MODULE II
PRODUCTION PLANNING AND CONTROL

CONCEPT OF PRODUCTION, PLANNING AND CONTROL

Production planning and control may be defined as the direction and coordination of the firm's material and physical facilities towards the attainment of pre-specific production goals in the most efficient available way.

Production planning and control consists of the organization and the planning of the manufacturing processes routing, scheduling, dispatching and inspection, coordination and the control of materials, methods, machines, tooling and operating time. The ultimate objective is the organization of the supply and movement of materials and labor, machine utilization and related activities in order to bring about the desired manufacturing results in the terms of quality, time and price.

Production planning and control is an important task of Production Manager. It has to see that production process is properly decided in advance and it is carried out as per the plan. Production is related to the conversion of raw materials into finished goods. This conversion process involves a number of steps such as deciding what to produce, how to produce, when to produce, etc. These decisions are a part, of production planning. Merely deciding about the task is not sufficient. The whole process should be carried out in a best possible way and at the lowest cost. Production Manager will have to see that the things proceed as per the plans. This is a control function and has to be carried as meticulously as planning. Both planning and control of production are necessary to produce better quality goods at reasonable prices and in a most systematic manner.

Goldon B. Carson:
"Production planning and control involves generally the organization and planning of the manufacturing process. Specifically, it consists of the planning of the routing, scheduling, dispatching and inspection, co-ordination and the control of materials, methods, and machines, tooling and operating times. The ultimate

objective is the organization of the supply and movement of materials and labour, machine utilization and related activities, in order to bring about the desired manufacturing results in terms of quantity, time and place."

James L. Lundy:
"Basically, the production control function involves the co-ordination and integration of the factors of production for optimum efficiency. Overall sales orders or plans must be translated into specific schedules and assigned so as to occupy all work centres but overload none. The job can be done formally in which case elaborate charting and filing techniques are used ; or it can be done informally, with individuals' thoughts and retention there of supplanting tangible aids."

Charles A. Koepke:
"Production planning and control is the coordination of a series of functions according to a plan which will economically utilize the plant facilities and regulate the orderly movement of goods through the entire manufacturing cycle, from the procurement of all materials to the shipping of finished goods at a predetermined rate."

Characteristics of Production Planning and Control
1. It is the planning and control of manufacturing process in an enterprise. The questions like—What is to be manufactured? When it is to be manufactured? How to keep the schedule of production etc.? —are decided and acted upon for getting good results.

2. All types of inputs like materials, men, machines are efficiently used for maintaining efficiency of the manufacturing process.

3. Various factors of production are integrated to use them efficiently and economically.

4. The manufacturing process is organized in such a way that none of the work centers is either overworked or under worked. The division of work is undertaken very carefully so that every available element is properly utilized.

5. The work is regulated from the first stage of procuring raw materials to the stage of finished goods.

Objectives of Production Planning and Control

Planning of production precedes control. Whatever is planned needs to be controlled. The ultimate objective of both planning and control is to use various inputs in an efficient way and to have a proper control over various targets and schedules fixed earlier.

The following details will bring out the objectives of production planning and production control:

Production Planning:

1. To determine the requirements for men, materials and equipment.

2. Production of various inputs at a right time and in right quantity.

3. Making most economical use of various inputs.

4. Arranging production schedules according to the needs of marketing department

5. Providing for adequate stocks for meeting contingencies.

6. Keeping up-to-date information processes.

Production Control:

1. Making efforts to adhere to the production schedules.

2. Issuing necessary instructions to the staff for making the plans realistic.

3. To ensure that goods produced according to the prescribed standards and quality norms.

4. To ensure that various inputs are made available in right quantity and at proper time.

5. To ensure that work progresses according to the predefined plans

Stages of Production Planning and Control

Pre-planning, Planning and Control are the important stages of Production planning and control. They are briefly discussed below.

1. Pre-planning

This covers an analysis of data and outline of basic planning policy based on sales reports, market research, and product development and design. On the broad aspects of planning, this stage is concerned with problems of equipment policy, new process and materials, layout and work-flow. Pre-planning production as a production planning and control responsibility is also preoccupied with collecting data on the '9Ms', i.e., on men, money, materials, methods, machines, market, matter, minutes and milieu mainly with respect to availability, scope and capacity.

2. Planning

When the task has been specified, a thorough analysis of the '9Ms' is first undertaken to select the appropriate materials, methods and facilities by means of which the work can be accomplished. This analysis is followed by routing, estimating and scheduling.

The more detailed, realistic and precise the planning, the greater conformity to schedules achieved during production, and subsequently the greater the efficiency of the plant. There are two aspects of planning — a short-term one, concerned with immediate production programmes, and a long-term phase, where plans for the more distant future are considered and shaped. Prominent planning functions are those dealing with standardization and simplification of products, materials and methods.

3. Control

This stage is affected by means of dispatching, inspection and expediting. Control of inventories, control of scrap, analysis of work-in-progress, and control and transportation are essential links of this stage. Finally, evaluation takes place to complete the production planning and control cycle

PLANNING PREMISES

Planning is made for the future. Future is uncertain the management makes certain assumptions about the future. The assumptions are not to be based on hunch or guess work. It should be developed through scientific forecasting of future events.

"Planning premises are the anticipated environment in which plans are expected to operate. They include assumptions or forecasts of the future and known conditions that will affect the course of plans such as prevailing policies and existing company plans that controls the basic nature of supporting plans." So planning premises provide a framework for planning and action in the midst of uncertainties in the business environment. They imply not only the assumptions about the future but also predictions. Planning premises constitute the framework with which planning is done.

Types of Planning Premises:

Planning premises may be classified as:

(a) Internal and external

(b) Tangible and Intangible

(c) Controllable, semi-controllable and uncontrollable

(d) Constant and variable

(e) Foreseeable and unforeseeable

(a) Internal and External Premises:

Internal premises are those which exist within the business enterprise. This may include men, material, money and methods. Competence of managerial personnel and skill of labour force are some of the important internal premises.

