

# Production Planning and Control for Mechanical Engineering Technology

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## **Abstract:**

"Production Planning and Control for Mechanical Engineering Technology" is a textbook thoroughly created to cater to the academic needs of Mechanical Engineering Technology students at Universiti Tun Hussein Onn Malaysia (UTHM). It represents a culmination of extensive dedication and experience in the teaching of Production Planning and Control (PPC) course, a pivotal domain within the field of industrial engineering.

With a rich teaching background more than five years, the author recognized the imperative need for a comprehensive resource that captures the evolving complexities and advancements within the realm of production planning and control. This realization served as the driving force behind the creation of this textbook, strategically structured to provide a profound and well-organized understanding of the course.

The book is structured into seven comprehensive sections, each serving as a gateway into a vital aspect of production planning and control, namely fundamental of forecasting, inventory management, aggregate planning, resource planning, short-term scheduling, and lean production.

Embark on an enriching academic journey through the pages of this textbook, digging into the depths of production planning and control. Acquire not only theoretical expertise but also practical understanding, equipping yourself for a future where industry expectations meet academic excellence.

**Keywords:** ABC analysis, forecast, Kanban, lean, MRP



# Production Planning and Control for MECHANICAL ENGINEERING TECHNOLOGY

Tengku Nur Azila Raja Mamat  
Rahim Jamian  
Salwa Mahmood



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UTHM



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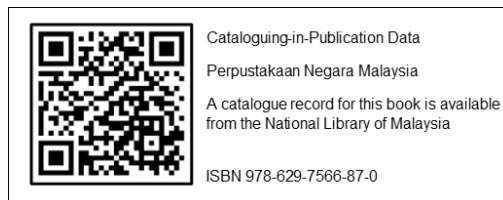
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# INTRODUCTION, AIM & SYNOPSIS

## INTRODUCTION

This book generally is a learning guide for the course Production Planning and Control. This course is offered to students in Year 4 Bachelor of Mechanical Engineering Technology at the Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia.

## AIM

This book is designed to acquaint readers with the fundamental concepts of production planning and control, a crucial aspect of the operational landscape. It commences with a broad and comprehensive overview of the operational environment. Subsequently, it employs a progressive approach, narrowing down from the overall operational context to departmental, line-specific, and, ultimately, unit-level environments as it explains key concepts.

## SYNOPSIS

This course introduces the concept of production planning and control. In **Chapter 1 Introduction to Production Planning and Control**, basic definitions and concepts of operation, manufacturing, and business are explained. It is important to understand the overall overview of an operation before related concepts are introduced.

In **Chapter 2 Fundamental of Forecasting**, forecasting is defined, and several mathematical techniques involved are explained. The techniques like Delphi method, and moving average, and trend projections are either from qualitative or quantitative approaches. These techniques can suit certain conditions with advantages and limitations.

**Chapter 3 Inventory Management System** brings inventory management into business. The importance of inventory management and related concepts are explained. Then, three inventory management models are introduced: the economic order quantity (EOQ) model, the production order quantity (POQ) model, and the quantity discount model.

Subsequently, in **Chapter 4 Aggregate Planning**, aggregate planning is discussed. It begins with the definition and importance of aggregate planning, followed by the introduction of ten strategies available in aggregate planning. The strategies are either capacity options, demand options, or a combination of both.

**Chapter 5 Resource Planning** introduces resources management and planning which brings Material Requirements Planning (MRP) into business. MRP can be successfully constructed if these important elements are available, known and controlled. There are the bills of materials (BOM), lead times, inventory data, and purchasing data. Based on the inventory status, MRP can be represented as net MRP or gross MRP. Then, several extensions of MRP are also discussed.

**Chapter 6 Short Term Scheduling** narrows down the PPC concept from long-term to short-term planning. Short-term scheduling involves the assigning of jobs; in which methods like input-output, Gantt chart, and assignment method are introduced, and prioritizing jobs; in which job prioritizing criteria and Johnson's Rule are introduced.

Finally, in **Chapter 7 Lean Production** and Just-in-Time (JIT), the lean concept is brought into business. The history and evolution of the lean concept and JIT are explained. The Kanban system is introduced and explained in detail; as an approach towards lean production.

# CHAPTER 1

## INTRODUCTION TO PRODUCTION PLANNING AND CONTROL

### 1.1 Manufacturing Planning and Control

Production encompasses the generation of both goods and services, resulting in the creation of value through the conversion of inputs into outputs. This process involves the transformation of raw materials into finished products. The activities related to producing goods and services are integral to all types of organizations. Within this context, Operations Management (OM) encompasses the range of activities that occur throughout the production process.

OM techniques are universally applicable across a wide spectrum of productive organizations worldwide. Whether it is in an office, a healthcare facility, a dining establishment, a retail store, or a manufacturing plant, the production of goods and services relies on OM. The efficient production of goods and services necessitates the proficient utilization of OM concepts, tools, and techniques.

