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Study of stochastic sequence-dependent flexible flow shop via developing a dispatching rule and a hybrid GA

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ABSTRACT

A flexible flow shop is a generalized flow shop with multiple machines in some stages. This system is fairly common in flexible manufacturing and in process industry. In most practical environments, scheduling is an ongoing reactive process where the presence of real time information continually forces reconsideration of pre-established schedules. This paper studies a flexible flow shop system considering non-deterministic and dynamic arrival of jobs and also sequence dependent setup times. The problem objective is to determine a schedule that minimizes average tardiness of jobs. Since the problem class is NP-hard, a novel dispatching rule and hybrid genetic algorithm have been developed to solve the problem approximately. Moreover, a discrete event simulation model of the problem is developed for the purpose of experimentation. The most commonly used dispatching rules from the literature and two new methods presented in this paper are incorporated in the simulation model. Simulation experiments have been conducted under various experimental conditions characterized by factors such as shop utilization, setup time level and number of stages. The results indicate that methods proposed in this study are much better than the traditional dispatching rules.

1. Introduction

Scheduling in manufacturing systems is typically associated with allocating a set of jobs on a set of machines in order to achieve some objectives. It is an important decision making process in the operation level. Manufacturing environments in the real world are subject to many sources of change which are typically treated as random occurrences, such as new job releases, machine breakdowns, etc.

In this paper, we will focus on Flexible Flow shop Scheduling system with Sequence Dependent Setup Times (SDST/FFS). In the considered problem, jobs arrive dynamically over the scheduling period and the objective is to find a schedule that minimizes average tardiness of jobs. Following gives a review of the literature relevant to this problem.

Dispatching rules are very common techniques to deal with dynamic scheduling problems and especially flow shops. Hunsucker and Shah (1992) examined the performance of six different dispatching rules to minimize two tardiness-based criteria in a dynamic flow shop. Lodree et al. (2004) suggested a new rule to minimize the number of tardy jobs, while Branke and Mattfeld (2005) demonstrated that avoiding early idle times helps in minimizing total tardiness in a dynamic flow shop. More recently, Swaminathan et al. (2007) examined minimization of total weighted tardiness in a dynamic flow shop where new jobs arrive at every shift change, while Alfieri (2007) studied the interaction between a number of dispatching rules and due-date quoting policies in a simple dynamic flow shop. Rajendran and Alicke (2007) developed dispatching rules to take into account the presence of bottleneck machines in a flow shop system. Another work that deals specifically with the mean flow time criterion in a dynamic flow shop is that of Rajendran and Holthaus (1999). They compared 13 existing and proposed dispatching rules in a 10-machine flow shop and also concluded that the SPT dispatching rule gives the lowest mean flow times for all the machine utilization levels examined. Kianfar et al. (2009) proposed four dispatching rules to minimize the sum of tardiness and rejection costs and through a statistical simulation model showed the performance of their new methods.

Jayamohan and Rajendran (2000) provide a set of new dispatching rules to minimize various performance measures such as mean, maximum and variance of flow time and tardiness in dynamic shops. A static rule which minimizes the number of tardy jobs is also proposed. To evaluate these proposed rules, their relative performance is analyzed in open job shops and reported in comparison with the standard benchmark rules such as the SPT and EDD, popular rules like ATC and MOD, and the best performing rules in literature such as RR, PT+WINQ, PT+WINQ+SL and AT+RPT. When job

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