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Ranked sequence positional weight heuristic for simultaneous balancing and scheduling jobs in a distributed manufacturing environment

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Abstract

In the current competitive and globalized manufacturing scenario Distributed Manufacturing Environments are increasing, and it turns mandatory to explore improved operational approaches. For enhanced simultaneous balancing and scheduling jobs in a Distributed Manufacturing Environment (DME) a mathematical model of Ranked Sequence Positional Weight (RSPW) is proposed. The model capabilities are analysed through a test problem and the results have demonstrated that the proposed RSPW heuristics mathematical model do perform better than other competitive approaches.

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Keywords: Simultaneous balancing and scheduling; Distributed manufacturing environments; Integer programming; Mathematical model; RSPW; Heuristics.

1. Introduction

Many studies do exist about independent scheduling problems arriving in traditional production units, such as a machine, a shop floor, or a plant, where each type of production units correspond to a management level. Thus, the scheduling problems were investigated independently and separately at each management level. In real-world production, production scheduling decisions occur at different management levels, such as company and plant levels, and are based on correlative dependence and do interplay [1].

Over the past few years much research and study, only to refer some [2, 3, 4], have proven that distributed manufacturing system enables the enterprises to enhance the flexibility and re-configurability for achieving better quality and cost effective manufacturing strategies. Recently emerged extended and networked manufacturing or network based manufacturing paradigm is one such distributed manufacturing system which can support the above mentioned requirements and their functionalities [5].

Production scheduling problems at multiple management levels in a distributed manufacturing environment (DME) have not been simultaneously examined based on a holistic view. Methods in which the use of real-time production data would suffice to make scheduling decisions remain undetermined. A scheduling mechanism that can generate effective scheduling solutions to real-world production scheduling problems in the distributed labor-intensive manufacturing environment needs to be established based on real-time production data.

Most production scheduling problems are non-deterministic polynomial-time hard [6]. Current labour-intensive manufacturing is characterized by short production lead-time, short life-cycles, volatile customer demands, small quantities with frequent product change, and distributed multi-plant production environments. These characteristics inevitably

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increase the complexity of production scheduling problems in the global labour-intensive manufacturing environment.

In this paper we propose a Ranked Sequence Positional Weight (RSPW) heuristic to solve an integer programming mathematical model for balancing and scheduling the jobs in a typical distributed manufacturing environment proposed by [7]. The results will show better performance than other two competitive approaches. The rest of the paper is organized as follows: in section 2 the problem is defined, and section 3 presents the mathematical model and the proposed heuristic to solve him; then, the proposed approach is simulated and the obtained computational results are compared with two other approaches in section 4; finally, in section 5 a conclusion is presented highlighting for the benefits of the RSPW.

2. Simultaneous balancing and scheduling problem in DMEs

Emrul Kays et al. [7] presented a simultaneous balancing and scheduling problem that can happen commonly in the DME, a typical DME comprised by one focal and three local companies. The global decision maker of the focal company was directly involved with the customers by means of receiving the orders and supplying the goods. For satisfying the received customer demand on time, the global decision maker assigns the associated jobs to its geographically distributed local manufacturing facilities and/or companies. In doing so, the global decision makers faced two decision problems i.e. (a) which job to be assigned to which resource and (b) what would be their processing sequences, which could allow the balancing and scheduling problems to be addressed simultaneously. For proper comprehension of this simultaneous balancing and scheduling problem, a typical extended and/or distributed manufacturing environment is illustrated in the following Fig. 1.

In Fig.1 the global decision maker of the focal company is responsible to assign the jobs *j* sequentially to the local company *l* by featuring the local cycle time and/or takt time C. Each of this company *l* is capable to perform any of these jobs *j*. However, to accomplish a job *j*, it needs to undergo two different operations and/or perform two tasks through the sequentially arranged resources. Besides, the focal company has also decided not to allow any form of job preemption after it starts processing through any of the resources in a local company *l*. Therefore, to satisfy the customer demand on time, the global decision maker has to assign the jobs *j* in local company *l* in a manner that the time jobs spent in the resource *r* is reduced. For attaining this objective and solving the simultaneous balancing and scheduling problem, we propose an Integer Programming (IP) model together with a Ranked Sequence Positional Weight (RSPW) heuristic as presented in the following sections.

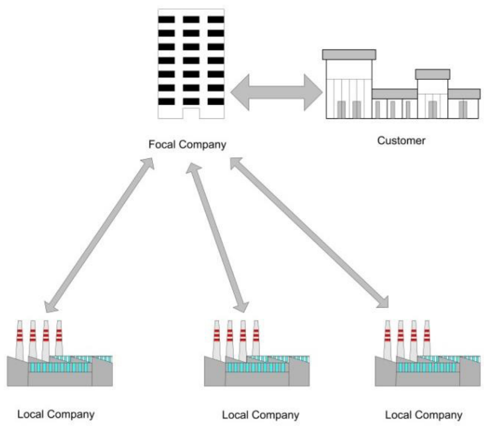

Fig. 1. A typical distributed manufacturing environment.

3. Proposed Model

The notations, indices, and variables that are used in the proposed mathematical model as well as heuristics are given as follows:

Nomenclature

N	total number of tasks
l	number of local companies, l =1, 2,…,m
i	number of tasks, i =1,2,3,…,n
j	number of jobs, j=1,2,3,…,k
r	number of resources, r=1,2,3…,p
a	the number of resource decision variables
s	sequence position of the job j, s=1,2,…,s
t_i	processing time of task i where i ϵ SN
T	a function of processing time
T_l	start time of tasks processing at any local company l
C_{il}	completion time of any task i within each of the local company l
C_{ilrs}	completion time of any task i at factory l in resources r for the sequence position s
$C_{(j, s)}$	completion time of job j in sequence position s
$C_{max\ il}$	maximum completion time of task i in local company l
$D_{j,s}$	assignment weights of job j in position s
C	local cycle time and/or takt time
SN	set of all tasks and NϵSN
ST_j	set of tasks that are needed to accomplish for each of the job and $ST_j \subset$ SN
ST_a	set of the numbers of particular decision variables for assigning a task i at sequence position s in a typical resource r
$ST_{b,c}$	set of tasks that precedes a task
ST	set of all jobs for producing an end item
ST_U	set of all unassigned jobs
ST_{el}	set of all eligible Jobs for assigning in local company l
ST_l	set of jobs assign to a local company, l
x_{il}	1 if task i is assigned to local company l; 0 otherwise
R_{iars}	1 if task i is processed in resource r first for sequence position s; 0 otherwise