CHAPTER I

INTRODUCTION

1.1 Introduction

The shop floor is where all the action takes place in a manufacturing organisation. The design and control of the shop floor is considered one of the key factors that govern the performance of an organisation. The location where work is performed and the method of how to achieve it greatly affect productivity and quality of the organisation. The level of productivity and quality of an organisation, interns, determines its ability to compete in the market. Therefore the arrangement of the facilities must be carefully planned and managed in order to realise the organisation's full potential and make the organisation most competitive.

The purpose of this project is to investigate and analyse the facility layout and operational behaviour of an Orthopaedic Equipment manufacturer and then to utilises the Group Technology methodology to improve the shop floor. The concept of Group Technology has been selected because it is one of the most effective tools that are often used to improve the productivity for a job-shop type manufacturer.

1.2 Company Background

The case company was established in 1987. It started off as a local machine shop which provides its services to the industry around the Bangkok province. With time, the company slowly starts to prove itself to the customers as a reliable service provider and has grown consistently machine by machine. Currently, the company

employs a total of 70 staff and utilises more than 40 manual machines and 12 CNC machines and provide its services internationally. During the Asian economic crisis in the year 1995, the company suffers financial losses and shortage of work because the nature of the company is of a service organization which heavily depends on the productivity of other manufacturing entities. With this in mind, the company realised that it needs to develop its own product line to create work for itself in order to prevent the repeat of the 1995 disaster and to create new market opportunity. After careful analysis of the company's capabilities, the management has decided on producing orthopaedic implants, instruments, and fixtures which will make the company the first in Thailand to produce such commodity. With years of research and development, the orthopaedic business shows a very promising but hard earned future. After the company's successful launch into the medical-marketplace, there emerge a number of competitors to contend for market's supremacy.

1.3 Background of Situation

Machine Setup – The time taken to setup the machine is a major cause of concern. The machines need to be setup and calibrated every time the machine has a new order. Machine setup takes approximately 1 hour to complete. On average, the batch sizes are kept below 100 in order to control the quality and traceability. With 2006 production volume, this equates to about 1300 hours used for machine setup. Therefore, if the setup frequency can be reduces, then the machine utilisation rate can be improve.

Machine allocation problem – Another problem that the shop floor is facing is machine allocation. Once an order has arrived, the production manager will delegate the order to different functional departments (i.e. turning, milling, and polishing) depending on the process sequence. After that, each functional department's supervisor will further delegate the work to different machines. Although the production manager and the supervisors are trying to optimise the job delegation and use the machine that best suited the job, in reality, the jobs are simply assigned to the first available machine because the production manager and supervisors do not have adequate information to effectively manage the machines.

Layout Problem – With the desire to retain its market leadership position, the company needs to utilise its resources to its full potential. Currently, through constant growth of the company in the pass 18 years, the shop floor has somewhat developed in an unplanned manner. The machines are placed according to its order of acquisition. The only real layout that the shop floor has is the separation of manual and CNC machines – an informal functional layout. See figure 1 below. The current

functional layout of the shop floor is not suited to the nature of the products. As the result, the manufacturing process cannot operate at its full potential; the material flow and scheduling system that accompany the functional layout is ineffective and inefficient.

