Chapter 31
Optimization and Mathematical Programming to Design and Planning Issues in Cellular Manufacturing Systems under Uncertain Situations

Vahidreza Ghezavati
Islamic Azad University, Iran

Mohammad Saeed Jabal-Ameli
University of Science and Technology, Iran

Mohammad Saidi-Mehrabad
University of Science and Technology, Iran

Ahmad Makui
University of Science and Technology, Iran

Seyed Jafar Sadjadi
University of Science and Technology, Iran

ABSTRACT

In practice, demands, costs, processing times, set-up times, routings, and other inputs to classical cellular manufacturing systems (CMS) problems may be highly uncertain, which can have a major impact on characteristics of manufacturing system. So, development models for cell formation (CF) problem under uncertainty can be a suitable area for researchers and belongs to a relatively new class of CMS problems that not researched well in the literature. In this way, random parameters can be either continuous or described by discrete scenarios. If probability information is known, uncertainty is described using a (discrete or continuous) probability distribution on the parameters, otherwise, continuous parameters are normally limited to lie in some pre-determined intervals. This chapter introduces basic concepts about uncertainty themes associated with cellular manufacturing systems and briefly reviews literature survey for this type of problem. The chapter also discusses the characteristics of different mathematical models in the context of cellular manufacturing.

DOI: 10.4018/978-1-4666-1945-6.ch031

INTRODUCTION

During the past few decades, there have been various types of optimization techniques and mathematical programming approaches for cellular manufacturing systems under different random situations. In a cell manufacturing, once work cells and scheduling of parts in each cell are determined, it may be possible that cycle time in a specific cell be more than the other cells which creates a bottleneck in a manufacturing system. In this way, there are two different approaches in order to decrease cycle time in bottleneck cell: duplicating bottleneck machines or outsourcing exceptional parts which are known as group scheduling (GS) in the literature. Selecting each approach to balance cycle times among all cells can lead to variations in machines layout characteristics by changes in type and number of machines. Finally, formations of cells are also changed according to the changes in scheduling decisions. Thus, scheduling problem is one of the operational issues which must be addressed in design stage concurrently in an integrated problem so that the best performance of cells would be achieved. It is noted that scheduling problem includes many tactical parameters with random and uncertain characteristics. In addition, uncertainty or fluctuations in input parameters leads to fluctuations in scheduling decisions which could reduce the effects of cell formation decisions. Figure 1 indicates transmission of uncertainty from tactical parameters to the CMS problem.

Thus, in order to intensify effectiveness of the solution, integrated problem in uncertain conditions must be studied so that final solution will be robust and immune against the fluctuations in input parameters.

In the concerned problem, uncertain parameters can be listed as follows:

- Demand,
- Processing time,
- Routings or machine-part matrix,
- Machines' availability,
- Failure rate of machines,
- Capacities,
- Lead times,
- Set-up considerations,
- Market aspects,
- …,

where the impact of each factor is discussed in the following sections.

PROBLEM BACKGROUND

Group technology (GT) is a management theory that aims to group products with similar processes or manufacturing characteristics, or both. Cellular manufacturing system (CMS) is a manufacturing

Figure 1. Illustration of uncertainty transmission to the CMS decision