DUE DATES IN A MANUFACTURING SHOP: AN UNWEIGHTED CASE *

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Abstract

A dispatching rule is proposed for job shop operations where the performance criteria are due date related. The dispatching rule is constructed by combining the characteristics of the shortest process time rule and a dynamically determined earliest due date rule. The performance of the proposed rule is compared to currently well known rules across various shop environments using discrete simulation.

1.0. Introduction

Job shop scheduling has been studied over a long period of time by many researchers. Particularly, due date performance has been the subject of extensive research resulting in many different dispatching rules (see Panwalkar and Iskander [17]). The continuing level of research effort reflects the importance of job shop manufacturing and the difficulties of the problem solving.

In a job shop where jobs arrive at random and require a due date promise, due dates are either dictated by the customer or decided through negotiation between the customer and the shop controller. When the shop controller can influence the due date decision, he should consider the balance between the length of delivery promise and the chance of the delivery being late. In order to assign a job a proper due date, its flow time in the shop must be estimated. There are two phases in job shop control: the first phase is to determine proper due dates for arriving jobs, and the second phase is to control the work flow to meet the due dates. The objective of this paper is to present a dispatching method to meet the due dates in the second phase.

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For convenience, the notation to be used in this paper is shown below:

\( a_j \): arrival time of job \( j \)

\( c_j \): completion time of job \( j \)

\( m_j \): number of stations for job \( j \) to go through

\( a_{ij} \): process time of job \( j \) at station \( i \), \( i = 1, 2, \ldots, m_j \)

\( p_j \): sum of process time of job \( j \) \( (= \sum_i a_{ij}) \)

\( R_j \): routing sequence of job \( j \)

\( d_j \): due date of job \( j \)

\( s_j \): slack of job \( j \)

\( m \): number of workstations in the shop.

There are several methods of assigning a due date to an arriving job (see Conway [5]). Each method represents an attempt to predict the proper amount of job flow time in the shop. Under TWK, one particular due date setting method, a job with a longer process time will get a proportionally longer due date, i.e.:

\[
d_j = a_j + (DSF)(p_j),
\]

where \( DSF \) is a due date set factor, the value of which is the concern of the first phase of the due date control. Once a due date is given to a job, the job slack, \( s_j \), is defined as:

\[
s_j = d_j - a_j - p_j = (DSF - 1.0)p_j
\]

The ultimate objective of job scheduling is cost effectiveness. Some of the relevant cost elements are inventory carrying cost, late delivery cost, and sometimes overtime cost. Since these costs are hard to estimate, non-cost measures, such as mean tardiness \( (MT) \), proportion of tardy jobs \( (PT) \), or mean flow time \( (MF) \), are often used. Those performance measures are defined as follows:

\[
MT_t = \frac{1}{n_t} \sum_{j \in J_t} \max(0, c_j - d_j)
\]

\[
PT_t = \frac{1}{n_t} \sum_{j \in J_t} I_j \quad \text{where } I_j = \begin{cases} 1.0, & \text{if } c_j > d_j; \\ 0, & \text{otherwise}. \end{cases}
\]

\[
MF_t = \frac{1}{n_t} \sum_{j \in J_t} (c_j - a_j),
\]

where

\( J_t \): set of jobs completed during time period \([0, t)\)

\( n_t \): cardinality of \( J_t \).