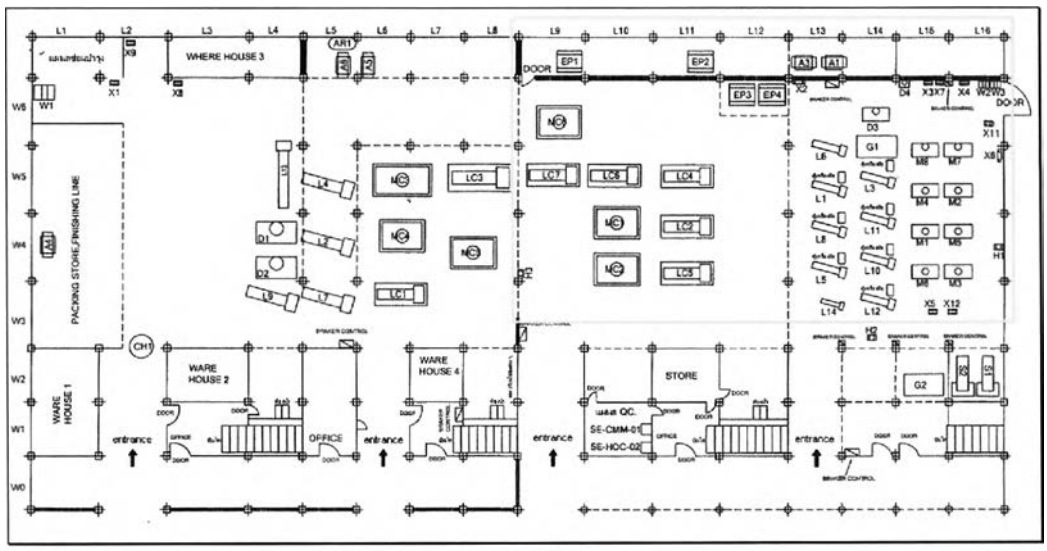


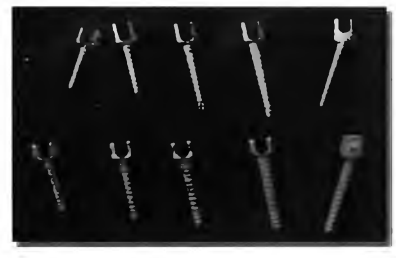
Figure 1.1. Current layout of the factory

It should be noted that, the Orthopaedic products are primarily manufactured in the highlighted area (yellow boxed) in figure 1.1 above. Figure 1.2 below shows the real image of this area. This area will be the main focus of the project.

Figure 1.2. The orthopaedic equipment production facilities

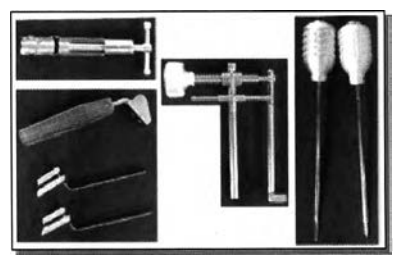
Product Detail – With the current product line, there exist a number of product families that have similar features and shares common manufacturing processes. The products can be separated into three main families:

Screws: Cylindrical in shape, main process requirement is turning



Bone Plates: Bars shape with holes, main process requirements is milling and drilling

Surgical tools: various sizes and shapes, small in production numbers in comparison to the Screws and Bone Plates.



With the existence of the product families, the Group Technology approach shall be adopted to improve productivity.

1.4 Statement of Problem

Problem Overview

"The company is experiencing a productivity problem. Demand has been high but the company is having a hard time meeting it. The current functional layout approach to manufacturing is not suited to the nature of the product range. There exist a number of product families which may benefits more from the Group Technology application. "

Specific Problems and Causes

Problems

- ✘ low production rate
- ✘ Slow throughput time
- ✘ Unnecessary product movement
- ✘ Non-standardised machine allocation
- ✘ Large amount of Work In Progress
- ✘ Full capacity cannot be achieved

Causes

- ➧ Current Functional Layout is not suitable for the product range
- ➧ No proper material movement procedure established
- ➧ No established production steps.
- ➧ Poor machine allocation
- ➧ High frequency of machine setup

1.5 Objective of the Research

The objective of this project is to improve the shop floor of an orthopaedic equipment manufacturer by applying the Group Technology theory.

1.6 Scope of Project

The final deliverables of the project will include:

- An analysis of the original shop floor layout and the company's operational behaviour
- New Facility layout designs
- An analysis of the new design to validate the solution

Specific aspects of Shop Floor improvement

The specific aspect of improvements that is of our focus are the improvement of machine utilisation rate, setup requirements, transfer distances, material waiting time, and throughput time.

Definition of the terms Shop Floor and Layout redesign

The term 'shop floor' will include only the manufacturing part of the factory and specifically the machines that are directly used by the Orthopaedic product line. The layout redesign process will only cover the conceptual design of the physical layout of the concerned machineries; it will not cover the detail designs i.e. piping arrangement, lighting, electrical outlets configuration etc. The redesign process will includes all of the machineries used for the orthopaedic product line.

Analysis of the shop floor layout:

The analysis of the shop floor layout will only cover the mapping of the current (December 2006) layout in order to create a base plan to work from.

Analysis of the company's operational behaviour will include:

Production flow and material movement analysis to identify key issues with the current manufacturing system.

