European Journal of Operational Research 257 (2017) 13–24

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Discrete Optimization

A simulation-based study of dispatching rules in a dynamic job shop scheduling problem with batch release and extended technical precedence constraints

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ARTICLE INFO

Article history:
Received 30 November 2015
Accepted 15 July 2016
Available online 21 July 2016

Keywords:
Dynamic job shop scheduling problem
Dispatching rules
Simulation scheduling
Extended technical precedence constraint
Due date tightness

ABSTRACT

This paper considers a simulation-based analysis of dispatching rules for scheduling in a dynamic job shop with batch release taking into account the extended technical precedence constraint which is a new term defined as the extension of conventional routing-based technical precedence constraint in our paper. With respect to tardiness-related measures, the relative performances of some widely-used dispatching rules as well as four new ones proposed in our paper are evaluated for different settings of the model parameters. The results of the simulation study demonstrate the effectiveness of the four new proposed dispatching rules, and also reveal that the relative performance of dispatching rules can be affected by some model parameters. For the standard job shop scheduling problem model, where there are no extended technical precedence constraints between jobs, as well as for the models taking into account the extended technical precedence constraint, it is shown that for minimizing the total tardiness and the percentage of tardy jobs, the four new proposed dispatching rules are very effective under relatively loose due date. With respect to tardiness-related objectives, the relative performance of the analyzed dispatching rules can be affected by changing not only the levels of the extended technical precedence constraint, but also the due date tightness.

1. Introduction

The job-shop scheduling problem (JSP) has been extensively studied over the last several decades and it attracts the attention of researchers and practitioners equally. The classical JSP is usually defined as: there are n jobs, each consisting of a specific set of operations which have to be processed by m machines or work stations within a given time period according to a given technical precedence order, a schedule need to be made to minimize a measure (or multiple measures) of performance. Obviously, the classical JSP is a static scheduling problem, in which all information for the n jobs is pre-known, and with the description of "a given technical precedence order", it usually means conventional routing-based precedence constraints, i.e., all operations belonging to the same job must be processed in a specified order and no gap need to be considered between one operation's finishing and its immediate successor's starting (Cheng, Gen, & Tsujimura, 1996; Shakhlevich, Sotskov, & Werner, 2000).

However, these conditions may not always hold in many scheduling problems in realistic manufacturing systems. For example, in mould & die manufacturing industry, the manufacture systems of which are typically make-to-order, this means that almost all of their processing tasks (usually moulds or dies comprising of some jobs) come from orders. The manufacturers get orders randomly over time, resulting in jobs releasing to the shop batch by batch intermittently. It can be regarded as the dynamic job-shop scheduling problem (DJSP), in which the jobs released to the shop intermittently and are included in the current scheduling procedure. In the process of mould and/or die manufacturing, there are usually some kinds of technical precedence, apart from conventional routing-based precedence, occur.

For example, in electrical discharge machining, a commonly encountered situation when processing mould & die parts is that the electrode must be completed before a part, e.g., a female die to be processed with the electrode. Another case is the assembly operation, the only one operation belonging to the mould & die (not any of a part) which can be considered as a special job, can start its processing only after all of its composing parts have been completed. Obviously, these precedence constraints arise between two or more different jobs. Actually, the unconventional technical precedence may also occur between two operations of the same

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http://dx.doi.org/10.1016/j.ejor.2016.07.030
0377-2217/