Introduction

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Supply Chain Management – just another short-lived management philosophy? The gains that have been realized when adopting *Supply Chain Management* (SCM) and Advanced Planning are impressive:

- Hewlett-Packard cut deskjet printer supply costs by 25% with the help of inventory models analyzing the effect of different locations of inventories within its supply chain. This analysis convinced Hewlett-Packard to adopt a modular design and postponement for its deskjet printers (Lee and Billington 1995). In 2004 Billington et al. (Billington et al. 2004) gave an account of a thorough analysis of Hewlett-Packard's inkjet cartridge supply chain. As a result savings of $80 million (in net present value) were achieved by a move of transocean freight lanes from air to sea despite an increase in supply chain inventory.
- Car manufacturer BMW applied a strategic-planning model to its global production sites. By reallocating the supply of materials as well as the distribution of finished cars to the global markets it is expected that investments and costs for materials, production, and distribution will be reduced by about five to seven percent (Fleischmann et al. 2006).
- Intel Corporation devised a suite of capacity models of production facilities along the semiconductor supply chain in collaboration with its key suppliers. Now, Intel has access to all the suppliers' models but holds each in strictest confidence. These models may well be used for various planning horizons (next 5 years, next 9 months, or next 8 weeks). While Intel profits from a better exploitation of bottlenecks the suppliers' benefits are more accurate requests and forecasts from Intel. Dollar savings of hundreds of millions are estimated for the suppliers and tens of millions for Intel (Shirodkar and Kempf 2006).
- Swift & Company owns slaughter and processing operations at five plants in the US. An advanced scheduling and capable-to-promise (CTP) software solution was created which enables Swift to answer customer queries within seconds, i.e. to promise the shipment of an order-line-item quantity on the requested date given the availability of cattle and plant capacities over a 90-days planning horizon. The project's return on investment in the first year of production was 200 percent (Bixby et al. 2006).

These impressive gains show the potential of coordinating organizational units and integrating information flows and planning efforts along a supply chain.

Which manager can afford not to present such substantial gains in improving competitiveness? Nowadays, these gains cannot be achieved by one company alone, because companies have attempted to concentrate their business on those activities which they know best – their core competencies. As a result, all other activities have been outsourced to other firms, when possible. Consequently, the characteristics and the quality of a product or service sold to a customer largely depend on several firms involved in its creation. This brought about new challenges for the integration of legally separated firms and the coordination of materials, information and financial flows not experienced in this magnitude before. A new managerial philosophy was needed – Supply Chain Management.

As with many management philosophies, impressive gains reported from pilot studies are promised. Often a few principles build the main body of such a new management philosophy. Since there are usually many more facets involved in managing a company successfully, some neglected factors may give rise to improvements achievable by the next management philosophy highlighted a few years later. Still, each management philosophy usually contains some building blocks that are advantageous and will survive over a longer period of time.

No great fantasies are needed to forecast that SCM will not be the ultimate managerial philosophy, although in our opinion it has many more facets than most of its predecessors. Since there are several facets to look at, SCM is difficult to grasp as a whole. While being aware of the broad area covered by SCM, this book will concentrate on recent developments in coordinating materials and information flows by means of the latest software products – called *Advanced Planning Systems* (APS). During the past fifteen years progress in information technology – like powerful database management systems – communication means – like *electronic data interchange* (EDI) via the Internet – as well as solution methods to solve large quantitative models – e. g. by mathematical programming – opened up new perspectives for planning and controlling flows along a supply chain. A customer's order, demand forecasts or market trends may be exploded into required activities and sent to all parties in the supply chain immediately. Accurate schedules are generated, which secure order fulfillment in time. Roughly speaking this is the task of APS. Unlike traditional *Enterprise Resource Planning* (ERP) these systems try to find feasible, (near) optimal plans across the supply chain as a whole, while potential bottlenecks are considered explicitly.