External premises centre round the markets and derived from the external environment surrounding the business. Examples: Product market, money market, population growth, government policies, business cycles technological changes.

(b) Tangible and Intangible Premises:

Tangible premises are those which can be measured quantitatively. They may be quantified in terms of money, time and units of production. Intangible premises are those which cannot be measured quantitatively. Examples are: Reputation of the business, Public relations, employee morale, motivation etc. Planning is to consider both tangible and intangible premises.

(c) Controllable, Semi-Controllable and Uncontrollable Premises:

There are certain factors which are well within the control of the management to a great extent. Factors like materials, money and machines are areas where management has maximum control over their future commitments. The management can decide what policies, procedures, rules and strategies are to be followed in the organisation for achieving the objectives. Semi-controllable premises are those assumptions about future which are under the partial control of a business. Examples of such premises are demand for the product, Trade union relations.

Non-controllable premises are entirety beyond the scope of business like government policy, international trade agreements, wars, natural calamities new discoveries and inventions etc. Such events cannot be predicted or controlled. These factors disturb all well thought-out calculations. All intangible premises also fall in this category as human behaviour also cannot be predicted accurately.

(d) Constant and Variable Premises:

Constant premises are those which behave in similar fashion irrespective of action taken. They are definite, well known and well-understood. The behaviour of constant premises is not subject to changes these are ignored in planning. Such factors are men, machine and money. Variable premises are those which vary in relation to the course of action.

The management is to consider these factors in formulating plans as their variations are dependent on the action taken by the management. These cannot be controlled and predicted. For example, sales volume of the enterprise can be partly controlled by the management. There are certain other factors which affect the sales volume of the enterprise but are quite uncontrollable.

MAKE TO STOCK

Make to Stock (MTS) planning is a commonly utilized production strategy that is used by manufacturing facilities that involves producing items to match anticipated consumer demand. This production strategy is not the same as producing a certain amount of goods and then trying to sell them after the fact.

The basis of Make to Stock is that the production target is determined by your demand forecast. This means that you must have an accurate demand forecast for MTS to be executed properly. Make to Stock will estimate how many orders will be generated for each product and then supplies enough stock in order to sufficiently meet those orders. The MTS method requires an accurate forecast of this demand to determine how much stock it produces. If demand for the product can be estimated accurately, the MTS strategy is an efficient choice for production.

Example of Make to Stock (MTS) Planning

The following example outlines the steps that a toy manufacturer would take to use MTS within their production facility.

1. **Create Forecast** - The first step to use Make to Stock is to estimate the demand for the products you will need to produce. There are many strategies that can be used to generate an accurate demand forecast. In this example, the manufacturer may find that they sell 40% more toys on average in the last quarter of the year.
2. **Produce Items** - Once the forecast has been generated, manufacturers have a target quantity of goods to produce. There are many planning and scheduling steps involved in the production of items. Planners and schedulers will need to ensure that there are enough materials and resource capacity to produce the additional demand.
3. **Hold In Inventory** - The next step is to hold the finished products in inventory while waiting for the customer orders to come in. As this is one of the most costly steps, it is preferable for manufacturers to minimize the amount of time that items are stored.
4. **Receive Customer Orders** - When using a Make to Stock strategy, you will have products in stock when your customer orders come in. If your forecast was accurate, you should have just enough products in stock - not more or less.

5. **Ship To Customer** - The last step is to ship the products to the customer. Because your manufacturing facility used a Make to Stock production strategy you will be able to deliver items to your customers in a timely fashion.

Advantages of Make to Stock

1. Efficient use of resources

Production is planned well in advance based on expected demand. Therefore, the use of resources is also planned accordingly, facilitating efficiency.

2. Economies of scale

Since goods are produced on a large scale, the fixed costs of production are divided equally over a large number of units produced. It drives down the average cost of production per unit and lets companies avail of the benefits of economies of scale.

3. Scheduling

Decisions on when to produce and how much to produce are made in advance. Therefore, work can progress smoothly according to a schedule, and at any point in time, how much is left to be done can be determined.

4. Quick response time

The finished goods are available in the shop, ready for immediate sale. The customer can choose a product to purchase and take delivery of it at the same time.

Disadvantages of Make to Stock

1. Inaccuracy of forecasts

Forecasts for consumer demand can sometimes be misleading. Sales can be unusually low during an anticipated peak season due to some external anomaly, such as a recession. On the other hand, demand may pick up unexpectedly during an anticipated off-season.

2. Inventory levels

Despite the best efforts at making accurate forecasts, inventories may fall short or remain in excess perpetually.

3. Unpredictable consumer preferences

The decision to produce a certain quantity of a commodity is made on the basis of expected demand. However, customer preferences and trends keep changing continuously. So, there is always a risk of inventories going waste due to obsolescence.

MAKE TO ORDER

Make to order (MTO), or made to order, is a business production strategy that typically allows consumers to purchase products that are customized to their specifications. It is a manufacturing process in which the production of an item begins only after a confirmed customer order is received. It is also known as mass customization. The make-to-order (MTO) strategy means that a firm only manufactures the end product once the customer places the order, creating additional wait time for the consumer to receive the product, but allowing for more flexible customization when compared to purchasing directly from retailers' shelves.

This type of manufacturing strategy is referred to as a pull-type supply chain operation because products are only made when there is firm customer demand. The pull-type production model is employed by the assembly industry where the quantity needed to be produced per product specification is one or only a few. This includes specialized industries such as construction, aircraft and vessel production, bridges, and so on. MTO is also appropriate for highly configured products such as computer servers, automobiles, bicycles, or products that are very expensive to keep inventory.

In order to manage inventory levels and provide an increased level of customization, some companies adopt the make to order production system. The MTO strategy relieves the problems of excess inventory that is common with the traditional make-to-stock strategy. Dell Computers is an example of a business that uses the MTO production strategy, wherein customers can order a fully customized computer online and receive it in a couple of weeks.

