Chapter 1 Introduction

1.0 The Manufacturing Sector

The manufacturing sector being a versatile industry is always experiencing intense competition and is faced with the need to make radical improvements in order to survive and compete globally. Therefore, production activities must be well-planned and implemented in order to satisfy changing customer demands for products of the highest quality, sold at the lowest price and delivered just in time. In order to continue to operate economically, firms need to have efficient planning of resources that will lead to significant reduction of costs and improved optimum productivity. This can be done with the help of modern and advanced technology which can automate many production activities like production planning and control.

For companies to continue to operate profitably, production systems must be able to yield high levels of performance along a variety of performance dimensions that can improve the visibility of the production process and control. An effective production plan is necessary to achieve a world-class production status with the ability to compete among fierce competitors in the manufacturing environment. An automated and customisable production planning tool thus will enable manufacturing plants to remain competitive. This tool which will be developed in this research, uses object-oriented techniques as part of the software engineering process will also enabled the reuse of classes in future software enhancements. In addition, object-oriented engineering process which offers a modular way of analysis and design can accommodate the dynamics of a fast changing manufacturing environment, thus making it a very suitable technique for the development

of a production planning tool. This object-oriented approach also offers a new and powerful model for writing computer software which speeds the development of new programs and with proper use will improve the maintenance, reusability and modifiability of the software. With this in mind, the customisable production planning tool that will be developed will bring about improved efficiency and productivity for production companies thereby prolonging uncertain and fluctuating business life.

1.1 Overview of Manufacturing Production Process

Production is the process of assembling a finished product with a fixed procedure in a way which is consistent with quality and costs. According to Wickham Skinner, who says,

" *The manufacturing task statement begins with a clear and explicit concept of what the manufacturing function must accomplish.*" [Skinner87]

This task involves various stages of production starting with business planning (strategic), master planning (tactical), execution planning and control (operational), until the product is manufactured and delivered to the customer. Apart from these, there is inventory control which is maintaining sufficient stock to meet fluctuating demands. A typical production company has three main levels of planning as mentioned above. These can be further divided into :

a. Strategic planning :-

consists of business planning, marketing planning and production planning which are the responsibility of the top management.

b. Master management planning :-

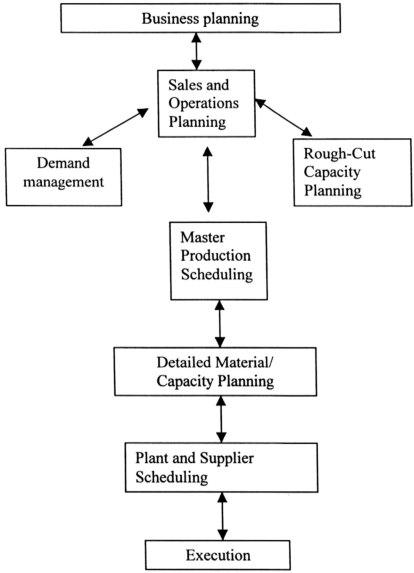
consists of master production scheduling and materials requirements planning.

c. Execution planning and control :-

includes production activity control and performance measurement.

Manufacturing firms vary greatly in their products, production processes, relations with customers, and plant layouts. The format of the production plan is not standardised and varies with the type of business and the products produced. Presently, most manufacturing companies are using computer-based production and inventory control functions or manufacturing resource planning (MRP II) to produce all types of goods and services. Many companies, having achieved success with MRP II, are developing Just-In-Time or better known as JIT, a technology first invented by the Japanese, to further improve manufacturing efficiency and are addressing the challenging problem of how production control must be modified to support flexible automation and computer-integrated manufacturing. Figure 1.1 [Landvater95] shows an overview of what is involved in manufacturing planning. The details of each process will be explained in the next chapter.

Figure 1.1 An overview of manufacturing planning / MRP II of a plant



In today's competitive environment, production of goods and services are very much driven by changing customer demands for immediate delivery of products of the highest quality, sold at a competitive price. Therefore, production activities must be well planned to satisfy customer demands, yet at the same time, must be able to operate in an

economical manner. To this end, manufacturing production planning is crucial in order to attain efficient output with minimum costs while meeting changing market conditions.

1.2 Motivation

In the face of intense competition in the marketplace, companies have to deal with demanding customers and fulfilling their satisfaction in whatever way possible. Many companies now have the concept of 'customer-oriented' focus which shifts the emphasis to customer's priority and preference in order to sustain a continuous stream of customers' orders. As a result, many manufacturing companies have to deal with requirements for high product variety, unpredictable demand patterns, greatly reduced product life cycles, and short customer delivery time. Added to these constraints, production companies are also facing pressure of having to reduce costs so as to maximise profits in order that their investments will yield positive returns besides prolonging business life.

