Department of Mechanical Engineering

Production Planning & Control

UNIT-I
PRODUCTION PLANNING AND CONTROL

What is ppc?

***"The highest efficiency in production is obtained by manufacturing the required quality of product , of required quantity ,at the required time by the best and cheapest** method" -*

Hence, **PPC is a tool to coordinate all manufacturing activities in a production system.**

Objectives

The main objectives of PPC may be summarized as followings:-

a) It is used to establish target and check the deviations by comparing on some performance measures.
b) Decides the nature and magnitude of different input factors to produce the output.
c) Coordinates different resources of production system in the most effective and economic manner and to coordinate among different departments.
d) Elimination of bottleneck
e) Utilization of inventory in the optimal way.
f) Smooth flow of material.
g) To produce in right quantity and quality at right time.
h) Scheduling production activities to meet delivery schedule
i) Expediting the system under production
j) To ensure flexibility in production system to accommodate changes and uncertainty
k) Optimizes the use of resources for minimum overall production cost
l) To ensure the production of right product at right time in right quantity with specification rightly suited to customers
m) Stable production system, with least chaos, confusion and undue hurry.

Production

production refers to the transformation of inputs into finished goods/ or creation of services in order to satisfy the customer needs. This uses different inputs mainly including 6M's namely, man, material, machine, money, method and management. Production involves application of processes by which the inputs can be transformed into desired product (output) of potential utility while improving properties and adding economic values through the best method without compromising on quality.

Different forms of production based on the processes used:

1. Production by extraction or separation: like petrol, kerosene, sugar etc
2. Production by assembly: car

Types of Production systems There are mainly three types of production systems mentioned as below:

(1) Continuous/Mass production
(2) Job or unit production
(3) Intermittent/Batch production