Advantages of Make to Order

1. Reduces wastage

When a stock of goods lies unsold, there is wastage not only of the materials used to make them, but also the money and labor put into producing them. In MTO, since products are manufactured after receiving a customer's order and in the quantity specified, wastage and loss are minimized.

2. Less inefficiency

When a large variety of goods are made on a large-scale basis, there is a risk of inefficiency because workers and machines need to adhere to different rules. In MTO, all efforts are focused on making the product according to the specifications of the customer, so workers and machines tend to be more efficient.

3. Greater variety

Since only customized goods are produced and sold, MTO offers a greater variety of products. In fact, it provides customers the product exactly the way they want it.

Disadvantages of Make to Order

1. Irregular sales

It is difficult to determine when demand may arise for a particular customized product. So, there may be periods of high sales and months of no sale at all. For example, the demand for military aircraft arises in times of hostile international relations, but such situations cannot be predicted in advance.

2. Lengthy delivery time

Since production starts after receiving an order, the product reaches the customer after some time. Moreover, because it takes time to customize the product, the delivery time may take longer.

3. Availability of raw materials

The uncertainty of demand raises the necessity of keeping a sufficient supply of raw materials so that production can start immediately after receiving an order. In case the raw materials are not ready, it takes more time to procure them and deliver the final product to the customer.

Make to Order vs. Make to Stock

Make to Stock (MTS) is a more common production technique wherein producers produce commodities on a large scale and put them up on shelves in the shop to be sold. Whatever is not sold immediately is stored as inventory.

When goods are stored in such a way for a long time, they tend to become obsolete or go to waste. In response to such a drawback, production techniques shifted to make to Order, especially for sectors like technology, in which obsolescence is predominant. MTO removes the dependence of companies on forecasts of consumer demand, which can be inaccurate and misleading sometimes. It instead focuses on actual demand and eliminates the risk of obsolete inventories.

ASSEMBLE TO ORDER

Assemble-to-order (ATO) is a business production strategy where products that are ordered by customers are produced quickly and are customizable to a certain extent. It typically requires that the basic parts of the product are already manufactured but not yet assembled. Once an order is received, the parts are assembled quickly and the final product is sent to the customer.

The assemble-to-order strategy is a hybrid between the make-to-stock strategy (MTS) and the make-to-order strategy (MTO). A make-to-stock strategy is one where products are fully produced in advance. The idea is to build an inventory that matches expected or anticipated consumer demand. This method would consist of setting a production level, building up inventory, and then attempting to sell as much assembled product as possible. It's used mostly for high-volume goods, consumables, and items that can be bought in bulk or as a single unit. A make-to-order strategy is one where products are manufactured once the order has been received. Production is driven by demand and items are only produced when orders are confirmed. In other words, the supply chain operation does not begin until there is evidence of sufficient customer demand. This strategy

is often employed for high-end goods or items made individually or in small batches.

The ATO strategy attempts to combine the benefits of both make-to-order and make-to-stock—getting products into customers' hands quickly while allowing for the product to be adapted or altered in certain ways, as per customer request. In most cases, the time and costs associated with building the product from its components are minimal. However, the time and costs to build the components, which are usually ordered from a supplier, can be considerable.

Example of Assemble-to-Order (ATO)

Consider a manufacturer of personal computers. It might have all of the essential parts of a computer—motherboards, graphic cards, processors, monitors, keyboards—in stock, already manufactured. These parts are The company depends on various suppliers for these components. When orders for new PCs arrive, it is easy for the company to assemble and customize the computers using the various components. The process is driven by customer demand, however, and until the order arrives, the components sit on shelves.

The Advantages of Assemble-to-Order

- **Specialization** - Overall, the most substantial advantage pertaining to an assemble-to-order strategy pertains to the specialization of each product to meet consumer expectations. As opposed to MTS, you are able to ensure that consumers hand-pick all features and components within a product and ultimately develop a personalized product just for that consumer. It leads to a much more quality product and the consumer has some say in what exactly they want as opposed to taking something right off the shelf.
- **Inventory Reduction** - Inventory reduction is another advantage to an assemble-to-order strategy, considering that product is not manufacturing and created until an order is placed. This saves a facility a substantial amount of money on inventory costs and ultimately reducing warehousing space. Inventory reduction is by far the biggest advantage pertaining to assemble to order (ATO).

