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Combined Optimization of Dynamic Facility Layout and Production Planning

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Abstract
Facility layout and production planning are two important phase during in flexible production system a significant effect on efficiency of production and cost with the changing of consumer demand of production. The problem on show on considering the integration between facility layout and production planning this research paper on develops the model of flexible production process based on the Petri Net. The serial optimization approach combing reach ability graph algorithm theory and search algorithm is designed to work out the problem. Then the flexible production planning and dynamic layout are obtained sequentially. Finally, This model minimizes the total cost over a discrete and finite time horizon for establishing, operating, and closing facilities, including the transportation costs for shipping demand from facilities to customers.
Keywords*: Petri Net, flexible production mode, dynamic facility layout, production planning, serial optimization approach.*

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I. INTRODUCTION

The introduction of the paper should be explain the nature of the problem, Dynamic facility location models can be considered to be extensions of the conventional (single-period or static) models as they include time varying demand. Most of the models developed in the literature for dynamic location problems assume that facilities can be relocated between periods in response to changes in demand. There are associated relocation costs for changing the location of facilities between periods, which can represent the initial investment for establishing new facilities and the cost (or savings) for the closure of existing facilities.

The flexible production mode [1].Facility layout and production planning as two important phases during flexible production mode, have a significant effect on production efficiency and cost with the changing of consumer demand. Motivated by the problem, considering the integration between facility layout and production planning, this paper develops the model of flexible production process based on the Petri Net.

The serial optimization approach combing reach ability graph algorithm and search algorithm is designed to work out the problem. Then the flexible production planning and dynamic layout scheme are obtained sequentially. Finally, a case study is carried out to verify the validity and performance of the methodology. The facility layout will be dynamically adjusted according to the production demand in different stages. The production planning also need to be calculated ahead to meet the production demand simultaneously.

The facility layout and production planning are the main factors that affect production efficiency and material handling cost. The facility layout will affect the logistics distance between facilities. The production planning will decide the different process sequence that result in the different quantity of logistics between the different facilities. Both facility layout and production planning will have impact on production efficiency and cost. Consider the quantity and total distance of logistics in the variable production environment.

This paper combines the facility layout and production planning to optimize and achieve high-efficiency and low cost production targets and rearrangement cost of re design layout.

This type of paper considers the logistic quantity of production process while the previous studies simplify the flow of material to study the facility layout problem [2]. And the Petri Net (PN) is a modelling tool for representing discrete events which was originally created by Dr. Carl Adam Petri [3]. The production process model is built based on Timed-Transition Petri Net (TTPN) [4] which effective represent the assembly time. The search algorithm [5] has been used in solving the production planning already. Further the results of the flexible production planning and dynamic layout scheme are obtained by serial optimization approach combing reachability graph algorithm and search algorithm. This paper summarizes the model of flexible production process and serial optimization method of dynamic facility layout and production planning.

II. LITERATIRE REVIEW

The minisum and minimax location problems are classic location problems that have been formulated as continuous or discrete location models. The minisum problem has the objective of finding the location of a single or multiple facilities in such a way that the weighted Euclidean distances from a fixed number of points to the facilities are minimum. In the minimax problem, the objective is to determine the location of facilities such that the maximum distance from a set of points to the new facilities is minimum. The Background of Research is respond to the personalized customer demand in the FMS. The facilities can be divided into modules and adjusted by the location for the different production plans. Some researchers have studied how to divide the module by PN. Li et al. [6] used PN model to supervise and control reconfiguration manufacturing system (R.M.S). And these are three stages rapid generation full PN model was proposed to describe the reconfigurable manufacturing unit.

According to Dideban et al [7].Proposed a new integrated control theory method based on PN. And the PN was decomposed into sub-modules to implement the constraints of the PN model. This paper proposes the flexible production mode that each facility has the Multiple Assembly functions. Each facility can finish the multiple processes during the production process. The assembly function of each facility depends on the actual part type. In this paper, the workshop area is divided into different regions first. And then the facility is laid out. There is also production planning in the FMS based on the PN. Lefebvre et al. [8] used TTPN to calculate the minimum time of completion by avoiding dead transitions. And the proposed method used local reachable graph to ensure computational complexity

According to Kammoun et al. [9] proposed decomposition method of TPN applying for flexible scheduling problem under variable constraint conditions. And the optimal sequence of Timed-Petri Net (TPN) was found to achieve the minimum processing time. Baruwa et al. [10] proposed an efficient search method based on Colored Petri Net (CPN). This method is applicable to the flexible scheduling problem of different work station resources and operations with the same series but different sizes.Yu et al. [11] used P.N. to describe the FMS that can efficiently carry out unit configuration and operation with the heuristic search algorithm. This method was used to solve the problem of FMS with buffer. Basak et al. [12] proposed a target oriented PN method which achieves high efficiency production control for the workshop in the FMS. At the same time, the system model can be simplified into linear program (LP) by using time-assignment identification map. This paper considers using the TTPN to set up the flexible production mode based on the FMS and calculate the batch Product completion time. This model can effectively express the time characteristics of production planning and layout and its design.

