ABSTRACT

Facilities layout design is one of the key factors for successful operation in manufacturing firm. The term facility in the manufacturing context includes machines, workstations and inspection stations. The traditional problem of facility layout in a manufacturing setting is defined as the determination of relative locations for, and allocation of the available space among a given number of machines. Developing a machine layout is an important step in designing manufacturing facilities due to the impact of the layout to material handling cost and time, and consequently, affects the overall productivity of the shop floor. Poor layout would result in having more parts spending longer time moving from one machine to another, and thus results in increasing material handling costs. In contrast to the block layout the objective of the machine layout problem is to find the appropriate placement of machines in a cell.

A growing number of organizations have adopted new manufacturing philosophies such as group technology (GT) to become world class manufacturers. Group technology is a philosophy with the central objective of increasing production efficiency by grouping various parts and products with similar design and/or production processes together. Cellular manufacturing (CM) is the application of group technology (GT) in manufacturing systems. Since GT allows for the combined benefits of mass production while dealing with multi-product, small lot-sized production, the reported benefits of CM are simplified and reduced material handling, reduced set-up time, shorter lead times, reduced work-in-process, improved productivity, simplified scheduling and better overall control of operations. The foremost problem for cellular
manufacturing system (CMS) design is cell formation (CF), which groups the machines into machine cells and parts into part families. For decades, many methods for the CFP have been reported. Of the above methods, GA is one of the meta-heuristic. In this research, a new grouping methodology is proposed for design layout in the production facilities that address the problems discussed in literature findings is needed.

A mathematical model is developed with the objective of minimization of intercell flows and maximizing the total parts flow within cells considering the data of process plans for parts, production volume and cell size of production facilities. A relationship between machines is calculated on the basis of the process plans for parts obtained from process plan sheets. Then the machines are classified into machine cells using the relationship. The model is formulated as a 0-1 integer programming and grouping genetic algorithm (GGA) procedure to solve the mathematical model. This research proposes an efficient GA to solve the multi-objective cell formation problem partially adopting Falkenauer’s (1998) grouping genetic algorithm (GGA), which is an extension of general GAs. The developed Pro-GGAs procedure and cell design model tested with numerical examples derived from the previous literature and case study. A heuristic approach also proposed for generation of facility layout modules for production facilities. Furthermore, the sequence of operations and the impact of the layout of cells are also considered.

The proposed GGA was compiled in C language and the numeric examples were tested on PC. The Pro-GGA was tested with datasets that have been published in the literature and have been widely used in many comparative studies. All the data sets were transcribed from the original articles. The results show that the genetic algorithm based approach is comparatively better than the known results. From the case study results, it is
concluded that the proposed methodology can be used to solve large facility problems using Pro-GGA. A feasible facility layout module is obtained. Since layout modules are developed based on an analysis of operation sequences, this new approach to facility layout would allow the facilities planner to customize the layout for any facility based on the unique composition of the product mix processed in that facility.

Chapter 1 of the thesis work deals with the introduction of the research and describes the background for the study undertaken.

Chapter 2 reviews the past research and the relevant literature on design of facility layouts in the production facilities and review of the research on the cell formation problem with genetic algorithms, and the improvements obtained with GGA that are better than those obtained with general GAs are presented.

In Chapter 3, the objectives of the research work are described with research approaches.

In Chapter 4 the proposed Grouping Genetic Algorithm (Pro-GGA) for cell formation problem is explained step by step. The mathematical model and heuristic procedure adopted for the study are discussed. The results of numerical study are discussed and results are compared.

In Chapter 5 an outline of generation of facility layout modules for design of facility layout is presented. Two examples were selected from the previous literature and the proposed methodology is applied. The results are discussed and the layout modules are generated for design an optimal facility layout.
In Chapter 6, an example of planned basic intelligence of gas turbine model with 29 parts and 29 machines is selected for case study and tested with Pro-GGA. Layout modules are generated and optimal facility layout is designed. The results are detailed.

In Chapter 7, various conclusions derived from the observations of the experimental study and results are detailed. Scope and importance of future outline of work is also presented.