Disadvantages of Assemble-to-Order

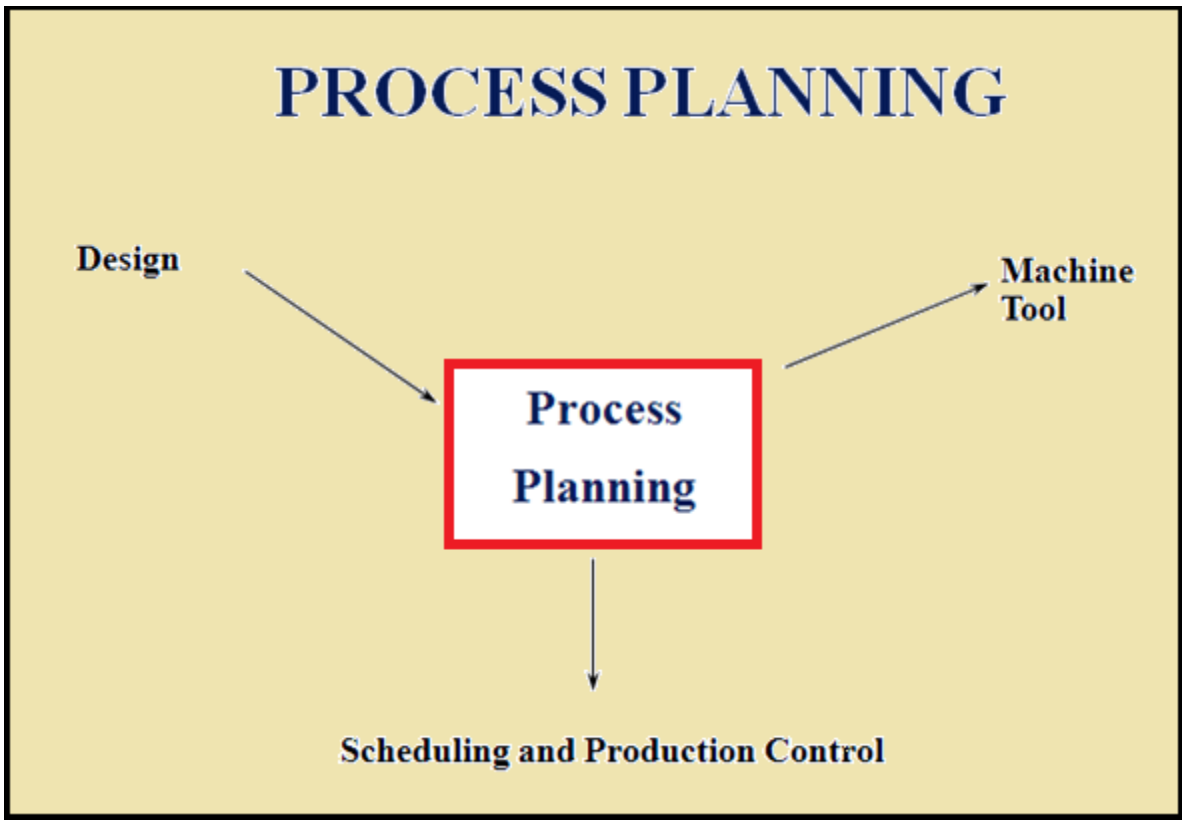
- **Low Supply** - One disadvantage pertaining to assemble to order is the lack of supply of inventory that is ready to sell. Once again, as opposed to MTS, you will have to assemble parts together or completely manufacture a new product, leading

to longer lead times. Instead of having stores filled with inventory, you will be taking orders through the phone or website and will eliminate the ability to purchase and take home something within the same day. This could potentially lead to a loss of profits and sales and could decrease profitability.

- **Waiting Time** - Once again, waiting time is another substantial drawback of assemble-to-order. Within assemble-to-order, the lead times are due to having to manufacture the product and a lack of supply on hand, which takes longer to fulfill consumer orders. A long wait time could send individuals away to already finished product or places filled with options of inventory.

PROCESS PLANNING

In companies, planning processes can result in increased output, higher precision, and faster turnaround for vital business tasks. A process is described as a set of steps that result in a specific outcome. It converts input into output. Process planning is also called manufacturing planning, material processing, process engineering, and machine routing. It is the act of preparing detailed work instructions to produce a part. It is a complete description of specific stages in the production process. Process planning determines how the product will be produced or service will be provided. Process planning converts design information into the process steps and instructions to powerfully and effectively manufacture products. As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to make simpler and improve process planning and realize more effectual use of manufacturing resources.



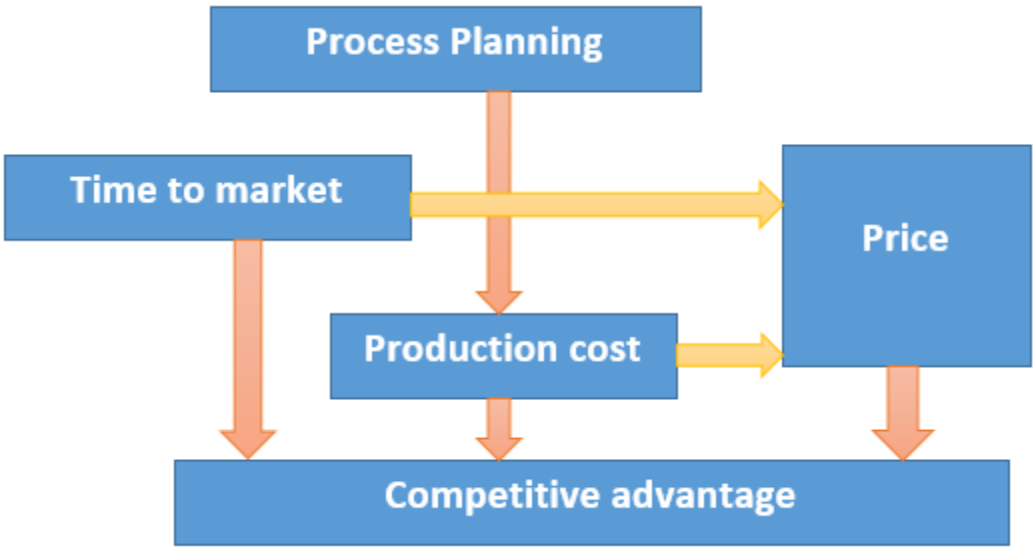
It has been documented that process planning is required for new product and services. It is the base for designing factory buildings, facility layout and selecting production equipment. It also affects the job design and quality control.

Objectives of Process Planning:

1. The chief of process planning is to augment and modernize the business methods of a company.
2. Process planning is planned to renovate design specification into manufacturing instructions and to make products within the function and quality specification at the least possible costs. This will result in reduced costs, due to fewer staff required to complete the same process, higher competence, by eradicating process steps such as loops and bottlenecks, greater precision, by including checkpoints and success measures to make sure process steps are completed precisely, better understanding by all employees to fulfil their department objectives.

3. Process planning deals with the selection of the processes and the determination of conditions of the processes.
4. The particular operations and conditions have to be realised in order to change raw material into a specified shape. All the specifications and conditions of operations are included in the process plan.
5. The process plan is a certificate such as engineering drawing. Both the engineering drawing and the process plan present the fundamental document for the manufacturing of products. Process planning influences time to market and productions cost. Consequently the planning activities have immense importance for competitive advantage.

Effect of process planning on competitive advantage:



Principles of Process Planning

General principles for evaluating or enhancing processes are as follows:

- First define the outputs, and then look toward the inputs needed to achieve those outputs.
- Describe the goals of the process, and assess them frequently to make sure they are still appropriate. This would include specific measures like quality scores and turnaround times.

