CHAPTER III

DESIGN CONCEPT

This chapter will briefly explain the thinking behind the overall design methodology and the cell formation process to help the reader better understands the design. This chapter will establish a basic framework for the next chapter (chapter 4) so that the reader will have a better understanding of why each tool is used and what was the thinking process that lead to the resulting cells formed.

3.1 Cell Manufacturing Rationale

The main idea of this project is to utilize the cell formation concept to improve the shop floor of the case study company. As mentioned earlier in the introduction in chapter 1, the company is facing a productivity problem. The current facility layout of the company is of a function layout type which is not suitable for its product range. The functional layout is causing three main problems for the company – high machine setup time, machine allocation problem and ineffective material flow path, all of which lead to manufacturing inefficiency. The aim of the project is to improve the shop floor and its efficiency which will ultimately make the company more competitive. However, due to the large number of product being made, if we are to improve each product one-by-one, it would take forever to complete. This is where cell manufacturing concept comes in. The idea is to solve the different problems that have similar background all in one go. The similarity of the products can range from material type, shapes and sizes through to manufacturing process requirement. In this project, the similarity is the shape and manufacturing process requirements of the products. Cell manufacturing is known to be very effective for improving factory that produces a range of product that display a degree of similarity. By implementing the cell manufacturing concept, one of the major benefit that is expected to be had is the reduction of setup time, followed by the improvement in machine planning and material flow paths.

3.2 Cell Formation Concept

One of the most important steps in this project is the process of cell formation. We have to determine which machine will goes into what cells and why. Many factors have been taken into account to create the most effective cells. This section will goes through the thinking framework of this project. The main steps of cell design are:

1. Product analysis – volume and process
2. Machine technical capability decision
3. Capacity decision
4. Overall layout design

The details of each step shall be explained below.

3.2.1 Product Analysis

The first item to look at before any cell designing process can be started is the product. We must first understand the product before doing anything. The type and volume of the product must be established so that the cell design process can be built around it to satisfy the products manufacturing requirements i.e. volume and technicality. The products that are selected for this project were selected because they provide a good representative of the overall product range, see section 4.2.2.1 for details

Product Volume - The first item to look at when attempting to form a manufacturing cell is the production volume. Before the cells can be formed, we must know how much of each product is expected to be built so that the actual machining time requirement can be calculated later on. For this project, the proposed volume will be based on the 2006 production volume, see section 4.2.2.2 for details.

Product Manufacturing Process - With the product volume established the next item to look at are the manufacturing processes to see which processes are required for which products. In the factory, the two main manufacturing processes are turning and milling. These two categories can further be separated into CNC process and manual process. By looking at the product range, the product can be categorized into the three groups, screws, plates and instruments according to its process requirement as mentioned earlier in section 1.3. The processing time of each product are recorded in the process flowcharts to be used for further analysis, see section 4.2.3.1 for the process flowcharts analysis and appendix A for full details of the process flowcharts.

Product Manufacturing Time Requirement - With the production volume and the process time requirement of each product known (from the manufacturing process data collected in the process flowcharts), the machine requirement of each product can be calculated (see details in appendix B.2). We can then calculate how many CNC lathe, CNC milling, manual lathe, manual milling, and other machines are required in each cell.

3.2.2 Machine Technical Capability Decision

After the numbers of machines per cell have been calculated, the next step is to decide on the specific machine to be put in the cell. It is important to delegate the appropriate machine to the appropriate product. Not every CNC machines are the same. For the same type of machine, there are of different age and sizes - this lead to the machines to have different tolerance capability, different number of tooling turret, different machining rates, and so on. Hence there is a need to put the right machine to the right process as some product do requires more machining technical capability than other. i.e. the milling operation required on the end of the Poly Axial Screw requires more tolerance capability than the milling operation on the Bone Plate, therefore, newer milling machine with better tolerance control should be assigned to the Poly Screw product the control the tolerance. One of the easiest ways to choose the appropriate machine is to talk to the people who are most familiar with the machine – the operators and the department managers. This project will not explain in details why each machine was chosen for the specific product as its technical detail is irrelevant to the cell manufacturing concept. This point is only raised so that the readers are aware that this is one if the issue to be investigates when trying to form manufacturing cells that has the same type of machine.

3.2.3 Capacity Decision

Capacity Check - With the cell established, the next step is to check if the cell will have enough capacity to cover the proposed volume (check if the manufacturing time requirement can be satisfied). See section 4.2.4.3 for full details. One of the critical factors that affect the capacity analysis is the assumption of the batch size.

Assumption of the Batch Size - The assumption of the average batch size lead to the setup frequency calculation which ultimately determine the actual machine time available values used in the capacity analysis. The setup frequency figures affect almost every aspect of this project. First, it is used to calculate the actual available machine time. The actual available machine time is then use to calculate the production capacity of the cells. If the average batch size assumption is inaccurate, the setup time calculation will be incorrect and the rest of the project will be flawed and the proposed cells may not have enough or too much production capacity. The average values that were used were 100, 65 and 10 for the screws, plates and instrument product group respectively. These values are close to the actual average batch size in 2006 but slightly lower. The decision to use the 100,65 and 10 figures were based on the fact that the factory wishes to reduce its average batch size to the proposed level in order to improve its quality control and product traceability. The averaged values will give a better representation of the future situation. Another reason behind using a lower batch size values (which will give higher setup frequency) is because by doing so, the total setup time calculated in appendix C will be higher than actual values and the resulting available machine time values will consequently be lower. This will give the design a safety factor. The author feels that it is better to have slightly over capacitated cells than to be on the short end.

3.2.4 Overall Layout

The final step of the design is to arrange the cells onto the schematic of the shop floor. Two tools are used to simplify and minimize the material traveling distance – the string diagrams and the transfer frequency analysis. The string diagram in section 4.2.3.2 is used to illustrate the material flow path. The transfer frequency analysis in section 4.2.4.3 was used to determine the closeness priority of the machine placement.