Chapter 6

Metaheuristics Methods for Configuration of Assembly Lines: A Survey

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ABSTRACT

Balancing assembly line is an important problem in manufacturing because of its high investment cost, efficient production system cost, and incorporation of various aspects of decisions and production tasks. This problem has been studied intensively for decades and various solution procedures have been proposed. Recently, many balancing and sequencing of assembly lines problems are solved using metaheuristics methods. The methods offer higher flexibility in their adaptability to fit the need of various optimization problems. The implementation of metaheuristics methods in ALBP enables researchers to explore more aspect of the assembly lines with higher complexity. This study provides in deep discussion of assembly lines balancing problems and the application of metaheuristics method to solve the problems including the new advances in the state of the art and possible future development.

INTRODUCTION

Assembly lines can be described as a set of sequential workstation in which components of product are assembled to produce finished product or subassembly. It is a flow oriented production systems and is commonly used in manufacturing systems to produce high quality standard of commodities (Becker & Schooll, 2006; Scholl et al., 2010; Boysen et al., 2007; Boysen et al., 2008). Assembly lines maximize the system productivity; therefore most goods of daily life are made

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in manufacturing systems that utilizes assembly lines production systems in its later stages (Amen, 2001). In its early development, the assembly lines were applied to reduce the mass production cost of standardized products and enhanced the specialized workers (Shtub & Dar-El, 1989; Scholl, 1999). However, due to the changes of product requirement as well as systems requirement, assembly lines are now available for low volume assembly-to-order production (Mather, 1989) and enable the products individualization (Boysen et al., 2007; Boysen et al., 2008).

Designing assembly line is commonly associated with the development of new products or variants of products which integrate different functions and considerations. There are several decisions that must be considered in the assembly lines design: product design, process selection, line layout and line balancing (Battaia & Dolgui, 2012). The product design and process selection refers to the information about the works in the assembly lines. Line layout refers to the workstation shape, the workstation situation, the production flow directions as well as the assembly rules. The line balancing defines the assembly lines efficiency (Battaia & Dolgui, 2012).

There are several factors that could determine the efficiency of assembly lines (Scholl, 1999; Driscoll & Thilakawardana, 2001): number of tasks, task time variability, cycle time, and precedence constraints. High number of task requires high number of workstation. It also increases the feasible task sequence to be explored. Therefore, the problem complexity will likely grow exponentially with the increase number of tasks. A high variability of task time could reduce the load uniformity among workstation in the strongly constrained tasks. Cycle time and task time are interplay each other. Assigning small task times with respect to cycle time will likely produce lower idle time if compared to assigning the larger ones. For the last factor, precedence constraint will reduce the number of feasible solution, however it less likely to find an efficient solution.

The investment cost for assembly lines are high, therefore, the assembly lines must be configured in such a way supporting the efficient production system. This involve accomplish the assembly line objective, satisfy the demand and following the constraints (Kim et al, 2007; Simaria & Vilarinho, 2009). In other words, balancing assembly lines must comprise all the decisions and tasks including the system's capacity and the assigning tasks (Boysen et al., 2007). The term assembly lines balancing problems (ALBP) used in this chapter refers to the assignment of tasks into workstation and assuming that the tasks, constraints and all decision considerations have been decided. This approach is commonly used in the academic discussion of assembly lines balancing problems.

The Assembly Lines Balancing Problems (ALBP) is belonging to NP-hard problem, (Wee & Magazine, 1986) and its variant also belongs to NP-hard problems (Scholl, 1999). There have been many methods proposed to solve this problem, both exact and approximate methods. Currently, many metaheuristics methods have been applied to solve the ALBP due to its flexibility and efficiency. In the last few years, the number of publications on this field increase significantly, which mean that this topic play an important role in production research. In this chapter, we conduct a literature study on the application of metaheuristics methods to solve ALBP. The aim of the study is to provide a big picture of the domain discussed in the chapter, therefore, could help researchers and practitioners to understand the current state of this domain better.

BACKGROUND

According to Ghosh and Gagnon (1989), the first analytical statement of ALBP was introduced by Helgeson et al (1954) while the first mathematical model of this problem was proposed by Salveson (1955). According to Salveson (1955), assignment of tasks into workstations must obey the following criteria: