Chapter 22
Decision Support Framework for the Selection of a Layout Type

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ABSTRACT

One of the most important design decisions in a firm is the choice for a manufacturing layout type. This chapter shows which aspects have to be taken into account and suggests a systematic method for the decision problem. The method can be seen as a decision support framework, which links the various aspects. The framework is based on the AHP (Analytic Hierarchy Process) approach. A case study, concerning a Dutch firm, illustrates the applicability of the framework in a practical instance.

INTRODUCTION

The choice for a manufacturing layout is a strategic issue and has a significant impact on the performance of the operations function of a company (Meijers and Stephens, 2004, Francis et al. 1992). A variety of manufacturing layout types may be applicable in a practical situation. Table 1 presents some alternative layout types for high-variety/low-volume situations. The most dominant layout type in practice is the process-oriented functional layout, where machines of the same type are located in the same area (Slomp et al., 1995). An important alternative is the socalled Cellular Layout type, where machines are grouped in cells and each cell is responsible for the complete manufacturing of a part family. This product-oriented layout type has gained substantial attention in literature and in practice (Wemmerlöv and Hyer, 1989, and Wemmerlöv and Johnson, 1997). Both types of manufacturing layout have their advantages and disadvantages. Several authors present alternative layout types to cope with the disadvantages of the functional and/or cellular layout type. Rosenblatt (1986) suggested a dynamic plant layout where cellular configurations periodically change depending on the demand in each period. Balankrishnan and

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Cheng (1998) present a review on the dynamic plant layout problem. Venkatadri et al. (1997) and Montreuil et al. (1999) propose a socalled fractal layout for job shop environments in order to gain the flow time advantages of Cellular Manufacturing and the flexibility of a functional layout. This type of layout is robust with respect to changes in demand and product mix. Another robust design, the socalled holographic or holonic layout, is proposed by Montreuil et al. (1993). Here individual machines, or machines types, are strategically distributed through the facility. Production orders are assigned to available machines which are located in the same area of the plant. A special case of the holonic layout is the socalled distributed layout (Benjaafar and Sheikhzdeh, 2000 and Benjaafar et al., 2002) where machine replicates are strategically distributed across physical space. Some researchers stress the need for a hybrid layout system which combines several layout types (e.g. Irani, 1993). Irani and Huang (2000) and Benjaafar et al. (2002) define a modular layout in which products have to be manufactured by one or more modules. Each module may have its own internal layout. A modular layout is an example of a hybrid layout. Wemmerlöv and Hyer (1989) show that many companies apply a hybrid layout.

Table 1. Layout types and some major advantages and disadvantages

Type of Layout	Explanation	Major advantages	Major disadvantages
Process Layout or Functional Layout	Machines of the same type are located in the same area.	Routing Flexibility. Specialization in process type.	Complexity of coordination between departments.
Cellular Layout	Machines are grouped in cells and each cell is responsible for the complete manufacturing of a part family.	Short setup times because of the dedication of families to cells.	Sensitive for unbalance in the load of identical machines in different cells. Inflexible for the introduction of new products.
Dynamic Cellular Layout	A reconfigurable cellular layout.	Enables the cell layout to respond to product changes.	Costs of reallocating machines in case of product changes
Fractal Layout	Machines are grouped in various fractals, which are (more or less) identical cells able to produce all products.	Enables the cell layout to deal with changes in product mix.	Limited specialization of workers and machines.
Holonic Layout or Holographic Layout	Each machine (type) is an autonomous entity (holons) and is seemingly random (=random or based upon transition probabilities) located throughout the plant.	Provides efficient process routes for any production order. As orders arrive, routings are constructed by searching for compatibility between order requirements and machine availability, location, and capability.	Complexity of coordination between machine requirements of the various production orders
Distributed Layout or Scattered Layout. (Distributed or scattered layouts can be seen as special cases of the holonic layout)	Distributed or scattered layouts are those where machine replicates are strategically distributed across physical space.	Flexibility of assigning manufacturing orders to available machines which are located in the same area.	Limited specialization of workers and machines. Complexity of coordination.
Hybrid layout	Several layout types exist within one department	Fit between the various characteristics of the product types of a company and the various layout options.	Complexity of planning and control
Modular layout (Modular layouts can be seen as a special case of a hybrid layout)	Machines are clustered in modules. Each module has its own layout and is responsible for a number of operations to be performed on a product	Recognizes the layout needs of the various operations needed per product.	Complexity of the linkage of the various modules