coordination among the customers is paramount. Realising this, Chapter 10 proposes a multi-agent self-healing approach that can assist in selecting outsourcing partners, and developing effective coordination among themselves and between manufacturing units. The agent-based approach is extended in Chapter 11 to cover

simulation-based optimisation for supply chain management, and considers the entities (*e.g.* supplier, manufacturer, distributor and retailer) in a supply chain as intelligent agents in a simulation. This chapter also gives an outline on how these agents pursue their local objectives as well as how they react and interact with each other to achieve a more holistic outcome.

In addition to forward supply chains, reverse supply chains are becoming equally important, owing to increasing environmental concerns. Chapter 12 identifies the major barriers of a battery recycling system as an example, and shows how the interaction among those barriers hinders the recycling activities along its reverse supply chain. The issue of the reverse supply chain is further discussed in Chapter 13, looking at the optimal design of reverse logistics and closed-loop supply chain networks.

In a decentralised environment, global logistics services have increased dramatically and become extremely complex and dynamic. The logistics industry is changing in a variety of ways, including mergers to form integrated transportation service providers, outsourcing, and the increased use of information technology. Chapter 14 provides an overview of this evolution and looks at important trends in the logistics services industry. In this sector, routing and scheduling of delivery vehicles often involves complex decision making. Chapter 15 addresses the problem of multiple-vehicle pick-up and delivery, with time windows and heterogeneous capacitated vehicles, using simulated annealing as well as a simple and fast meta-heuristic.

Chapter 16 proposes the use of conventional simulation tools to model and visualise the coordinating behaviours of a networked distributed system. This can be a great assistance in accelerating system development, especially when it is large in size and complex in nature.

Finally, Chapter 17 discusses the implication of robustness and capability indices in the optimisation process of an airline's fleet. It introduces a technique capable of effectively addressing contradicting outcomes and minimising potential losses.

All together, the seventeen chapters provide an overview of some recent R&D achievements in supply chain design, supplier selection, vehicle routing, and system visualisation. With the rapid advancement of ICT, particularly Internet- and Web-based, we believe that this will continue to be a very active research field for years.

The editors would like to take this opportunity 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 Anthony Doyle, Senior Editor for Engineering, and Claire Protherough, Senior Editorial Assistant, for their constructive assistance and earnest cooperation, both with the publishing venture in general and the editorial details. We hope that readers find this book informative and useful.

Skövde, Sweden — Lihui Wang
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Overview of Enterprise Networks and Logistics for Agile Manufacturing

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Abstract

The demand for research and development of enterprise networks and logistics has been on an upward trajectory over the last decades. With a need for more innovative and responsive enterprise network structure, technology and supply chain to deal with an ever-changing and highly competitive market, the agility of processes, organisations and their supply chain, particularly in a manufacturing environment, need to be re-examined. This chapter provides an overview of the current status and potential future trends in this area. More specifically, this will be analysed within the context of agile manufacturing.

1.1 Introduction

The terms of enterprise network, logistics, supply chain, supply network and value chain are often used interchangeably and interpreted synonymously in the literature. The terms carry different meanings, depending on how these terms are interpreted and in what context they are being used.

Taking a normalised perspective from the literature, this chapter begins with a clear definition of their variations and explains the contexts within which they differ. We will then overview and critically analyse enterprise networks and logistics in the context of agile manufacturing. Previous literature in these related fields will be drawn on to provide a baseline for comparative analytics driving the discussions between current and future projections of enterprise network and logistics for agile manufacturing.

1.2 Logistics

Authors often use the term supply chain management synonymously with the term logistics. Logistics is actually a sub-set of supply chain management. Logistics refers to the distribution and movement of materials, components, parts, products and services from one node to another, up and down the supply chain. Logistics involves deciding upon various transportation modes, for example, air, rail, road and sea, to manage the movement and distribution of the above. From an organisational perspective, logistics could also be categorised into inbound and outbound logistics. Inbound logistics deals with managing the inward flow of materials, components, parts, products and services from suppliers or third party logistics to the organisation. Outbound logistics deals with managing the outward flow of materials, components, parts, products and services from the organisation to customers or third party logistics. Many organisations, in diverse industries, do not want to manage their own logistics operation, and use third party services in this area. Fourth party logistics has also emerged providing another layer of services to third party logistics. When the demand on third party logistics is very high and triggers insufficient capacity (*e.g.* fleet and so on) to manage the delivery, fourth party logistics will be used to meet the demand. Both inbound and outbound logistics requires good relationship management with suppliers and customers. The relationship with tier suppliers is paramount and the same applies to tier 1 customers. A tier 1 customer could be a distributor or retailer and this provides a large market size for the product or service. Hence, management of the supply chain is very important in ensuring that the right quality and the right quantity are delivered and received at the right time.

Reverse logistics is equally important given the nature for rework and re-distribution of products in order to satisfy various environmental requirements. When designing a logistics operation, one must consider the element of reverse logistics and how this could be designed into or designed out of the process. Designing reverse logistics into the operation includes considerations such as the methods by which the product could be returned directly to manufacturers. Designing reverse logistics out of the operation includes consideration such as the methods by which good product design eliminates the needs for return (*e.g.* decomposable materials).

1.3 Supply Chain Management

Supply chain management, taking logistics as a sub-set, integrates with all other important elements such as suppliers, manufacturers, distributors, retailers and customers in a holistic whole to ensure that the entire supply chain is integrated upstream and downstream. Supply chain management activities include sourcing, procurement, manufacturing and logistics. In a supply chain, in addition to managing the flow of materials, components, parts, products and services, managing information/knowledge, cash and intellectual capital flow are equally important. Building a long-term partnership with suppliers rather than an arms-length relationship is paramount in a supply chain.