Robust and Integrated Airline Scheduling

A thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy

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New Zealand

2009

Abstract

In airline scheduling a variety of planning and operational decision problems have to be solved. In this thesis we consider the problems aircraft routing and crew pairing: aircraft and crew must be allocated to flights of a schedule in a minimal cost way.

Although these problems are not independent, they are usually formulated as independent mathematical optimisation models and solved sequentially. This approach might lead to a suboptimal allocation of aircraft and crew, since a solution of one of the problems may restrict the set of feasible solutions of the problem solved subsequently.

Also, in minimal cost solutions, aircraft and crew are highly utilised and short turn around times are usually used for aircraft and crew. If such a solution is used in operations, a short delay of one flight can cause very severe disruptions of the schedule later in the day due to the lack of buffer times. We formulate an integrated aircraft routing and crew pairing model that can generate solutions that incur small costs and are also robust to typical stochastic variability in airline operations.

We propose two new solution methods to solve the integrated model. The first approach is an optimisation based heuristic approach that is capable of generating good quality solutions quickly, the second approach can solve the integrated model to optimality.

In an extension of the integrated model we allow the departure times of some flights in the schedule to vary in some time window. This creates additional flexibility that leads to aircraft routing and crew pairing solutions with improved cost and robustness compared to the integrated model without time windows.

Using data from domestic Air New Zealand schedules, we evaluate the benefits of the approaches on real world problem instances. Our solutions satisfy all rules imposed for these problems and are ready to be implemented in practice. We generate solutions that dramatically improve the cost and robustness of solutions obtained by existing methods.

Acknowledgements

First of all I would like to thank my supervisors Professor David Ryan and Associated Professor Matthias Ehrgott. Without their great support and enthusiasm for the project this thesis would not have been possible.

I also would like to thank Air New Zealand for providing the crew pairing solver, data, and valuable feedback. I particularly would like to thank Chris Cullinan, Graeme Andrews, and Jeremy Hutson for providing the required data and for their time to discuss results and provide important feedback that led to improvements of the algorithms.

I would also like to thank all colleagues at The Optima Corporation, particularly Amanda, Jody, Paul, and Jeff. Their suggestions during my studies and help with the crew pairing optimiser is very much appreciated. Special thanks go to Amanda for taking the time to proofread an earlier draft of this thesis.

I am grateful for all help I received from many different colleagues and friends from the Department of Engineering Science, especially Lizhen, Andrea, Richard, Hamish, and Andrew.

I would also like to thank my family, in particular my loving parents Monika and Manfred, and my sister Carolin for their great support to help me reach my goals. Thanks also to all friends in New Zealand, Germany, and wherever else for making my life as enjoyable as it is. Most importantly, very special thanks to Andrea, for simply everything. With you, writing a PhD is a sweet dream rather than a nightmare.

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