BASICS IN SUPPLY CHAIN MANAGEMENT

INTRODUCTION

Operations Management works in a complex environment affected by many factors

a. Government
b. Economy
c. Competition
d. Customers
e. Quality

Order Qualifiers

Generally a supplier must need the set minimum requirements to be considered a viable competitor in the market place. Customer requirements may be based on price, quality and delivery and hence so forth is called Order Qualifiers.

One should recognize that the order winners and qualifiers for any product or market combination are not static.

Life Cycle of most products

The life cycle of most products can be broadly classified into the following

a. Introduction - Design and Availability are more important
b. Growth Maturity - Quality and Delivery are important for growing products
   Price and Delivery are often the order winners for mature products.
c. Decline

Manufacturing Strategies

Customers want delivery lead-time to be as short as possible and manufacturing must design a strategy to achieve this. There are **four manufacturing strategies**, which help in achieving this.

a. Engineer to Order
b. Make to Order
c. Assemble to Order
d. Make to Stock

Key elements of Supply Chain

a. Supply
b. Production
c. Distribution

The Just in Time concept (JIT) was developed by Toyota and other Japanese companies in the year 1970.

One of the more important elements in Supply Chain is Partnerships. As partnership grew, there were many changes in relationship including

a. Mutual Analysis for Cost Reduction
b. Mutual Product Design
c. Paper Based Systems gave way to Electronic Data Interchange and informal Communication Methods.

3 Critical issues that should be managed as an extension of partnership

a. Flow of materials
b. Flow of Information Technology
c. Flow of information electronically
d. Fund Transfers

To get the most profit, a company must have atleast 4 main objectives

a. Provide best customer service
b. Provide lowest production costs
c. Provide lowest Inventory Investment
d. Provide lowest Distribution Costs

Current Supply Chain Concept

Companies currently adopting the Supply Chain Concept view the entire set of activities from raw material production to final customer purchase as a linked chain of activities.

Various **Activities in Physical Supply Chain/ Distribution**

a. Transportation
b. Distribution Inventory
c. Warehousing
d. Packaging
e. Materials Handling
f. Order Entry

Supply Chain Metrics

A metric is a verifiable measure stated in either quantitative or qualitative terms defined with respect to a Reference Point.

What does Metric give us?

a. Control by Superiors
b. Reporting of data to supervisors and external groups
c. Communication
d. Learning
e. Improvement

Major Changes in day – today's production

a. Customers that are never satisfied
b. A supply chain that must be large and must be managed
c. A product life cycle getting shorter and shorter
d. A vast amount of data
e. An emphasis on profit margins that are more squeezed
f. An Increasing number of alternatives

Performance Standards

Transforming company policies into objectives and specific goals create performance standards

Materials Management

The Concept of having one department responsible for the flow of materials from supplier through production to consumer, thus minimizing total costs and providing a better level of customer service is termed as **Materials Management**.

Other names include **Distribution Planning** and **Control and Logistics Management**.

Main Objective of Materials Management

a. The main objective is to be able to deliver what customers want, when and where they want it and do so at a minimum cost.
b. The main concern of Materials Management is to balance between Priority and Capacity.

Other Objectives of Materials Management

a. Maximize use of firms resources
b. Provide required level of Customer Service

5 Basic Inputs for **Manufacturing Planning and Control Systems**

a. Product Description
b. Process Specifications
c. Time needed to perform operations
d. Available facilities
e. Quantities Required

Primary Activities for Manufacturing Planning and Control

a. Production Planning
b. Implementation and Control
c. Inventory Management

Priorities for Production Planning

a. Forecasting
b. Master Planning
c. Materials Requirements Planning
d. Capacity Planning

Methods of **describing the product**

a. Engineering Drawings
b. Specifications
c. Bill Of Materials – Describes Components used to make the product. Also describes the sub Assemblies of various stages of manufacture.

PRODUCTION PLANNING SYSTEM

A **good planning system** must answer 4 questions

a. what are we going to make
b. what does it take to make it
c. What do we have
d. What do we need

5 major levels in the Manufacturing Planning and Control Systems

a. Strategic Business Plan
b. Production Plan
c. Master Production Schedule
d. Materials Requirements Plan
e. Purchasing and Production Activity Control

Each level is for a different time span and for different purposes. Each differs in the following

a. Purpose of plan
b. Planning horizon
c. Level Of Detail
d. Planning Cycle

At each level 3 questions must be answered

a. What are the priorities
b. What is the available capacity
c. How can differences between Priorities and Capacity be resolved.

Strategic Business Plan: (Reviewed every 6 months to One year)

- Statement of Major goals and objectives the company expects to achieve over the next 2 to 10 years
- It is a statement of broad direction of the firm and shows the kind of business
- Development of strategic business plan is the responsibility of Senior Management.
- The Strategic Business Plan is updated annually and SOP is updated atleast monthly.