### 1.2 Manufacturing Versus Services Operations

Productions generally can be categorized into two types based on their operation: manufacturing and service operations.

In manufacturing operations, the production activities that create goods are usually obvious. Manufacturing operations generate tangible, physical products that can be stored in inventory until their demand arises. Examples of tangible products are laptops, motorcycles, rice cookers, and LCD projector. On the other hand, service operations create intangible offerings that cannot be pre-produced. Examples of service operations include healthcare, education, consultation, and laundry. However, in numerous examples, products represent a combination of both goods and services, as exemplified in a restaurant, where the food is a tangible entity, while the act of serving the food is intangible.

# CHAPTER 2

## FUNDAMENTAL OF FORECASTING

### 2.1 Fundamental Principles of Forecasting

Forecasting involves the art and science of anticipating future events. These predictions can take on various forms, including subjective or intuitive estimations, historical data analysis extended into the future using mathematical models, or a combination of both.

An effective forecast typically aligns with several key criteria, such as being timely, reliable, accurate, meaningful, documented, and user-friendly. Nevertheless, forecasting inherently carries elements of risk and uncertainty, making it advisable to indicate the degree of uncertainty associated with specific forecasts. Additionally, the accuracy of a forecast depends on the currency of the data used. In certain instances, the data employed for predicting a variable may require forecasting themselves.

The impact of forecasting extends across an organization, influencing decisions and activities in various domains, including human resources, accounting, finance, marketing, product or service design, and supply chain management.

Forecasts can span different timeframes. Short-term forecasting covers daily to monthly horizons, aiding operational decision-making such as inventory management, ordering, and workforce scheduling. Typically, quantitative techniques like time series analysis are employed in short-term forecasting. Medium-term forecasting encompasses several months to up to two years, often termed as intermediate-term. Both quantitative and qualitative methods find application in this timeframe, supporting activities like production planning and cash budgeting. Long-term forecasting, usually undertaken at higher organizational levels, projects beyond the two-year horizon. Given the heightened uncertainty, in-depth knowledge about products and markets is essential. This scenario is common when introducing new products to the market, embracing emerging technologies, or establishing new facilities. Often, historical data might be unavailable in such cases.

# CHAPTER 3

## INVENTORY MANAGEMENT SYSTEM

### 3.1 Basics Concepts of Inventory

Every organization implements some form of inventory planning and management system. For instance, a bank employs methods to regulate its cash reserves, while a hospital employs methods to oversee blood supplies and pharmaceuticals. Inventory management stands as one of the most critical functions within an organization. It involves ensuring that the right materials or goods are readily available for manufacturers, delivered in the correct order, of the right quality, to the precise location, and at the designated time. The seamless coordination of these elements is essential for producing high-quality goods that meet customer requirements and specifications.

Inventory management is closely linked to forecasting activities since effective planning hinges on forecasted values, such as projected production volumes and forecasted sales. Figure 3.1 provides a visual representation of the interconnection between forecasting and inventory planning.

The roles of inventory within an organization encompass, but are not limited to:

- i. Offering a range of goods to meet expected customer demand and insulating the firm from fluctuations in that demand, which is a common practice in retail establishments.
- ii. Facilitating the separation of various stages within the production process. In cases where a firm's supplies experience variations, maintaining additional inventory may be necessary to decouple the production process from suppliers.
- iii. Capitalizing on quantity discounts by making larger quantity purchases, which can reduce the cost of goods and their delivery.
- iv. Serving as a hedge against inflation and upward price changes.

In designing an inventory system in the organization, two important questions must be answered first. How inventory items can be classified? How accurately inventory records can be maintained?

# CHAPTER 4

## AGGREGATE PLANNING

### 4.1 Introduction to Aggregate Planning

Aggregate planning, also known as aggregate scheduling is determining the quantity and timing of the production for the intermediate (medium) future, often from 3 to 18 months ahead. The purpose of aggregate planning is to determine the best way to meet forecasted demand while minimizing cost over the planning period; by adjusting production rates, labor levels, inventory levels, overtime work, subcontracting work, and other controllable variables.

In order to conduct aggregate planning, the following elements are required:

- i. Measurable items; examples are production output or sales
- ii. Forecast value; reasonable medium-range planning period
- iii. Method for determining the cost
- iv. Model of a combination of forecast and cost, to make a scheduling decision

Aggregate planning is part of a larger production planning and control while breaking down aggregate planning into a detailed plan is called disaggregation. Disaggregation results in a master production schedule (MPS) that subsequently provides input to material requirements planning (MRP).

