Integrating noncyclical preventive maintenance scheduling and production planning for multi-state systems

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ABSTRACT

This paper integrates noncyclical preventive maintenance with tactical production planning in multi-state systems. The maintenance policy suggests noncyclical preventive replacements of components, and minimal repair on failed components. The model gives simultaneously the appropriate instants for preventive maintenance, and production planning decisions. It determines an integrated lot-sizing and preventive maintenance strategy of the system that will minimize the sum of preventive and corrective maintenance costs, setup costs, holding costs, backorder costs, and production costs, while satisfying the demand for all products over the entire horizon. The model is first solved by comparing the results of several multi-products capacitated lot-sizing problems. Then, for large-size problems, a simulated annealing algorithm is developed and illustrated through numerical experiments.

1. Introduction

Maintenance scheduling and production planning are two important activities which can significantly contribute to better business management in industry. These activities directly operate on the same resources and equipment. Due to the difference between maintenance and production purposes, their relationship has been considered as mutually in conflict, especially if the production and maintenance planning are done separately. According to Berrichi et al. [7], the conflicts may result in an unsatisfied demand in production, due to equipment unavailability if the production service does not respect the time needed for maintenance activities. Integration of maintenance and planning activities can avoid conflicts. In Aghezzaf et al. [2] and Chung et al. [13], the authors have shown the benefits of integrating maintenance and production planning. Communication and collaboration between the two departments are the main keys to doing successful planning in production systems.

Much research related to integrated production and maintenance planning can be found in the literature, especially during the last few years. In these integrated models, it is considered that the beginning times of preventive maintenance (PM) tasks are decision variables, as well as production jobs, and both (maintenance and production) are jointly scheduled [7]. Budai et al. [10] classified these problems into four categories: high level models, the economic manufacturing quantity models, models of production systems with buffers, and production/maintenance optimization models. In the last category, where our work is situated, many problems have been presented in the literature. Most of these models aim to optimize a combination of maintenance and/or production costs, production makespan or system availability (or unavailability). Berrichi et al. [7] suggested a model minimizing, simultaneously, the makespan for production and the system unavailability for systems with parallel machines. The model was solved by genetic algorithms. Berrichi et al. [8] improved the obtained results by using an ant colony algorithm. Ben Ali et al. [5] studied a job-shop scheduling problem under periodic unavailability periods for maintenance tasks. The problem was solved by developing an elitist multi-objective genetic algorithm minimizing makespan and total maintenance cost. Chung et al. [13] presented a model also optimizing the production makespan, with a reliability option based on the acceptability function for multi-factory networks. The maintenance strategy is suggested for both perfect and imperfect maintenance policies. A bi-objective optimization model minimizing simultaneously the production makespan and the system unavailability is considered by Moradi et al. [26], where production decisions assign the appropriate n jobs to m machines and maintenance decisions determine the instants of PM activities.

Pan et al. [31] suggested an integrated scheduling model incorporating both production scheduling and preventive maintenance planning for a single machine in order to minimize the maximum weighted tardiness. Cassady and Kutangolu [11] and
PM actions and job sequence. Yu-Lan et al. [43] extended these and production scheduling model for a single machine minimizing the total weighted expected completion time to intervals (instead of equal intervals) which leads to more efficient solutions. Jin et al. [18] presented a model determining the optimal number of preventive maintenance activities in order to maximize the average profit under uncertain demand by using the financial “option” approach.

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