Schematic Production System

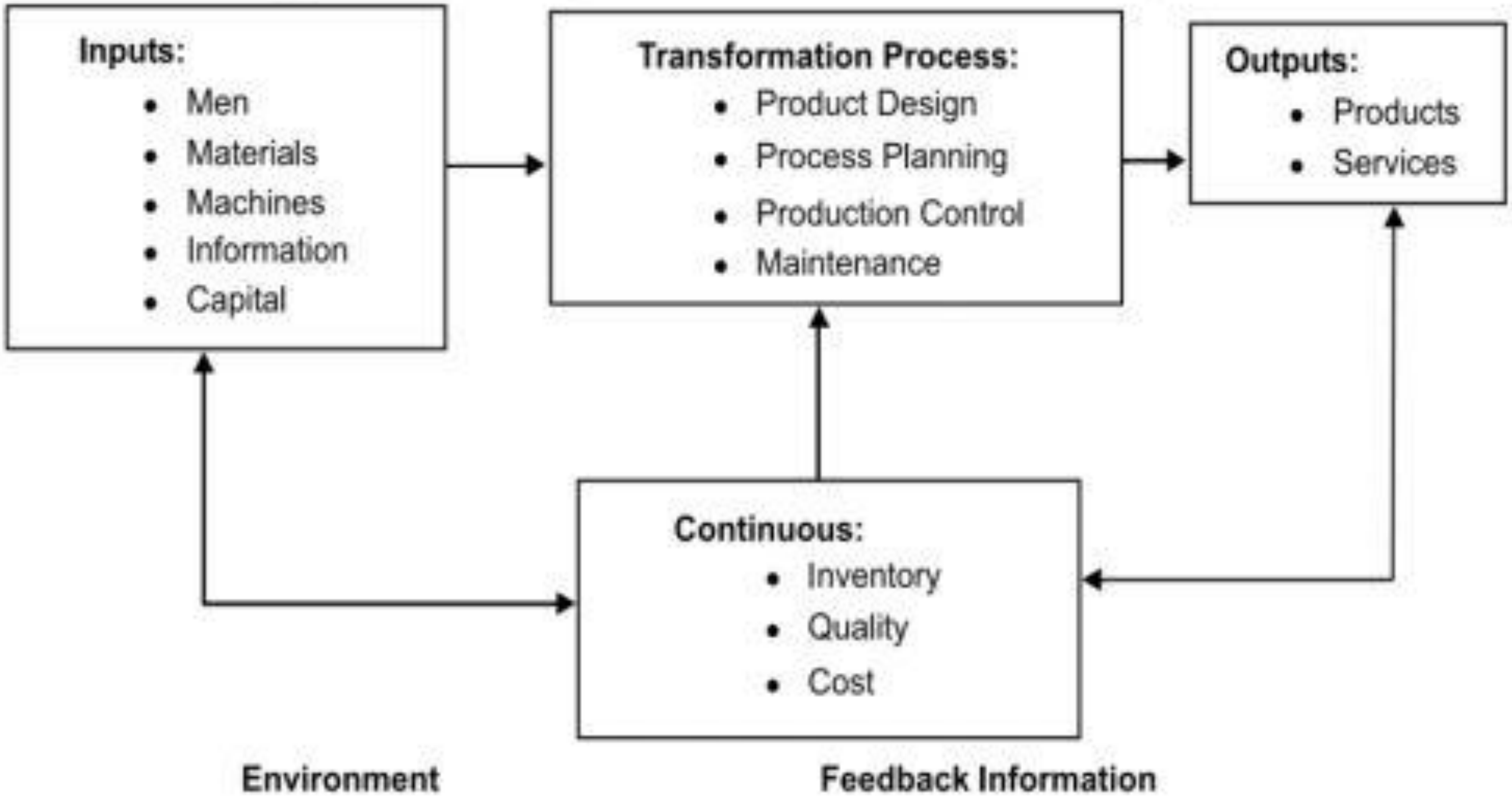
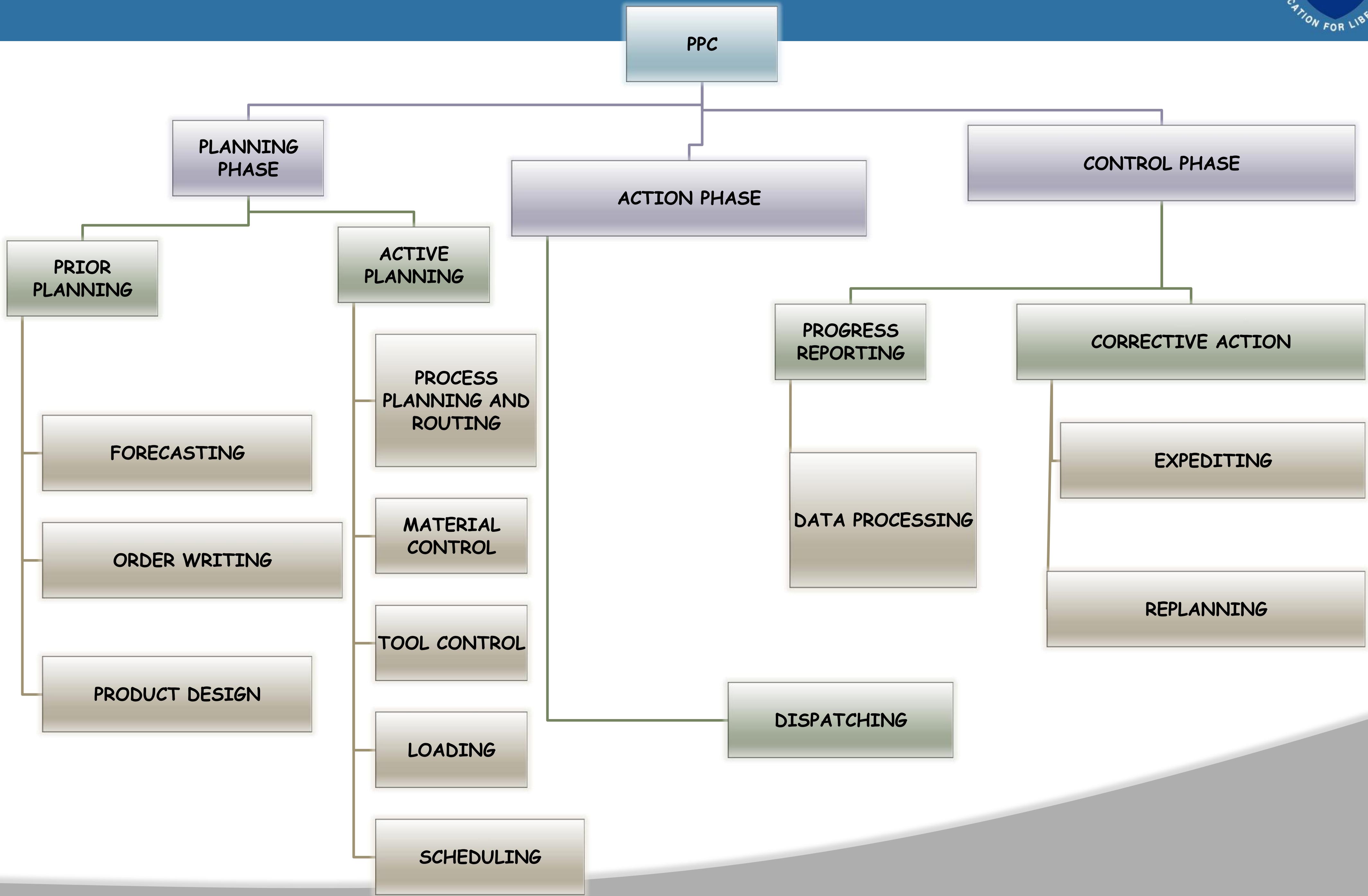


Fig. 1.1 *Schematic production system*

Definition

Edwood Buffa defines production as “a process by which goods and services are created” Some examples of production are: manufacturing custom-made products like, boilers with a specific capacity, constructing flats, some structural fabrication works for selected customers etc. At each stage of processing, there will be value addition. It is easy to understand a production system from the figure 1.1. There are various inputs which essentially pass through a transformation/ conversion process and finally converted into some

Functions of ppc



PLANNING PHASE

PRIOR PLANNING

- FORECASTING — Estimation of type, quality & quantity of future work
- ORDER WRITING — Giving authority to one or more person to undertake a particular job
- PRODUCT DESIGN — Collection of information regarding speifications,BOM,drawings etc

ACTIVE PLANNING

- PROCESS PLANNING AND ROUTING — Finding the most economical process of doing a work and deciding where and how work will be done
- MATERIAL CONTROL — Involves determining the requirements and control of materials
- TOOL CONTROL — Involves determining the requirements and control of tools used
- LOADING — Assignment of work to manpower, machinery etc
- SCHEDULING — Determines when and in what sequence the work will be carried out. It fixes the starting as well as ending time for the job

ACTION PHASE

It is the transition from planning to action phase. In this phase the worker is ordered to start the work

ACTION PHASE

DISPATCHING

CONTROL PHASE

Data regarding the job process is collected

It is interpreted with the present level of performance

Taking action if the progress reporting indicates the deviation of the plan from the originally set targets