Production Plan: (The level of details is not high)

The production plan is more concerned with the following details

a. Quantities of each product group that must be produced in each period.
b. Desired Inventory Levels
c. Resources of equipment, labor and material needed in each period.
d. Availability of resources needed.
e. Planning Horizon of each Supply Chain is from 6 to 18 months and is perhaps reviewed each month or quarter.

Master Production Schedule

- This is a **plan for the production of Individual end Items**
- The term Master Scheduling is the process of developing a Master Production Schedule.
- **Master Production Schedule is the End result** of this process.

- Forecast of individual end items, sales orders and existing capacity.

Material Requirements Plan is a plan for production and purchase of the components used in making the items in the master production schedule.

Purchasing and Production Activity Plan

- Represent the implementation and control phase of Production Planning and Control System.
- Purchasing is responsible for establishing and controlling the flow of raw materials into the factory
- Production activity control is responsible for planning and controlling the flow of work through the factory.

Capacity Management

The basic process is one of calculating the capacity needed to manufacture the priority plan and finding methods to make that capacity available.

Sales and Operation Planning (SOP)

This is a process for continually revising the strategic business plan and co-ordinating plans of various departments

Sales and Operation Planning benefits

- Provides a means of **updating the strategic business plan** as conditions change
- Provides a mean of managing change
- Planning ensures the various department plans are realistic, coordinated and support the business plan.
- It **provides a realistic plan** that can achieve the company objectives
- Permits better management of production, inventory and backlog.

Manufacturing Resource Planning (MRP II)

a. **Strategic business plan incorporates the plans of marketing, finance and production**
b. Thus, **a fully integrated planning and control system is called Manufacturing Resource Planning or MRP II System**. This phrase MRP II is used to distinguish from Materials Requirement Planning
c. MRP II is a **method for effective planning** of all resources of a manufacturing company.
d. MRP II **provides co-ordination between marketing and production**
e. Order sizes may need to be changed, cancelled and delivery dates adjusted. This kind of change is done in the Master Production Schedule
f. Marketing and Production managers can change the Master Production Schedule.

Enterprise Resource Planning

As MRP Systems evolved, they tended to take the advantage of two changing conditions

a. Computers and Information Technologies becoming significantly faster, more reliable and more powerful.
b. Movement toward integration of knowledge and decision making in all aspects of direct and indirect functions and areas that impact materials flow and materials management.

- As MRP and MRP II systems became both larger in scope and integration, it was given a new name – **Enterprise Resource Planning**.
- **Difference between MRP and ERP** is that MRP takes into account only manufacturing while ERP takes the entire enterprise into account.
- **The APICS Dictionary defines ERP as**: An accounting oriented information systems for identifying and planning the enterprise wide resources needed to make, ship and account for customer orders.
- The larger scope of ERP systems allows the tracking of orders and other important planning and control information through out the entire company from procurement to ultimate customer delivery.

Making the Production Plan

The **prime purpose** of production plan is to **establish production rates** that will accomplish the objectives of the strategic business plan.

Basic Steps for Production Plan

a. Establish product groups
b. Basic Strategies
c. Developing a make to stock production plan
d. Developing a make to order production plan

In a manufacturing process, the following can be varied.

A. People can be hired and laid off, overtime and short time can be worked and shifts can be added or removed
B. Inventory can be built up in slack periods and sold or used in periods of high demand
C. Work can be sub-contracted or extra equipment leased.

Basic Strategies

The production planning problem typically has the following characteristics

A. A **time horizon** of 12 months is used, with periodic updating perhaps every month or quarter
B. Production Demand consists of one or a few product families or common units
C. Demand is fluctuating or seasonal
D. Plant and equipment are fixed within the time horizon
E. A variety of management objectives such as low inventories, efficient plant operation, good customer service and good labor relations

3 Basic strategies that can be used **in developing a production plan**

A. Chase Strategy
B. Production Leveling
C. Sub Contracting

Chase Strategy

Produce when there is a demand. Eg. Farmers, Hotels, Restaurants, Post Offices

Adv: Inventories can be kept to a minimum.
Goods are made when demand occurs and are not stock piled.

Production Leveling

Continually producing an amount equal to the average demand.

Adv:

a. It results in smooth level of operation that avoids the costs of changing production levels.
b. Build a stable workforce

DisAdv:

a. Sometimes demand is less and the inventory runs out
b. Other times demand is more and inventory runs out

Sub Contracting

a. As a pure strategy, sub contracting means always producing at the level of minimum demand and meeting any additional demand through sub contracting.
b. Sub contracting can mean buying the extra amounts demanded or turning away the extra demand.