- When mapped, the process should appear as a logical flow, without loops back to earlier steps or departments.
- Any step executed needs to be included in the documentation. If not, it should be eliminated or documented, depending on whether or not it's necessary to the process.
- People involved in the process should be consulted, as they often have the most current information.

Major steps in process planning:

Process planning has numerous steps to complete the project that include the definition, documentation, review and improvement of steps in business processes used in a company.

Definition: The first step is to describe what the process should accomplish. It includes queries like, what is the output of this process? Who receives the output, and how do they define success?, What are the inputs for the process?, Are there defined success measures in place - such as turnaround time or quality scores? And Are there specific checkpoints in the process that need to be addressed?

Documentation: During the documentation stage, interviews are conducted with company personnel to determine the steps and actions they take as part of a specific business process. The results of these interviews is written down, generally in the form of a flow chart, with copies of any forms used or attached. These flow charts are given to the involved departments to review, to make sure information has been correctly captured in the chart.

Review: Next, the flow charts are reviewed for potential problem areas.

MASTER PRODUCTION SCHEDULING (MPS)

Master Production Scheduling is the process that helps manufacturers plan which products and related quantities to produce during certain periods. MPS is proactive in that it drives the production process in terms of what is manufactured and what materials are procured.

In previous articles, we introduced Bills of Materials (BOM) and Material Requirements Planning (MRP), two legs of the inventory planning tripod. The third is the Master Production Schedule (MPS).

A Master Production Schedule is a Schedule of the completions of the end items and these completions are very much planned in nature. Master production schedule acts as a very distinct and important linkage between the planning processes. With the help of this schedule, one can know the requirements for the individual end items by date and quantity. In companies, MPS are generally produced in order to know the number of each product that is to be made over some planning horizon. This schedule forms a very unique part of the company's sales program which deals with the planned response to the demands of the market.

A master production schedule is also in management language referred to as the master of all the schedules as this schedule provides the production, planning, purchasing & top management, the most needed information required for planning and control of the whole manufacturing process or the operation.

Objectives of Master Production Schedule (MPS)

1. Keeping the inventories at the desired level by making perfect use of the resources that are available with the company.

2. Setting up due dates for the availability of the end items and also providing the required information regarding resources and also the materials – which act as the supporting pillars of the aggregate planning.

3. Maintaining properly, the desired level of customer service.

4. Setting particular schedules for the production of the parts and the components that are used as the inputs to materials requirements planning, in the end items.

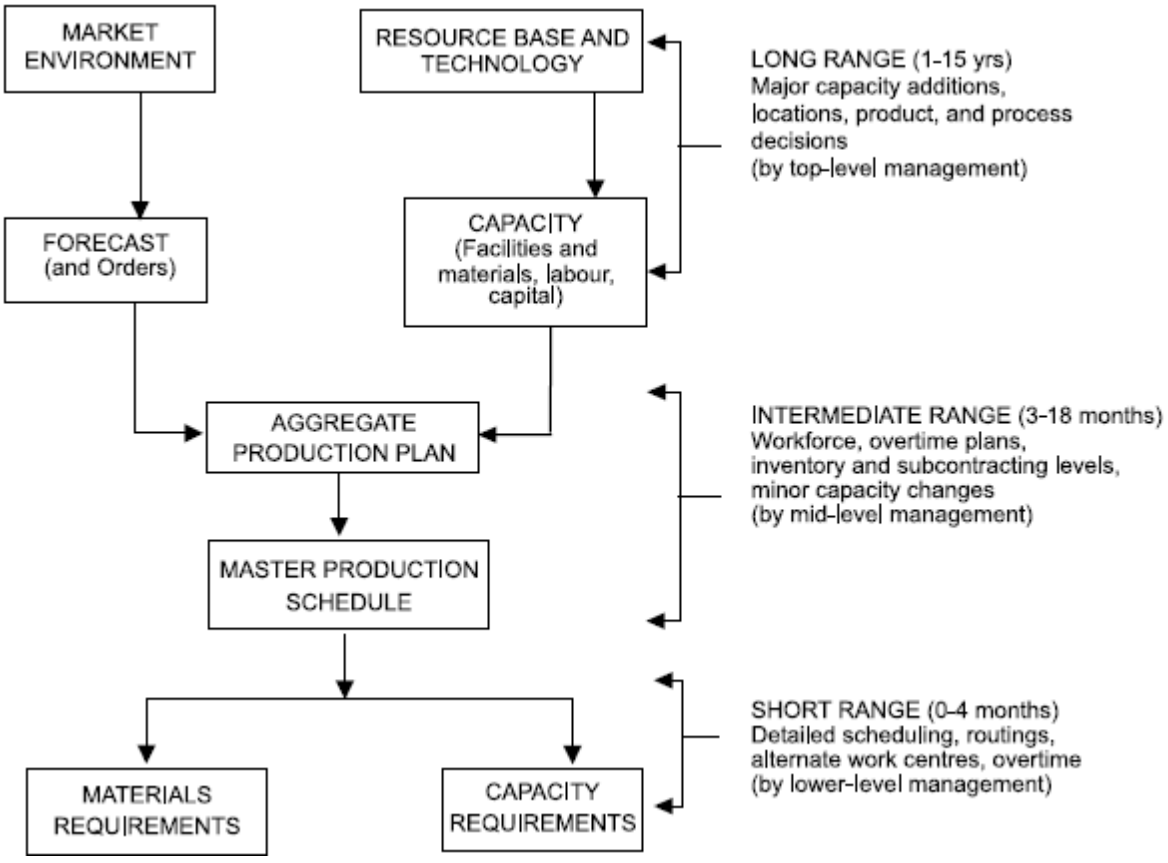
Functions of Master Production Schedule

Master Production Schedule (MPS) gives a formal detail of the production plan and converts this plan into specific material and capacity requirements. The

requirements with respect to labor, material and equipment are then assessed. The main functions of MPS are:

1. **To translate aggregate plans into specific end items**: Aggregate plan determines level of operations that tentatively balances the market demands with the material, labor and equipment capabilities of the company. A master schedule translates this plan into specific number of end items to be produced in specific time period.

