Springer Berlin Heidelberg New York
springer.com

Supply Chain Engineering:

Useful Methods and Techniques

Alexandre Dolgui and Jean Marie Proth

2010, XX, 539 p. 149 illus., Hardcover, ISBN: 978-1-84996-016-8

http://www.springer.com/engineering/production+eng/book/978-1-84996-016-8

About this book

This book considers how modern production and operations management (POM) techniques can respond to the pressures of the competitive global marketplace by integrating all the activities in supply chains, adding flexibility to the system, and drastically reducing production cost. Several challenges for POM are answered. This book proposes comprehensive analysis of concepts and models to choose outsourcing strategies, and dynamic pricing policies. Efficient inventory management techniques in Supply Chains, Radio Frequency Identification (RFID) technologies, as well as the methods for the design flexible and reconfigurable manufacturing systems (RMS) are presented. A significant place is devoted to lean manufacturing, line balancing (assembly lines, U-lines, bucket brigades), dynamic facilities layout approaches and new warehousing techniques. Real-time assignment and scheduling methods are also developed.

Written for:

This book is written for students and professors in industrial & systems engineering, management science, operations management, and business, as well as industrial managers looking to improve the efficiency and effectiveness of their production systems. Readers will appreciate the way explanations are given using basic examples, providing detailed algorithms, while discarding complex and unnecessary theoretical details. In addition, all the examples and in fact everything that is introduced has been carefully chosen taking into account eventual industrial application.

Table of contents:

Preface

Supply Chain Engineering is an emerging field based on analysis and comprehension of essential principles of production and distribution systems. This scientific domain concerns the methodical evaluation and optimization of production systems, logistics networks, and their management policies to increase the effectiveness of multifaceted demand and supply chains.
Worldwide competition has grown ever stronger since the beginning of the eighties. The pressure of the competitive global market has intensely affected the production systems, calling for:

- Integration of the activities that cover the whole production spectrum from customers' requirements to payment.
- Flexibility in face of customer demand changes.
- Drastic reduction of production costs.

To reach these objectives, radical changes have been introduced in production systems, thanks to new manufacturing technologies that increase efficiency and IT technologies that improve system organization and management.
Furthermore dynamical pricing and revenue management, which proposes approaches that define the price of the products based on market situations, attracts more and more researchers and practitioners. Pricing accents the return on the investment.
Supply chains are emblematic examples of the renewal of production systems in the last decades. It is through this new paradigm that cost reduction and service enhancement can be achieved. To make this easier to implement, new types of manufacturing systems have been introduced, for example: Reconfigurable Manufacturing Systems (RMS), assembly lines with worker's flexibility, bucket brigades or U-shaped assembly lines. Over the same period, new technologies arose to monitor the state of systems in real time. We can mention Radio Frequency IDentification (RFID), Internet applications or "intelligent" storage facilities, to name a few. These technologies favor one of the most important objectives of production systems management: the ability to make a decision almost immediately.
Radical changes in the criteria that express the new objectives of production systems in the face of competition are another important aspect. The introduction of some new criteria reflects the Just-In-Time (JIT) requirements. For instance, conventional scheduling optimization is now restricted, in the best case, to deciding the order products are launched in production. In other words, the conventional scheduling activity migrated from the tactical to the strategic level. In actual production systems, this is replaced by a real time scheduling, also called real time assignment. Other criteria are used to reflect quality, flexibility and Work-In-Progress (WIP): adequate quality is now unavoidable to meet customers' satisfaction; flexibility is a necessary condition to remain competitive in an ever changing market; and reduction of WIP is a factor to minimize the production cost and the probability of obsolescence.
The authors of this book collaborate closely with companies. They have been charged with numerous contracts covering a wide range of industrial activities, including steelmaking, aerospace research, car manufacturing, microelectronics, and machining industry. In these areas, authors worked on design and management problems. They reached the following conclusions:

- The difficulty for companies lies much more in determining the exact nature of a problem and defining the criteria to be taken into account, than in solving the problem itself.
- The models available in literature are often difficult to apply in real life, due to the assumptions that were made in order to have a treatable model.
- To be acceptable to companies, models must be simple, easy to apply and adjustable to the systems under study.