With the increased international competition in the manufacturing industry, this has led to the continuous pursuit of greater productivity, reduced costs and better customer service, a matter of urgency not withholding survival for many, if not for all. Since production is faced with such a difficult yet challenging task, there is a need to properly plan and execute the production operations to suit the requirements of their customers, and at the same time, to achieve company's objectives. This can be done through a well-designed, customisable planning system using object-oriented techniques analysis and design whereby the essence of some domain within the real world is abstracted to provide a model from which a software system can be quickly and ultimately be developed.

Besides, object-orientation analysis can be used to analyse large domains such as the manufacturing industry.

1.3 Problem Statement

Production planning is a complex task and different manufacturing companies have different way of implementing. In order to achieve a satisfactory level of output and to meet customer demands on time, it is vital for manufacturing companies to have a production plan to carry out this objective. Production planning is a very basic function of manufacturing management applicable in all manufacturing companies. Planning refers to the activity of determining what is to be produced, what quantity is to be produced, when it is to be produced and what resources at what quantity are to be used.

> " *The production plan is a statement of the planned rate of production expressed in aggregate terms.*" [Smith89]

This plan becomes the focal point for integrating the manufacturing operations of a company with its business and marketing plan. The purpose of a production planning system is to develop a logical sequence of production in order to obtain efficient output while also satisfying market demands. To accomplish this, the use of modern, computer-based systems of production and inventory control has proven to be an important part of the ongoing race with the external competition in the manufacturing environment.

A computer-based production planning tool that is well-designed will enhance reusability through the use of classes in object-oriented development. This will help in designing a more robust system that meets the requirements more quickly and with a minimum effort

and a maximum of flexibility. Besides, with a customisable software engineering technology, this planning tool will be able to accommodate different production environments. As such, production planning and control will become more manageable resulting in a higher productivity and improved efficiency thus gaining competitive advantage for the manufacturing sector.

Object-orientation uses a modular approach to the analysis, design and implementation of software systems. This modularity is recognised for its importance in communicating ideas and in reducing complexity to a comprehensible level. This proves useful in a manufacturing environment with all its production complexities so as to create a more simplified model in the software engineering process. The development of a customisable planning tool will be the focus of this research.

1.4 Research Objectives

The objective of this research is to develop a computerised and reusable object-oriented customisable production planning tool which is applicable to all manufacturing companies. In order to achieve this, a thorough study and research were done through industrial visits to a semiconductor plant at Motorola SemiConductor, Petaling Jaya. A survey was carried out among the staff particularly the planners involved in production planning. This will be explained in depth in the next chapter. With this objective in mind, the proposed object-oriented planning tool will be built to enhance :

a. maximum customer satisfaction through monitoring delivery lead times and ensuring that orders are promptly delivered on time through the use of a good object-oriented

planning software. It will be able to accommodate different manufacturing environments such as make-to-stock, make-to-order and assemble-to-order.

b. maximum efficiency in the utilisation of production resources. This system provides control on the use of production resources through check and balance so that the plant knows when production resources are under utilised or when there is over supply of production factors.

c. a system which is more manageable and maintainable through a more flexible tool that is adaptable and customisable to the changing technologies within the manufacturing industry. The software will allow customers to customise their inventory and forecasting methods according to their production time frame.

d. a system that will control access security for only authorised employees. This is done by restricting the level of access for different types of users.

Through object-oriented software engineering, this can bring about dramatic improvements on development time and cost. The object-oriented development is also intended to promote reuse and reduce downstream errors and future maintenance. This will ultimately lead to a more efficient system that will enable the manufacturing domain to gain advantage in the production of goods that will be able to meet customers' expectations and timing as well as their ever-changing demand patterns.

With these objectives set, the planning system will enable improved efficiency by producing only what is needed and eliminating wastage of resources in whatever way possible. This will help to lower production costs in addition to helping manufacturing

companies stay competitive, prolonging business life which is very uncertain and often short with the threat of severe competition and fluctuating business cycles.

1.5 Summary of Proposal

This research project is aimed at developing a customisable production planning tool which is based on a research done at *Motorola Semiconductor Products Sector* (SMS) in Sungei Way Free Trade Zone as well as from knowledge gained through literature review on manufacturing systems. This proposal is intended to capture the importance of a computerised and customisable production planning tool and inventory control in a production process in line with the motivation stated above.

Since planning is an integral part of the company's strategic plan that is developed together with the business and marketing plans, the success of the outcome of the production activities depend greatly on how well a plan is created and executed.

