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A Review On Facility Layout Design Of An Automated Guided Vehicle In Flexible Manufacturing System

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Abstract

This paper presents a review on facility layout design of an Automated Guided Vehicle in Flexible Manufacturing system. We address many issues related to layout design, location of pickup and delivery points and flow path design. We discuss various developments in layout design, comparison of tandem layout with other layouts, various developments in location of pickup and delivery points and flow path design. We further classify different models and results from key publications in literature.

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Keywords: Automated guided vehicles; flexible manufacturing system; tandem layout.

1. Introduction

Automated guided vehicle is a material handling system that uses independently operated, self-propelled vehicles guided along defined pathways. Automated guided vehicle has its par usage in material handling since 1970's. Its usage has become an eminent part even in flexible manufacturing systems because of its extremely flexible, space efficient, multi-tasking, highly reliable and extendable nature [1]. However, the design and control of an automated guided vehicle system is influenced by various aspects such as vehicle scheduling, load size specification, guide path layout, location of load pickup and drop-off points, vehicle routing and traffic control which increases its complexity [2]. In this paper the role of facility layout design is addressed. Facility layout design methodology is one of the primary aspect to be dealt for an efficient and economical working of an automated guided vehicle system. For U.S manufacturers about 10% to 30% of total material handling cost are reduced because of an efficient facility design [3].Facility layout design is categorized into layout design, pickup and delivery points, flow path design. In layout design the workspace is divided into set of complex polygons known as cells. For proper sequential working of a manufacturing system, the layout is combined with the material flow system. The material flow system is characterized in terms of flow path design and direction of vehicle flow, number and location of pickup and delivery points [4]. The flow path and location of pickup and delivery points must be determined effectively as they

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Nomenclature	
P/D	pickup and delivery
LPP	linear programming problem
QAP	quadratic assignment problem
TLMV	tandem loop with multiple vehicle

influence the path that an automated guided vehicle must track which impacts the flexibility and operational costs of a manufacturing system [5].The rest of the paper is organized as follows: Section 2 deals with the nomenclature; the layout design is forecasted in section 3, section 4 envisages the pickup and delivery points, section 5 describes the flow path design and finally conclusions are drawn in section 6.

2. Layout design

The flexibility of a FMS depends upon the effective utilization of the total work space available at the warehouse. The layout design significantly effects the balancing of workload and occurrence of bottlenecks among Automated Guided Vehicles [6]. Thus, layout design plays a prominent role in proper working and smooth running of the manufacturing system.

The different layout design configurations discussed by past researchers include:

3.1. Conventional layout:

3.1.1. Unidirectional layout design:

Unidirectional layout design is used when the vehicle flow has a constrain to travel only in one direction. In this system, the distance travelled by the vehicle might be greater in moving from one point to other and has less complexity in control system which is more economical [7] as shown in below Table 1 and Table 2.

3.1.2. Bidirectional layout design:

Bidirectional layout design is used when the vehicle flow occurs in two directions. In this system, the distance travelled by the vehicle will be significantly reduced, but the complexity of the control system is very high. The main advantage of the system lies in the achievement of less vehicle travel time [7].

3.2. Single loop layout design:

The vehicle flow in the single loop layout system occurs only in one loop eliminating any other alternative or branched routes. The single loop layout system has eliminated the vehicle congestion at intersections, however the vehicle interference occurs when multiple vehicles are used as the vehicles may travel with different velocities.

Table 1. Different developments in layout design

Author	Developments	Technique or approach used
Maxwell and Muckstadt [8]	Introduced conventional layout for unidirectional AGV system.	-
Gaskins and Tanchoco [7]	Design of flow path by minimizing the total travel distance	0-1 integer programming technique
Gaskins and Tanchoco [9]	Design of virtual flow paths for an AGV system	Mixed integer programming
Sinrich and Tanchoco [10]	Single closed loop guide path layout was introduced to minimize the flow in the system	Optimal single loop algorithm
Sinrich and Tanchoco [11]	Developed a mathematical model for single loop AGV system	Heuristic model
Banerjee and Zhou [12]	Developed an optimization technique for single loop material flow	Genetic approach
Asef-vaziri [13]	Developed a model for designing a unidirectional AGV layout and location of P/D points by minimizing total travel distance simultaneously	Linear programming model
Z.-Farahani [14]	Design a method for loop layout and locating P/D points simultaneously	Genetic algorithm