CHAPTER I

INTRODUCTION

1.1 Background

Facilities Management is a logical outgrowth of a competitive market (Lewis and Marron 1973). Facilities design(Figure 1.1) constitutes a vital element of Facilities Management. Facility layout, a subclass of facilities design, is concerned with the optimal spatial arrangement of facilities, such as, plants, machines, equipments, service counters etc., for achieving certain objectives of an organization. The survival and growth of an organization are very much dependent on the arrangement and coordination of these facilities. Low-volume production and mass production are two of the predominant features of the present industrial complex. In the mid-fifties, the principles of group technology were introduced. It was argued that the cell system of manufacture based on group technology principles would help derive the benefits of mass production to low-volume (job and/or medium size batch) production (Ivanov 1968, Edwards 1971a). Incidentally, in the mid-sixties, computer-aided facilities design was proposed to supplement

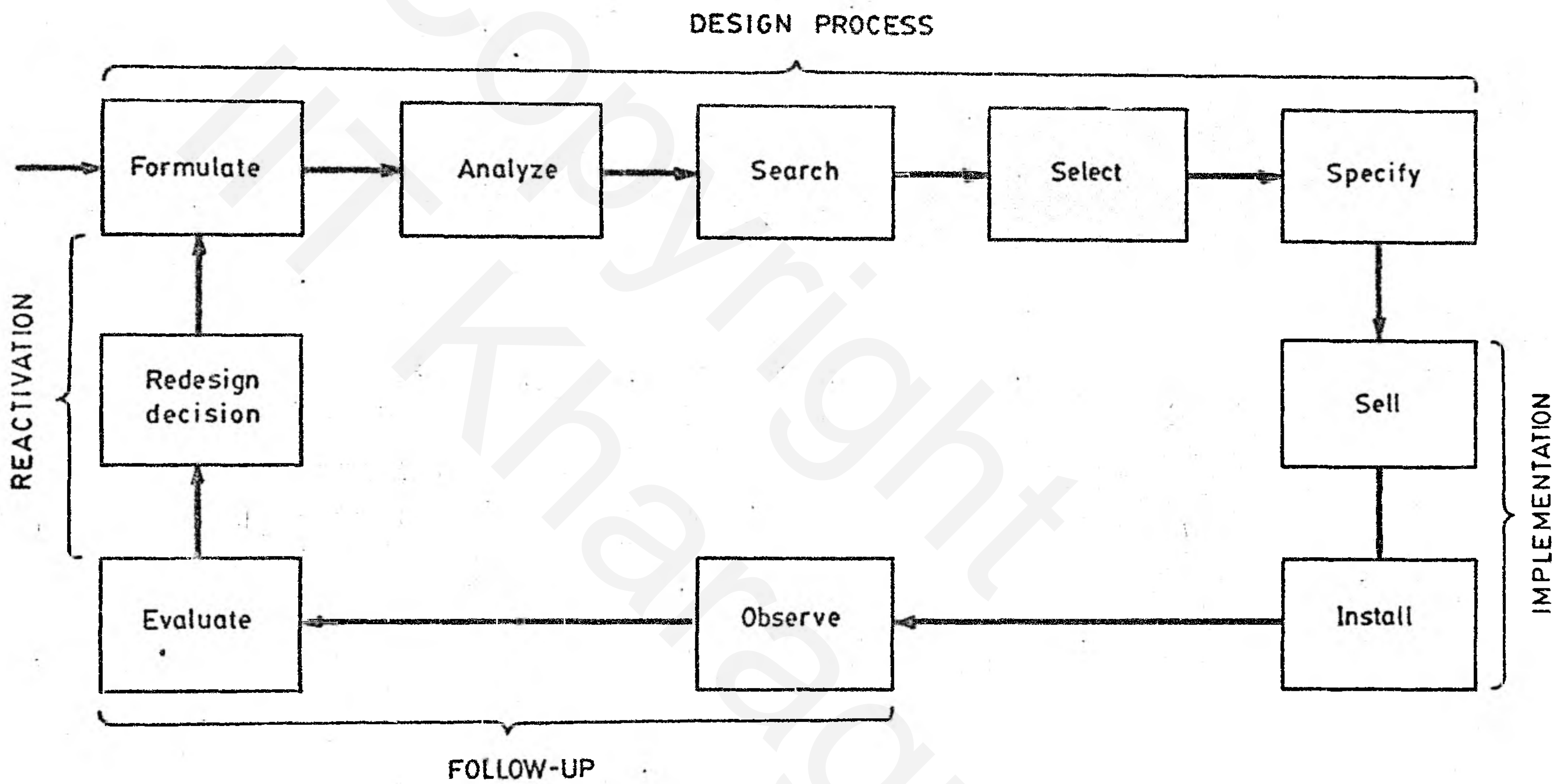

Figure 1.1. Design cycle

(Francis and White 1974, P.20).

visual aided methods for facility (plant) layout (Buffa et al. 1964, Lee and Moore 1967 etc.). The computer-aided group technology and facilities design, in the subsequent years, have been playing a pivotal role for developing and designing more effective manufacturing systems. Since then, practitioners and academicians in the field of production management have been continually working towards the development of these two areas, namely, group technology and facilities design.

1.2 The Problem

Group technology aims at forming the cells, each cell consisting of a group of machines and a family of related components, so as to finish processing, as far as practicable, all the related components within the cell itself. The superiority of a group technology model depends on its ability for forming cells with minimum amount of intercell flows. Burbidge (1971) and several others have proposed various group technology models for minimizing intercell flows. The facility layout problem, essentially, aims at locating highly interrelated facilities, as far as possible, close to each other, so as to achieve the various objectives, such as, minimization of total material handling cost, smooth workflow etc. (Muther 1955). Several computer-aided facility layout models for solving such problems are available (Tompkins and Moore 1978).

1.3 Scope of Application

