YVES POCHET AND LAURENCE A. WOLSEY, Production Planning Using Mixed Integer Programming. Springer 2006. ISBN 978-0-387-29959-4. £38.50/$59.95. 477 pp. Hardbound

Recently published Production Planning Using Mixed Integer Programming by Yves Pochet and Laurence Wolsey has raised considerable expectations. Firstly, problems of production planning are among the most interesting in Operations Research. For instance in discrete-time constant-capacitated single-item lot sizing with start-up costs, given a discretized time horizon, constant production capacity per period, constant cost of starting production in a period, constant cost of stocking one unit for one period, and non-constant demand at each period, a production schedule is sought, meeting the demand at a minimum cost. Such a seemingly very specific problem has deep connections to solving optimisation problems using integer programming in general. Secondly, both authors are renowned experts in the field. In the past two decades (Pochet, 1987), Yves Pochet has established himself as an authority on applications of integer programming to lot-sizing problems, which is the method of choice in real-life production planning. Laurence Wolsey is then a long-established authority on integer programming in general, having co-authored the acclaimed Integer and Combinatorial Optimization (Nemhauser and Wolsey, 1988). Some of these expectations are fulfilled.

The book assumes little knowledge but basic linear algebra. In more than 170 pages, Chapters 1–3, 6, and 8 provide a very up-to-date, but not overly rigorous introduction to integer programming and production planning in general. The emphasis put on mixed integer rounding and mixing sets, heuristics in-built in general purpose integer programming solvers, as well as on decompositions and heuristics using integer programming should be praised, although material covered by first-year Computer Science textbooks (e.g. an explanation of how fast is exponential growth in Section 3.4) could perhaps be replaced by a brief introduction to concepts and techniques used in the proofs presented later. For example matroids are not even defined, the less explained, before they are used in proofs in Chapter 9. At the heart of the text is a classification of lot-sizing problems and their integer programming formulations, introduced in Chapter 4. Uncapacitated (LS-U), constant capacitated (LS-CC), and general capacitated (LS-C) single-item lot-sizing problems, both continuous and discrete, are covered in some detail in Chapters 7 and 9. Chapter 10 covers extensions involving backlogging and start-up times. Finally, multi-item problems are succinctly touched upon in Chapter 11. Stemming from the previous work of Wolsey (2002) and others, the classification aims to be a cook-book of sorts, helping the practitioner to pick the right formulation to be fed into a modern general purpose integer programming solver. Hiding most of the underlying polyhedral theory behind computational experience with Dash Xpress-MP, the treatment truly is applicable.

In its systematic approach and emphasis on real-life computational expe-

rience, the book presents a major step forward from the previous works on integer programming formulations of production planning (Shapiro, 1993). Although the book tries to be as self-contained as possible, undergraduate students and mathematically less inclined readers might only benefit from reading the corresponding chapters in a standard Operations Research textbook (Winston and Goldberg, 2004) first. In contrast with the exceptionally well-written and exquisitely edited The Travelling Salesman Problem (Applegate et al., 2007), a recent book studying the applications of integer programming to another well-known optimization problem, several rather unconventional editorial decisions might be worth mentioning. Individual chapters are accompanied by exercises, which is certainly worth praising. The organization of chapters follows a spiral-like pattern, approaching many concepts in three different chapters, at three different levels of intricacy. Finally, and most surprisingly, figures seem rather hastily drawn and writing lacks lucidity in a number of places. Although the authors are hardly to blame for the failings of their editor, such trivia might make reading somewhat less than pleasurable. Nevertheless, books blending classification of problems and integer programming formulations, underlying polyhedral theory, and computational experience with modern solvers in individual problem domains should certainly be lauded as a bridge between the theory and practice of integer programming.

There is no doubt that this volume offers the present best introduction to integer programming formulations of lot-sizing problems, encountered in production planning.

References

Applegate D. L., et al. *The Travelling Salesman Problem: A Computational Study* (2007) Princeton, NJ: Princeton UP.

Nemhauser G. L., Wolsey L.A. *Integer and Combinatorial Optimization* (1988) New York, NY: John Wiley & Sons.

Pochet Y. *Lot-sizing problems: Reformulation and cutting plane algorithms* (1987) Belgium: Louvain-la-Neuve. PhD thesis.

Shapiro J. F. *Mathematical Programming Models and Methods for Production Planning and Scheduling* In: Handbooks in Operations Research and Management Science (1993) Vol 4. Chapter 8.

Winston W. L., Goldberg J. B. *Operations Research: Applications and Algorithms* (2004) 4th edn. Boston, MA: Duxbury (Thomson).

Wolsey L. A. Solving Multi-Item Lot-Sizing Problems with an MIP Solver Using Classification and Reformulation. *Manag. Sci.* (2002) 48(12): 1587–1602.