Adv: Costs associated with the excess capacity are avoided and because production is leveled, there are no costs associated with changing production levels.

DisAdv: Cost of purchasing may be greater than if the item were made in the plant.

Developing a make to stock production plan

Products are made and out into inventory before an order is received from the customer. Eg. Clothes, Frozen goods and bicycles.

Steps needed to make a **make-to-stock production plan**

a. Total the forecast demand for the planning horizon
b. Determine the opening and ending inventory
c. Calculate the total production required as follows
   Total prod = total forecast + back orders + ending inventory – opening inventory
d. calculate production required for each period by dividing total production by the number of periods
e. Calculate the ending inventory for each period.

Generally firms **make to stock** when

a. Demand is fairly constant and predictable
b. There are a few product options
c. Delivery times demanded by the market place are much shorter than the time needed to make the product.
d. Product has a long shell life

Information needed to make a production plan as follows

a. Forecast by period for planning horizon
b. Opening Inventory
c. Desired Ending Inventory
d. Any past due customer orders also called **back orders**

Level Production plan

Developing a **make to order production plan**

Generally firms **make to order** when

a. Goods are produced to customer specification
b. The customer is willing to wait while the order is being used
c. The product is expensive to make and store
d. Several product options are offered.

Various Strategies

a. Assemble to order – Automobiles and Computers
b. Backlog
c. Level Production Plan

Following information is needed to make **a production plan for make to order products**

a. Forecast period by planning horizon
b. Opening backlog for customer orders
c. Desired Ending backlog

Resource Planning

Once the preliminary production plan is established, it must be compared to the existing resources in the company. This is called resource planning

2 Questions must be answered.

a. Are resources available to meet the production plan
b. If not, how will the difference be reconciled?

If enough capacity to meet the production plan cannot be made available, the plan must be changed. A tool often used is the **Resource Bill.**

The Resource Bill shows the quantity of critical resources needed to make one average unit of product group.

MASTER SCHEDULING

The Master Production Schedule is a vital link in the production planning system

a. Forms link between production planning and what manufacturing will actually build
b. Forms the basis for calculating the capacity and resources needed
c. The MPS drives the materials requirement plan. As a schedule of items to be built, the MPS and bills of Material determine what components are needed from manufacturing and purchasing
d. It keeps priorities valid. The MPS is a priority plan for manufacturing

- Production Plan deals with families of products. The **MPS is a plan for Manufacturing**.
- **MPS works with end items**
- **MPS drives the Materials Requirements Plan**

MPS forms a vital link between sales and production as follows

a. It makes the possible valid order promises. The MPS is a plan of what is to be produced and when. As such it tells sales and manufacturing when goods will be available for delivery.
b. It is a **contract between marketing and manufacturing**.

Information needed to develop an MPS is provided by

a. Production Plan
b. Forecasts for individual items
c. Actual orders received from customers and for stock replenishment
d. Inventory levels for individual end items
e. Capacity restraints

The MPS is a device for communication and a basis to make changes that are consistent with the demands of the market place and capacity of manufacturing.

Objectives in developing an MPS are as follows:

a. To maintain the desired level of customer service by maintaining finished goods inventory levels or by scheduling to meet customer delivery requirements
b. To make the best use of material, labor and equipment.
c. To maintain inventory investment at the required levels.

3 **Steps in preparing an MPS**

a. Develop the preliminary MPS
b. Check the preliminary MPS against available capacity
c. Resolve the differences between the preliminary MPS and capacity availability

Rough Cut Capacity Planning

- Checks whether the critical resources are available to support the preliminary Master Production Schedules
- Critical Resources include bottleneck operations, labor and critical materials
- Process similar to resource requirements planning used in the production planning purpose. The difference is that now we are working with a product and not a family of products

Finally MPS must be judged against 3 criteria

- **Resource Use**: Is the MPS within the capacity restraints in each period of the plan? Does it make the best use of resources?
- **Customer Service**: Will due dates be met and will delivery performance be acceptable?
- **Cost**: Is the plan economical or will excess costs be incurred for overtime, sub contracting, expediting or transportation.

Master Schedule Decisions

MPS schedule should take place in each of the following where the smallest number of product options exists.

a. Make – to – order Products: MPS is usually a schedule of finished good items.
b. Make – to – order products: MPS is usually a schedule of actual customer orders
c. Assemble – to – order products: Different colors added to form another color.

Engineer to Order is a form of Make to Order

- Product Designed before manufacturing based on customer's very special needs. Eg. Bridge

Planning Horizon

This is the time span for which plans are made. It must cover a period of atleast equal to the time required to accomplish the plan.

- **For MPS, the minimum planning horizon is the longest cumulative or end to end lead time**

Production Planning, Master Scheduling and Sales

- The MPS is a plan for what production can and will do
- The MPS is a plan for specific end items or buildable components that manufacturing expects to make over some time in the future.