Re planning of the whole affair becomes essential, in case expediting fails to bring the deviated plan to its actual path

- PROGRESS REPORTING
  - DATA PROCESSING
- CORRECTIVE ACTION
  - EXPEDITING
  - REPLANNING

Stages/steps in ppc

ROUTING

- Related to production planning

SEQUENCING

- Related to production planning

SCHEDULING

- Related to production control

DISPATCHING

- Related to production control

FOLLOW UP

- Related to production control

1. routing

- **Routing is the first step in production planning and control.**
- **Routing can be defined as the process of deciding the path (route) of work and the sequence of operations.**
- **In short, routing determines ‘What’, ‘How much’, ‘With which’, ‘How’ and ‘Where’ to produce.**

Advantages of routing

- Routing gives a very systematic method of converting raw-materials into finished goods.
- It leads to smooth and efficient work.
- It leads to optimum utilization of resources; namely, men, machines, materials, etc.
- It leads to division of labor.
- It ensures a continuous flow of materials without any backtracking.

Continued……

- **It saves time and space.**
- **It makes the work easy for the production engineers and foremen.**
- **It has a great influence on design of factory's building and installed machines.**

Steps /procedure of routing

- Product analysis determines what to manufacture and purchase
- Product analysis is done again to determine materials required for production
- Fix the maufacturing operations and their sequences
- Decide the number of units to be manufactured in each lot of production
- Estimate the margin of scrap in each lot of production
- Analyse the production cost
- Prepare the production control forms for effective routing
- Prepare a separate route sheet for each order

TECHNIQUES OF ROUTING

- **Route card**
- **Work sheet**
- **Route sheet**

1. Route card

- **This card always accompanies with the job throughout all operations.**
- **This indicates the material used during manufacturing and their progress from one operation to another.**
- **In addition to this the details of scrap and good work produced are also recorded.**

Route card

PRODUCTION ROUTE CARD

Customer Name

Product ID & Product Name

Quantity (Unit)

Generate Date

Customer Specific Requirement	Special Process / Characteristic

Process	Start Date	End Date	Production Unit	Rejected Unit	Reason For Rejection	Accepted Unit	Remarks

2. worksheet

- It contains
- Specifications to be followed while manufacturing.
- Instructions regarding routing of every part with identification number of machines.
- This sheet is made for manufacturing as well as for maintenance.

3. route sheet

- It is also called as route card
- It lists the manufacturing operations in the decided sequence along with the machines associated with each operation
- It also indicates the department in which the operation is to be done and the part will go for the next operation
- It also consists of the information such as part name, part number and product number
- It gives information about the material specification and cutting tools,jigs,fixtures and necessary devices for each operation.

2. SEQUENCING

- **Defined as the order in which jobs pass through machines or work stations for processing**
- **The main aim is to find out such sequence out of the possible sequence that will complete the work in shortest time**
- **Sequencing problems becomes tedious as the number of jobs and machines increases**

3. scheduling

- **Scheduling means setting of starting and finishing dates for each operation, assembly and the finished product.**
  It also means to :
- **Fix the amount of work to do.**
- **Arrange the different manufacturing operations in order of priority.**
- **Fix the starting and completing, date and time, for each operation**

4. dispatching

- **It’s the next step after scheduling**
- **Also means starting the actual production of a particular work which has been planned in routing schedule.**
- **It provides the necessary authority to start the work.**
- **It is based on route-sheets and schedule sheets.**

Dispatching includes the following:

- **Issue of materials, tools, fixtures, etc., which are necessary for actual production.**
- **Issue of orders, instructions, drawings, etc. for starting the work.**
- **Maintaining proper records of the starting and completing each job on time.**
- **Moving the work from one process to another as per the schedule.**
- **Starting the control procedure.**
- **Recording the idle time of machines.**

4. Follow up

- Follow-up or Expediting is the last step in production planning and control. It is a controlling device. It is concerned with evaluation of the results.
- Follow-up finds out and removes the defects, delays, limitations, bottlenecks, loopholes, etc. in the production process. It measures the actual performance and compares it to the expected performance. It maintains proper records of work, delays and bottlenecks. Such records are used in future to control production.

