CHAPTER ONE
INTRODUCTION

The traditional approach to the organization of production is to use line layout where possible and functional layout in all other cases.

In line layout, the machines are arranged in a line in their sequence of usage. Usually the line production system will be efficient if all the components processed in it use the machines in the same sequence and if there is approximate balance between the work loads at each machine.

If line production is not possible, then the machines are used to manufacture different components in batches. The traditional approach to the organization of batch production is known as functional layout or process layout in which the machines with similar functions are grouped together.

In functional layout, manufacturing is done using simple but often inefficient rules for routing and scheduling. Also in this type of manufacturing, only very small portion of the total time to produce the component is spent for setting the tool and machining the component. The remainder is spent in transporting the materials between the work centres and waiting for tooling, inspection etc.

Group technology is the recent trend in processing components. Other names for Group technology are Cellular manufacturing systems or Group production methods (Burbidge,
1979). It is a production system which offers some distinct advantages compared to the functional layout. Cellular manufacturing systems (Group technology) may be considered as an extended application of product layout to process layout.

The basic attempt of cellular manufacturing systems (Group production methods) is to identify families of components that require similar processing on a set of machines. In turn these machines are grouped into cells. Each cell is capable of satisfying almost all the requirements of the component family assigned to it.

The schematic diagram for converting a traditional form of organization in batch production machine shop to Cellular production system is illustrated in Figure 1.1. The basic idea in the conversion is that the rearrangement of the machines such that almost all the operations of each component are processed in any one of the groups of machines.

1.1 Historical Development of Groups

The use of groups in production organization has two main origins.

a) Development of methods by engineers, who were mainly interested in finding the methods to reduce stocks and work in progress, reduce throughput times and setting times and thereby increasing capacity

b) Development of organization in groups by behavioural scientists, who were interested for ways to increase workers motivation and job satisfaction.
FROM: PROCESS-SPECIALISING SECTIONS

1 - lathes; M - millers; D - drills; C - gear cutting; B - broach; S - shaper; G - grinder; K - keyseater.

Each part visits many sections.

TO: GROUPS COMPLETING "FAMILIES" OF COMPONENTS

Each part visits only one group.

Fig.1.1 THE CHANGE TO GROUPS IN MACHINE SHOPS (FROM BURBIDGE, 1979)
1.1.1 The Engineer's Approach to Groups

The development of Group technology by engineers sprang initially from the work of Professor Mitrofanov of Leningrad University (1966).

He found that if similar components were loaded on the machines (lathes) one after another, considerable reduction in setting time and hence better utilization of machines were possible.

The early work on Group Technology was devoted to exploiting these findings. Without any change in organization, attempts were made to plan the sequencing of work on machines in order to reduce setting time and achieve an increase in capacity. These early examples of Group Technology are usually referred as the single machine approach. The single machine approach gave no saving in stock or throughput time and was found difficult to apply efficiently in any sections other than those which did first operations.

The next development was to form groups of machines composed of different types of machines to complete almost all the operations of each component with in a group. These early groups were usually formed by selecting components by visual observation. A few families of components with similarity in shape were selected so that they could be machined on the same groups of machines. It was believed at this stage that groups would only be suitable for a limited
range of components. This stage in the development of Group Technology is called as the pilot Group stage. Major savings were possible by pilot groups but the method to form further groups found to be complicated.

The next stage was the development of methods for planning a total division of workshops into groups. Most of these early methods were based on classification and coding methods, but later these have been largely replaced by machine-component cell formation techniques.

1.1.2 The Behavioural Scientist’s Approach to Groups

Behavioural scientists concentrated on new methods of work organization in order to increase worker’s motivation and job satisfaction. Unlike the engineers who were mainly interested in machine shops, most of the work by behavioural scientists has been done in assembly, in process industries, and in offices.

Both engineers and behavioural scientists have succeeded in most of their applications of groups in achieving the benefits for which they were looking.

1.2 Group Technology and its Benefits

In general, GT is an attempt to bridge the gap between the two distinct ends of the processing mode spectrum. The extent to which the manufacturing system assumes the advantages of mass production is determined by the basic form of the Group technology manufacturing system implemented: the
GT-centre (Single machine system), the GT-Cell (Group layout system), or the GT-Flow line.

GT-centre is used to manufacture a parts spectrum with a similarity in one type of operation and which can be carried out at one individual workplace or on one machine. It therefore constitutes the first and lowest degree of rationalization within the framework of the GT-manufacturing systems.

The basic idea of the GT-cell is to split the manufacturing area into machine groups in which all machining operations required for the manufacture of a certain parts spectrum can be accomplished. This basic form of GT-layout allows a flexible operation sequence and constitutes a second or medium degree of rationalization.

In the GT-flow line, the places of work for the associated parts spectrum are laid down in a layout according to a fixed operation sequence. This case thus represents the third or highest degree of rationalization for GT-manufacturing systems.