1.7 Expected Benefits

The specific aspects of shop floor improvement that is expected to be realised by using the Group Technology theory are:

- Increase in machine utilisation rate
- Reduction in setup time
- Increase in manufacturing capacity
- Product quality improvement
- Reduction of the material movement
- The material flow on the shop floor will be more simplified

1.8 Solution Approach

1.8.1 Main Theory

Group Technology theory will be used as the main concept to deal with the problems mentioned in section 1.3 and 1.4. Group Technology has been selected because the characteristic of the case study company fits well with the requirements for successful Group Technology implementation. Specifically, the company's job-shop and product family characteristic. Figure 1.3 below shows the benefits of Group Technology which are expected to be had from applying the theory to this project.

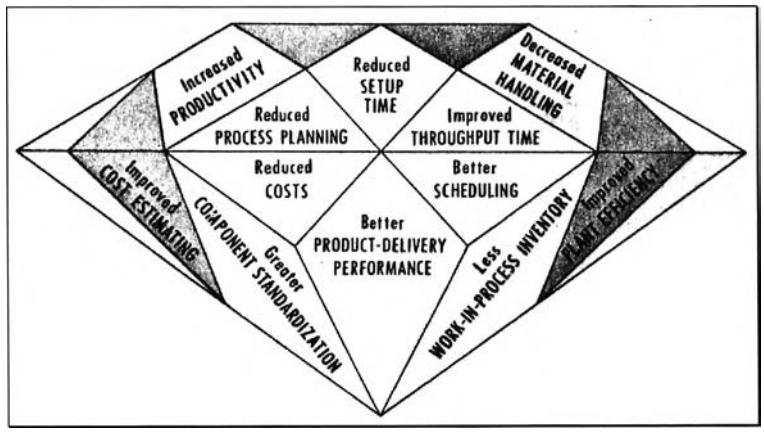


Figure 1.3. Benefits of Group Technology (DeVries, Harvey and Tipnis, 1976)

1.8.2 Specific Techniques

From the overall Group Technology theory, the technique of *Cell formation* will be used as the main tool to deal with the layout production efficiency problems.

Cell Formation

This project will utilise the Cellular Formation approach as the primary solution. According to Vakharia (1986), the cell formation approach is considered one

of the most suitable techniques for this situation since the trait of the company is of a job shop with a number of product families. However, Russel and Taylor (2003), said that cell formation approach may present an unrealistic solution if the products families were not well sorted Other layout design technique(s) such as hybrid layout and modified functional layout may be used according to the initial result.

1.8.3 Ground Works

In order to successfully utilise these two techniques, there are some ground work that must be done. This generally involves the establishment of product families, analysis of the current layout and operational behaviour of the company.

Establishing product families

The establishment of product families is vital to the Group Technology application. From a brief analysis of the product line, it shows that there exist three distinct product families – Screws, Bone Plates and Surgical tools. Further work is required to systematically sort the products into useable product families. The criteria that will be used to group the product into families are their process requirements. This will be achieved through the use of the Production Flow Analysis (PFA).

Analysis of the current shop floor layout

The mapping of the shop floor layout will be carried out by using the old plan that the company already has and then update it to obtain the current floor plan to create a base to build upon

Analysis of the company's operational behaviour

An in depth investigation focusing on production flow and material movement will be conducted to determine the company's current operational behaviour. This will help identify key issues with the current manufacturing system i.e. bottlenecks, machine utilisation rates, level of scrap etc

1.8.4 Evaluate the Design

With the design created, it must be evaluated to see how it will benefit the company. The main *quantitative* performance indicators will be the setup time, amount of extra capacity generated and the distance of the material flow path. At the end of the day, for the solution to be effective in real life application, other factors that the design techniques may have left out or over simplified must be taken into account. Reality check can be achieved by reviewing the solutions using the experience of the management and the expertise of the workers to ensure that all the fundamental needs have been satisfied.

1.9 Research Procedures

As stated in section 1.8, this project can be divided into three phases - Ground Works, Solution Creation and Solution Evaluation. The research procedures are as follow:

Ground Works

1. Update Layout
2. Collects relevant manufacturing data
3. Analyse the production flow and material movement
4. Establish production cells according to the manufacturing processes requirements
5. Use the information acquired to determine overall performance of the company and to identify key issues with the current manufacturing system i.e. bottleneck, machine utilisation rates

Solutions Creation

6. Design new shop floor layout(s)

Solutions Evaluation

7. Evaluate the new design performance.
8. Convene with different levels of the organisation to collect there opinions and comments on each solutions
9. Use the collected information to discuss with top level management to validate the solution