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Selected Heuristic Methods used in Industrial Engineering

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Abstract

This paper deals with a heuristic approach to material supplies of assembly lines (e.g. automotive industry) and to optimization of a stacker which is used in production lines or stores. A modern method for supplying assembly lines with material is using the so called 'milk run' – trains supplying not only one point in assembly production lines but several points. A graph model is used. An analytical solution for creation of trains is not known; most probably it does not exist. Solutions using "brute force" may be very slow. They cannot be used for more than a dozen demands.
A repeated random selection of n-tuples of transport demands and building of trains from this selection could be a good way to solve this task.
A model of assembly production lines has been developed and the speed of convergence of random selections to a suboptimal solution has been calculated and measured. A thousand selections give good results. These heuristic results have been compared with some deterministic strategies (nearest demand, building of n-tuples).
A similar approach has been used for optimization of a stacker in a workshop and in a store.

Keywords: using graphs in logistics; material supplies; heuristic optimization -assembly lines - milk run; FMS; stacker

1. Introduction

Any production enterprise is nowadays focused more than ever before to optimize production costs. This means not only cost savings but also lowering risks of order delay and due dates. Computers are increasingly used and therefore there is a shift from decisions made by production management based on long-term experience and intuition to a growing support from computers. It is accordingly necessary to study and develop algorithms leading

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to optimization of costs and lowering of potential risks.

Optimization methods and algorithms have been studied and developed at the Department of Industrial Engineering and Management for a long time [1].

Optimization methods have been explored and researched in the following fields:

- Moves of a stacker and two stackers on one rail
- Operative plans of production
- Daily plans of production [2]
- Selecting appropriate picking method [3]

While researching these tasks we came to the conclusion that too sophisticated methods mostly fail due to the inaccuracy of the input data. This inaccuracy is more caused by dynamic changes in this process and its development in time than by insufficient quality of work in technical preparation of the production, inaccurate observations and measuring in the production process. Because of this, research and development activities have been focused more on simple and robust methods of optimization which could be both easier in implementation and resistant to changes of parameters of optimized systems.

Other authors ([4], [5], [6] [7], [8],[9],[10],[11]) solve the optimization in industrial engineering using mathematic models and elaborated heuristic optimization techniques.

2. Assembly line supply system

Experiments with simulation and optimization of supply routes in the automotive industry have been carried out by cooperation between the university and industry. There is a growing trend of changing from fork lift trucks to manual or automatic trains. These trains consist of a tractor and some carriages. Two strategies exist:

- Detaching a carriage on the supply point at the assembly line: the last carriage is detached at the supply point, it depends on the sequence of carriages. This sequence is created in the central store. Empty carriages are collected after separation of the last carriage with material.
- Taking off material from the carriage directly at the workplace: in this case, the length of a train stays constant and there is no need to collect the empty carriage. Manipulating material at workplaces takes longer than detaching a carriage.

If carriages are not detached it is also possible to distinguish:

- One carriage transports material only to one supply point
- One carriage transports material to many supply points: in this case the new task is for optimal filling of a carriage both from the point of view of carriage capacity and manipulation at the workplace

3. Test model of a production line supply system

A test model of assembly lines supplied by logistic trains based on experience acquired by the analysis of production lines in an automotive enterprise has been developed (Fig. 1).

Fixed supply routes have not been considered because there is no possible optimization. Dynamically created routes have been found according to the momentary state of transport demand. The length of trains varies from 1 to 4 carriages which means delivery for a maximum of 4 points in the assembly line. Carriages are detached at supply points. Collations of empty carriages are not solved because they are in principle simpler than transportation of carriages with material.

This model has been transformed into an orientated mathematic graph with 21 vertices in which 0 is the central store (U00) and start of every transport of a maximum of 4 carriages (Fig. 2).

Groups of n demands ($1 < n < 20$] are randomly generated from vertices needing service by trains. Every group can be considered as a subgraph. The task is to cover the subgraph with circles of a maximum of 5 vertices (start in the central store and 4 supply points in assembly lines) so that the total length of these circles representing the routes