Available to Promise (ATP) is that portion of a firm's inventory and planned production that is not already committed and is available to the customer. This allows delivery promises to be made and customer orders and deliveries to be scheduled correctly.

Scheduled Receipt (SR) is an order that has been issued either to manufacturing or to a supplier.

Projected Available Balance (PAB) is calculated in one of the two ways, depending on whether the period is before or after the **demand time fence.**

a. **Demand time fence** is the number of periods, beginning with period 1 in which changes are not expected due to excessive cost caused by schedule description.

For periods before demand time fence it is calculated as
PAM = prior period PAB or on-hand balance + MPS – Customer Orders

This process ignores the forecast and assumes the only effect will be from customer orders.

b. For periods after the demand time fence, forecast will influence the PAB, so it is calculated using the greater of the forecast or customer orders.

PAB = prior period PAB + MPS – greater of customer order of forecast.

MPS establishes a schedule (Priority Plan) showing the components required at each level of the assembly and based on lead times, calculates the time when these components will be needed.

MATERIALS REQUIREMENT PLANNING

The MRP is the system used to supply the missing parts. There are **two types of demand**

a. Dependent Demand
b. Independent Demand

Dependencies are of two types

a. Horizontal Dependency : Dependency of components among each other is termed as horizontal demand
b. Vertical Dependency: Dependency of a component on its parent is vertical.

The major building blocks of material requirement planning is called Bills of Material

Objectives of MRP

There are **two main objectives**:

a. Determine requirements
b. Keep priorities current

Determine Requirements

a. The main objective of any manufacturing planning and control system is to have the right materials in the right quantities available at the right time to meet the demand for the firm's products
b. Objective of MRP is to determine what components are needed to meet the master production and based on lead time, to calculate the periods. When the components must be available, it must determine the following.
    a. What to order
    b. How much to order
    c. When to order
    d. When to schedule delivery

Capacity Requirements Planning

The MPS drives the MRP. The MRP is a priority plan for the components needed to make the products in the MPS. The plan is valid only if capacity is available. When needed to make the components and the plan must be checked against available capacity. The process of doing so is called Capacity Requirements Planning.

Bill of Material Processor

The computer software program that organizes and maintains the bills of material structures and their linkages is called **Bill of Material Processor**.

Inputs to Material Requirement Planning System

3 **inputs to MRP** systems

A. Master Production Schedule
B. Inventory Records
C. Bills Of Material

The MRP system needs to know how much is available, how much is allocated and how much is available for future demand. These data are maintained in the **Inventory Record File or Part Master File or Item Master File.**

For **Inventory Records**, two types of information are necessary

a. **Planning Factor** – Includes items such as Order Quantities, lead times, safety Stock and Scrap.
b. Status of Each item

APICS defines a BOM as a listing of all sub assemblies, intermediates, parts and raw material that go into making the parent assemble showing the quantities of each required to make the assembly.

Important formats of bills

a. **Product Tree** – Normally used to testing and teaching

b. **Parent Component Relationship** – An assembly is considered a parent and the items that comprise it are called its component items

c. **Multilevel Bills** – Are formed as logical groupings of parts info sub-assemblies based on the way the product is assembled.

    a. One convention used in multilevel bills of material is that the cost items on the tree are always purchased items.
    b. Top level or end product level is the level zero and its components are at level one.

d. **Multiple Bill** – Used when companies usually make more than one product and the same components are often used in several products.

    ### Advantages of Single Level Bills

    a. Contain only the parent and its immediate components
    b. Duplication of records is avoided.
    c. Number of records and in computer systems, the file size is reduced by avoiding duplication of records.
    d. Maintaining bills of material is simplified.

e.

f. **Indented Bill** – Bills that use indentation as a way of identifying parents from components.

g. Planning Bill

a. Planning Bills are an artificial grouping of components for planning purposes.
b. Used to simplify forecasting, production scheduling and materials requirement planning.

g. **Summarized Parts lists**, lists all the parts needed to make one complete assembly.

Where used and pegging: (Difference between BOM and WUP)

Where used report gives the same information as a bill of material but this gives the parents for a component whereas the bull gives the components of a parent.

Pegging Report

a. A Pegging Report is **similar to a where used report**
b. A Pegging Report shows **only those parents for which there is an existing requirement** whereas **the where used report shows all the parents for a report**.
c. The **Pegging Report shows the parents creating the demand for the components**, the quantities needed and when they are needed.

Uses of **BOM**

a. Product Definition
b. Engineering Change
c. Service Parts
d. Planning
e. Order Entry
f. Manufacturing
g. Costing.

