


Chapter 12

Design of Facility Layout for Industry 4.0

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ABSTRACT

The concept of Industry 4.0 combines a large number of fully or partly autonomous devices and humans into a system, which is, due to synergies, more flexible and effective than a fully automated system. To reach this objective we have to ensure such facility layout that ensures an efficient transport system which takes into account the large number of participants. The most important design goal is to minimise the path travelled by transport devices. In the case of Industry 4.0 we have two altered conditions: the number of devices (machines, workplaces, storages) connected in one system is substantially larger, and autonomous transport devices and humans have different organisational needs regarding the facility layout. This chapter presents a highly efficient method for preparation of layouts that is based on simplified space and the physical appearance of the system. The design of transportation paths will be subjected to finding the optimum layout of devices to lower transportation costs.

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INTRODUCTION

The floor, or Facility Layout Problem (FLP) has been studied widely for decades; in general, it is defined as a search for the most efficient arrangement of objects on the plane. The general definition of a floor layout is *the determination of relative locations for, and the allocation of, available space among a number of workstations* (Azadivar & Wang, 2000; Ripon, Glette, Khan, Hovin, & Torresen, 2013). The Facility Layout Problem is a common variant of the general definition of a problem which addresses the problem of placement of devices in the facility for industrial purposes. Kusiak and Heragu, in this manner, used the term *facility* to represent a machine, workstation, inspection-station, washing-station, locker-room, rest area, or any manufacturing or support facility (Kusiak & Heragu, 1987).

This chapter addresses the problem of design of facilities in the circumstances of Industry 4.0, where an altered approach is needed to this problem; therefore, the abbreviation FLP is meant strictly as a *Facility Layout Problem*. The motivation for research of facility layout design in Industry4.0 is economical, technical and organisational; there are multiple goals which have to be met in practice. Because of the integration of a large number of (partly) autonomous devices based on IIoT, the FLP evolves a larger problem with new constraints, or better said without traditional constraints. The layout of a facility plays a very important role regarding its effectiveness. Layout defines the production/manufacturing system regarding the operating of devices, organisation of services and transportation of workpieces. In practice, a highly efficient operation relies on short and simple transport paths without bottlenecks. The goal of this paper is to prepare a facility layout which is tailored to the system's main purpose, and not to a human view of perfect organisation. Motivation for our research was made on a presumption; in the facilities of a new generation, which consists of a large number of heterogeneous devices, it is possible to obtain a better layout with the omission of the predefined general shape of the manufacturing system.

This paper discusses the search for a near optimal layout of devices in a facility according to the concepts of Industry 4.0. After the Introduction, the second section of the paper deals with background of FLP, the third section presents the FLP in Industry 4.0. The fourth section presents a highly efficient method of solving of FLP based on simplified space presentation. The fifth section deals with discretised space representation and the search for a layout without any pre-defined shape. The sixth section presents an idea of a system for facility design, which is based on ideas presented in the previous two chapters. A discussion of the findings follows.

BACKGROUND

FLP is one of the most important problems in the literature of production management and industrial engineering, attracting the attention of many researchers in the field of Static and Dynamic Layouts (Hosseini-Nasab, Fereidouni, Fatemi Ghomi, & Fakhrazad, 2018). The FLP is concerned primarily with finding an optimum arrangement of a set of facilities in any layout, subject to certain qualitative or quantitative constraints. The FLPs, like most facility design and planning problems, are computationally non-polynomially difficult (Islier, 1998).

The definition of FLP can depend on:

- Space presentation. Modern researches try to solve the problem on the level of an actual layout, together with the design of transport paths, and take many constraints into account (shape and size

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