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Airline Re-Fleeting Managing Revenues and Maintenance Operations

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Abstract

Airline re-fleeting, also known as Demand Driven Dispatch, is the reassignment of aircraft to flights close to departure to improve operating profitability. It swaps aircraft of different sizes on flight legs to change capacity in response to demand. Schedules are usually fixed many months ahead of the departure date, with limited information about demand. Demand driven dispatch makes capacity flexible again, changing aircraft assignments nearer to departure. Using more detailed and reliable demand information to better match capacity supplied with quantity demanded, revenues may be increased and operating costs decreased. Previous research on demand driven dispatch have not incorporated or significantly simplified key issues such as revenue management and maintenance operations; making changes few days in advance to the day of operations may dramatically influence aircraft airworthiness if available flying hours until maintenance are not considered. The focus of this paper is on the integration of demand driven dispatch, revenue management and maintenance operations in an airline network environment. A stochastic mixed integer model is proposed to solve the fleet re-assignment problem while considering aircraft maintenance requirements. Stochastic demand is considered to model demand predictions. Realistic computational experiments drawn from IBERIA, the major Spanish airline, are presented.

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Keywords: Airline Operations; Revenue Management; Aircraft Re-fleeting; Maintenance.

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1. Introduction

The airline schedule planning problem is defined as the sequence of decisions that need to be made to make a flight schedule operational. Given the high level of competition in the airline industry, effective decision making is crucial to the profitability of an airline. However, this decision making should not be only based on the available airline's resources. Passenger demand fluctuations arising from stochastic market demands could affect the actual performance of the planned schedules. In practice, the performance of an optimal plan could be reduced when applied to actual operations where passenger demand fluctuations occur. In other words, stochastic disturbances arising from variations in daily passenger demand could affect the optimality of the fleet assignments and timetables. Therefore, to set a good flight schedule, not only the fleet and related supply have to be considered, but passenger demand fluctuations arising from stochastic market demands in actual operations also must be considered.

The schedule planning process typically starts from an existing schedule with a well-developed route structure and fleet composition. In the construction of each new schedule, changes are introduced to the existing schedule to reflect changes in demands and the market environment. Due to the enormous size and complexity of the problem, schedule planning is a multi-step process, usually separated into four, sequentially solved sub-problems: schedule design, fleet assignment, maintenance routing, and crew scheduling (Barnhart & Cohn, 2004; Lohatepanont & Barnhart, 2004; Belobaba et al., 2015; Cadarso & Marín, 2011 and 2013; Cadarso et al., 2017). Obviously, pricing and revenue management are of vital importance but they are usually addressed once schedule design and fleet assignment are fixed, which is done many months ahead of the day of operations and therefore with limited information about passenger demand.

Demand driven dispatch makes capacity flexible again, changing aircraft assignments nearer to departure. It is the reassignment of aircraft to flights close to departure to improve operating profitability. Shebalov (2009) provides an overview of this process of dynamic capacity reallocation based on information available in revenue management systems. Thus, using more detailed and reliable demand information from the revenue management system, demand driven dispatch has the potential to better match capacity supplied with quantity demanded, simultaneously increasing revenues and decreasing operating costs (Berge & Hopperstad, 1993; Fry & Belobaba, 2016). Wang & Regan (2006) propose a heuristic for yield management over two flights with swappable aircraft while Wang & Meng (2008) simultaneously make optimal dynamic yield management and fleet assignment decisions. However, the fleet assignment problem is not integrated in detail.

As stated by Fry & Belobaba (2016), theoretically promising, demand driven dispatch still poses a host of challenges, including not only potential disruptions and interaction with the revenue management process. Interactions with maintenance and crew schedules are also of key importance.

The objective of this paper is to provide a basis for an integrated approach addressing demand driven dispatch, revenue management and maintenance operations in an airline network environment. For getting such a objective a stochastic mixed integer model is proposed to solve the fleet re-assignment problem while considering aircraft maintenance requirements.

1.1. Contributions

Previous studies on demand driven dispatch have incorporated neither detailed revenue management processes nor maintenance schedules in a single integrated mathematical model. All existing literature deals with disintegrated or partially integrated models: different models or tools are usually used to solve re-fleeting and revenue management problems. Here, an integrated model is proposed which incorporates detailed maintenance operations and which establishes the basis for revenue management. Even though detailed revenue management processes are not explicitly addressed, the basis for its future integration is included; a two-stage mathematical model which may be extended to capture passenger types, fare classes and booking limits. Regarding maintenance operations, making schedule changes weeks ahead to the day of operations may dramatically influence aircraft airworthiness if available flying hours until maintenance are not considered; a novel approach is presented to integrate maintenance schedules within a demand driven dispatch scheme.