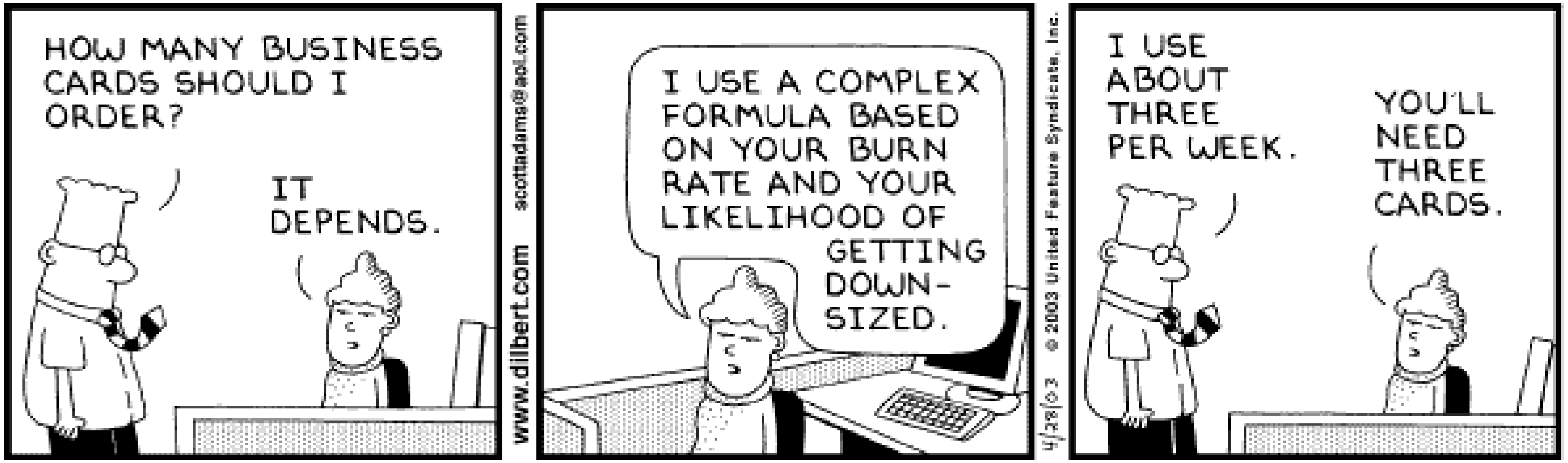
Gantt chart

- **It's a type of bar chart that illustrates a project schedule.**
- **It is the graphical representation of the duration of tasks against the progression of time.**
- **Its shows the comparison between the planned and actual progress of job through several activities of departments.**

Forecasting

Forecasting means "Prediction is very difficult, especially if it's about the future."

Nils Bohr



Objectives

- **Give the fundamental rules of forecasting**
- **Calculate a forecast using a moving average, weighted moving average, and exponential smoothing**
- **Calculate the accuracy of a forecast**

UNIT-II

FORECASTING

Forecasting is a tool used for predicting future demand based on past demand information.

Some general characteristics of forecasts

- Forecasts are always wrong
- Forecasts are more accurate for groups or families of items
- Forecasts are more accurate for shorter time periods
- Every forecast should include an error estimate
- Forecasts are no substitute for calculated demand.

Key issues in forecasting

1. A forecast is only as good as the information included in the forecast (past data)
2. History is not a perfect predictor of the future (i.e.: there is no such thing as a perfect forecast)

REMEMBER: Forecasting is based on the assumption that the past predicts the future! When forecasting, think carefully whether or not the past is strongly related to what you expect to see in the future…

Some Important Questions

- **What is the purpose of the forecast?**
- **Which systems will use the forecast?**
- **How important is the past in estimating the future?**

Answers will help determine time horizons, techniques, and level of detail for the forecast.

Qualitative forecasting methods

Grass Roots: deriving future demand by asking the person closest to the customer.

Market Research: trying to identify customer habits; new product ideas.

Panel Consensus: deriving future estimations from the synergy of a panel of experts in the area.

Historical Analogy: identifying another similar market.

Delphi Method: similar to the panel consensus but with concealed identities.

Quantitative forecasting methods

Time Series: models that predict future demand based on past history trends

Causal Relationship: models that use statistical techniques to establish relationships between various items and demand

Simulation: models that can incorporate some randomness and non-linear effects

Time Series: Moving average

- The moving average model uses the last t periods in order to predict demand in period $t+1$.
- There can be two types of moving average models: simple moving average and weighted moving average
- The moving average model assumption is that the most accurate prediction of future demand is a simple (linear) combination of past demand.

Time series: simple moving average

In the simple moving average models the forecast value is

t is the current period.

F_{t+1} is the forecast for next period

n is the forecasting horizon (how far back we look),

A is the actual sales figure from each period.

Time series: weighted moving average

We may want to give more importance to some of the data…

t is the current period.

F_{t+1} is the forecast for next period

n is the forecasting horizon (how far back we look),

A is the actual sales figure from each period.

w is the importance (weight) we give to each period

How do we choose weights?

1. Depending on the importance that we feel past data has
2. Depending on known seasonality (weights of past data can also be zero).

WMA is better than SMA because of the ability to vary the weights!

Time Series: Exponential Smoothing (ES)

Main idea: The prediction of the future depends mostly on the most recent observation, and on the error for the latest forecast.

Smoothing constant alpha *α*

Denotes the importance of the past error

Why use exponential smoothing?

1. Uses less storage space for data
2. Extremely accurate
3. Easy to understand
4. Little calculation complexity
5. There are simple accuracy tests

Exponential smoothing: the method

Assume that we are currently in period *t*. We calculated the forecast for the last period (F_{t-1}) and we know the actual demand last period (A_{t-1}) …