Flowchart of aggregate plan and master schedule



2. Evaluate alternative schedules: Master schedule is prepared by trial and error. Many computer simulation models are available to evaluate the alternate schedules.

3. Generate material requirement: It forms the basic input for material requirement planning (MRP).

3. Generate capacity requirements: Capacity requirements are directly derived from MPS. Master scheduling is thus a prerequisite for capacity planning.

4. Facilitate information processing: By controlling the load on the plant. Master schedule determines when the delivery should be made. It coordinates with other management information systems such as, marketing, finance and personnel.

5. Effective utilization of capacity: By specifying end item requirements schedule establishes the load and utilization requirements for machines and equipment.

Different Master Production Scheduling techniques

The MPS needs to plan for what will be manufactured at the most efficient level. If the MPS covers too many items, it will be difficult to put the plan into action, effectively. Whereas, if the plan is not detailed enough, the production will suffer. As a general rule, master scheduling should happen where the smallest number of product alternatives exists.

- In **make-to-stock** environments, a limited number of items are assembled from a larger number of components, for example, video recorders or computers. The MPS should in this case be a schedule of finished goods items.
- In a **make-to-order** environment, many different finished goods can be produced from a relatively small number of raw materials. A great example of this process would be how cars are manufactured. The subassemblies for many cars will be the same but the different models of cars manufactured differ in specific options such as color, stereo, sunroof, and electric windows. The MPS in a make-to-order environment is a schedule of the actual customer orders.
- **Assemble to order** environments make use of raw materials to form basic components and complete subassemblies. These components and subassemblies make up a variety of finished products. The Master Production Schedule should therefore take place at the subassembly level.

The Benefits of MPS

- Ability to make adjustments to fluctuations in demand while minimizing waste
- Prevents shortages and scheduling mishaps

- Improves efficiency in the location of production resources
- Provides more effective cost controls and more accurate estimates of material requirements and delivery dates
- Reduces lead times throughout the year
- Provides an effective communication conduit with the sales team for planning purposes

Importance of MPS

A production plan is an aggregate plan that schedules product families in relatively long time intervals. Master production schedule is used for individual end products and in shorter time intervals. MPS is important in the following aspects:

1. It is the link between what is expected (production planning) and what is actually to be built, i.e., material requirement planning and final assembly schedule

2. It develops data to drive the detailed planning, MRP. MPS is a priority plan for manufacturing. It keeps priorities valid.

3. It is the basis for calculating the resources available (capacity) and the resources needed (load). It provides devices to reconcile the customers' demand and the plant's capability.

4. It makes possible reliable delivery promises. It provides salespeople information on available-to-promise (ATP) indicating when end products are available.

5. It is a tool that can be used to evaluate the effects of schedule changes. It is a device for communication and a basis to make changes consistent with the demands of the marketplace and manufacturing capacity.

6. It is a contract between marketing and manufacturing departments. It is an agreed-upon plan. It coordinates plans and actions of all organizational functions and is a basis to measure the functions' performance.

7. It provides management with the means to authorize and control all resources needed to support integrated plans.

8. In the short horizon, MPS serve as the basis for planning material requirement, production of components, order priorities, and short-term capacity requirements.

9. In the long horizon, MPS serves as the basis for estimating long-term demands on the company resources such as people, equipment, warehousing, and capital.

MATERIAL REQUIREMENT PLANNING (MRP)

Meaning

Material Requirement Planning is a special technique to plan the requirements of materials for production. For the manufacturing company to produce the end items to meet demands the availability of sufficient production capacity must be coordinated with the availability of all raw materials and purchased items from which, the end items are to be produced.

In other words, there is a need to manage the availability of dependent demand items from which the products are made. Dependent demand items are the components, i.e., materials or purchased items, fabricated parts or sub-assemblies that make up the end product.

One approach to manage the availability of dependent demand items is to keep a high stock of all the items that might be needed to procured the end items and when the on-hand stock drops below a present re-order level, the items are procured or bought as the case may be to replenish the stock to the maximum level.

However, this approach is costly due to the excessive inventory of components, fabricated parts and sub-assemblies to ensure high service level.

Objectives of MRP:

The objectives of material requirement planning in operations management are:
(a) It determines the quantity and timing of finished goods demanded.

(b) It determines the time phased requirements of the demand for materials, components and sub-assemblies over a specified planning time horizon.

(c) It computes the inventories, work-in-process batch sizes and manufacturing and packing lead times.

(d) It controls inventory by ordering materials and components in relation to orders received rather than ordering them from stock level point of view.

(e) It improves customer service by meeting delivery schedules promised and shortening the delivery lead times.

(f) It reduces inventory cost by reducing inventory levels.

(g) It improves plant operating efficiency by better use of productive resources

Material Requirement Planning System Inputs:

Following are the basic three inputs of any MRP System:

a. Master Production Schedule (MPS):

This is the schedule of the quantity and timing of all end products to be produced over a specific planning horizon. The planning horizon should be long enough to cover the cumulative lead times of all components that must be purchased or manufactured to meet the end product requirement. MPS is developed from customer's orders or from forecasts of demand or both. MPS is the key input which drives the MRP programme as it tells what the company intends to produce. The maximum length of time that is planned in a MPS will depend on the company's ability to forecast demand and its requirements, but a one year span is usually common.

b. Bill of Material (BOM) File:

A bill of material file, also known as product-structure file, is a computerized file listing all finished products, the quantify of raw materials, parts, sub-assemblies and assemblies in each product. The MRP programme obtains information about the components needed to make an end product from BOM file. A bill of material not only lists all the required parts but also is structured to reflect the sequence of steps required to produce the end product.