### 4.2 Demand and Capacity Options

To develop aggregate planning, controllable variables are to be considered. Common controllable variables involved in aggregate planning are production rates, labor levels, and inventory levels. Those controllable variables lead to aggregate planning strategies that potentially be opted by an organization to meet forecasted demand while minimizing cost.

Ten aggregate planning strategies will be discussed: five from capacity options available, three from demand options, and two mixing options. This categorization is illustrated in Figure 4.1. Capacity options tend to absorb demand fluctuations without changing the demand. They are changing inventory levels, varying workforce size by hiring or layoffs, varying production rates through overtime or

# CHAPTER 5

## RESOURCES PLANNING

### 5.1 Introduction to Resources Planning

Resources are one of the most high-priced investments for an organization. With market volatility causing resourcing constraints, it is necessary to undergo resource planning and utilize the workforce to its maximum potential.

Resource planning is the process of identifying, estimating, and allocating the resources needed to successfully complete a project, program, or initiative. It is a short-range plans that help managers in arranging short-range activities.

### 5.2 Material Requirements Planning (MRP)

Material requirements planning (MRP) is one of the common dependant demand techniques used in resources planning. It is initiated from the MPS, as discussed previously in Chapter 4. Whereas when dealing with independent demand, techniques such as EOQ, POQ, and quantity discount model discussed in Chapter 3 are used.

MRP provides significant benefits to organizations, which includes:

- i. Better response to customer orders as a result of improved adherence to schedules
- ii. Faster response to market changes
- iii. Improved utilization of facilities and labor, which yields higher productivity and return on investment
- iv. Reduced inventory levels frees up capital and floor space for other uses

To construct MRP, the following information is required:

- i. Specifications or bills of material (BOM): materials, parts or ingredients required to make a product
- ii. Lead times: how long it takes to get the materials, parts or ingredients ready
- iii. Inventory data: inventory availability – what is in stock
- iv. Purchasing data: what is in order, or also called expected receipt

# CHAPTER 6

## SHORT-TERM SCHEDULING

### 6.1 Introduction

Scheduling is defined as assigning works or jobs to the specific people and work centres or machines. A finite capacity schedule is made by matching the specific tasks to the specific people or machines. A short-term scheduling refers to scheduling carried out in days, hours, or minutes. In other words, scheduling provides due dates to the specific jobs. In a broader view of production planning and control, short-term scheduling comes after material requirements planning (MRP) that has been discussed in Chapter 5.

There are two types of scheduling available. The first type is known as forward scheduling. This type of scheduling begins as soon as the requirements are known. An example of forward scheduling is in the clinic; once a patient registers in the clinic, he is scheduled to see the doctor on the spot. The second type of scheduling is backward scheduling. This type of scheduling begins with the due dates and schedules the final operations first and the other job steps in reverse order. An example of backward scheduling is in manufacturing, where customer order with the earliest due date is scheduled to be processed first.

The strategic importance of scheduling can be explained in three aspects: efficiency, cost, and customer satisfaction. A good scheduling results in the efficient movement of goods and services and proper allocation of assets. Efficient movement contributes to added production capacity, reduced waste and error, and faster throughput; thus cost is reduced. Eventually, with less error and increased capacity, the production can delivery faster and better, so that customer demand is successfully fulfilled.

For a scheduling to be carried out, the following database are required:

- i. Item master file – database or documents contains important information on each item in an operation. For example, an item (or component) should contain the name, type, price, location and quantity
- ii. Routing file – information on the available routes (or sequence of processes) of products

# CHAPTER 7

## LEAN PRODUCTION

### 7.1 Introduction to Lean

Lean is a method of production management that is developed based on the principle of just-in-time (JIT) introduced by Toyota Motor Company, during the mid-1970s. This approach emerged as a strategic response to the global oil crisis that occurred earlier in that decade. Over time, JIT principles have evolved and matured into what is now commonly referred to as lean production.

### 7.2 Lean and Just-in-time (JIT)

JIT is often characterized as a systematic approach aimed at achieving continuous improvement by eliminating waste and minimizing variations. Beyond production control techniques, it encompasses comprehensive quality control programs, strategic facility and line design, as well as fostering an attitude of employee involvement and ongoing training.

Waste and variations exist due to uncertainty in various aspects of business operations, including:

- i. Market conditions: Fluctuations or unpredictability in customer demand can lead to overproduction or underproduction, resulting in wasted resources.
- ii. Quality problems: Quality issues and defects in products or services can cause rework, scrap, or customer returns, contributing to wasted efforts and resources.
- iii. Design changes: Variability in production processes, machine breakdowns, or inconsistent quality can result in rework, scrap, or overproduction, adding to waste.
- iv. Supply chain: Uncertainties in the supply chain, such as delays in material delivery or disruptions in supply, can cause excess inventory or stockouts, leading to waste.

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# Production Planning and Control for MECHANICAL ENGINEERING TECHNOLOGY

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Happy reading and learning!



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