

Preface

Airlines and the practice of Operations Research have had a long, mutually beneficial relationship. As part of a regulated industry until 1978, US domestic airlines had the luxury of supporting significant research and development efforts in operations research. Since then, in a largely de-regulated industry, airlines continue to be major consumers, and developers, of Operations Research theory, methodology and applications. As a result, Operations Research has become a critical component of the problem solving culture at airlines, and is credited with enabling advanced capabilities leading to tremendous benefits.

The airline industry has been a consistent source of Operations Research opportunity. Airline applications have motivated many developments in Operations Research methodology in areas such as large-scale optimization, forecasting and customer modeling. Some of Operations Research's major success stories are from the airline industry, in particular crew scheduling, fleet assignment, operations management and revenue management. As airlines work to gain competitive advantage, they experiment with new technology; if it works, they use it. Today, no major airline operates without significant Operations Research support. Due to the size of the industry, even modest measureable improvements can have significant impact.

Even with this long history, the airline industry and related Operations Research opportunities continue to evolve. In this book, we review Operations Research theory, applications and practice in seven major areas of airline planning and operations. In each area, a team of academic and industry experts provide an overview of the business and technical landscape, a view of current best practices, a summary of open research questions and suggestions for relevant future research. There are several common themes in current airline Operations Research efforts. First is a growing focus on the customer in terms of: (1) what they want; (2) what they are willing to pay for services and (3) how they are impacted by planning, marketing and operational decisions. Second, as algorithms improve and computing power increases, the scope of modeling applications expands, often re-integrating processes that had been broken into smaller parts in order to solve them in the past. Finally, there is a growing awareness of the uncertainty in many

airline planning and operational processes and decisions. Airlines now recognize the need to develop ‘robust’ solutions that effectively cover many possible outcomes, not just the best case, “blue sky” scenario. The topics by chapter include:

1. *Customer Modeling*. Airline success depends on creating and delivering products and services valued by customers. Historically airlines have used multiple models to analyze the effects of schedule, price and competition. As a result, different functional areas within an airline often had inconsistent views of their customers. For example, demand models used for scheduling are generally different and inconsistent with those used in revenue management. Airlines are currently adopting modeling approaches based on customer preferences and intent toward travel, combining the various aspects of customer behavior. These models are not only improving the accuracy of current applications, they offer the potential to integrate customer modeling and decision making across multiple application areas. [Chapter 1](#) covers the various methodologies for customer modeling as well as the current and emerging applications.
2. *Airline Planning and Schedule Development*. The schedule is one of the most visible aspects of airline product design. Airline scheduling has been the focus of significant Operations Research work in the past. The full scheduling problem is so large and complex that it has been broken into a sequence of smaller problems to allow solutions to be generated for specific components, such as fleet assignment and aircraft routing. Advances in modeling and IT are allowing components to be re-integrated, resulting in improved airline performance through the generation of schedules that more accurately model customer demand, pricing and revenue management, crew scheduling and operations. Airline scheduling continues to be an area of active research. [Chapter 2](#) also describes many remaining open research questions.
3. *Revenue Management*. There is a long history of modeling success and well-documented benefits in revenue management. Industry business practices continue to evolve in areas such as restriction-free pricing and product de-bundling. Revenue Management requirements and opportunities evolve as well. Its scope, once limited to overbooking and discount allocation, is expanding into airline pricing and product design. [Chapter 3](#) provides a view of current business and technical landscapes, as well as suggested areas for future research.
4. *Airline Distribution*. With the development of computerized reservation systems and global distribution systems, the airline industry had a sophisticated electronic commerce infrastructure long before the dot-com age. Pioneering work in the 1980s measured the impact of screen placement on airline bookings sold through travel agencies. Since then, the number of distribution channels has increased, along with opportunities for new Operations Research applications. These applications apply to channel providers as well as to airlines. [Chapter 4](#) provides a comprehensive overview of this newly emerging area.
5. *Crew Management Information Systems*. Developing efficient crew schedules has been one of the key applications areas for Operations Research. [Chapter 5](#) describes the development of crew management optimization algorithms

including recent advances using the volume algorithm, primal-dual methods and constraint-based approaches. [Chapter 5](#) also reviews the development of information systems that facilitate the integration of crew management modeling with airline planning and operations.

6. *Airline Operations*. Airlines manage the flows of aircraft, crew and passengers, choreographing thousands of components to provide efficient, reliable transportation. Due to the size and complexity of airline operations, Operations Research methodologies often fail to solve enough of the problem, fast enough, to be useful in daily practice. [Chapter 6](#) describes recent advances and successes in solving the airline operations problem. While the use of Operations Research in airline operations is becoming more typical, many research questions remain.
7. *Air Traffic Flow Management*. Flow management focuses on maintaining safe and efficient flow of aircraft through controlled airspace. Historically, flow management was a constraint for airlines. Now, however, the relationship between airlines and air traffic control is evolving to provide airlines with greater participation in flow management decisions. [Chapter 7](#) describes the modeling environment and opportunities for both Air Traffic Flow Management and the airlines.

This book is the result of hard work and collaboration; we would like to thank the many contributors to this effort. First, we would like to thank the authors. Each chapter was written by a team of experts, drawing on decades of both academic and industrial experience. They provided great insights into how the business and technical environments shaped current modeling approaches as well as an expert view of the future. Next we would like to thank Fred Hillier for his vision and for giving us the opportunity to take on this project. We hope this is a small addition to his substantial contribution to the Operations Research profession. Finally, we would like to thank Matthew Amboy and Springer for their support in producing and distributing this book.

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