The BOM has a series of levels, each of which represents a stage in the manufacture of the end product. The highest level or zero level of BOM represents the end product or the finished goods. The next lower level might represent the sub-assemblies that are combined to make the final assembly.

c. Inventory Status File:

This file contains important information such as what items should be ordered and orders should be released. The file gives the complete and up-to-date information on the hand quantities, gross requirements, scheduled receipts and planned order releases for the item. It also tells about lot sizes, lead times, safety stock level, etc. The gross requirements are total needs from all resources. Whereas the net requirements are 'net' after allowing for available inventory and scheduled receipt. Schedule receipts are quantities for which order has already been placed with vendor and in-house shop.

Besides the above, following may also be the inputs:

(i) Routing File:

This file specifies the sequence of operations required to manufacture components, sub-assemblies and finished goods.

(ii) Master Parts File:

It contains information about production time of sub-assemblies and components produced internally and lead time for externally procured items.

MRP System Outputs:

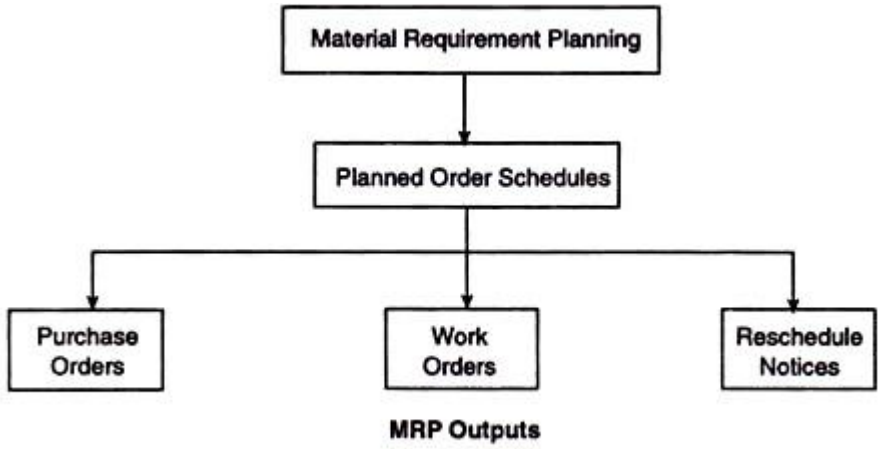
The outputs of any MRP System are:

a. Planned order schedule which is a plan of the quantity of each material to be ordered in each time period. The order may be purchase order on the suppliers or production orders for parts or sub-assemblies on production departments.

b. Changes in planned orders (reschedule notices).

c. Planning reports like inventory forecast, purchase commitment reports, stock-out incidences, etc.

d. To project capacity requirements.



Benefits of MRP:

MRP is a new way of managing manufacturing operations. It is not only to calculate how much material to order and when. It is a decision support system which provides timely and valuable information to operations managers.

The potential benefits of MRP system are:

a. Inventory:

MRP will substantially reduce inventory investment in dependent demand items while improving operational efficiency by removing the risk of shortages associated with the EOQ. The MRP system has numerous benefits over the fixed order size system (EOQ) for control of production items.

MRP system focuses on actual requirements. It is product oriented. Whereas EOQ focuses on replenishing supply and is part oriented. MRP is based on future production data while EOQ is on past demand data.

b. Purchases:

MRP helps in generating purchase order and in case of any changes, reschedule notices are also generated. These reports facilitate the purchase department in listing out the priority items and making them available in time.

c. Planning, Engineering and Schedule:

MRP plans orders for purchasing and shop scheduling for the quantity of items that must be available in each time period to produce the end items. The orders are planned for enough ahead to allow adequate time for scheduled completion of the

final product without having material waiting unnecessarily for entry into a particular stage of the production process.

d. Production:
MRP can improve flow of work, thereby reducing intermittent delays and reducing the manufacturing cycle time for the jobs.

e. Sales:
As one of the functions of MRP is to report the changes in demand, it improves the company's ability to react to changes in customer orders, improves customer services by helping production meet assembly dates and helps to reduce delivery lead times.

Although MRP is an excellent tool for initial planning and scheduling, its greatest benefits may be its ability to re-plan and reschedule in view of unforeseen contingencies. The MRP system can predict shortages and overages soon enough so that something can be done to prevent them. It can help order priorities to help up-to-date by planning and re-planning order due dates. MRP provides exception reporting whenever a mismatch of timing between demand and supply exists. It is a priority system: typical messages are to delay, expedite, or cancel an existing order, launch a new order, etc. It attempts to make the due date and need date coincide, so operations proceed as planned while inventory investment is minimised.

If a component to an assembly is not available when planned, MRP can reschedule all other components for the same assembly to a later date while rescheduling shop priority. MRP does not actually reschedule orders, but it prints messages specifying exactly where changes are appropriate. The decision to make changes remains with management personnel.

MRP II

MRP II is a computer-based system that can create detailed production schedules using real-time data to coordinate the arrival of component materials with machine and labor availability. MRP II is used widely by itself, but it's also used as a module of more extensive enterprise resource planning (ERP) systems. MRP II is

an extension of the original materials requirements planning (MRP I) system. Materials requirements planning (MRP) is one of the first software-based integrated information systems designed to improve productivity for businesses. A materials requirements planning information system is a sales forecast-based system used to schedule raw material deliveries and quantities, given assumptions of machine and labor units required to fulfill a sales forecast.

By the 1980s, manufacturers realized they needed software that could also tie into their accounting systems and forecast inventory requirements. MRP II was provided as a solution, which included this functionality in addition to all the capabilities offered by MRP I.

MRP I vs. MRP II

For all intents and purposes, MRP II has effectively replaced MRP I software. Most MRP II systems deliver all of the functionality of an MRP system. But in addition to offering master production scheduling, bill of materials (BOM), and inventory tracking, MRP II provides functionality within logistics, marketing, and general finance. For example, MRP II is able to account for variables that MRP is not—including machine and personnel capacity—providing a more realistic and holistic representation of a company's operating capabilities. Many MRP II solutions also offer simulation features that allow operators to enter variables and see the downstream effect. Because of its ability to provide feedback on a given operation, MRP II is sometimes referred to as a closed-loop system.