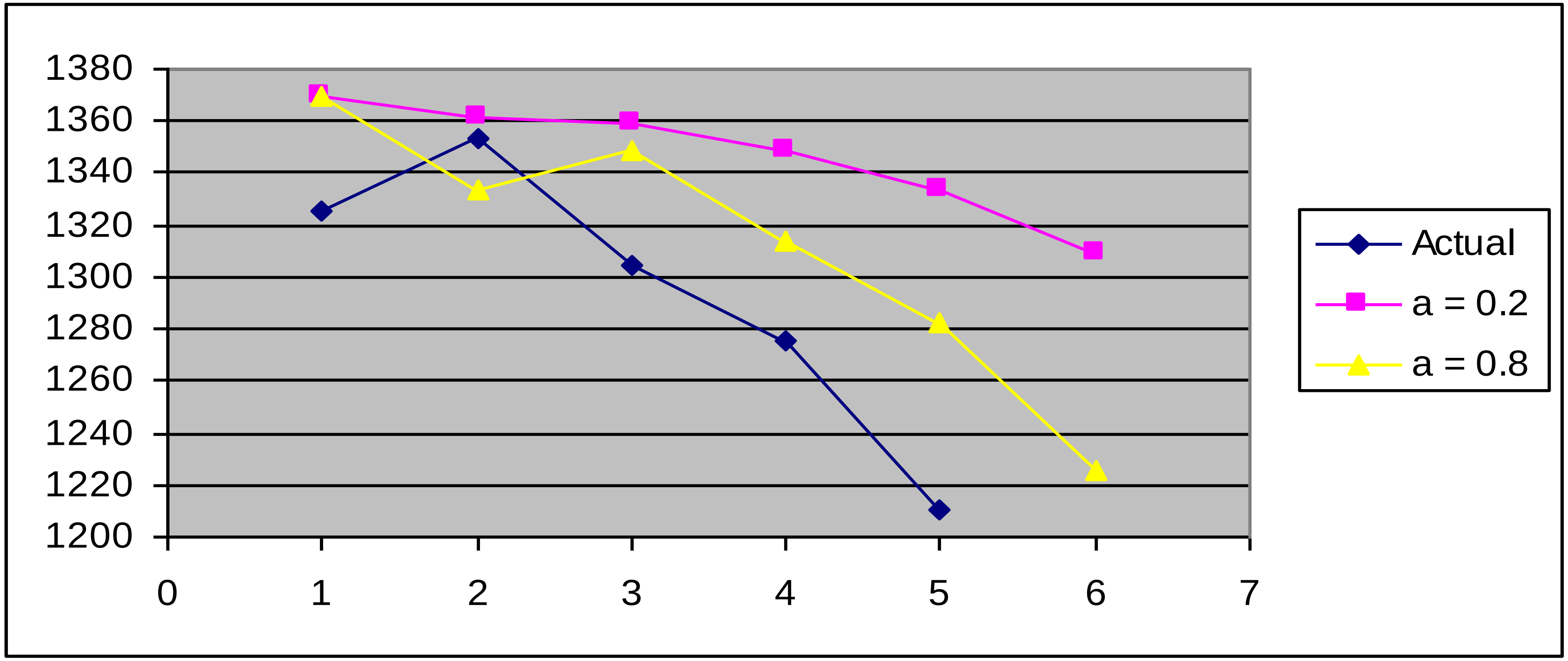
$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

The smoothing constant *α* expresses how much our forecast will react to observed differences…

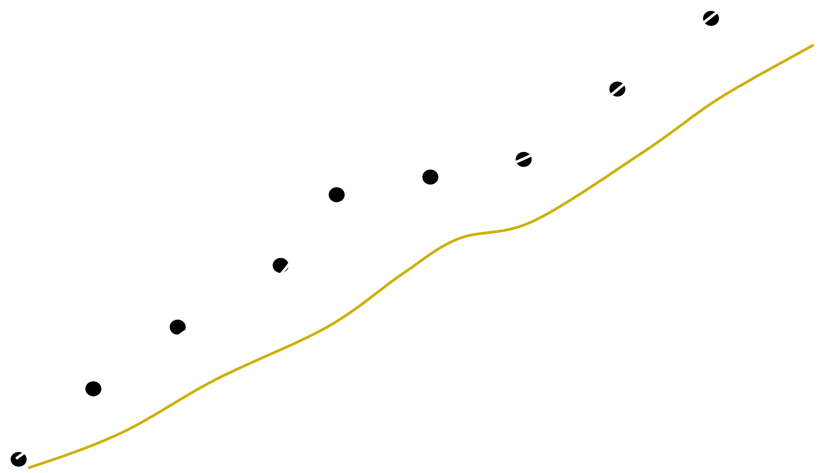
If *α* is low: there is little reaction to differences.

If *α* is high: there is a lot of reaction to differences.

Impact of the smoothing constant



Impact of trend



Regular exponential smoothing will always lag behind the trend.

Can we include trend analysis in exponential smoothing?

Exponential smoothing with trend

FIT: Forecast including trend

δ: Trend smoothing constant

$$FIT_t = F_t + T_t$$

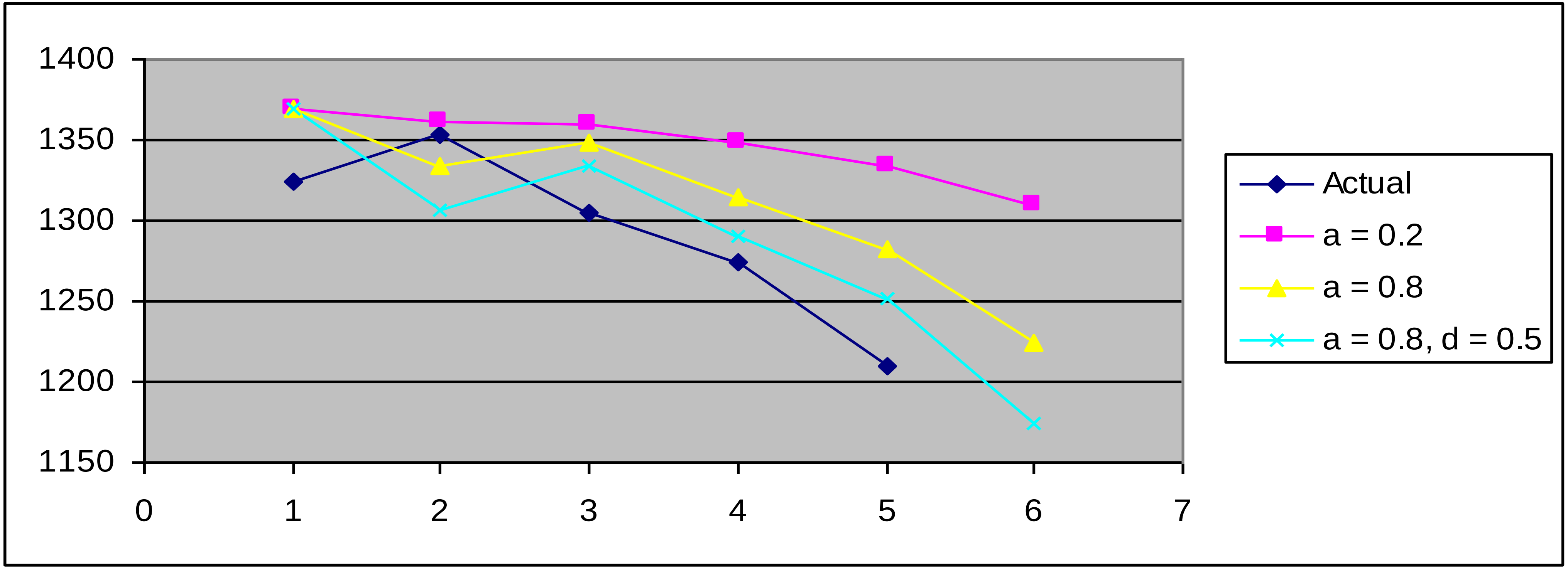
$$F_t = FIT_{t-1} + \alpha(A_{t-1} - FIT_{t-1})$$

