Rostering RAF Air Traffic Control Personnel

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1 Introduction

Research in personnel scheduling has largely focussed on specific industries or professions. The available literature includes many examples of work done on nurse rostering [1] and aircrew scheduling [2], with a great variety of both mathematical optimisation and heuristic approaches explored [3] [4]. An interesting addition to this area is the rostering of military Air Traffic Control (ATC) personnel, mainly due to the complicated nature of the set of constraints and goals to be met. Rostering ATC personnel has some similarities with both nurse and aircrew scheduling, all are subject to shift patterns, appropriate qualifications, crew duty/working hours restrictions and rest break planning. The differences however, make this a unique problem, with some novel, challenging and interesting issues that require further exploration. Despite the military roots of operations research, very little work on military rostering appears in the literature [5], although this could be due to security restrictions. Currently, the rostering of ATC personnel is produced manually, usually by an air traffic controller as a secondary or additional duty. It is

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obviously undesirable to use a highly qualified specialist to do what is an administrative task, and the removal of a controller from ATC duties adds additional pressure to already over committed ATC operations. As such a system which can automatically generate solutions of comparable or superior quality is highly desirable.

2 Problem Definition

Each ATC unit is made up of a set of control positions and controllers. Each controller holds a set of qualifications that allow them to work in one or more positions to achieve a specific ATC task. As an example, a controller can work in the Aerodrome control position, controlling all aircraft landing and departing from the runway, or operating close to the airfield and coordinating their movement with RADAR controllers in another part of the building. Each position requires at least one controller to operate it, and they must be relieved by another controller that holds a qualification for that position. This means each shift requires enough qualified controllers to operate all positions, and spare controllers that can offer breaks to their colleagues. In practice this often means that a controller will take a break from one position and return to another position to give another colleague their break. Any roster produced must offer this flexibility to give rest breaks, as controller fatigue is a flight safety issue. To obtain a qualification, a controller is designated as under training (UT) in a position, and then must be supervised by another controller who holds the qualification for the position and an additional unit instructor (UI) rating in that position. UI ratings are specific to a particular position, and not all controllers will hold UI ratings in all of their qualified positions. Also, the UT may well hold qualifications in other positions and whilst under training cannot be used by the unit to staff other positions. This burden of training is further compounded by the nature of military service, as personnel are only likely to be at a particular unit for 3-5 years. When new controllers arrive, they are not qualified in any position so must join the training queue. When experienced controllers leave, all their qualifications for that unit are cancelled, and they arrive at their next unit as unqualified controllers. The main military ATC training school produces new controllers every 6-8 weeks, and these personnel are distributed to ATC units to undertake on the job training for their first qualification controlling real aircraft. The rostering problem then becomes one of not only having to schedule suitable controllers to positions, and allowing those controllers to take reasonable rest breaks, but to do it in such a way that new controllers can be trained to maintain the effectiveness of the unit. Controllers also require leave and can fall ill, just like in nurse/aircrew scheduling, but because they are military personnel they also have additional requirements to deploy overseas, undertake duties outside of ATC and undertake regular training courses for core military skills.

3 Solution Approach

Some potential approaches from the literature that could be used for parts of the solution include those demonstrated in [6] and [7]. Due to the size and complexity of the overall problem, the authors elected to decompose the problem into the following four parts. Each part is then solved using a heuristic based method.

1. Shift allocation: Using heuristic techniques from Nurse Rostering, a feasible allocation of controllers to shifts is produced. An additional requirement is that a minimum number of qualifications for each position must exist.
2. Task allocation: From the shift allocation, the controllers are allocated particular tasks or positions for the shift. If this allocation is infeasible, a new shift is generated.
3. Break assignment/feasibility: Once the tasks can all be covered, the system then needs to check if breaks for all controllers on shift can be given. Some softer constraints are used here for example certain positions may not be staffed at all times and this will allow flexibility to give rest breaks. Any failure here causes a reallocation of tasks.
4. Training: Finally, training controllers are scheduled. The first simple check is the existence of a UI in a required position. Although training is a critical task for any unit, it is also the first requirement to be relaxed as the ATC task always takes priority. Similarly, during periods of low traffic levels, training is unlikely to be productive and during periods of low staff availability training is invariably cancelled. A choice can be made at this stage if training is desired to return to the task allocation stage and attempt to swap controllers to place UIs in the appropriate positions.

4 Planned Research

Although of significant theoretical interest, the aim of the research is to provide a robust system of rostering to RAF ATC units. Close cooperation between the authors and RAF units is required to benchmark the system and evaluate it's usefulness in an operational environment [1]. The next stage of the research is to take data provided by partner units, and produce experimental problem instances. These can then be used to evaluate the developed heuristic-based algorithms and to fine tune the system to a point where it is deemed ready for use in a live environment. The system will then be used to generate rosters, and these can then be evaluated against the current manual approach by experienced RAF ATC personnel. With the permission of the Squadron Commander at an ATC unit, the rosters produced will then be used operationally for a fixed period of time, and their effectiveness rated by the unit command staff.

[1] The motivation for this research stems from one of the authors previous career as a RAF ATC Officer

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