Preventive Maintenance with Aircraft on Ground Case Consideration, and Airline Crew Scheduling Problem: A Meta-Heuristics Approaches

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ABSTRACT

This study formulates an innovative aircraft preventive maintenance model by taking into account the aircraft on ground (AOG) problem. The proposed model is solved by using binary particle swarm optimization (BPSO) and Genetic Algorithm (GA). It also proposes a methodology solution based on BPSO and GA to solve the airline crew scheduling problem. Additionally, a study of computational results is given to improve the quality of the solutions and the performance of the proposed algorithms.

Keywords: Aircraft Maintenance, Crew Scheduling, Genetic Algorithm, Logistics, Particle Swarm Optimization

1. INTRODUCTION

Air transport has known an increase competition in recent few years. Hence, this situation requires the airline companies to try to improve existing approaches or even develop new techniques. Nowadays, the airline companies seek to optimize the planning of aircraft maintenance and airline crew scheduling. We study two major problems in this paper:

- The Aircraft Maintenance Routing Problem (AMR), which can be defined as the problem of assigning each aircraft to a particular route, and must be routed to a maintenance station in order to undergo different maintenance checks mandated by the Federal Aviation Administration (FAA).
- The airline Crew Scheduling (CS) is decomposed into two subproblems. First, the crew pairing problem is to construct, for duty period, a series of rotations from all

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flight segments. Then, the crew assignment problem consists of assigning rotations by adding vacation days and other activities.

This work aims to: Propose an innovative mathematical formulation for the AOG main-
tenance problem; to present a methodology experiment based on binary particle swarm optimization and genetic algorithm; and to present comparative studies of results for the GA and PSO for the preventive maintenance model, and CS problem.

This paper is organized as follows: in Section 2 we describe a literature review. A mathematical preventive maintenance is developed in Section 3. A series of results is presented in Section 4. Conclusions are reported in Section 5.

2. LITERATURE REVIEW

For 45 years, the focus of the researchers was on demand forecasting, aircraft fleet scheduling and routing, especially different approaches and models have been proposed to deal with the AMR problem.

For example, Sarac, Battia, and Rump (2006), developed an operational aircraft maintenance routing problem formulation that includes maintenance resource constraints, available man-hours, and maintenance slots; the objective is to minimize the total daily maintenance costs.

In addition, Sriram and Haghani (2003) assumed that the origin and the destination pairs are already given and maintenance is overnight operations; the objective is to determine the routes giving the minimum cost. Also, Afsar, Espinouse and Penz (2006) selected routes for aircraft maintenance scheduling for an acyclic horizon. Besides Orhan, Kapanoglu, and Karakoc (2011), developed a model which maximizes the utilization of the remaining time, in addition Diaz-Ramrez, Huertas, and Trigos (2013) solved simultaneously the maintenance routing and the flight scheduling problems.

Furthermore, Barnhart et al. (1998) proposed a model to solve simultaneously the fleet assignment and aircraft routing, also, Basdere and Bilge (2014) developed an integer linear programming model and heuristic approach to get feasible routes for each aircraft in the fleet, a Branch-and-Band method is used to solve the problem.

Consequently, Papadakos (2009) developed an approach for airline scheduling and solved the integrated model by Bender decomposition method combined with accelerated column generation, in addition (Belien, Demulemeester, DeBruecker, & Bergh, 2013) proposed an enumerative algorithm to solve the problem of constructing the workforce schedules of aircraft line maintenance, and formulated a mixed integer linear problem.

Similarly, Papakostas (2010) described a short-term planning of the airline maintenance, and proposed an approach to solve the aircraft maintenance planning problem, correspondingly Zhong, Youchao, Gabriel, and Haiqi (2011) developed a disassembly sequence planning method for maintenance of large equipment including civil aircraft systems.

Additionally, Ezzinbi, Sarhani, EL Afia, and Benadada (2014) proposed a solution for the problem of Aircraft On Ground, and used meta-heuristics algorithms to solve the AMR problem, similarly (Quan, Garrison, Greenwood, & Liu, 2007) presented and demonstrated novel evolutionary algorithm for solving the preventive maintenance scheduling problem.

Moreover, Joo (2009) developed and tested a dynamic approach for scheduling preventive maintenance at a depot with the limited availability of spare modules and other constraints; identically, Wang (2012) established a model to jointly optimize the spare part ordering quantity, ordering interval and Preventive Maintenance interval; enumeration and stochastic dynamic programming algorithm are used to demonstrate the model.

Meta-heuristics is a set of methods used in research operations to solve combinatorial optimization problems. Binary PSO (Kennedy & Eberhart, 1997). (Holland, 1992) used and GA to solve the airline maintenance and crew
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