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ORIGINAL ARTICLE

Real-time rescheduling metaheuristic algorithms applied to FMS with routing flexibility

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Abstract This paper presents the results of a simulation study of a typical flexible manufacturing system that consists of seven machining centres, a loading and an unloading area, and six different part types. Owing to the existence of identical machining centres, the part types have alternative routings (their number varies between two and eight). One of the objectives of this work is to show how the following metaheuristics: ant colony optimisation, genetic algorithms, simulated annealing, tabu search, particle swarm optimisation and electromagnetism-like method, are adapted for solving the alternative routing selection problem in real time in order to reduce the congestion in the system by selecting a routing for each part among its alternative routings. The other goal is to highlight the impact of the real-time rescheduling of parts contained in the loading station on system performances when these metaheuristics are applied. The simulation results jugged by the production rate, machines and material handling utilisation rate show that for an overloaded system, the real-time rescheduling outperforms the case without rescheduling, but it has a negative impact on the work in process.

Keywords Flexible manufacturing systems · Alternative routing · Real-time routing selection method · Metaheuristics adaptation · Rescheduling

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1 Introduction

A flexible manufacturing system (FMS) can be defined as a system composed of computer numerically controlled machine tools, linked by an automated material handling system, and a computer-controlled network that coordinates the activities of processing stations and the material handling system. More specifically, it is stated by Raj et al. [1] that this new production system has been designed in such a way that it has the efficiency of a well balanced transfer line and ability to provide the flexibility of a job shop. Moreover, in their view on scheduling theory, a general FMS may be considered to be a job shop with parallel machines and additional limited resources and other FMS features such as alternate routings, pallet and fixture limitations and finite-in-process buffers.

Flexibility is an important feature that distinguishes FMSs from other manufacturing systems. One type of flexibility FMSs offer is routing flexibility. It is defined by Bilge et al. [2] as the ability of a manufacturing system to use multiple alternate routes to produce a set of parts. This major contributor of the flexibility of an FMS has several advantages. But according to Yu and Greene [3] its implementation entails a huge cost of