Mathematical models in airline schedule planning: 
A survey

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The schedule is an airline’s primary product, having the most influence (along with price) on a passenger’s choice of an airline. Once an airline decides (at least tentatively) on a schedule, a host of related problems have to be resolved before it can consider the schedule feasible, and can proceed to market the schedule. Among these problems are traffic forecasting and allocation that forecasts traffic on each flight leg for use in the fleet assignment model, fleet assignment that decides the fleet type of the aircraft flying the legs in the schedule, equipment swapping to change an assigned equipment type on a leg if and when necessary, through flight selection for determining which pairs of flights to market as one-stops (without any aircraft change), maintenance routing that develops aircraft rotations to provide adequate opportunities for overnight maintenance, and flight numbering to number flights as consistently as possible with a prior schedule. Considerable methodological and computational advances have been made in the recent past in developing models and solution methods for almost all of the problems mentioned above. In this paper we survey these various models and solution techniques.

1. Introduction

An airline schedule, for our purposes, is a list of flight legs that the airline plans to fly. A flight leg is a non-stop flight from an origin to a destination with specified departure and arrival times. The schedule is usually fixed for a period of time, usually up to three months, with some minor alterations from month to month. A portion of an airline schedule is shown in table 1.

<table>
<thead>
<tr>
<th>Flt. No.</th>
<th>From</th>
<th>To</th>
<th>Dep.</th>
<th>Arr.</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>547</td>
<td>BOS</td>
<td>PIT</td>
<td>525p</td>
<td>711p</td>
<td>12345</td>
</tr>
<tr>
<td>1753</td>
<td>BOS</td>
<td>PHL</td>
<td>730p</td>
<td>851p</td>
<td>1234567</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

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The first line of the schedule in table 1, for instance, says that the airline is offering a flight (Flight No. 547) from Boston to Pittsburgh, departing Boston at 5:25 PM and arriving at Pittsburgh at 7:11 PM. The column labeled frequency indicates the days on which this flight is offered (in this case, Monday through Friday). Two different flights may share a flight number. Typically, this is the case for one-stop or two-stop flights.

In this paper, we use the term airline schedule planning in a broad sense, to include all the planning decisions that have to be made for a schedule to be considered operational. Figure 1 illustrates some of these planning considerations, along with the sequence in which the decisions are made.

![Figure 1. The schedule planning paradigm.](image)

The schedule is usually determined based on traffic forecasts for the month, tactical and strategic initiatives, and seasonal demand variations, and is currently