Materials Requirements and Planning Process

a. Purpose of Material Requirements planning is to determine the components needed, quantities and due dates, so items in the master production schedule are made on time.

b. Basic MRP Techniques
   a. Exploding and Offsetting
   b. Gross and Net Requirements
   c. Releasing Orders
   d. Low Level coding and netting

Exploding and Offsetting

Lead Time: is the span of time needed to perform a process. In manufacturing, it includes the time for
   a. Order Preparation
   b. Queuing
   c. Processing
   d. Moving
   e. Receiving and Inspecting
   f. Any Expected Delays

Exploding is the process of multiplying the requirements by the usage quantity and recording the appropriate requirements through out the product tree.

Offsetting is the process of placing the exploded requirements in their proper periods based on lead time.

Planned Order

a. It is the responsibility of the material planner to release planned orders
b. Releasing an order means that authorization is given to purchasing to buy the necessary material or to manufacturing to make the component
c. When authorization to purchase or manufacture is released, the planned order receipt is cancelled and a scheduled receipt is created in its place.

Scheduled Receipts are orders placed on manufacturing or on a vendor and represent a commitment to make or buy.

Open Orders: Scheduled receipts on the MRP record are Open Orders on the factory or a vendor and are the responsibility of purchasing and of production activity control

On Hand Inventory: When goods are received into inventory and available for use, the order is closed out and the scheduled receipt disappears to become part of on hand inventory.

Basic MRP Record: Several points that are important in a MRP records are

A. The current time is the beginning of the first period
B. The top row shows periods called time buckets
C. The number of periods in the record is called planning horizon, which shows the number of future periods for which plans are being made.
D. It should be atleast as long as the cumulative product lead time.
E. Quantity shown in the projected on hand row is the projected on hand balance at the end of the project
F. The immediate or most current period is called the ACTION BUCKETS. A quantity in the action bucked means that some action is needed now to avoid a future problem.

Capacity Requirement Planning

The MRP priority plan must be checked against available capacity. At the MRP planning level, the process is called CRP.

Low Level Coding and Netting

Low Level Code is the lowest level on which a part resides in all bills of material. Also every part has only one low level code.

Planned Orders are automatically scheduled and controlled by the computer.

Responsibility of Planner

Releasing or launching, a planned order is the responsibility of the planner. When released, an order becomes an open order to the factory or purchasing and appears on the MRP record as a scheduled receipt.

Exception Messages

A good MRP system generates exception messages to advise the planner when some event needs attention.

Egs of Exception Messages are

A. Components for which planned orders are in the action bucket and which should be considered for release.
B. Open orders for which the timing or quantity of scheduled receipts does not satisfy the plan. Perhaps a scheduled receipt is timed to arrive too early or late and its due date should be revised.
C. Situations in which the standard lead times will result in late delivery of a zero level part. This situation might call for expediting to reduce the standard lead times.

Transaction Messages mean that planner must tell the MRP software of all actions taken that will influence the MRP records.
Eg. Planner releases an order, when a scheduled receipt is received or when any change to the data occurs.

Managing the MRP

Planners receive feedback from many resources such as

a. Suppliers action through purchasing
b. Changes to open orders in the factory such as early or late completions or different quantities
c. Management action such as changing the master production schedule

Planner must consider two important factors in managing the materials requirements plan

a. Priority
b. Bottom Up Re-planning
c. Reduce system nervousness. To reduce system nervousness, firm the planned orders.

At each level, manufacturing develops the priority plans to satisfy demand. However, without the resources, to achieve the priority plan, plan will be unworkable. **Capacity Management** is concerned with supplying the necessary resources.

CAPACITY MANAGEMENT

Capacity can be defined as the amount of work that can be done in a specified time period.

APICS defines Capacity as the capability of a worker, machine, work center, plan or organization to produce output per period of time.

Capacity is the rate of doing work, not the quality of work done.

2 kinds of capacity are important

a. Capacity Available
b. Capacity Required

Capacity Available is the rate at which work can be withdrawn from the system.

Capacity Management

APICS defines Capacity Management as the function of establishing, measuring, monitoring and adjusting limits of levels of capacity in order to execute all manufacturing schedules.

Capacity Control

Process of monitoring production output comparing it with capacity plans and taking corrective action when needed.

Capacity Planning

A. Process of determining the resources required to meet the priority plan and methods needed to make that capacity available.
B. Involves calculating the capacity needed to achieve the priority plan and finding ways to making that capacity available.

Process of capacity planning is as follows

C. Determine the capacity available at each work center in each time period.
D. Determine the load at each work center in each time period.
    i. Translate the priority plan into the hours of work required at each work center in each time period
    ii. Sum up the capacities required for each item on each work center to determine the load on each work center in each time period.
E. Resolve differences between available capacity and required capacity.

