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Multi-Objective Optimization for Aircraft Fleet Management: A Multi-Parametric Approach

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Abstract : Fleet availability is a crucial indicator for an aircraft fleet. However, in practice, fleet planning involves many resource and safety constraints, such as annual and monthly flight training targets, maximum engine usage limits. Due to safety considerations, engines must be removed for mandatory maintenance and replacement of key components. This situation is known as the 'threshold.' The annual number of thresholds is a key factor in maintaining fleet availability. However, traditional method heavily relies on experience and manual planning, which may result in ineffective engine usage and affect the flight missions. This study aims to address the challenges of fleet planning and availability maintenance in aircraft fleet with resource and safety constraints. The goal is to effectively optimize engine usage and maintenance tasks. This study has four objectives: minimizing the number of engine thresholds, minimizing the monthly lack of flight hours, minimizing the monthly excess of flight hours, and minimizing engine disassembly frequency. To solve the resulting formulation, this study uses parametric programming techniques and ϵ-constraint method to reformulate multi-objective problems into single-objective problems, efficiently generating Pareto fronts. This method is advantageous when handling multiple conflicting objectives. It allows for an effective trade-off between these competing objectives. Empirical results and managerial insights will be provided.

Keywords : aircraft fleet, engine utilization planning, multi-objective optimization, parametric method, pareto optimality
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