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Book Review

Irfan M. Ovacik and Reha Uzsoy

Decomposition methods for complex factory scheduling problems

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Delivery and lead-time performance have become key performance criteria for manufacturing companies. Besides reduced lead-times and reliable due dates, customers want customized products, resulting in large product varieties and small production batches. As a result, many new production technologies are used, resulting in processes that are difficult to control. This book discusses scheduling algorithms for complex manufacturing facilities and focuses on a specific industrial context, namely semiconductor manufacturing.

In Chapter 1, the authors introduce the factory scheduling problem – the problem of assigning machines to jobs on the shop floor to achieve desired levels of shop performance. Chapter 2 discusses the industrial context that motivated their research: semiconductor manufacturing. The four basic steps in semiconductor manufacturing are wafer fabrication, wafer probe, assembly or packaging, and final testing. The authors formulate the factory scheduling problem (FSP) as a job shop scheduling problem and compare it with the classical job shop scheduling problem. The FSP is more or less the classical job shop scheduling problem with some additional features:

1. Due date related performance measures.
2. Reentrant product flows.
3. Different types of production equipment with different scheduling characteristics.

Since the classical job shop scheduling problem is already very difficult to solve optimally, the authors propose to use heuristic decomposition methods (Chapter 3). They distinguish temporal (hierarchical/linear), entity (operation/job/workcenter), and hybrid decomposition schemes. Chapter 4 discusses the disjunctive graph representation of the classical job shop scheduling problem and shows how it can be adapted to represent the FSP, where, e.g., set-up times occur on the machines.

The Shifting Bottleneck procedure of Adams et al. [1] is a workcenter-based decomposition procedure that uses this representation to solve instances of the classical job shop scheduling problem. Several versions of this procedure are compared in Chapter 5 with a number of priority rules that are common in practice. In Chapter 6, the SB procedure is applied for scheduling semiconductor testing facilities. It appears that there is a need for better subproblem solution procedures. For example, the need to have algorithms to schedule a workcenter (consisting of one or more identical machines), taking set-up times into account. Chapters 7 and 8 discuss such algorithms, which are based on time-based decomposition.

In Chapter 9, the authors address time-based decomposition (rolling horizon) procedures for the FSP, using the algorithms developed in Chapters 7 and 8 for scheduling workcenters. The procedures combine a degree of global information

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with optimization to make dispatching decisions. Chapters 10 discusses a specialized decomposition procedure combining the solution procedures of Chapters 7 and 8 with control structures exploiting the special structure of the semiconductor testing environment. These procedures are tested in Chapter 11 on data which are based on real-life instances. Chapter 12 studies the effects of control structures and subproblem solution quality on the global performance of decomposition procedures.

This book is written clearly and it discusses relevant practical problems. The developed procedures are tested and compared to existing procedures very extensively. It indicates that for many companies it may be beneficial to switch from using simple scheduling rules to more sophisticated procedures, like the ones presented in this book. The book does not contain results of complex theoretical research efforts. This however, makes the book also accessible for practitioners also.

J.M.J. Schutten
Production and Operations Management Group
Faculty of Mechanical Engineering
University of Twente
P.O. Box 217
7500 AE Enschede
The Netherlands

Reference

[1] J. Adams, E. Balas, D. Zawack. The Shifting Bottleneck procedure for job shop scheduling, Management Science 34 (1988) 394–401.