Planning Levels

a. Resource Planning
b. Rough Cut Capacity Planning
c. Capacity Requirements Planning

Resource Planning

a. Involves long range capacity resource requirements and is directly linked to production planning.
b. Involves translating monthly, quarterly, annual product priorities from the production plan into some total measure of capacity.

Rough Cut Capacity Planning

Takes capacity planning to the next level of detail. The master production schedule is the primary information source. Purpose of rough cut capacity planning schedule is the primary information source. Purpose of rough cut capacity planning is to check the feasibility of MPS, provide warnings of any bottlenecks, ensure utilization of work centers and advise vendors of capacity requirements.

Capacity Requirements Planning

a. Proportional to material requirements plan
b. Focuses on component parts
c. Concerned with individual orders at the individual work centers and calculate work center loads and labour requirements for each time period at each work center.

d. Occurs at the level of MRP
e. Process of determining in detail the amount of labor and machine resources needed to achieve required production
f. Capacity Planning is the most detailed, complete and accurate of the capacity and planning techniques.

Inputs for CRP are the open orders, planned order releases, routings, time standards, lead times and work center capacities.

The above information can be obtained from the following

Open Order file
Materials Requirements Plan
Routing File
Work Center file

Open Order File

Open shop orders appear as scheduled receipt on the material requirements plan
Open order file is a released order for a quantity of a part to be manufactured and completed on a specified date.
Shows all relevant information such as quantities, due dates, operations
Is a record of all active shop orders.

Planned Order Releases is determined by the computer's MRP logic system

Routing File

is the path that work follows from work center to work center as it is completed and is kept in a computer based system, in a Route File
A routing file should exist for every component manufactured and contain the following information
Operations to be performed
Sequence of operations
Work Centers to be used
Possible alternate work centers
Tooling needed at each operation
Standard times: Setup times and Run times per piece

Work Center File

Work Center is composed of a number of machines or workers capable of doing the same work
Egs. Several sewing machines of similar capacity could be considered at a work center
Work Center File contains information on the capacity and move, wait and queue times associated with the center.

Move Time – Time normally taken to move material from one workstation to another
Wait Time – is the time a job at a work center after completion and before being moved
Queue Time – is the time a job waits at a work center before being handled
Lead time – is the sum of queue, setup, run, wait and move times

Capacity Available

Capacity Available is affected by the following

a. Product Specifications
b. Product mix
c. Plant Equipment
d. Work Effort

Measuring Capacity

A. Units of Output
   In case of a variety of products being made at the same center, the unit common to all products will change
B. Standard Time
   The time it would take a qualified operator working at a normal pace to do the job

Levels of capacity

Capacity needs to be measured on atleast 3 levels

a. Machine or individual worker
b. Work Center
c. Plant, which can be considered as a group of different work centers

Determining capacity available

2 ways of determining the capacity available

a. Demonstrated Capacity is figured from historical data
b. Calculated or rated capacity is based on available time, utilization and efficiency

Rated Capacity

Rated or Calculated, capacity is the product of available time utilization or efficiency

Available Time – is the number of hours a work center can be used.

Utilization – Percentage of time that the work center is active compared to the available time is called Work Utilization

Utilization = (Hours actually worked/ Available hours) * 100
Efficiency = (Actual rate of production/ Standard rate of production) * 100
Rated Capacity = Available time * utilization * efficiency
Demonstrated Capacity = Total History/ Number of histories

Capacity Required

Determining capacity required is a two step process

Determine the time needed for each order at each work center
Sum up the capacity required for individual orders to obtain the load

Actual Time = Capacity Required/ Efficient Utilization

Load

- on work center is the sum of all required times for all the planned and actual orders to be run on the work center in a specified period
- Steps in calculating load are as follows
    - Determine the standard hours of operation time for each planned and released order for each work center by the time period
    - Add all the standard hours together for each work center in each period. The result is the total required capacity on that work center for each time period of the plan

Work Center Load Report

Shows future capacity requirements based on released and planned orders for each time period of the plan

Scheduling orders

- Most orders are processed across a number of work centers and it is necessary to calculate when orders must be started and completed on each work center, so the final due date can be met. This process is called **Scheduling.**
- APICS defines scheduling as " **A TIME TABLE FOR PLANNED OCCURENCES**"

Back Scheduling

- The usual process is to start with the due date and using the lead times to work back to find the start date for each operation. This is called **Back Scheduling**
- To schedule we need to know for each order
    - Quantity and Due Date
    - Sequence of operations and work centers needed
    - Setup and runtimes needed for each operation
    - Q, Wait and Move times
    - Work Center Capacity available

The information needed is obtained from the following

- **Order file** – Quantities and Due Dates
- **Route File** – Sequence of operations, work centers needed, setup time and run time
- **Work Center File** – Q, Move and Wait times and work center capacity

Process

a. For each work order, calculate the capacity required at each work center
b. Starting with due date, schedule back to get completion and start dates for each operation

2 ways of balancing capacity available and load

a. Alter the load
b. Change capacity available

Changing the load may not be the preferred course of action. In the short run, capacity can be changed

Some ways that the **balancing** can be done are as follows

a. Schedule overtime/ under time
b. Adjust the level of work force by hiring or laying off workers
c. Shift workforce from under loaded to overloaded work centers
d. Use alternate routings to shift some load to another work center
e. Sub contract work when more capacity is needed or bring in previously subcontracted work to increase required capacity.

