Chapter 30
Performance Comparison of Cellular Manufacturing Configurations in Different Demand Profiles

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ABSTRACT

Cellular manufacturing systems (CMSs) are an effective response in the economic environment characterized by high variability of market. The aim of this chapter is to compare different configurations of cellular models through the main performance. These configurations are fractal CMS (defined FCMS) and cellular systems with remainder cells (defined RCMS), compared to classical CMS used as a benchmark. FCMSs consist of a cellular system characterized by identical cells each capable of producing all types of parts. RCMSs consist of a classical CMS with an additional cell (remainder cell) that in specific conditions is able to perform all the technological operations. A simulation environment based on Rockwell ARENA® has been developed to compare different configurations assuming a constant mix of demand and different congestion levels. The simulation results show that RCMSs can be a competitive alternative to traditional cells developing opportune methodologies to control the loading of the cells.

INTRODUCTION

Competitiveness in today's market is much more intense compared to the past decades. Considerable resources are invested on facilities planning and re-planning in order to adapt the manufacturing systems to the market changes. A well-established manufacturing philosophy is the group technology concept.

Group technology (GT) can be defined as a manufacturing philosophy identifying similar parts and grouping them together to take advantage

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of their similarities in manufacturing and design (Selim et al.,1998). It is the basis of so-called cellular manufacturing systems (CMSs). In current production scenario demand for products is characterized by continuous fluctuations in terms of volumes, type of product (part mix), new products introduction and the life cycle of products has significantly reduced. The planning horizon needs to be divided into smaller horizons (time bucket) and the length of each period is related to the characteristics of products. These characteristics need to be considered in design process of a manufacturing system. Introduction of Cellular Manufacturing Systems has already introduced significant improvements. They are conceived with the aim of reducing costs such as setup costs or handling costs and also to reduce lead time and work in process (WIP). They combine advantages of flow shop and job shop, but a further step can be accomplished to be competitive in the market. They allow significant improvements such as: product quality, worker satisfaction, space utilization. Benefits and disadvantages (Irani et al.,1999) are showed in Table 1. They documented that companies implementing cellular manufacturing have a very high probability of obtaining improvements in various areas.

The first column of Table 1 shows the case studies with improvements and the second column reports the percentage of improvement of the measures. Similarly, the third column shows the percentage of cases with worsening and in the fourth column is evidenced the rate of deterioration.

The demand volatility and continuous new product introduction lead to re-configure several times the cellular manufacturing systems in order to keep a high level of performance.

For the above reasons, new configurations have been proposed in literature such as Virtual Cell Manufacturing System (VCMS), Fractal Cell Manufacturing System (FCMS), Dynamic Cell Manufacturing System (DCMS), with the aim of keeping high flexibility of manufacturing systems.

The concept of DCMS was introduced for the first time by Rehault et al. (1995). It provides a physical reconfiguration of the cells. The reconfiguration activity can be periodic or resulting from the variation of performance parameters. Reconfigure can mean duplicating machines,

Table 1. Benefits and disadvantages of CMS

Measure	Percentage cases with improvements	Average percentage improvement	Percentage cases with worsening	Average percentage worsening
Tooling cost	31%	-10%	69%	+17%
Labor cost	91%	-33%	9%	+25%
Setup Time	84%	-53%	16%	+32%
Cycle Time	84%	-40%	16%	+30%
Machine utilization	53%	+33%	47%	-20%
Subcontracting	57%	-50%	43%	+10%
Product quality	90%	+31%	10%	-15%
Worker satisfaction	95%	+36%	5%	-
Space utilization	17%	-25%	83%	+40%
WIP inventory	87%	-58%	13%	+20%
Labor turnover/absenteeism	100%	-50%	0	-
Variable production cost	93%	-18%	7%	+10%

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