These conclusions are also taken into account in this book.
This reference work presents a general view of new methods, techniques, resources and organizations that have erupted in the production domain during the past two decades. The objective of the authors was to furnish the best applied approaches. Of course, if a theoretical approach is more convenient to provide the essentials of the system under study, then it was included. Furthermore, when a simple and efficient model exists to represent an industrial situation, we discard more complicated models that do not provide significantly better results, even if they are widely cited in literature.
The book is organized into 11 chapters with 5 appendices. The following topics are covered.
Chap. 1 should be considered as an introduction to pricing. After outlining the importance of pricing to increase revenue, and providing the most common definitions in use in the field, pricing strategies are presented. The mechanisms that link costs, price and margin are analyzed. The selling curve is introduced and several methods to find the characteristics of importance to customers are developed. This chapter ends with price strategy in the oligopoly market.

Chap. 2 has as main goal to introduce stochastic dynamic pricing models with salvage values. The constraints to apply to make this model manageable are given. Pricing models for time dated items, with no supply option, in monopolistic environment, and with myopic customers are presented in detail.
Chap. 3 concerns outsourcing, which is little studied academically in spite its importance in the actual global market place. After defining the main notions, the most common benefits that may be expected from outsourcing are presented. The steps that lead to outsourcing are detailed. In particular, a vendor selection and evaluation model is developed and several approaches to solve this multicriteria problem are proposed. The strategic outsourcing in the case of a duopoly market is then developed exhaustively. The arguments of the Pro and Cons are explored. One of original aspects of this chapter lies in the analysis of offshoring in China. Some arguments in this discussion are quite different from the ones usually used in the literature. The reason may be that the effects of offshoring on workers in developed countries are taken into account.
Chap. 4 considers inventory management in Supply Chains. The advantages of sharing information among the different levels of a Supply Chain are discussed. A particular attention is given to the bullwhip effect and the actions to be taken in order to reduce this undesirable phenomenon. Some usual and robust models are highlighted such as the Newsboy (or Newsvendor) model, finite horizon model with stochastic demands and well known (R, Q) and (s, S) models. For the last two models, we show how simulation can be used to find the "optimal" values for their parameters. Echelon stock policies, which are tools that meet supply chain requirements, are analyzed along with their complimentary tools, as Material Requirements Planning (MRP) and Manufacturing Resources Planning (MRP2). Due to the importance of the subject (mainly at the design level), we also review the most common lot sizing models.
Chap. 5 gives a brief description of the RFID (Radio Frequency Identification) technology. An analysis of the parameters of importance when selecting tags is conducted and a succinct guideline for RFID deployment is suggested. Some applications are reviewed and the importance of this technology for the efficiency of Supply Chains is outlined. The main domains where RFID is applied routinely are listed. The evaluation of this technology, and in particular the financial implication, is performed. A special section deals with privacy concerns that are an important problem of RFID in today's situation. The last section raises the problem of authentication, which is especially significant for the case of counterfeit tags.
Chap. 6 entitled "X-Manufacturing Systems" presents an overview of manufacturing system organizations. This chapter influenced by the heavy demands for flexibility and adaptability of manufacturing systems in the modern environments. The history of the concept of flexibility is presented and the majority of production system concepts are analyzed: Dedicated Manufacturing Lines (DML), Flexible Manufacturing Systems (FMS), Agile Manufacturing Systems (AMS), Reconfigurable Manufacturing Systems (RMS) and Lean Manufacturing Systems (LMS). Each is defined, its advantages and drawbacks are studied and some illustrative examples are reported. Comparisons are made among them and their appropriateness to supply chains is highlighted.
Chap. 7 develops a complex and essential issue (particularly for Lean Manufacturing) of line balancing which consists in minimizing the total idle time. The models examined in this chapter have deterministic times. The COMSOAL approach is analyzed comprehensively along with possible improvements. Other algorithms the most frequently mentioned in the literature, such as RPW, KW-like heuristic, B&B-based and mathematical approaches, are also presented and illustrated. The use of meta-heuristics is shown in the third part of this chapter. Simulated annealing, taboo search and genetic algorithms are discussed. Then, the properties and evaluation of line balancing solutions are underlined. We go also over the evaluation criteria for line balancing from literature.
Chap. 8 generalizes assembly line balancing models presented in the previous chapter to stochastic operation times and mixed models with several types of products assembled. The problems tackled in this chapter are examined from a practical point of view. In particular, probabilities are defined as is usually done in companies, *i.e.*, by three parameters: minimum, most frequent and maximum values of the variable under consideration. This leads to the notion of triangular density. Problems are solved numerically. A powerful tool is proposed for computing the integration of functions: Tchebycheff's polynomial approach. Numerical examples are presented to illustrate these realistic solutions. Finally, the new concepts of dynamical work sharing are explained using the examples of the bucket brigades and U-shaped assembly lines.
Chap. 9 is devoted to the control reactivity which is becoming a pivotal factor for competitiveness. We show that the static scheduling is slowly vanishing from the industrial environment. It is replaced by dynamic scheduling and real time assignment approaches that are able to provide an optimal or near-optimal solution in real time. The most popular priority (or dispatching) rules are presented first, followed by a second type of dynamic scheduling called "repair based approach" that consists of computing a static schedule at the beginning of the working period and adjusting it in case of unexpected events.
Chap. 10 concerns facility layout design. Until the 80s, the objective was to optimize the layouts assuming that the environment remained basically steady. This situation is referred to as Static Facility Layout (SFL). Linear layouts, functional department layouts and cellular layouts are studied in the first part of this chapter, as well as tools and algorithms used to perform optimal layout designs. In the middle of the 90s, the problem evolved toward Dynamic Facilities Layouts (DFL) and Robust Layouts (RL) to meet the needs of enterprises manufacturing multiple products in a rapidly changing market. Most results in these areas concern only the