$$T_t = T_{t-1} + \delta(F_t - FIT_{t-1})$$

The idea is that the two effects are decoupled,

(*F* is the forecast without trend and *T* is the trend component)

Exponential Smoothing with Trend



Linear regression in forecasting

Linear regression is based on

1. Fitting a straight line to data
2. Explaining the change in one variable through changes in other variables.

By using linear regression, we are trying to explore which independent variables affect the dependent variable

The best line is the one that minimizes the error

The predicted line is …

$$Y = a + bX$$

So, the error is …

$$\varepsilon_i = y_i - Y_i$$

Where: ε is the error

y is the observed value

Y is the predicted value

Least Squares Method of Linear Regression

The goal of LSM is to minimize the sum of squared errors…

$$\text{Min} \sum \varepsilon_i^2$$

Least Squares Method of Linear Regression

Then the line is defined by

$$\mathrm{Y} = \mathrm{a} + \mathrm{bX}$$

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{\sum xy - n\bar{x}\bar{y}}{\sum x^2 - n\bar{x}^2}$$

How can we compare across forecasting models?

We need a metric that provides estimation of accuracy

Forecast Error

Forecast error = Difference between actual and forecasted value (also known as *residual*)

Measuring Accuracy: MFE

MFE = Mean Forecast Error (Bias)

It is the average error in the observations

$$\mathrm{MFE} = \frac{\sum_{i=1}^{n} A_t - F_t}{n}$$

1. A more positive or negative MFE implies worse performance; the forecast is biased.

Measuring Accuracy: MAD

MAD = Mean Absolute Deviation

It is the average absolute error in the observations

$$\mathrm{MAD} = \frac{\sum_{i=1}^{n} |A_t - F_t|}{n}$$

1. Higher MAD implies worse performance.

2. If errors are normally distributed, then σ_ε=1.25MAD

Measuring Accuracy: Tracking signal

The tracking signal is a measure of how often our estimations have been above or below the actual value. It is used to decide when to re-evaluate using a model.

$$\mathrm{RSFE} = \sum_{i=1}^{n} (A_t - F_t)$$

$$\mathrm{TS} = \frac{\mathrm{RSFE}}{\mathrm{MAD}}$$

Positive tracking signal: most of the time actual values are <u>above</u> our forecasted values

Negative tracking signal: most of the time actual values are <u>below</u> our forecasted values

Which Forecasting Method Should You Use

- Gather the historical data of what you want to forecast
- Divide data into initiation set and evaluation set
- Use the first set to develop the models
- Use the second set to evaluate
- Compare the MADs and MFEs of each model