PRODUCTION ACTIVITY CONTROL

Production Activity control is responsible for executing the master production schedule and Material Requirements Plan.

The **Material Requirements Plan authorizes PAC to**

a. Release work orders to shop for manufacturing
b. Control the work orders and make sure it completes on time
c. Responsible for immediate detailed planning of work orders, through manufacturing, carrying out the plan and control the work as it progresses to completion
d. To manage day to day activity and provide the necessary support

Activities of PAC

a. Planning
b. Implementation
c. Control Functions

Planning

PAC must do the following

A. Ensure that the required materials, tooling, personnel and information are available to manufacture the required shop orders.
B. Estimate start and end scheduled dates for each shop order at each work center so that the scheduled completion date can be met.

Implementation

PAC will

A. Gather information required by the shop floor to make the product
B. Release orders to the shop floor as authorized by MRP. This is called **Dispatching**

Control

The PAC should do the following

a. Rank the shop orders in order of priority, sequence by work centers and create a dispatch list based in this information
b. Tract the actual performance of work centers against the scheduled plan and take corrective actions by replanning, rescheduling and adjusting capacity to meet final delivery.
c. Monitor and control work in process, lead time and work center Q's
d. Calculate the work center efficiency, operation times, order quantities and scrap.

Manufacturing processes can be broken down into 3 categories

a. Flow Manufacturing
b. Intermittent Manufacturing
c. Project Manufacturing

Flow Manufacturing

A. For discrete items, the engineering is called **Repetitive Engineering** or **Flow Manufacturing**
B. Flow Manufacturing is concerned with the production of high volume standard products.
C. And if goods are produced in a continuous manner, it is called **Continuous engineering**.

4 major Characteristics of Flow Manufacturing

A. Routing are fixed, work centers are arranged as per routing. Time taken to perform at each work center is the same as other work center.
B. Work Centers are dedicated to produce a fixed range of similar products, machinery and tooling are especially designed to produce specific products.
C. Material flows from one work center to another using some form of mechanical transfer
D. Capacity is fixed for the line

Intermittent Manufacturing

This type of manufacturing is usually followed for a variety of products/ variations in a product range and order quantities.

This kind of **manufacturing is characterized** by the following

a. Flow of work through the shop is varied and depends on the design of the product. Work at one workstation may take longer than work at another workstation. Thus workflow is not balanced.
b. Machinery and resources should be flexible enough to do varied types of work. Machinery is usually grouped for similar kinds of function they perform.
c. Throughput times are generally long. Scheduling work as it arrives when needed is difficult. The time taken at each work center varies and work, queues before work centers causing long delays in production. Work in Process inventory is often large.
d. Capacity of line differs and depends on particular mix of products being built and is difficult to predict.

Project Manufacturing

Involves creation of one or more small number of units

Data Requirements

a. What and how to produce
b. When are the parts needed so that the completion date can be met
c. What operations are required to make the parts and how long will the operations take
d. What the available capacities of work centers are

Files contained in databases to answer such questions are of two types

a. Planning
b. Control

Planning Files

A. planning files are needed
B. Item Master File
C. Product Structure File
D. Routing File
E. Work Center Master File

Control Files

a. Shop order Master File
b. Shop order Detail file

Order Preparation

a. Once authorization to process an order has been received, production activity control is responsible for preparing and planning its release to the shop floor
b. Tooling generally not considered in MRP, so material availability must be checked. The various types of tooling used at this stage is
    a. MRP
    b. If MRP is not available, then PAC should check capacity manually
    c. Capacity Requirements Planning

Checking **Capacity Availability** is a two step process

a. Order must be scheduled to see when capacity is needed
b. Load on work centers must be checked in that period

Objective of Scheduling – is to meet the required deadline to effectively use manufacturing resources.

To develop an **effective schedule**, the planner must have

a. Routing Information
b. Capacity Required and available Capacity
c. Manufacturing Lead Times

Manufacturing Lead Times (MLD)

Is the time normally required to produce an item in a typical lot quantity. It consists of 5 elements

a. Q time – Largest of 5 elements (85% - 95% of the total lead time)
b. Setup Time
c. Run Time
d. Wait Time
e. Transit Time

PAC – responsible for managing the Q by regulating the flow of work at work into and out of work centers.

