Large Scale Self-rostering in the Aviation Industry

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Background: Schedules for airline crew, often referred to as rosters, vary greatly from one month to the next due to crew availability and changes to the flight schedule. Contrary to many other scheduling problems, start and end times of most activities are fixed (e.g. departure and arrival timings) and it is mainly the sequencing of these activities that can be affected when constructing the crew rosters. Due to the size of the planning problem (often hundreds or thousands of crew, time constraints, and the high costs involved, almost all rosters are constructed by industry-strength optimizers with very little manual intervention. These optimizers automatically respect all flight and duty time rules like “max duty time” and “minimum rest”, often hundreds of different constraints from regulators, unions and the company. The optimizers strive to find the overall solution with the lowest “cost”. The cost function, or objective function, takes many aspects into account; summarized in these five categories:

- Real costs (duty days, hotel costs, per diem, over time, positioning etc.)
- Robustness (distance to rule limits, keeping crew together etc.)
- Productivity (ability to staff all flights with available resource)
- Flight safety (fatigue risk)
- Quality of life aspects (bids, requests etc.)

There are a number of different bidding philosophies designed to let crew influence their rosters;

1. **Bid entry**
   - By Crew
   - **Crew**

2. **Pre-processing**
   - **Planning process:** Once bids and requests have been collected, typically via a web page or a mobile app, and the bid “window” has closed, this is the typical planning process:
     - 1. Requests are given out to crew respecting quotas and rules. They are pre-assigned to the roster and locked so that the optimizer cannot alter them.
     - 2. Using the placed bids, and associated bid points, from each crew a “max roster” run is sent off to the optimizer where all activities can be overbooked; meaning having more crew than actually needed. This run is made to establish the maximum (yet realistic) amount of bid points each crew can achieve. In this run every pilot can get the popular LHR layover on the 5th. However, the run is run in such a way that crew end up with their fair share of production; a crew member asking for 30 days off will not be granted that, as it would not be realistic. The output of this planning is simply the maximum bid points each crew can achieve, but rosters are not used.
     - 3. Finally the production run is made. Here each crew will have a bid ratio target, meaning the ratio between bid points achieved, and the points reached in the max roster run. There are several ways of setting this up, but it is quite common to set the optimizer to
       - Try to reach at least 70 or 80% in bid ratio for all crew, or
       - Aim for at least 50% for the most junior crew and some 90% for the most senior ones.

3. **Planning & Optimization**
   - **Crew Rostering Optimization**
   - **User input:**
     - Rosters ( Moody's nhgs)
     - Ratings
     - Rule parameters
     - Objective function parameters
   - **Optimizer**
     - Initial solution
     - Fast
     - OK quality
     - Best solution
     - Take back (de Creo or replacement)
   - **Summary:**
     - Most airline crew members can already today exercise a lot of influence on their rosters. This enables the rosters to be more personalized and tailored to the individual, providing a good basis for also reducing fatigue risk. Once the rosters are constructed and published, crew can in addition use fatigue science tailored to their physiology to become aware, prevent and mitigate fatigue risk as far as possible.

4. **Operational usage**
   - **Crew usage**
     - Crew will receive their published rosters for the coming months typically by the 20th to 22nd in the current month. The publication may be a PDF, an email, or access directly over a webpage or a mobile app like CrewAlert Pro. In case of the latter, predicted alertness, sleep debt, body clock de-synchronization, projected sleep times can all be investigated in the app with the help of a bio-mathematical model. The upcoming duties with elevated fatigue risk are also flagged with color coding. The predictions take into account personal settings and circumstances, like commute times etc. Being aware of fatigue risk is, of course, a pre-requisite for managing the risk.
   - **Roster updates:**
     - CrewAlert Pro makes available to crew as changes occur, for example from delays, technical problems or re-scheduling due to crew falling ill.

5. **Publication**
   - **CrewAlert Pro**

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