location of manufacturing entities on the available factory surface at the design stage. Rapid advances in mechanical engineering and manufacturing organization may lead to the possibility of real-time rearrangement in the near future.
Chap. 11 presents warehousing. Certainly, warehouses are critical components of production systems. In this chapter, their usefulness is highlighted and various functions and equipment are analyzed. Recent advances such as the value added services and their corresponding areas are covered. Special attention is paid to the warehouse management, in particular, to the main difficulties faced by their managers. The design stage is also extensively considered via developing storage algorithms for unit-load warehouse as well as examining warehouse sizing static and dynamic models. The last section of this chapter concerns the location of warehouses. Single- and multi-flow location problems are put forth. Remember that layout techniques, which also concern warehouses, were presented in Chap. 10.
Five types of optimization techniques are reported and illustrated at the end of the book in **appendices**. Each one of the approaches covered in these appendices has been used in at least one chapter to solve real life problems:

- The first appendix explains stimulated annealing method.
- The second is devoted to dynamic programming based on the optimality principle.
- The well known Branch-And-Bound (B&B) method is explained in the third.
- The fourth presents taboo search approach.
- Genetic algorithms are presented in the last appendix.

We had several audiences in mind when this book was written.
In companies, the people in charge of management, production, logistics, Supply Chains, and looking for suggestions to improve the efficiency of their systems, will be certainly interested in many of the advances covered in this book. They also will appreciate the way explanations are given by using basic examples, providing detailed algorithms, while discarding complex and unnecessary theoretical developments. To summarize, this book is written for managers and engineers with analytical backgrounds, who are interested in capturing the potentials and limits of the recent advances in production and operations management.
The academic audience consists of the many researchers working in topics related to Operations Research, supply chain management, production system design, facility layout, scheduling, organization, *etc*. This book will also be useful to professors who teach industrial and systems engineering, management science, operations management as well as business management specifically because of the carefully chosen examples that are provided and the application oriented approach in which the notions are introduced.
To summarize, this book is within the comprehension of industrial managers having an analytical background and eager to improve the efficiency of their company, as well as researchers and students working in various related areas.
The authors acknowledge Mrs. Marie-Line Barneoud for help in formatting of this book and Mr. Chris Yukna for his help in proofreading the English.

Alexandre Dolgui
Jean-Marie Proth

France, February 2009

Contents