Cycle Time OR Throughput time– The length of time taken from when material enters a production facility until it exits.

Scheduling Techniques

a. Forward Scheduling
b. Backward Scheduling

Operation Overlapping

Adv:

a. Reduces the total manufacturing lead times.
b. If the operations are well planned, there will be no idle time

DisAdv:

a. Move costs are increased if overlapping operations are not close to each other
b. May increase Q and lead times for other orders
c. Does not increase capacity but potentially reduces it, if the 2nd operation is idle waiting for parts from the 1st operation.

Operation Splitting

Is the 2nd method of reducing manufacturing lead time. The order is split into two or more parts and is run on two or more machines.

Operation Splitting is practical when

a. A suitable work center is idle
b. Setup time is less than manufacturing run time
c. It is possible for an operator to run 2 or more machines at the same time

Scheduling bottlenecks

In intermittent engineering, it is impossible to balance the demand capacity against the available capacity. Hence some work centers are overloaded and some under loaded. The overloaded ones are termed as **BOTTLENECKS.**

APICS defines bottlenecks as “a facility function, department or resource whose capacity is equal to or less than the demand placed on it.

Some Bottleneck Principles

a. 100% usage of non bottleneck resource does not effectively produce 100% utilization
b. The usage of a non bottleneck resource is not determined by its capacity but by some constraint on the system
c. Time saved by a non – bottleneck resource saves the system nothing
d. Load must be split
e. Capacity of a system depends on the bottleneck
f. Capacity and priority should be considered together
g. Focus should be on balancing the flow through the shop

Managing Bottlenecks

a. Establish a time buffer before the bottleneck
b. Control the rate of material feeding for each bottleneck
c. Do everything to provide the needed bottleneck capacity
d. Adjust the loads
e. Change the schedule

Gate Operation

A bottleneck must be fed at a rate equal to its capacity, so the time buffer remains constant. The first operation in this sequence of operations is called the GATE operation. This operation controls the work feeding the bottleneck and must operate at a rate equal to the output of the bottleneck, so that the time buffer Q is maintained.

Theory of Constraints

a. Manage the Constraint
b. Improve the process
    a. Identify the constraint
    b. Exploit the constraint
    c. Subordinate everything to the constraint
    d. Elevate the constraint
    e. Once the constraint is a constraint no longer, identify a new constraint and repeat all the steps.

Drum Buffer Rope Approach was developed by Theory of Constraints

Drum: The Drum refers to the drumbeat or pace of production, represents master schedule for the operation, which is focused around the pace or throughput defined by the constraint

Buffer: Since it is so important that the constraint never be "starved" for needed inventory, a "time" buffer is often established in front of the constraint

Rope: The rope pulls production to the constraint for necessary processing. While this may imply a Kanban Type pull system, it can be done well by a well coordinated release of material into the system at the right time

Control

To control Q's and meet delivery requirements, PAC must

a. Control the going in and coming out of each workcenter. This is called I/O control
b. Set the priorities for each workcenter.

I/O Report – To control I/O, a plan must be derived along with a method for comparing what actually occurs against what was planned.

Cumulative Variance = Previous Cumulative Variance + actual – planned

Cumulative Variance is the difference between the total planned for a given period and the actual hold for the period.

Backlog is same as Q and expresses the work to be done in hours.

Planned Backlog = Previous backlog + planned i/p – planned o/p

Operations Sequencing

APICS dictionary defines Operations Sequencing as a technique for short term planning of actual jobs to be run on each work center based on priority and capacity.

Dispatching is a function of selecting and sequencing available jobs to be run at individual work centers.

A **Dispatch Report** consists of the listing by operation of all jobs available to be run at a work center with job listed in Priority Control. It normally includes

a. Plant, Department and Work Center
b. Shop Order number, Part Number, Operation Number, Operation Description
c. Standard Hours
d. Priority by information
e. Jobs coming to Work Center

Dispatching Rules

Five rules are available

a. First Come First Serve (FCFS)
b. EDD
c. ODD
d. SPT
e. Critical Ratio

Critical Ratio is an index of relative priority of an order to other orders at a work center.

CR = (Due Date – Present Date)/ lead time remaining
= Actual Time Remaining/ Lead Time Remaining

Production reporting provides feedback of what is actually happening on the plant floor. It allows the PAC to maintain on hand records of

a. On hand Balances
b. Job Status
c. Shortages
d. Scrap
e. Material Shortages

PAC needs these information for establishing priorities and answer question by deliveries, shortages and status of orders.

Types of information needed for various reports include

a. Order Status
b. Weekly I/O by department or work center
c. Exception Reports on such things as scrap, rework and late shop orders
d. Inventory Status
e. Performance summarizes on order status, work center and department efficiencies.

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