Optimization Models and Concepts in Production Management

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PREFACE

Motivation

Production Management (PM) is the subject of several multi-authored books; indeed, books consisting of collections of papers outnumber by far the 'true' books on this topic. Most of such literature is based on revised conference proceedings, and, though interesting for the scholar, is often difficult to read for the newcomer or the practitioner. Therefore, the reader may well wonder about the reasons behind this book.

A huge amount of scientific literature deals with the application of formal optimization methods to PM problems. Despite the conspicuous efforts of the academic community, the practical relevance of this bulk of world is by no means accepted, and a gap between theory and practice is evident. There are many reasons for this: the complexity and inefficiency of solution procedures for large scale discrete optimization problems, the stochastic and dynamic character of manufacturing environments, the difficulty of modeling their features, the fact that an algorithmic kernel, however complex it may be, would amount to a tiny part of the whole code in any practical software tool for PM.

Nevertheless, in our opinion, this gap can be bridged, at least partially. With respect to the past, the diffusion of computerized PM tools has increased: though such tools are usually not based on optimization methods, this has created the information system substrate necessary to the fruitful introduction of more advanced methods. The introduction of powerful and relatively cheap workstations has paved the way for the use of optimization software libraries. Recently, after much work on the improvement of algorithmic efficiency, the emphasis has somewhat shifted to model management and generation and to the integration of optimization libraries with spreadsheets.

All of this is a great help in making optimization methods more appealing to the practitioner. Nevertheless, there are other discouraging difficulties:

- the literature on optimization approaches to PM is scattered in many journals and conference proceedings, and is strongly oriented towards academic readers;

- there are some excellent books on optimization *methods*, but, besides being rather technical, they do not give the flavor of what it's like applying them in practice.

In editing the book, we have tried to keep such inconveniences in mind: the contributions, although strongly linked to the research activity of each author, have a tutorial nature. We prefer to refer to such contributions as *chapters* rather than *papers*, since, although independently written by different authors, they are related one to another: the first page of each chapter outlines its contents and provides links to other ones. In this respect, the book should be considered as a sort of bridge between PM text-books and the scientific literature. Furthermore, the emphasis is not on optimization methods *per se*, but on optimization models and concepts (hence the title of the book): we have tried to emphasize the role of mathematical modeling in developing heuristics and hierarchical decomposition approaches.

Optimization models can be used to build the algorihmic kernel of an overall PM architecture, which has to be designed, integrated in a dynamic environment and evaluated, both from the operational and economic point of view. This is why we have included chapters on integration with knowledge based approaches, on PM systems design and on performance evaluation, though not strictly related to formal optimization techniques.

As far as the academic community is concerned, a rather surprising fact, partly explaining the theory-practice gap, is that there is a gap even within the academic world itself. A wide group of researchers deals with PM: people from Operations Research, Information Processing, Control Systems Theory, Manufacturing Engineering and Technology. Each part of this group has its own conferences, its own set of journals and so forth. Actually, there is some overlapping between these research communities: some of the contributors of this book cannot be considered as representatives of just one of the aforementioned research groups. Nevertheless, the need for improved communication is evident. For this reason, we have invited a group of contributors in such a way to cover all the different research groups concerned with PM. This requisite has been considered even more important than the need to cover all possible applications of optimization to PM. Indeed, the experienced reader will notice that some relevant topics (e.g. inventory control, dynamic lot sizing and local search) have been omitted: this was necessary in order to keep the book to a reasonable size, and we have sacrificed some topics which are already covered in some well-known text-books.

Clearly, much work is needed in order to successfully exploit optimization approaches to solve PM problems; in particular, we believe that more attention

should be paid to the integration with technological issues. To achieve this, the cooperation of all the aforementioned research communities is called for: we do hope that this book will prove a useful reading for both new researchers and practitioners and a first step to this aim.

Content Overview

The book consists of the following ten contributions:

1. *Deterministic Machine Scheduling*, by S.L. van de Velde;
2. *Large Scale Shop Scheduling by Lagrangian Decomposition*, by G. Dobson and U.S. Karmarkar;
3. *Dynamic Programming for Production Scheduling: Models, Heuristics and Case Studies*, by J. Teghem;
4. *The Combinatorial Approach to Flow Management in FMS*, by A. Agnetis, C. Arbib and M. Lucertini;
5. *Optimal Production Control Based on Continuous Flow Models*, by A. Sharifnia;
6. *Factory Level Aggregate Scheduling: Bridging the Gap between Optimized Scheduling and Real Time Control*, by P. Brandimarte, W. Ukovich and A. Villa;
7. *Stochastic Models for Production Control*, by J.A. Buzacott and J.G. Shanthikumar;
8. *A Knowledge-Based Approach for Production Control in a MRP Environment*, by A. Kusiak and H.-H. Yang;
9. *Simulation as a Tool for Optimization*, by C. Heavey and J. Browne;
10. *A Methodology Supporting Design and Implementation of Production Management Systems Including Economic Evaluation*, by G. Doumeingts and B. Vallespir.

The selected topics are functional to different 'reading paths' which are offered to different readers.

- Readers interested in Discrete Optimization topics may wish to focus on chapters 1, 2, 3, 4.
- The development of heuristic methods from optimization models is exemplified in chapters 2 and 3. Also chapters 5 and 6 can be considered within this framework.
- Decomposition and aggregation approaches for difficult optimization problems are covered in chapters 2, 5, 6.
- Stochastic models are applied in chapters 3 (third case study), 5, 7.
- Topics related to production control are covered in chapters 5, 6, 7, 8.
- Readers interested in the design and evaluation of software architectures for PM should refer to chapters 9 and 10.

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