A Two Stage Heuristic Solution Approach for Resource Assignment during a Cell Formation Problem

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ABSTRACT
Design of Cellular Manufacturing System (CMS) involves four major decisions: Cell formation (CF), Group layout (GL), Group scheduling (GS) and Resource assignment (RA). These problems should be regarded, concurrently, in order to obtain an optimal solution in a CM environment. However, solving complexity by simultaneous consideration of these problems will be increased. In order to overcome this difficulty, in this paper a two stage heuristic procedure is proposed for CF and RA decision problems. The solution approach contains a heuristic multivariate clustering technique as the first stage to find the best machine-cluster center distances. Next in the second stage a new mathematical model based on extracted distances and also worker related issues including salary, hiring, firing and cross-training is proposed. In order to verify and validate the performance of proposed approach a mathematical model considering the inter-intra cell part trips and also operator related issues are developed and some numerical examples are solved using Lingo Software. Moreover, the necessity of simultaneous consideration of CF and RA is investigated. The analysis of results verifies the solution approach in both optimality and computational time aspects.


1. INTRODUCTION

Cellular manufacturing system (CMS) is an innovative manufacturing strategy and an application of the group technology (GT) concept which can be used in order to increase both flexibility and efficiency of manufacturing systems in today’s competitive environment. Some advantages of CMS implementation are quality and efficiency improvement, material handling cost reduction, work in process inventory reduction, setup cost reduction and etc. A CMS design problem includes four main steps.

(1) Cell formation (CF): grouping machines and parts into manufacturing cells in order to achieve some objectives such as inter-cell part trips reduction.

(2) Group layout (GL): determining the optimal layout of machines and cells within cells and shop floor, respectively.

(3) Group scheduling (GS): determining the sequence of parts within manufacturing cells to minimize some objectives such as tardiness and makespan.

(4) Resource assignment (RA): assigning the workers and other manufacturing resources to machines and cells resulting in production efficiency improvement.

In order to reach a practical solution in a cellular environment these decisions should be regarded concurrently. Accordingly, many studies have been conducted to design a CMS in recent years. These studies can be classified into following categories:

1. Mathematical Programming-based Techniques These approaches consider the cellular manufacturing system as an optimization problem. Because of its ability in considering many real world production factors such as operation sequence, machine reliability and alternative process routings, mathematical programming approaches are widely used in recent studies. Purcheck [1] developed a mathematical model for cell formation problem. In his research part families are formed and then machines are assigned considering processing requirements of each part family. Also, Onwubolu and Mutingi [2] have