Book review

Michael L. Pinedo, *Planning and Scheduling in Manufacturing and Services* , Springer , Berlin, 2005, ISBN 0-387-22198-0, 506pp., € 59.95.

"*Planning and Scheduling in Manufacturing and Services*" written by Michael L. Pinedo and published in the *Springer Series in Operations Research* is a recent book intended for a senior level or master level course on planning and scheduling either in an engineering or a business school.

The book consists of four parts. Part I introduces the main features of scheduling models in manufacturing and in services. Part II focuses on models in manufacturing, in particular on project planning and scheduling, machine and shop scheduling, flexible assembly systems scheduling, economic lot scheduling, and supply chain scheduling. Part III focuses on models in services, in particular on timetabling, scheduling in sports and entertainment, planning and timetabling in transportation, and workforce scheduling. Part IV deals with planning and scheduling system design, development and implementation.

Part I consists of Chapters 1–3. Chapter 1 takes the reader through a number of environments ranging from an automobile assembly line through a soccer league tournament to hospitals and airports in order to underline the role and the impact of the planning and scheduling function on modern manufacturing and service systems. Chapters 2 and 3 describe the basic characteristics of the manufacturing and service models considered in Parts II and III.

Part II consists of Chapters 4–8. Chapter 4 is a primer on project scheduling. It covers the CPM and PERT methods, the time/cost trade-off analysis, and project scheduling with personnel constraints. Chapter 5 focuses mainly on minimizing the makespan in a job shop. It covers the disjunctive graph model of job shops, the shifting bottleneck heuristic, and the job shop solution using constraint programming techniques. Chapter 6 considers mixed-model assembly systems. It covers assembly line sequencing to minimize cycle time and the Goal Chasing heuristic to produce a sequence of models that keeps the usage rates of all parts as constant as possible. Chapter 7 covers various ELSP models and heuristics for their solutions. Chapter 8 presents a framework for a global optimization of the entire supply network where particular nodes can be optimized locally through the methods discussed in Chapters 5–7.

Part III consists of Chapters 9–12. Chapter 9 considers reservation and timetabling models. The former are important in hospitality industries, the latter in the scheduling of events such as meetings, classes, and exams. The chapter covers the problem of maximizing the number of activities assigned, the timetabling problem with workforce constraints, and timetabling problems with operator or tooling constraints. The associated graph coloring problems are also presented. Chapter 10 discusses the scheduling of tournaments and programs in broadcast television. It covers integer and constraint programming, and local search frameworks for tackling various features of the tournament optimization of the US college basketball, major league baseball, and European soccer. It also covers integer programming model for scheduling network television programs. Chapter 11 focuses on the scheduling of oil tankers, the routing and scheduling of aircraft, and the timetabling of trains. It presents integer programming models (and their branch-and-bound solvers) of tanker scheduling, and aircraft routing and scheduling. The MIP model of the train timetabling problem is also presented.

Chapter 12 considers various models for workforce scheduling. They include the shift scheduling of nurses in hospitals or operators in call centers, and crew scheduling in airlines or trucking companies. The chapter presents an algorithm for days-off scheduling, the linear programming model of shift scheduling and cyclic staffing, and the integer programming model of crew scheduling and operator scheduling in call centers.

Part IV consists of Chapters 13 and 14. Chapter 13 deals with the design, development, and implementation of planning and scheduling systems. It covers database, object base, and knowledge base issues, modules to generate plans and schedules, user interface, and interactive optimization. Chapter 14 discusses some advanced topics in system design. They include robustness, learning mechanisms, systems reconfigurability, and Internet related features. It provides brief introductions to measures of robustness, machine learning mechanisms (case-based reasoning and neural networks, for instance), and to design of scheduling engines and algorithm libraries. Chapter 15 provides the author's view on what lies ahead for planning and scheduling.

A typical chapter in Parts II and III introduces a specific scheduling problem, formulates its mathematical model, discusses solution methods for the model, and closes with an interesting, real-life case to illustrate a practical solution to the problem. These cases include: Multi-product Planning and Scheduling at Owens–Corning Fiberglass, Scheduling the Atlantic Coast Conference Basketball Tournament, the classroom assignment problem at UC Berkeley, and Carmen Systems: Designs and Implementations, among others. The cases (more of them can be found on a CD-ROM accompanying the book), along with a selection of exercises at the back of chapters, make the book particularly appealing to teachers who look for a course text for their scheduling courses. This audience will also find the Power Point presentations on the CD-ROM very helpful. These presentations come from a selection of academic and commercial institutions.

Finally, the book's six appendices provide a sufficiently detailed overview of all solution techniques used in the book, which makes the book self-sufficient. Appendix A gives an overview of mathematical program formulations of scheduling problems. Appendix B overviews dynamic programming, and branch-and-bound procedures for integer programs. Appendix C gives an overview of dispatching rules, beam search, simulated annealing, tabu search, and genetic algorithms. Appendix D overviews constraint programming. Appendix E provides a useful overview of commercial and academic scheduling systems. Appendix F gives a crash course in the educational version of the LEKIN scheduling system, a teaching tool for job shop scheduling that can be found along with ILOG OPL Studio (Trial Version) and Dash Optimization Software on the accompanying CD-ROM.

The book is very well organized and very well written. Its modular structure (manufacturing-services-implementation) and the relative independence of its chapters allow for much flexibility in the design and delivery of a course on planning and scheduling. The book's lucid style that has been perfected throughout Michael Pinedo's work on his earlier successful books on scheduling, will help any reader with a reasonable background of operations research to grasp the main ideas rather quickly. The book makes hardly any use of the theory of computational complexity, a compromise consistent both with its applied orientation and with the mathematical background of its main engineering and business school audiences.

For a researcher working in the increasingly fragmented, technically diverse, and demanding field of scheduling, the book will serve as a general guide to planning and scheduling applications and their mathematical models. Undoubtedly, all these features make the book very attractive and warmly recommended by this reviewer.

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