Using heuristic search algorithms is common in solving production planning problems based on according to P.N. Mejía et al. [13.] combined the search algorithm with the improved evaluation function to generate a better solution. It was used for experimental testing in complex scheduling systems to ensure the quality and calculation time of solutions. Mejía et al. [14] used the two-layer filtering mechanism to limit the number of identifiers each layer. This method improved the memory space and computational efficiency by extending to each layer of search tree. Baruwa et al. [15] combined the search algorithm breadth-first heuristic search to guarantee the best solution.

The constraints of processing time and processing sequence are established by TTPN to limit the search space. This paper generates the reachable graph [16] and calculates the production planning by search algorithm. Most the facility problem just considered the macro logistics volume regardless of actual logistics of operation layer [2]. The minimum cost is the most frequently used optimization objective for the facility layout problem (FLP). However, several extensions of these models have been] proposed, with objectives such as the minimization of distance [17] [18] time The FLP of this paper considers logistics quantity combined with the actual logistics of production planning based on the PN

This paper takes the interaction between production planning and facility layout into consideration. There are few related studies until it becomes a hot topic recently [19].

This paper research on the joint optimization of dynamic facility layout and production planning based on the batch production demand contains three vehicle types (*X, Y, Z*), the quantity of each type is stochastic. There are three types facility and there are three process among the whole assembly process according to the process document. The quantity of facility in each process is (2, 3, and 2). The process time of each type car is (*X* (2, 3, 4), *Y* (2, 1, 3), *Z* (3, 2, 1)

III. THE MATHMATICAL MODEL

1. We develop a mathematical model for the DCFLP to determine the optimal time and location for establishing capacitated facilities (as well as the allocation of customers to facilities) in order to minimize the total cost, when demand and cost parameters are time varying We develop a mathematical model for the DCFLP to determine the optimal time and location for establishing capacitated facilities (as well as the

allocation of customers to facilities) in order to minimize the total cost, when demand and cost parameters are time varying.

2. The model determines a fixed configuration of facilities that minimizes the total cost when demand and cost parameters are time varying. The model determines a robust configuration of facilities that minimizes the maximum difference in terms of total cost with respect to the optimal solution for each time period. We implement Local Search and Simulated Annealing metaheuristic to solve this model.

3. The traditional manufacturing system is mainly composed by the line production mode, it can only produce one or several model during the production. It cannot meet the changing personalized market demand. So this paper proposes the flexible production mode which can meet the changing market demand. The facilities of flexible production mode include the facility and the automated guided vehicle (AGV). Among them, the multi-function facilities are used to complete the assembly process during the assembly process that can produce different vehicles. The AGV will carry the different car models to the next facility according the production planning among the facility when the facility assembly finishing the current process. The AGV distribution strategy is not considered in this paper. So every facility will have the AGV for delivering the vehicle product to the different facilities. As shown in figure 1. The dotted line in figure represents the path of the AGV.

The Timed-Petri Net

The mathematical representation of a discrete parallel system can be represented by Petri Net model. It contains places, transitions and directed arcs connecting places and transitions. The PN can be used to study the dynamic behaviour of the discrete event system. The Timed- Petri Net introduces the time attribute to describe the process of activity. It contains Placed-Timed Petri Net (PTPN) and Placed-Timed Petri Net (TTPN). This paper uses it to describe and analyse the production planning in the FMS

The need of Research Assumption in facility layout.

The relationship between facility layout and production planning needs to be considered comprehensively. The logistic affects production efficiency and cost, so this paper takes the logistic cost between facilities as the optimization objective

1. The AGV distribution strategy is the one-way logistics between facilities and the speed of AGV is 1m/s.
2. The assembly process is carried out according to the working procedure.
3. The spare parts are enough during the assembly process.
4. The logistics distance of parts between each facility is the linear distance between the centers of each facility.
5. The transport speed remains same and unchanged, so the distance is proportional to time.
6. The assembly demand will follow the sequence, that is to say there is no waiting at the start of the Assembly input process

IV. CONCLUTION

This Research paper on forward to the flexible production mode or system in the future. First the TTPN is used to model the flexible production mode. Then paper consider to the impact of layout facility associated with production planning control. That a serial optimization approach is proposed to solve the optimization problem on dynamic layout problem. The optimization of production planning and dynamic facility layout to the calculated by reach ability graph theory algorithm and the search theory algorithm.

V. FUTURE SCOPE OF WORK

This tile based on the combined optimization of Dynamic facility layout and production planning. It takes the logistics quantity among the stations under the process constraints and the location between all the facilities into consideration. The method of this research is suitable for different batch production process or line production when the demand changing. So the solution to the production planning and the facility layout over the multiple periods is available by this method. And increase the production quality, cost and efficiency.

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