Chapter 4
A Heuristic Approach for Car Sequencing Problem Including Assembly Ratio and Color Constraints

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ABSTRACT

A car factory contains three main workshops; body shop, paint shop and assembly shop. Each of these three workshops has their set of constraints which have to be met in a production day by arranging the vehicles. The car sequencing problem is used to create a production sequence that meets these constraints. Car sequencing problem first handled in the literature by optimization of assembly constraints including ratio constraints. After that, color constraints are integrated to assembly constraints. At this chapter, the scenario in which high priority ratio constraints are primary, color constraints are secondary is tackled and a heuristic approach is proposed. For optimization of ratio constraints, an initial algorithm based on the greedy algorithm is used. The developed algorithm is coded and used on data set which is proposed by Renault at the ROADEF'2005 challenge. According to results, it is achieved the range of results which is achieved by ROADEF finalists.

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INTRODUCTION

The car industry shows a rapid development in the late 19th century. The invention of the petroleum fuel powered engines and cars have occurred as a result of great efforts of European and American engineers. After these developments, some studies have performed in order to produce these commercial products. The first large-scale car production started at 1902 by Ransom Olds. At 1914, Henry Ford has moved up this mass production a step further with the developments on the assembly line. By latest developments, a car started to be produced in every 15 minutes.

Developments in the car industry continued both at Europa and America until the World War 2. Despite the pause in the growth during the war, it continued to grow at an increasing speed later. With the entry of new companies into the market, the competition increased, and it leads to the discovery of new targets such as manufacturing cars with less costly and better quality. Production systems have been improved in line with these objectives.

Nowadays, the car industry has become a challenging industry branch because of the strong competition, multi-product diversity and short product life. Increased consumer demand and quality expectations have become driving forces for the companies to improve their production methods. As a result of the studies about the productivity of the production line, a wide search area has emerged in the car industry. It has become mandatory for the companies to allow flexible operations to meet the demand of the customers. Optimal car sequencing is one of the many ways which provides this flexibility.

The standard car sequencing problem is known as a classical benchmark problem and has been widely studied since its first introduction in 1986 (Solnon, 2008). This problem involves scheduling cars using assembly shop constraints. In 2005 Renault proposed a car sequencing problem for ROADEF Challenge. The car sequencing problem which is proposed by Renault differs from the standard problem since, besides capacity constraints of the assembly shop, it also introduces color constraints to minimize the consumption of solvents in the paint shop and considers two categories of capacity constraints to take into account their priority.

In this chapter, the ROADEF scenario in which high priority ratio constraints are primary, color constraints are secondary is tackled and a heuristic approach is proposed. Firstly, a short information about standard car sequencing problem and ROADEF car sequencing problem are given. After the literature review, the proposed methodology is presented. The model is coded in C++, and the ROADEF'2005 data sets are used for evaluation.

CAR SEQUENCING PROBLEM

A standard car factory consists of three main production workshops; a body shop where the body is built up by forming sheets, a paint shop where corrosion resistance of the body is increased, and the body is painted and an assembly shop, where different components of the vehicles are installed. Figure 1 depicts the stages of the production line.

The car sequencing problem is about deciding the best sequence which makes the production process in these three workshops easier (Estellon et al., 2007). Each production workshop has its constraints, and all these constraints can conflict with each other. Due to these constraints challenge in the problem, only assembly shops took into consideration in the earlier studies.