

# Chapter 61

## Operator Assignment Decisions in a Highly Dynamic Cellular Environment

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### ABSTRACT

*Operators are assigned to operations in labor-intensive manufacturing cells using two assignment strategies: Max-Min and Max. The major concern is to see how these two approaches impact operators' skill levels and makespan values in a multi-period environment. The impact is discussed under chaotic environment where sudden changes in product mix with different operation times are applied, and also under non-chaotic environment where same product mix is run period after period. In this chapter, operators' skill levels are affected by learning and forgetting rates. The Max-Min strategy improved operators' skill levels more significantly than Max in this multi-period study; particularly in chaotic environment. This eventually led to improved makespan values under Max-Min strategy.*

### INTRODUCTION

Cellular manufacturing is considered as a collection of manufacturing cells that is dedicated to manufacture part families or assembly cells that are dedicated to process product families (see Askin & Standridge, 1993). The cellular manufacturing systems can be either machine-intensive or labor-

intensive. In labor-intensive cells, it is easier to reconfigure cells when a product is ready to be processed. Moreover, moving equipment is much easier than it is in machine-intensive cells. Basically, in labor-intensive cells, most of the operations require light-weight, and small machines as well as equipment that require continuous operator attendance and involvement (Süer & Tummaluri, 2008). Labor-intensive manufacturing cells have been observed in apparel, jewelry manufactur-

DOI: 10.4018/978-1-4666-1945-6.ch061

ing, electromechanical assembly, sewing, shoe manufacturing, medical devices, and car seat manufacturing industries. The operator's role in machine-intensive cells is limited due to the presence of automatic machines. On the other hand, the operator has a key role in labor-intensive cells, and the number of operators and their assignment to operations has a great impact on the cell's production rate. In some cases, the number of operations is less than the number of operators. This creates the possibility that multiple operators are assigned to perform the same operation. It is important to control operator assignments; however, when the number of cells and the number of operators increase, keeping track of operator assignment becomes difficult.

In this chapter, concepts such as learning and forgetting rates are discussed to show how operator skill level varies from time to time; thus, the assignment decision is affected. Forgetting and learning rates affect the operator's skills and they are affected by their current skills. Learning takes place when the operator performs an operation continuously for a period of time, consequently, the operator will be more familiar with performing an operation. On the other hand, forgetting happens when the operator does not perform an operation in a number of consecutive periods. This chapter addresses both operator assignment and cell loading decisions. Operator assignment determines which operators are assigned to perform each task and cell loading identifies the products to be run in each cell.

The work undertaken in this chapter is an extension of work by Süer and Tummaluri (2008). The operator assignment can be made by using two different strategies; 1) Max, 2) Max-Min. Max considers only the current state of the operator skills for operator assignment to maximize output rate. On the other hand, Max-Min considers long-term effect of assignment decisions and attempts to develop more homogeneous work force without sacrificing output rate. This homogeneous work force may be more effective in dealing with

drastic variations in demand and product mix in the long-term.

The objective of this chapter is to propose better mathematical models for operator assignment and also compare the performance of two major strategies, Max and Max-Min, in highly dynamic cellular environments. The main hypothesis is that Max-Min is a better strategy in operator assignment in the long-run. We want to show that long-term planning may help companies to better prepare their workforce for long-term operation than short-sided approach where only the immediate periods are considered. This approach is especially important in highly fluctuating demand environments and also in companies where product mix can quickly change. It is easier to implement such a strategy in companies where workforce is stable with low turnaround rate.

## **BACKGROUND**

In the literature, some researchers addressed areas related to this subject such as cell loading, operator assignment, skills, learning and forgetting rate and product sequencing. Süer (1996) discussed, in his paper, the subject of optimal operator assignment and cell loading in labor-intensive manufacturing cells. He stated that the operator assignment to cells influences production rate that each cell can produce. He proposed a two-phase methodology. In phase 1, he generated operator assignments for alternative manpower levels by using a mixed integer mathematical model. In phase 2, he found the optimal manpower levels for each cell and optimal product assignment to cells.

Nembhard (2001) discussed a heuristic approach for assigning workers to task based on individual learning rate. Basically, he ran experiments based on two conditions: a long production run and a short production run. Results were interpreted and showed that the heuristic approach have an impact on overall productivity. Best results were found when workers learn more gradually.

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