

Airline Operations and Scheduling

The planning and scheduling of airline operations is made up of complex problems. Since operations research is one of the most effective tools to solve the problems of this magnitude, it has had a vast impact on the management of the airlines' operations. Combined with the growing knowledge in computational methods and the introduction of computer technology, the operational problems can be solved in shorter time spans and savings can run up to several millions of dollars. The book "Airline Operations and Scheduling" gives the reader a comprehensive, easy-to-understand introduction to this challenging field of research.

by Massoud Bazargan

A book review by Stephan Peters

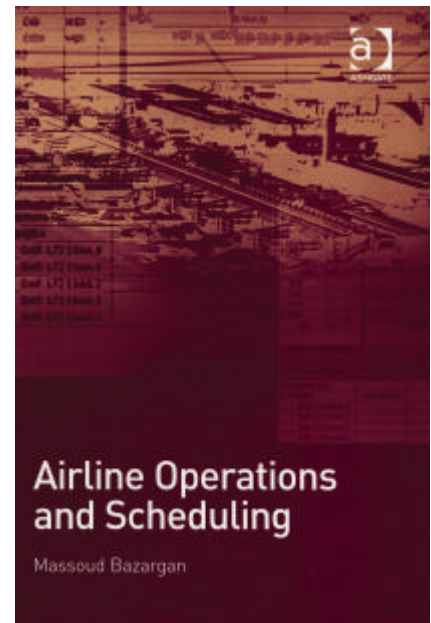
Introduction

Until recently, an interested reader in Operations Research (OR) techniques in airline operation would have been faced by a twofold problem. On the one hand, present day OR literature in universities is often too abstract. Students merely come in contact with general OR techniques and common examples and not with any course material, specific for airline operations. Because the airline industry is highly dynamic and the techniques used by the airlines evolve at the same pace, many of the academic courses have become outdated. On the other hand, airline OR techniques are highly specialized and, therefore, are only accessible for OR professionals, involved in airline planning and scheduling. These specialized techniques are described in the OR community's journals and, for the average graduate or MBA student, require the investment of considerable time and effort. With this book, Massoud Bazargan successfully fills the void between the general university courses and the highly specialized OR techniques on airline operations.

Book Discussion

The book is divided in three parts. The first part deals with the planning and scheduling phases of airline operations. Specifically, it explains the procedures how to optimize the operations and, therefore, the first part is aptly named Planning Optimization. Next, the "Operations and Dispatch Optimization" part discusses the operational aspects, such as revenue management and dealing with delays and cancellations. The last part of the book serves as a mix of subjects for the interested reader. It quickly highlights computation complexity, a case study of a start-up airline and two simulation case studies.

In the introduction of the book, the author hopes that his readers have some basic knowledge of linear and integer programming. Although the second chapter does provide a short review of the required OR techniques, such as network flows and integer programming models, readers without any basic OR knowledge will find the models in the book incomprehensible. Furthermore, knowledge of statistics is desirable; more specifically, understanding the normal distribution, also known as the Gauss distribution.



Chapters 3 to 7 address the issues concerning planning optimization. In the chapter Flight Scheduling, the author explains some basic concepts of airline economics. Also, he motivates why the planning process is decomposed into sub problems. In short, an integrated OR model of all the airline's operations is simply too complex to be solved, even with current computer technology. By decomposing the entire problem into subproblems, the OR model is reduced to manageable sized sub models. However, these smaller models still address thousands of variables and hundreds of constraints.

After this introduction, the key issues of each subproblem are discussed per chapter, going from long term, strategic choices to short term, tactical choices. First, the author explains how aircraft types are selected to fly the airline routes. In this model, operating costs and size of the aircraft fleet are of importance. Next, the assignment of a specific aircraft to one of the routing cycles is examined. For this submodel, the constraints are set by necessary maintenance checks on a regular basis and the availability of the aircraft at the different airports. Last, chapters 6 and 7 deal with crew scheduling and manpower planning. The former discusses how to pair

flight crews to consecutive routes and how to combine these valid pairings with the actual crew members. The latter, manpower planning, is a simplified adaptation of the crew scheduling models.

In the next part of the book, operations and dispatch optimization is clarified as the operational aspect of airline planning. First, the models used in revenue management are explained. How does the airline allocate the different seating classes per aircraft, according to demand patterns? How will this help increase the revenues? Also, the issues of overbooking and no-show passengers are elucidated. Secondly, the manner in which airlines assign the different arriving and departing flights to open gates is explained. In most cases, minimizing the walking distance for all transfer passengers is the main goal. The last chapter of this part discusses irregular operations. More than once, the airline has to deal with disruptions in normal operations due to unforeseen maintenance, delays and cancellations. The airline has to respond fast and effectively to minimize its losses due to these disruptions.

The last part of the book deals with computation complexity and discusses a case study of a start-up airline as well as two simulation case studies. The chapter on computation complexity gives the reader a glimpse of the difficulties of solving airline planning problems. Also in this chapter, the author specifies the advantages of the use of heuristic techniques. These techniques provide airlines with “near optimum” solutions in a timely fashion. The case studies in the last three chapters of the book again illustrate how OR techniques can be used and how simulation modelling is also an effective tool for airlines.

Reviewer's Opinion

Well, the book didn't disappoint me at all. I expected an elaborate book with long narrations and waves of examples. When I received the book from the chief editor, my initial reaction was: “Awfully thin, isn't it?” Nonetheless, I can honestly say that

I thoroughly enjoyed reading this book.

The concise and clear writing style of the author is merely one of the many pleasing features. The book is well-structured and the build-up of the chapters is beneficiary to the reading experience. Each chapter, the author begins by discussing the purpose of the model and its importance for the entire process of airline planning and scheduling. He provides the reader with the necessary background of the issues in the chapter. The mathematical approach is thoroughly clarified; this approach is needed to transform a real-life situation in an OR model. For every model, these explanations are accompanied by real-life or fictional examples. Last, each chapter finishes with a generalization of the mathematical model and lists relevant references for the readers which are looking for more complete discussions and more detailed models.

However, the book does not give any information on the solution process of the problems. Nor does it provide an educated reader with more advanced topics, like sensitivity analyses, decision analyses and heuristics, applied to the airline industry. To my regret, these are limitations set by the author and by the purpose of this book. Mentioning these subjects in future editions and/or providing references to interesting literature would be valuable additions to this book.



Conclusion

This book is accessible to a wide audience, taking into account the necessary OR knowledge. It elucidates all the processes relevant for operations and scheduling of an airline. It uses simple and clear examples for the explanation of the models. The author has fulfilled his goal to write a comprehensible, up-to-date book about airline operations. In my mind, this book is the ultimate introductory handbook of airline operations research techniques for graduate and MBA students, new airline recruits and junior airline consultants.

About the author

Massoud Bazargan is Associate Professor, Production/Operations Management & Operations Research at Embry-Riddle Aeronautical University and Manufacturing/Business Consultant. He has published in leading operations research, operations management and simulation journals and conference proceedings. His research interests include transportation, scheduling, man-power planning, supply chain management, cellular manufacturing, safety and simulation.

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