It is our intention to provide insights into the principles and concepts underlying APS. In order to better understand and remember the structure of our book a mind-map has been created (Fig. 1). Part I of the book introduces the basics of SCM starting with a definition of SCM and its building blocks. The origins of SCM can be traced back into the fifties, when Forrester (1958) studied the dynamics of industrial production-distribution systems (see Chap. 1).

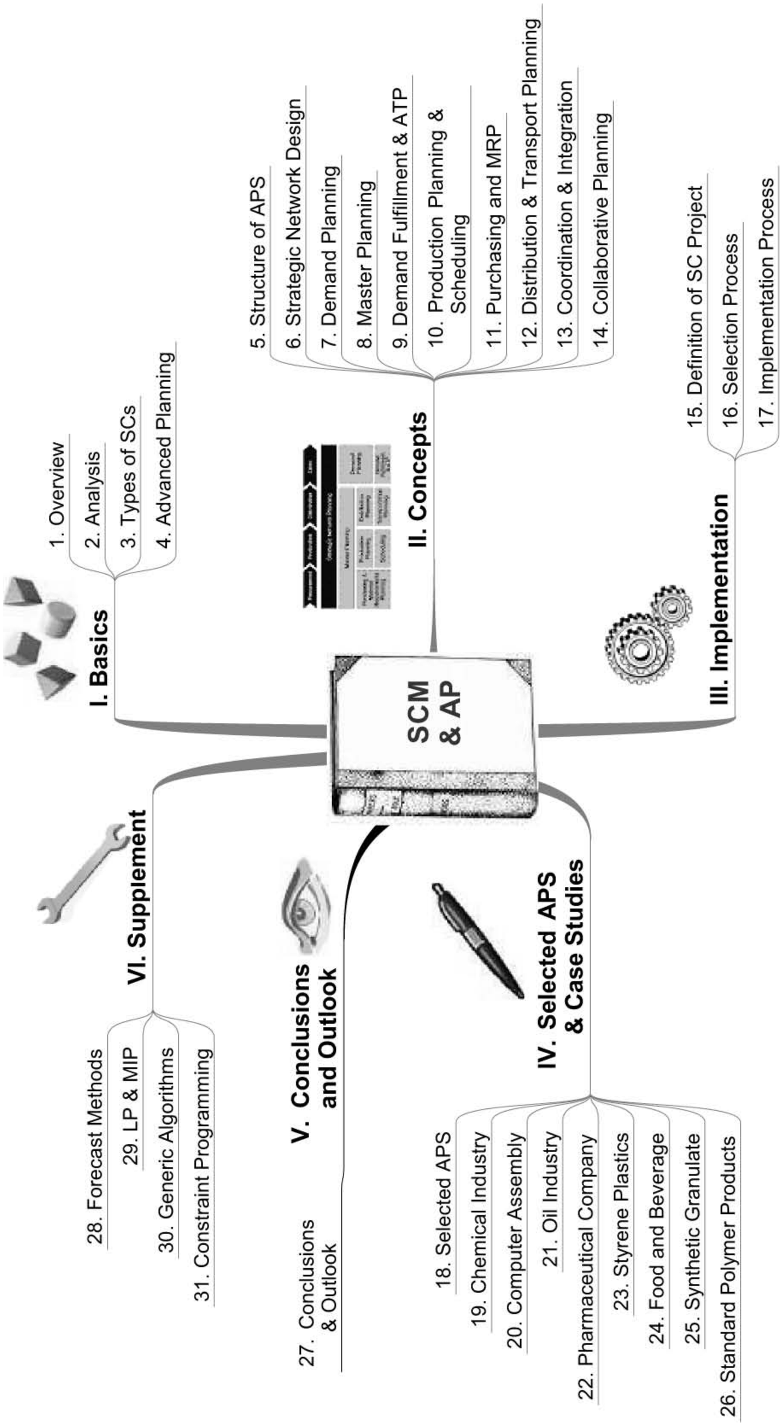

Fig. 1. Structure of this book

As a first step of introducing APS in industry it seems wise to document and analyze the current state of the supply chain and its elements (Chap. 2). A suitable tool for analyzing a supply chain are (key) performance indicators. They can provide valuable insights and guidance for setting targets for an SCM project. A well-known tool for analyzing a supply chain – the SCOR-model – provides a very valuable graphical representation with different levels of aggregation supplemented by performance indicators. Often, inventories at different locations in the supply chain are in the center of interest of management. Hence, we discuss potential reasons for the existence of inventories.

