

# Preface

During the 1960s through the 1980s, back when manufacturing dominated the agenda for many private and public sector companies, warehousing was generally viewed as a back-office operation that added little or no value, and in many cases it was treated as an undesirable but necessary cost-center. As the power of lean thinking and just-in-time inventory management spread through the manufacturing sector, one might even say that many “eyes looking for waste” turned to the warehouse, where plenty of excess inventories (considered one of the primary sources of “waste” in lean thinking) were kept in endless rows of racks, reaching heights of 40 ft (12 m) and more. Many individuals, who embarked on applying lean thinking to manufacturing, started to view warehouse design/management as a dead-end career.

However, two fundamental changes started to take shape, and it is not clear that either one of the changes were anticipated by the research or the industrial community. At least, it seems no one anticipated how fast the changes would occur, and how deep their impact would be. First, competition, which traditionally was mostly a regional phenomenon, confined primarily to continents or limited by geography, became global. Well-established, multi-national corporations as well as new companies just entering the market began to compete on a global scale never seen before. And the competition was not only for reaching large numbers of customers in existing and new markets, but it was also for identifying and utilizing sources of low-cost labor in every corner of the world. As a result, the manufacturing sector underwent a tremendous transformation, and in the process, global supply chain design and management emerged as a top-priority topic for many companies as well as the research community. In fact, a quick Google search on “global supply chain” generates over 750,000 hits on the web. Based only on articles, and excluding patents, a search of the same subject in Google Scholar generates over one million results!

A global supply chain, however, is not just an abstract entity composed of policies, supplier contracts, purchasing agreements, etc. that exist on a computer network or database. Rather, a global supply chain, in order to function properly, is an entity supported by a logistics system that makes it possible to move a variety

of goods through the system in a timely and cost-effective manner. When the supply chain is viewed as a network, transportation systems such as trucking, railways and shipping/air lines represent the “arcs” in the network, while the facilities that handle the goods through the network represent the “nodes.” Such facilities include:

- Manufacturing facilities
- Warehouses and distribution centers
- Container terminals (or seaports)
- Consolidation/deconsolidation centers
- Rail yards
- Crossdocks
- Airports (handling freight)

When viewed in the above context, warehousing—which takes place in all of the above facilities, to one extent or another—suddenly becomes a critical component of the global supply chain. In other words, as their supply chains extended around the globe, companies began to recognize that where and how raw materials, components and (semi) finished goods are stored in the network have a major impact on their operations, their agility/flexibility, their service levels and responsiveness to their customers, and their overall costs. The above recognition by no means implied that storing excess inventories became acceptable or desirable. Rather, as companies watched their supply networks get longer and more complex, and as they learned to apply lean thinking to their supply networks, they realized that warehousing the right amount/type of inventory in the right/most strategic locations can be a major competitive advantage. In the process, many companies also learned that warehousing is not only a point of storage in the network but also a point of critical information. That is, as supply chains became leaner, timely and correct information, especially inventory visibility and accuracy, which is a key function in warehousing, became essential for success.

The second fundamental change that impacted warehousing is the emergence of online shopping or e-tailing, especially in the United States and other developed/developing countries around the world. For example, according to CNNMoney.com and Virginia-based comScore, consumers in the United States spent a record 30.8 billion dollars shopping online during the month of December 2010. This figure represented a 13% increase from the same period in 2009, despite the recession. The growth in e-tail in Europe has been equally impressive. According to a BBC News article, for example, under the heading “online shopping defies slowdown,” it is reported that the e-tail growth rate is about ten times that of the growth rate of the traditional retail market in the United Kingdom as a whole, and it is forecast that online retail sales would reach almost 45 billion pounds by 2012, which represents roughly 14% of the total spending. Other projections on e-tail are equally startling. According to Forrester Research, web-based sales in the United States will reach 249 billion dollars by 2014, and in western Europe, online retail

sales are projected to increase by 68% from 68 billion euros in 2009 to 114 billion euros by 2014!

The phenomenal growth in e-tailing has had (and will continue to have) a major impact on warehousing and parcel/package delivery systems from the warehouse to the customer. That is, stocking the items that the customers need/want, picking, packing and shipping these items to the customers on a timely basis, and doing so with maximum accuracy, has now become a big and very viable business model, which transformed the warehouse from a back-office cost-center to a front-office profit-center! As a result, designing and operating a warehouse, and its various functions such as storage, order picking, sortation and so on, in the most efficient and effective manner has become a front-and-center concern for companies that are competing for a slice of the growing e-tail market.

Given the above changes, and the renewed focus on warehousing, a book concerned with advanced models, tools and applications for storage systems could not have been more timely. In the pages of this book, the reader will find a rich collection of insightful and practical models and algorithms presented in a series of chapters arranged in a logical, easy-to-follow manner. The models and algorithms presented cover a wide range of topics, such as order picking/batching and warehouse layout, and a wide range of systems, including automated systems (such as Automated Storage/Retrieval Systems), semi-automated systems (such as carousels) and manual systems (such as walk-and-pick systems). The book is further enriched with a section devoted to applications and case studies that show how theory is applied in practice. I congratulate the editor and the authors for their hard work and for putting together a book that is going to serve as an excellent reference for researchers and warehousing professionals alike.

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Warehousing in the Global Supply Chain  
Advanced Models, Tools and Applications for Storage  
Systems

Manzini, R. (Ed.)

2012, XXII, 486 p., Hardcover

ISBN: 978-1-4471-2273-9