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Mixed Zero-One Programming for Cell Formation Group Technology

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***Abstract*— This study is devoted to the cell formation problems in cellular manufacturing systems. Starting point of this study is a recent paper of Mahdavi et. al. (2007) which takes into consideration only a few factors of production systems. Further three mixed zero-one integer programming models are suggested. These models can be used for particular cases in which all the necessary information is available. Besides the new model, other main contribution of this study is the computational analysis of the models. Mahdavi et al. (2007) only provided two examples which are 6 parts / 6 machines and 10 parts / 10 machines problems. In this research randomly generated problems are used with the sizes from 6 parts / 6 machines to 20 parts / 20 machines. A real life problem (Jerald et. al. 2006), which has 43 parts and 16 machines is also analyzed. The results show that the new models are providing better solution in most of the cases and at the same time, the run times of the proposed models are shorter.**

***Keywords*: Cellular Manufacturing Systems, Cell Formation, Mathematical modeling, mixed Integer Programming, Linearization.**

I. INTRODUCTION

The idea of Group Technology (GT) was first proposed in 1920's by Russians. The main concept of GT is to decompose the system into subsystems and improve each subsystem based on the various objectives to achieve the higher performance of the system. The purposes of Group Technology are best achieved in business related to small to medium batch production; these companies represent a major part of manufacturing industry. The conventional approach to this type of manufacture is to use a functional layout in the factory where production equipments are located in functional departments according to the types of manufacturing processes. Typically, parts are transported from one department to another depending on the actual process plan. In this arrangement the planning of process route becomes a very complex task since a number of similar machine tools may be taken into consideration at each stage in the chain of manufacturing operations.

Flexible Manufacturing Systems (FMS) are one application area of GT. In general the notion of Cellular Manufacturing Systems (CMS) includes less automated production systems and the smaller versions of the traditional FMS, too, such that machines used in the production of certain part families are grouped together. This groups called cells. In CMS the main and the most researched **topic** is Cell Formation (CF). Many models were proposed to solve the CF problems. These models are based on the different approaches such as: mathematical programming, similarity coefficients, clustering, etc. CMS are known to be effective in reducing costs such as operating, material handling, and profits such as low unit costs and higher production volumes.

Since differently-processed products need different work cells, a large company with variegated products needs to build several different work cells if single process flows are preferred. Given enough volume of products to work with, work cells have been proven by experience to be faster and more efficient in manufacturing than batch and queue systems.

A large number of studies related to group technology/cellular manufacturing have been performed both in academia and industry. Reasman et al. (1997) gave a statistical review of 235 articles dealing with GT and CM over the years 1965–1995. They reviewed and classified these 235 articles on a five-point scale, ranging from pure theory to bona fide applications. In addition, they analyzed seven types of research processes used by authors.

Some studies on implementation of cellular manufacturing systems are Silveira (1999), and Wemmerlöv and Johnson (1997, 2000). Much of the research was focused on the performance comparison between cellular layout and