Although APS are designed to be applicable for a number of industries, decision problems may vary widely. A typology of supply chains (Chap. 3) will help the reader to identify which characteristics of a specific APS match the requirements of the supply chain at hand, and which do not, thereby guiding the selection process of an APS. Examples from industry illustrate different types of supply chains. Chapter 4 introduces the basics of advanced planning by applying the principles of hierarchical planning and explains the planning tasks along the supply chain by means of the supply chain planning (SCP) matrix.

Part II describes the general structure of APS (Chap. 5) and its modules in greater detail following the SCP matrix. Part II, however, will not only concentrate on functions and modeling features currently available in APS, but it will also describe ideas we regard to be good Advanced Planning and thus should be included in future releases of an APS. The presentation of concepts underlying these modules starts with strategic network design (Chap. 6) followed by operational planning tasks for procurement, production and distribution. The quality of decision support provided by an APS largely depends on an adequate model of the elements of a supply chain, the algorithms used for its solution and the coordination of modules involved. Chapters 7 to 12 describe the many modeling features and mention solution procedures available to tackle different planning tasks without explicitly referring to specific APS. Although several modules have been identified, software vendors claim to offer a coherent, integrated software suite with close links to ERP systems. These linkages are the topic of Chap. 13.

In case a supply chain consists of several legally separated organizations, planning functions (usually) will not be controlled by a single, centralized APS. Instead, each partner will perform its own decentralized planning functions supported by an individual APS. Here, collaborative planning comes into play (Chap. 14) where SC partners agree on the exchange of data and the coordination of planning processes. The overall objective is that the supply chain works in the most effective manner, i.e. ideally without interrupting the flow of information, materials and financial funds.

Part III is devoted to the implementation of an APS within a firm or supply chain. Obviously, this requires a lot more than modeling. Often a consultancy company is hired to provide the expertise and manpower needed to introduce new, more efficient processes, to customize the APS and to train personnel. Hence, we describe the tasks necessary for introducing an SCM project (Chap. 15), the selection process of an APS (Chap. 16) and its implementation in industry (Chap. 17).

Recalling the general structure of APS (Chap. 5), Part IV now considers specific APS offered by Aspen Technology, i2 Technologies, Oracle and SAP. It starts by pointing out differences in architecture (Chap. 18), followed by eight case studies. Here we demonstrate how concepts and ideas outlined in the preceding chapters are applied to industrial practice with the help of actual APS. The first case study (Chap. 19) addresses the (re-)design of the distribution network of a large chemical company including its 14 production sites. The next three case studies (Chaps. 20 to 22) provide valuable insights into the planning processes encountered in specific industries and how these can be supported by an APS. The following three case studies are mainly concerned with the implementation of specific APS modules, like demand planning (Chap. 23), master planning (Chap. 24) and scheduling (Chap. 25). In the latter, special emphasis has been given to show how to model supply chain elements in detail.

Although extremely powerful today, the functionality of an APS may not suffice to adequately model all the features required to solve a customer's decision problem. Here, a combination of both a standard APS and an individual software module may be a means to an end as will be shown in Chap. 26.

Part V sums up our experiences and gives an outlook of potential future developments.

Finally, a supplement (Part VI) provides a brief introduction to major algorithms used to solve the models mentioned in Parts II and IV and should enable the reader to better understand how APS work and where their limits are. Especially, forecast methods relate to Demand Planning (Chap. 28). Linear and mixed integer programming models are the solution methods needed if optimal master plans or distribution plans are looked for (Chap. 29). Last but not least, constraint programming and genetic algorithms constitute alternative solution engines within the scheduling module, where suitable sequences of jobs (orders) on multiple resources have to be generated (Chaps. 30 and 31).

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