Layout problems with aisles structure in manufacturing systems: formulation, exact approach and simulation optimization

ABSTRACT

Facility layout can have significant impacts on the safety, cost, time, and productivity of manufacturing systems. There are several major decisions involved when designing a facility layout. In general, facility layout problems are concerned with the decisions related to the allocation of the facilities such as machines, departments and workstations on the shop floor of a manufacturing system to achieve the given objectives and considering certain constraints. However, the facilities require paths that allow them to be connected. These paths, called aisles, are used for the transportation of materials and workers between the facilities. Since transporting materials between facilities is performed through an aisle network, designing a good aisle structure can contribute to reduce the transportation distance between facilities, to cut the material handling cost as well as transportation time and to preparing an smooth and safe material transportation. Therefore, designing a good aisle structure is very important for the efficiency of manufacturing systems, and should be included in the FLP. This thesis studies and analysis the problem of designing aisles in facility layout problems and provides an approach that allows designing aisles structure and facilities layout in an integrated manner.

Two novel approaches are developed to find the optimum facility layout and aisle structure. In the first approach, a mixed-integer linear programming model is developed to simultaneously find the optimum structure of the aisles including the number, position and width of the aisles, the position of the facilities, and the position of the entrance/exit doors in an unequal area facility layout problems. A branch-and-cut algorithm, improved by adding optimality cuts and efficient branching and node strategies, is used to solve the problem. The computational experiments show that the proposed approach is able to find the suited position of facilities and aisles structure for manufacturing systems up to 12 facilities.

In the second approach, simulation is fully integrated with an optimization method (i.e., a metaheuristic algorithm), enabling designers to consider various dynamic and stochastic factors such as transportation time, machine and transporters breakdowns, stochastic demand for products and stochastic process time. The great advantage of the proposed simulation optimization approach is that it can support a direct connection between simulation and many optimization algorithm and can handle the mentioned stochastic and dynamic phenomena of the system. Therefore, it can be applied for a wide variety of FLPs in many manufacturing systems.

Keywords: Facility layout problems, Aisle structure, Mixed-integer linear programming, Simulation optimization

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