The concept of group technology can be advantageously made use of in a situation where similarity, in terms of some characteristics, exists. Group technology models, therefore, have ample scope of application in the engineering industries in the areas like, variety control, drawing numbering, plastic moulding, foundry, ship building, shoe making, bulk material forming etc. (Burbidge 1979 ,Waghodekar and Sahu 1983). These models can also be used for biological classification of objects (called taxonomy). Facility layout models are of interest to people from several disciplines, such as, industrial engineers, economists, plant engineers, electronic engineers, town planners, architects, managers etc.

Group technology models, such as, production flow analysis (Burbidge 1971) etc.,and facility layout models, such as, CRAFT (Buffa et al. 1964) and CORELAP (Lee and Moore 1967) have been most frequently used for industrial applications. These and several other models have been designed with certain assumptions, which delimit their industrial application in the sense that none of these models consider the various practical constraints arising out of local factors in an organization. Most frequently, group technology and facility layout models have been considered as separate issues, It must, however, be noted in this context, that group technology and facility layout problems inherit a common consideration, viz., selection and placement of highly interrelated facilities as neighbours. Hence, further research is necessary for widening the scope of application of these models based on the common consideration associated with them.

1.4 Relevance of the Research Topic

As pointed out in the preceding section, a common consideration can be thought of for solving group technology and facility layout problems. Group technology aims at bringing together highly interrelated machines under one cell, whereas, facility layout strives for locating highly interrelated facilities as neighbours. In the context of facilities design, these two areas are very much interrelated. Hence, it is quite useful and relevant to propose and establish a common link in order to develop a unified approach to the facilities design problem. It is, however, beyond the scope of the present research work to propose a detailed unified approach for solving the facilities design problem. It is believed that the approaches presented in this dissertation, viz., MACE, MFLAP, MFLAPSA and COSIC based on the common consideration will help in formulating and developing such a unified approach to the facilities design problem.

1.5 Objectives of the Research Work

This research work is designed to answer the following questions :

1. What is the common consideration involved in group technology and facility layout problems, and how can it be expressed ?

