

Production scheduling problem of automobile mixed model assembly line

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ABSTRACT. Nowadays, the mode of production has changed from mass production to multi variety and small batch production, and mixed model assembly line has emerged. Mixed model assembly is widely used in automobile enterprises. This paper summarizes the theory and method of automobile mixed model assembly line scheduling, analyzes its characteristics and difficulties, summarizes the related optimization objectives, and introduces the related algorithms, so as to make the scheduling problem of mixed model assembly line more clear.

KEYWORDS: Automobile industry, mixed model assembly line, production scheduling

1. Introduction

With the continuous improvement of people's living standards, the demand for automobiles has become diversified, and consumers are more and more inclined to personalized and customized products. Therefore, the automobile industry has changed from the original single variety of mass production to the current multi variety and small batch production, and the assembly line has also developed into the current mixed model assembly line.

Mixed flow production is a common form of production line organization, which can produce many kinds of products in one production line. In 1961, Kilbridge MD and Wester first put forward the problem of mixed flow production and defined the concept of mixed flow line. In 1963, Arcus A. L [1] first proposed the scheduling problem of mixed model assembly line, which was proved to be NP hard problem in combinatorial optimization. Later, more and more experts began to pay attention to this problem, and many new methods, models and algorithms [2-4] came into being.

2. Mixed production in automobile industry

2.1 Modular automobile assembly technology

There are many disadvantages in the traditional assembly line of automobile. Firstly, the assembly line has to be designed for a long time in the general assembly workshop, which covers a large area and costs a lot. Secondly, there are too many parts, which can easily lead to installation errors or missing a part in the tense working environment, especially in the mixed mode production of multiple models. Under this condition, modular assembly technology has become an inevitable trend.

2.2 Characteristics of automobile mixed model assembly

Automobile mixed production refers to the alternative production of different types of vehicles in the same production line. This production mode has the following characteristics:

(1) The increase of vehicle types in the order increases the frequency of switching colors in the painting workshop, increases the types of body produced in the welding workshop, and increases the number of parts required in the final assembly workshop, thus increasing the difficulty of production scheduling.

(2) In the mixed production mode, different types and models of vehicles will be produced on the same production line. Moreover, due to the large number of automobile assembly processes, involving hundreds of parts, the demand for materials is more complex.

(3) Unforeseen chaos often occurs, such as downtime, order insertion, order cancellation, etc., which leads to insufficient inventory, untimely supply, etc., and affects the smooth implementation of the production plan. Therefore, in order to ensure production, it is necessary to reasonably arrange the production plan.

3. Optimization of mixed model assembly line scheduling

3.1 Optimization objective of automobile mixed production scheduling

In the automobile mixed model production, scholars mostly study the mixed model assembly workshop. In the early years, single objective scheduling optimization was mostly carried out for single workshop. With the deepening of science and technology and research, single objective optimization has been unable to meet the actual needs. Scholars began to carry out multi-objective optimization for single workshop, and many scholars carried out multi-objective scheduling optimization on the basis of considering multi workshop linkage. Optimization objectives can be divided into three categories: work completion, resource balance and cost.

(1) Work completion optimization objectives. Such as minimizing the operation time, minimizing the adjustment time, minimizing the line stop time, etc.

(2) Resource balance optimization objectives. Such as material consumption rate equalization, station load balancing, equipment utilization maximization, etc.

(3) Cost optimization objectives. Such as minimizing equipment operation cost, minimizing labor cost, minimizing logistics cost, etc.

In the process of scheduling optimization, researchers usually select multiple objectives from different angles for optimization, and often give them different weights when establishing the multi-objective optimization model, so that important optimization objectives can be achieved first.

3.2 Production scheduling method of automobile mixed model assembly line

The earliest scheduling method is based on simple rules. With the development of related theories, there are many advanced scheduling methods from simple to complex, from single to multiple. In vehicle manufacturing enterprises, mixed model production lines need to make long-term, medium-term and short-term plans. Due to the different accuracy of different levels of planning requirements, the corresponding methods will also be different, mainly including the following.

(1) Linear programming. This method can consider all kinds of production constraints and constraints, assign the order allocation to the production line, and establish the scheduling order according to the priority of the production line on the premise of meeting the rigid constraints.

(2) Heuristic algorithm. It is a method to obtain the optimal solution by setting goals and constraints in advance and constantly trying. The advantages lie in low computational complexity and fast operation speed, but the number and complexity of variables that can be processed are relatively high, and the stability of the scheme varies greatly according to different problems.

(3) Intelligent algorithm. It is mainly used to make short-term plans, which can take all the restrictions and constraints, as well as the delivery date and other factors into account. Including genetic algorithm, ant colony algorithm, particle swarm optimization, tabu search algorithm, simulated annealing algorithm and so on.

(4) Minimum circulation method. It is a greedy algorithm for making short-term plans. In each step, the strategy that increases the value of objective function least is selected from the current available strategies, that is, the most favorable model is selected when the production sequence of a vehicle is determined. The disadvantage of this method is that in most cases the scheduling scheme is the local optimal solution.

Each algorithm has its own defects, so many scholars have improved and fused the algorithm to make up for the defects of the algorithm itself. Su Ping [5] use simulated annealing algorithm to improve the genetic algorithm, and solve the problem that traditional genetic algorithm is easy to fall into local optimum. Wu Yongming[6] integrated particle swarm optimization algorithm and genetic algorithm, added crossover, mutation and other operations in the process of particle search, improved

the optimization ability and accuracy of the algorithm, and solved the defect that the basic particle swarm optimization algorithm is easy to fall into local optimum

4. Conclusion

At present, the research on automobile mixed production mainly focuses on a single workshop, without considering the linkage between the workshops. With the development of industry, the research on single workshop can not meet the actual needs. From the system point of view, the stamping, welding, painting, assembly workshop as a whole will be analyzed and considered, which will become the trend of future research. In addition, for all kinds of emergencies in the production process, we should increase the research, such as: emergency order processing, material shortage processing, etc., to improve the flexibility of mixed model production, which will also become a hot topic in the future.

In addition, with the emergence and rise of APS system and the continuous improvement of information level in production process, the feasibility of applying information technology to solve production scheduling problems is greatly increased. Therefore, with the continuous expansion of enterprise demand for APS, APS system will continue to improve and develop in the future.

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