MRP I included the following three major functionalities:

- master production scheduling
- bill of materials
- inventory tracking

MRP II includes those three, plus the following:

- machine capacity scheduling
- demand forecasting
- quality assurance
- general accounting

MRP II systems are still in wide use by manufacturing companies today and can either be found as stand-alone solutions or as part of an enterprise resource

planning (ERP) system. Enterprise Resources Planning (ERP) software systems are regarded as the successors of MRP II software. ERP suites include applications well outside the scope of manufacturing. These can include everything from human resources and customer relationship management to enterprise asset management.

In addition to the MRP I tools, the MRP II calculates and solves:

- The planning of the manufacturing resources of the organization
- Ability to simulate production processes
- Optimized calculation of routes and work centers
- It is based on the study of demand and the market.
- It covers more departments, not only production but also purchasing, quality, financial, etc.

The inputs are:

- Work Progress Feedback, showing how the work has progressed, to all levels of the schedule so that the next run can be updated on a regular basis.
- Resource Scheduling, which is the calculation of resources to convert the raw materials into finished goods.
- Batching Rules takes into account the logic which batches are produced (i.e. EBQ, Lot for Lot, etc.)
- Rough Cut Capacity Planning (RCCP), to match the workload to the capacity available.
- Software extension programs, such as including sale orders processing, cost accounting, etc.

Advantages of MRP II

The advantages of using an MRP II System are shown below:

- All the advantages coming from MRP I
- Optimization of machinery usage and productivity improvement
- Coordination and control of production and inventories
- Ease of adaptation to order changes.
- Reduction of outsourcing and idle times
- Financial knowledge of planned and real production.

MATERIAL HANDLING

Material Handling refers to the movements of materials and handling there in store. Handling of materials is an integral part of the production process. Handling can be manual or mechanical. The movement can be horizontal, vertical or the combination of these two.

Usually a large part of indirect labour is engaged in material handling. Also, the average material handling cost in nearly 25-30% of the total production cost. It has become clear that total or net cost of the production process can be lowered by making a saving in material handling cost.

Role of Material Handeling

Material handling plays an important role in manufacturing and logistics. Almost every item of physical commerce has been transported on a conveyor or lift truck or other type of material handling equipment in manufacturing plants, warehouses, and retail stores. These operators use material handling equipment to transport various goods in a variety of industrial settings including moving construction materials around building sites or moving goods onto ships.

Following are the most important functions of material handling:

(i) Transportation of materials from stores to shops.

(ii) Proper positioning of purchased material for the purpose of storage.

(iii) Transportation during process from one machine to other.

(iv) Unloading the imported materials from trucks or trolley.

(v) To make the economical use of floor space.

(vi) To maintain suitable flexibility of arrangements and layouts.

Material handling puts emphasis on the need of the installing efficient and economical methods for material handling. Material handlings equipment is not considered production machinery. A material handling system should be able to move and store the material effectively with minimum effort, maximum safety and in the shortest time.

Design of material handling systems

Material handling is integral to the design of most production systems since the efficient flow of material between the activities of a production system is heavily dependent on the arrangement (or layout) of the activities. If two activities are adjacent to each other, then material might easily be handed from one activity to another. If activities are in sequence, a conveyor can move the material at low cost. If activities are separated, more expensive industrial trucks or overhead conveyors are required for transport. The high cost of using an industrial truck for material transport is due to both the labor costs of the operator and the negative impact on the performance of a production system when multiple units of material are combined into a single transfer batch in order to reduce the number of trips required for transport

a) The unit load concept

A unit load is either a single unit of an item, or multiple units so arranged or restricted that they can be handled as a single unit and maintain their integrity. Although granular, liquid, and gaseous materials can be transported in bulk, they can also be contained into unit loads using bags, drums, and cylinders. Advantages of unit loads are that more items can be handled at the same time (thereby reducing

the number of trips required, and potentially reducing handling costs, loading and unloading times, and product damage) and that it enables the use of standardized material handling equipment. Disadvantages of unit loads include the negative impact of batching on production system performance, and the cost of returning empty containers/pallets to their point of origin.

b) In-process handling

Unit loads can be used both for in-process handling and for distribution (receiving, storing, and shipping). Unit load design involves determining the type, size, weight, and configuration of the load; the equipment and method used to handle the load; and the methods of forming (or building) and breaking down the load. For in-process handling, unit loads should not be larger than the production batch size of parts in process. Large production batches (used to increase the utilization of bottleneck activities) can be split into smaller *transfer batches* for handling purposes, where each transfer batch contains one or more unit loads, and small unit loads can be combined into a larger transfer batch to allow more efficient transport.

c) Distribution

Selecting a unit load size for distribution can be difficult because containers/pallets are usually available only in standard sizes and configurations; truck trailers, rail boxcars, and airplane cargo bays are limited in width, length, and height; and the number of feasible container/pallet sizes for a load may be limited due to the existing warehouse layout and storage rack configurations and customer package/carton size and retail store shelf restrictions. Also, the practical size of a unit load may be limited by the equipment and aisle space available and the need for safe material handling

The selection of material handling equipment's depends upon the followings:

(i) Nature of product and its portability.

(ii) Value of production.

(iii) Shape and size of products.

(iv) Methods of production.

(v) Sequence of operations.

(vi) The production rate of the industrial unit.

(vii) Space availability and type of layout used.

(viii) Distance to be covered by the material.

(ix) Power availability.

The various requisites of material handling equipment's are as follows:

(i) It must be able to perform the basic function of material handling like storage and transportation.

(ii) It must facilitate production planning, inspection and process control activities.

(iii) It should be able to reduce the work cycle time i.e. minimizing the unproductive material handling time.

(iv) It should improve the capacity utilization of plant.

(v) It should minimize the work in process or the total inventory requirements.

(vi) It should be able to reduce the workers mutual and physical fatigue. This factor will ultimately improve satisfaction and safety level of workers.