Partially Integrated Airline Crew Scheduling for Team-oriented Rostering

Markus P. Thiel, Taïeb Mellouli, Yufeng Guo

Decision Support and Operations Research Laboratory, and
International Graduate School of Dynamic Intelligent Systems,
University of Paderborn, Warburger Str. 100, D-33100 Paderborn, Germany
Email: {thiel; mellouli; guo}@dsor.de

Summary. Crew scheduling for airlines requires an optimally scheduled coverage of flights with regard to given timetables. We consider the crew scheduling and rostering process for airlines, where crew members are stationed unevenly among home bases. In addition, their availability changes dynamically during the planning period due to pre-scheduled activities, such as office and simulator duties, vacancy, or requested off-duty days.
Besides this highly complex setting, crew satisfaction becomes more and more important: Recent approaches focus on a variety of quality-of-life criteria like the consideration of individual preferences. Hence most of them are applied to individual rosters; certain aspects especially for the appropriate handling of teams are neglected. Therefore the introduced concept of Team-oriented Rostering addresses the upcoming demand for a reduction of the usually high amount of team changes among crew members within daily or day-by-day team compositions. It relies on the optimal set of roster combinations for the scheduled crew members within the assignment step.

Keywords: airline, crew scheduling (CSP), integrated crew scheduling, crew assignment (CAP), crew rostering (CRP), team-oriented rostering (ToRP), team changes

1 Introduction

The airline Crew Scheduling Problem (CSP) is well-known as one of the most difficult combinatorial problems. Its task is to assign all flights of a given timetable together with further activities to a limited number of crew members stationed at one or several home bases. Besides the consideration of all given activities, operational cost has to be minimized, and workload should be evenly distributed among home bases and crew members.

An airline crew typically receives a monthly or semi-monthly schedule which has to fulfill numerous work rules and regulations. There is a bundle of rigid rules imposed by civil aviation authorities, union contracts, and company policies (e.g. [1,4,6,7]). Less rigid rules considering crew satisfaction and personal preferences can be applied as well.

Due to its complexity the CSP is typically divided into two sequential sub-problems [1]: Firstly, in the airline Crew Pairing Problem (CPP) a set of pairings is generated that minimizes operational cost in such a way that each flight belongs to exactly one pairing (set of flight leg which starts and ends at the crew member's home base). Secondly, the airline Crew Assignment Problem (CAP) or airline Crew Rostering Problem (CRP) assigns generated pairings together with other scheduled activities, training, vacations, and requested off-duty periods. In order to build legal crew schedules or rosters for each crew member, all company rules and regulations must be satisfied. For a recent annotated bibliography on the state-of-art on scheduling and rostering we refer to [2].

In our research on the airline CSP, see [3,5], we propose a partially integrated procedure to solve the airline crew scheduling problem, thus making a contribution towards an exact optimal solution of the fully integrated CSP. We have investigated models that generate not just pairings, but *pairing chains*, in the first step, taking guaranteed individual scheduled activities of crew members into account. A pairing chain is a sequence of pairings which covers the scheduled time period, incorporating weekly rests so that all valid rules and regulations have been taken into account. The main benefit can be seen in the earlier consideration of the daily available crew capacity for each home base in the first step, thus significantly reducing the need for expensive changes in the assignment step.

In this paper we want to present how specific requirements for the newly introduced Team-oriented Rostering approach can be address within the above mentioned integrated crew scheduling approach, especially its underlying special network structures for the pairing phase.

The paper itself is structured as follows: We give a brief introduction to the general Team-oriented Rostering Problem, and some characteristics for cockpit crew in particular. In Section 3 we present the so-called aggregated time-space networks that we apply for our pairing generation and describe how this can be modified to meet the additional requirements for the team-oriented Rostering approach. We close with a brief result review in the conclusion.

2 Team-oriented Rostering

Hereby, we briefly introduce the special characteristics of the Team-oriented Rostering Problem (ToRP) in general and in particular for cockpit crew: The goal of Team-oriented Rostering is expressed by the creation of automated crew