In order to stay competitive, yet profitable, production planning is needed to develop the kind of relationship between market demands and production capabilities. With this in mind, a customisable production planning tool which has a more robust architecture through an object-oriented software engineering process is proposed in this dissertation. The customisable production planning tool consists of a set of cooperating classes and collaboration of objects which are suited for this system. This object-oriented system also has the potential of increasing reuse of classes of the planning system when technology evolves over time. Besides, it also provides a flexible infrastructure for deploying object-oriented technology that can be integrated within the whole manufacturing system. The software to be developed will be more robust with a low maintenance overhead and

resulting in a higher productivity. Ultimately, the tool developed will be able to help achieve their goal of making consistent profit in the face of increased competition and mounting market pressures.

To do this, the project covers the production plan for received orders which are scheduled for production until they are completed and delivered to the customer. This includes production control within a specified period of time within the production process. It focuses mainly on production planning for the aggregate level of the entire plant and schedules for completion of specific products as well as planning for production resources. It is a general computerised production planning tool which is customisable to any small to medium-size manufacturing company.

1.6 General Strategy of Research

The approach to this project is based on a field study at Motorola Semiconductor Sector, Kuala Lumpur for a duration of three months. During this time, direct experience was obtained by looking at how production for the semiconductor products were carried out on a large-scale basis. The exposure and the short experience have enhanced our knowledge about the manufacturing process which will be used in the development of the planning system. A survey on production planning was carried out among the planners in the factory who are directly involved in the planning and control of the production of the semiconductor products. The details of the analysis of the survey at Motorola will be presented in the following chapter.

The production planning at Motorola will be compared to the production planning at another semiconductor plant which is Siemens Semiconductor, Penang, whereby a study

based on production materials obtained from this plant was done. This comparison will enable us to provide variabilities for customisation purposes in the production tool. Besides, the literature review on the manufacturing process which will be presented in the following section will form a foundation in understanding what are the inputs for the planning system.

In general, the strategy of the proposed system is based on an object-oriented software engineering process for production planning that will be built in with common features found in manufacturing production planning software systems. The object-oriented tool will be developed as a set of generic classes, which can be customised according to different production environments.

Object-oriented analysis and design provide a more modular way of modelling problems through the use of objects which has both data and functional elements. This translates into clearer design and ultimately leads to clearer implementations that enable better control of complexity which will lead to a lower maintenance costs when completed.

In addition, as mentioned earlier, the opportunity of joining Motorola, Kuala Lumpur to study and obtain first-hand information at the plant's production system has enriched our experience, to better understand in reality how a large-scale production is done. A good grasp of how Motorola manufacture their semiconductor products for a variety of uses is really beneficial to the project. Production starts from the time the orders are received and are fed into the system for scheduling until the products are manufactured and shipped to the customers. This is a very complex task for a huge manufacturing plant which involves a lot of planning and process control in the production line. This meaningful experience acts as a guide in developing the proposed production planning tool

with the specific and common features built into this tool. Besides, this process of building the tool will be developed in an incremental and iterative manner associated with object-oriented software engineering life cycle. The details of the architectural framework will be explained in the later chapters.

1.7 Outcome

The intention of developing an object-oriented, customisable production planning tool is to produce generic components within the manufacturing domain which can then be reused through their classes. Applications can be built from the classes by extending or customising parts of the system while retaining the original design. The tool is also intended for use by manufacturing plants in providing solutions to the problems related to production planning. Object-oriented development offers more flexibility and some reusability in the implementation phases. Besides, it promotes future reuse and reduces maintenance as subsequent iterations of an object-oriented development are easier and faster because revisions are more localised. In addition, fewer iterations are usually needed because more problems are uncovered and corrected during the development phase. The outcome, ultimately is to meet the objectives stated for the planning system with the use of object-oriented techniques for the manufacturing production process.

1.8 Research Methodology

The research for this project is based on various methods including field study at a semiconductor plant for a short duration. In addition, a material study on another semiconductor plant is studied to see the similarities and differences of these two plants for a comparison purpose.

A literature review on production also provides additional information on the production process and products. This forms the theoretical aspects on the overview of the theory of production and inventory control. With regard to the technology used in developing the production planning software, the research is done based on related information technology textbooks, articles, reports, publication materials and journals, as well as tools developed by various experts on object-oriented systems with some reuse in mind.

All these methods have provided a good grasp in understanding more thoroughly how the manufacturing sector operates. Although there are many differences in the way the plants function, yet ultimately what matters is maximising output with utmost quality and efficient planning.

1.9 Chapters Organisation

The subsequent chapters will see a literature review of the production planning and control in the manufacturing sector followed by an analysis report on the survey conducted at Motorola Plant in Kuala Lumpur. Chapter 3 to Chapter 5 will see the software engineering process and its object-oriented development life cycle from analysis and design through to implementation and testing. Subsequently, the thesis will end with a summary of the whole development process, its strengths and weaknesses through to future enhancements.