The origin in the field of Group technology is the classification and coding system. The objective of classification and coding is to classify components by their features and to code these features so that components having similar code numbers possess similar features. There are three basic features of a component which can be classified as follows:

(1) shape
(2) function

(3) manufacturing operations and tooling.

Different classification systems use different features or combinations of these features. In using classification and coding for group design, similarity in features is used to group components into families.

As per Burbidge (1979), there are 46 classification and coding systems. When these systems are used to form groups, they only combine some of the components into easily recognized families and they do not divide the plant into groups of machines. Classification and coding systems based solely on design features tend to be efficient for variety reduction and design information retrieval but are not satisfactory as a basis for forming groups.

In the past decade the emphasis in the literature on Group Technology has slowly shifted from classification schemes to the development of methods for grouping components and associated machines.

The benefits of mass production in job shop is achieved through the formation of machine component cells. A cell essentially consists of a group of machines and a family of related components so as to finish machining all components concerned in the cell itself.

By centralizing the authority and responsibility for making complete components in the groups, possible general achievements are as shown in Figure 1.2.
FIGURE 1.2 BENEFITS OF GROUP TECHNOLOGY
(FROM ARN, 1975)
1.3 Classification of Group Technology Techniques

The problem of efficient machine - component cell formation has drawn the attention of a large number of researchers. The various approaches available can be classified as follows.

i. Evaluative methods
ii. Set theoretic methods.
iii. Similarity co-efficient (index) methods.
iv. Analytical methods

The detailed literature related to these approaches is reviewed separately and discussed in chapter-2.

1.4 Need for the Current Research

From the overall review of the current literature on machine-component cell formation, the following conclusions can be drawn.

1. No suitable algorithm is available to form groups for a given set of components, considering cost of handling and cost of excess capacity of the facilities simultaneously.

2. In the past, all the authors defined the similarity index as function of operational similarity only. But consideration of production volume of the components in addition to the operational similarity will be more realistic.
3. Most of the researchers in the past stressed that each machine type should be assigned to one cell and each component should be processed within a cell. Always formation of groups without inter-flows may not be possible in practical circumstances.

Thus there is a need to develop an algorithm/procedure by taking the above factors into consideration.

1.5 The Research Problem

Assume that several components with different production volumes require to be processed in different types of machines. The processing sequence of the components may be same, partially same or completely different. If all the components have the same processing sequence, then the solution will be to design a flow line. This problem is not considered here. Instead consider the situation where the processing sequences of all the components are not the same. Under these conditions the arrangement of machines will primarily affect the amount of material handling and hence its cost.

Suppose one production line is established for each component then the work flow between machines will be smooth and the corresponding excess material handling effort will also be a minimum. But this arrangement is likely to result in idle capacity if sufficient production volume does not exist.
Consider a production line which is set up according to the processing sequence of a component. Then this line is assumed as main line and the component corresponding to this main line is assumed to be the main component. Also consider some more main line sequences other than the component sequences. Each of these potential main lines will be suitable for processing more than one component, with minimum amount of backtracking. Suppose a group of components which has either the same or partially same processing sequence as that of a main line sequence is identified, then assume that the above group of components is processed in the line designed for the main line sequence. Under these circumstances definitely there will be increased utilization of facilities. At the same time the excess material movement between machines will be reduced to the extent of similar processing sequence as that of the main line sequence. With this approach one can aim to form the groups with minimum total cost (sum of excess material handling cost and excess capacity cost) for a given set of components.

The concepts of GT-Flow line, GT-Cell and GT-Centre are taken care in this research by proper definition of the problem situation.(ie. using main lines, auxiliary components and general pool which will be discussed later).

1.6 Aim of the Research

In general when the total number of main lines increase, the cost due to excess capacity (idle time)
of the machines will also increase and the cost due to excess material handling will decrease.

Therefore the aim of the research is to identify reasonable number of main lines and set up production lines corresponding to the processing sequence of these main lines. Also groups of several components which will be similar to each selected main line are to be identified and processed in it.

The algorithm described in this research achieves the necessary grouping of components based on their operation sequences using the criteria of minimising the sum of excess material handling cost and idle time cost.

1.7 Phases of Research

The figure 1.3 shows the phases of this research. The research consists of four phases which are as follows:

Phase I: Objective: To study the type of layout problems.
   Task-1: Study of the general concept of layout and working with process type layout.

Phase II: Objective: To confirm the need to develop an algorithm.
   Task-2: Reviewing literature on group technology techniques.

Phase III: Objective: To develop an algorithm for group formation:
   Task-3: Developing similarity index matrix and covering technique with modifications.
FIGURE 1.3 PHASES OF RESEARCH

1. Literature review on Group Technology
2. Work on Plant Layout
3. Development of Similarity Index
   with modifications
4. Designing of the overall algorithm
5. Experimentation with the algorithm
6. Comparison
7. Conclusions
Task-4: Designing overall algorithm.

Phase IV: Objective: To experiment and compare the algorithm and to draw conclusions.

Task-5: Experimenting with the algorithm.
Task-6: Comparing the algorithm.
Task-7: Analysis of the results and drawal of conclusions.