2. How can this common consideration be applied for forming cells in a group technology problem ?

3. How can this common consideration be explored for developing efficient multigoal approaches for solving the facility layout problems under various constraints ?

4. To what extent can this common consideration be adopted for assessing the complexity of facility layout problems ?

1.6 Organization of the Dissertation

This dissertation consists of nine Chapters as outlined below.

Chapter I introduces the whole dissertation. Background, definition and scope of the research problem are presented in this Chapter.

Chapter II presents a review of the published literature in the domain of group technology. It describes the evolution,concept, benefits and limitations of group technology and outlines the major approaches proposed for forming cells (Waghodekar and Sahu 1982).

Chapter III presents a reviw of the published literature in the area of facility layout. It summarises the major existing computer-aided facility layout models highlighting their scope of application and potential limitations. The role of human versus computer in solving the facility layout problem is discussed (Carrie 1980, Lewis and Block 1980, Nof 1980).

Chapter IV summarises the uses of cell formation techniques based on similarity coefficient in group technology and facility layout planning. Though additive type of similarity coefficient (Rajagopalan and Batra 1975) is widely used for designing group technology based cell system of manufacture, it is sparingly used for facility layout planning. This Chapter proposes and discusses the potential use of the product type of similarity coefficient in the areas of group technology and facility layout under several constraints, such as, constraints on shapes, areas, location flexibility etc.

Chapter V presents a computerized heuristic approach for machine-component cell formation in group technology, called MACE, (Waghodekar and Sahu 1984a). Many approaches reported in this area, after Burbidge's pioneering work in production flow analysis, make use of the similarity coefficient of the additive type. However, this Chapter proposes a heuristic approach based on the similarity coefficient of the product type. The proposed method has also been tested by using the similarity coefficient of the additive type. For a large number of problems tested, the method yields minimum number of exceptional elements. The method is computationally straightforward and is explained through a flowchart.

Chapter VI proposes a computerized heuristic approach of the construction type for solving the facility layout problem with multiple objectives (Waghodekar and Sahu 1984c). The major approaches reported for solving this problem are of the improvement type (Rosenblatt 1979, Sayin 1981, Dutta and Sahu 1982). However, the proposed approach aims at forming cells of highly interrelated facilities using the concept of similarity coefficient. The close placement of highly interrelated facilities in a cell, and of highly interrelated cells helps reduce, for a layout solution, the total flow cost and increase the total interfacility relationships, such as, closeness rating, safety etc. The method proposed has been illustrated through example problems. Although no claim is made for the optimality of the approach, the layout solutions generated are reasonably acceptable. A flowchart for the main program is also presented. The method is conceptually straightforward, and problems of small size can be easily solved manually.

Chapter VII proposes a computerized heuristic approach of the construction type for solving the facility layout problem with multiple objectives under the constraints of shapes and areas of facilities (MFLAPSA). The proposed heuristic approach locates the highly interrelated facilities close to each other, under one cell, using the concept of similarity coefficient. The application of the proposed heuristic approach is demonstrated through example problems. It produces reasonably acceptable solutions for the problems tested. A flowchart for the main program is also presented.

Chapter VIII describes a new method, called COSIC, for the measurement of complexity of a facility layout problem (Waghodekar and Sahu 1984b). Complexity of a layout problem can be viewed as the degree of ease (unease) with which a given number of facilities can be optimally arranged. The existing approaches, namely, coefficient of variation (Vollmann and Buffa 1966) and problem complexity rating (Block 1979, Lewis and Block 1980), do not always produce consistent results. In the proposed approach, a cost matrix is converted into a similarity coefficient matrix by making use of the concept of similarity coefficient of the product type. The standard deviation of the elemental values of a similarity coefficient matrix is used for the determination of layout complexity. The application of the proposed approach is illustrated through example problems. The results are shown to be consistent and reasonably acceptable.

Chapter IX presents the conclusions pertaining to the dissertation. It summarises the findings of the research work and highlights the implementation considerations and limitations of each of the algorithms proposed. The Chapter closes with the recommendations for future work.

Reference material is presented at the end of the Chapter IX.