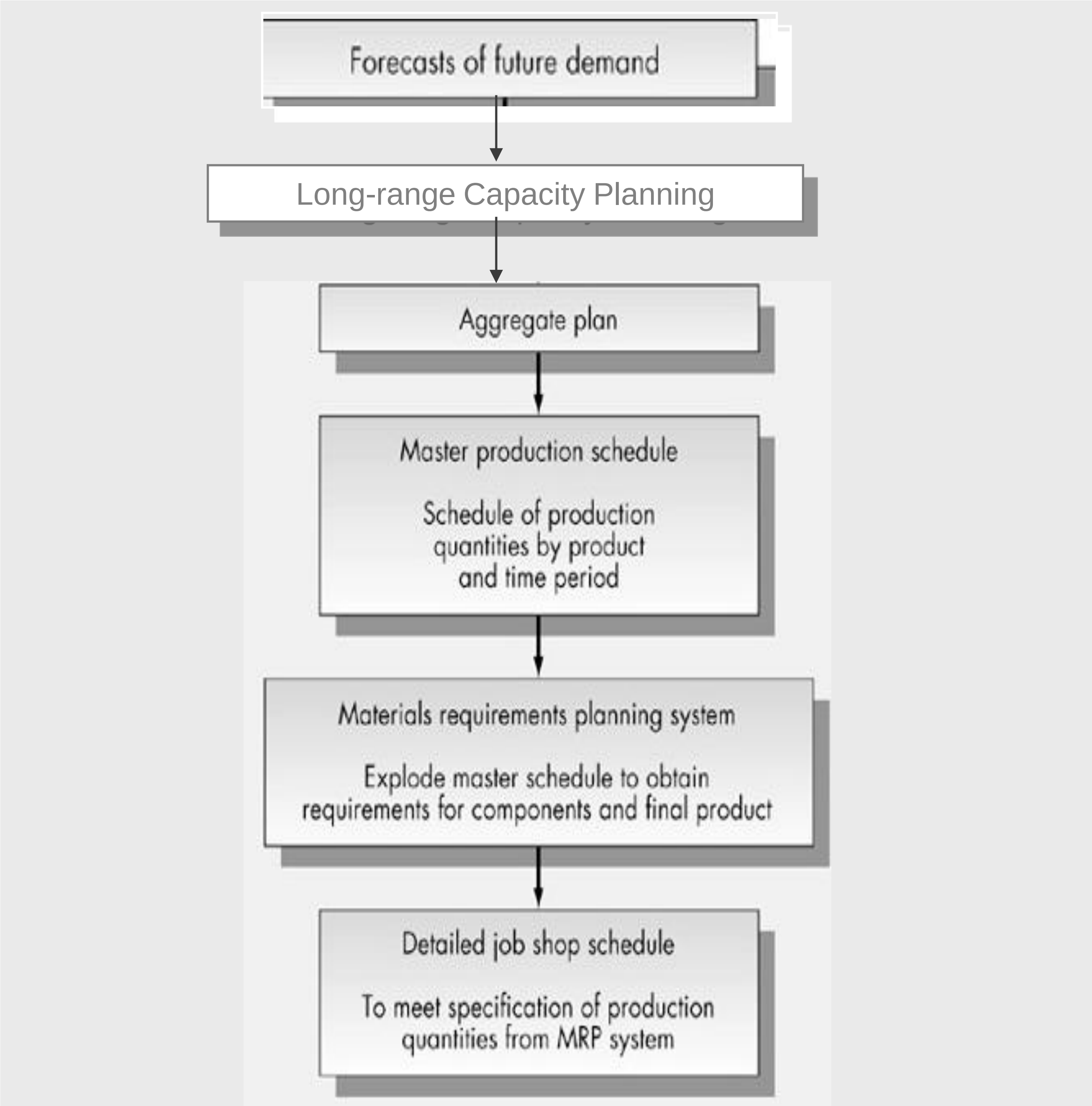
UNIT-III

INTRODUCTION TO MRP

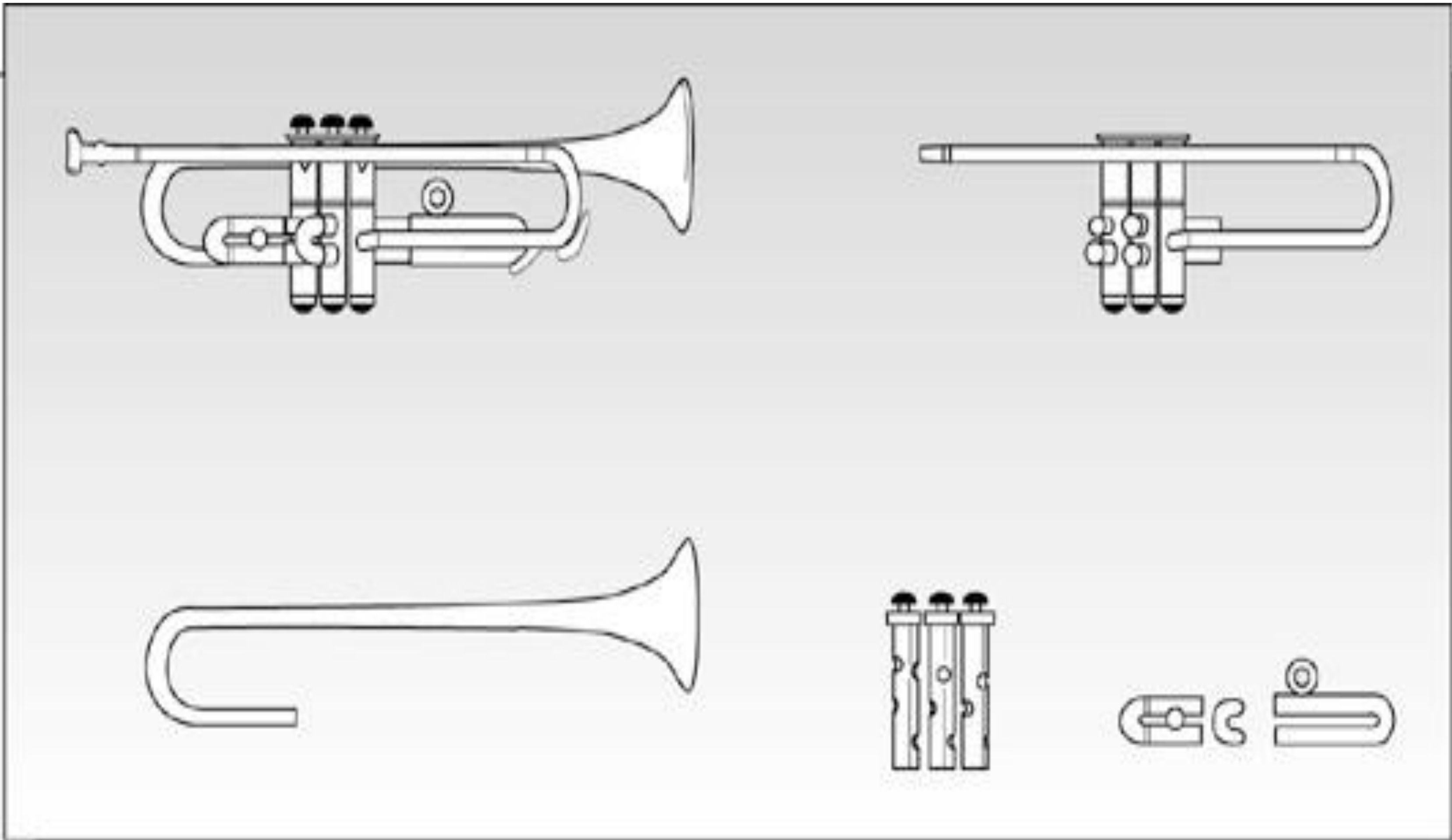
What is MRP

- Material requirements planning (MRP) is a dependent demand production planning and inventory control system.
- MRP integrates data from production schedules (MPS) with inventory records, scheduled receipts and the bill of materials (BOM) to determine purchasing and production schedules for the components required to build a product.

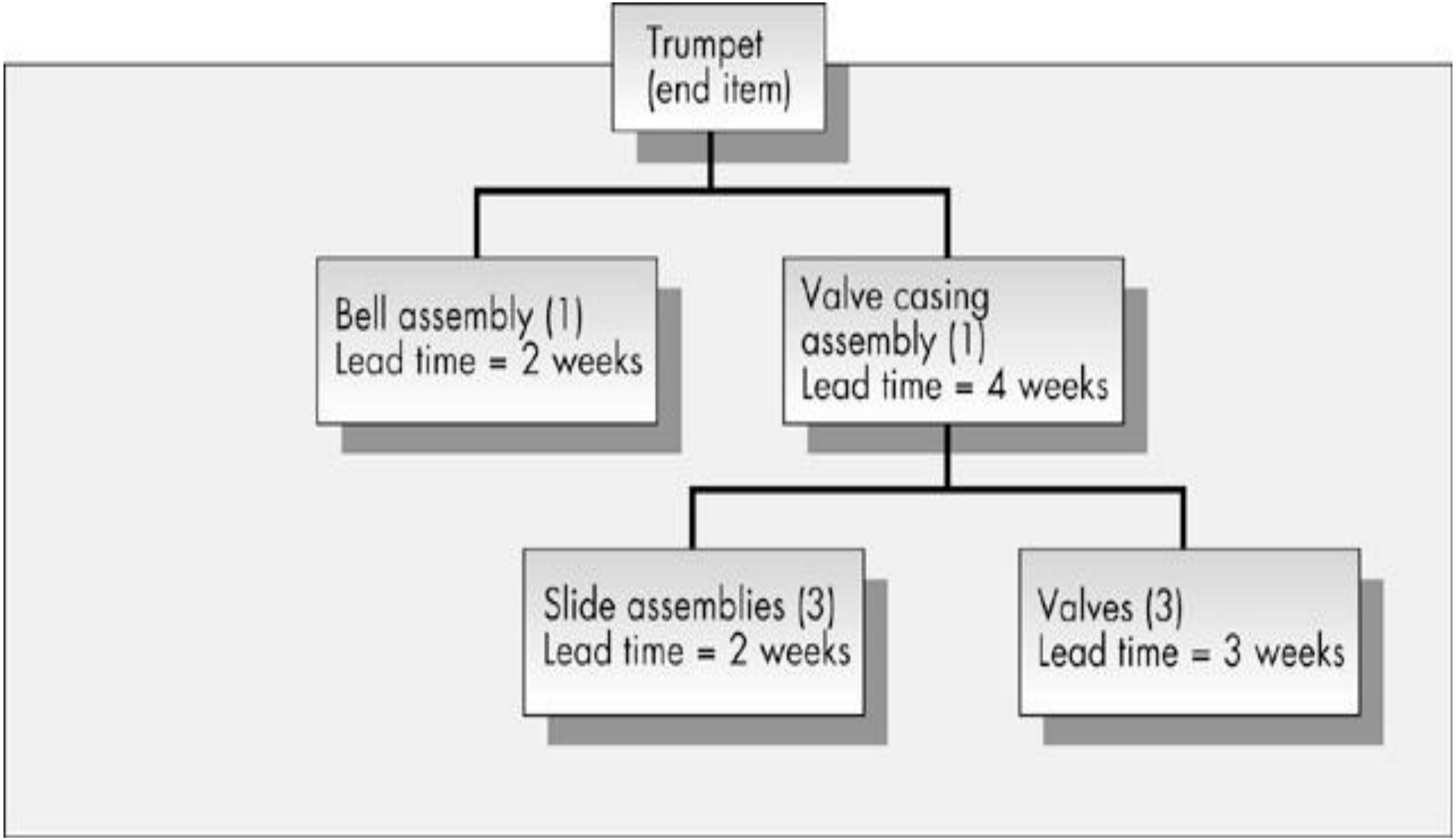
Hierarchy of Production Decisions



Trumpet and Subassemblies



Bill-of-Material for Trumpet



MRP

A computer-based information system that translates master production schedule (MPS) requirements for end items into time-phased requirements for subassemblies, components, and raw materials.

MRP

- The MRP is designed to answer three questions:
  - ***What*** **is needed?**
  - ***How*** **much is needed?**
  - ***When*** **is it needed?**

Benefits of MRP

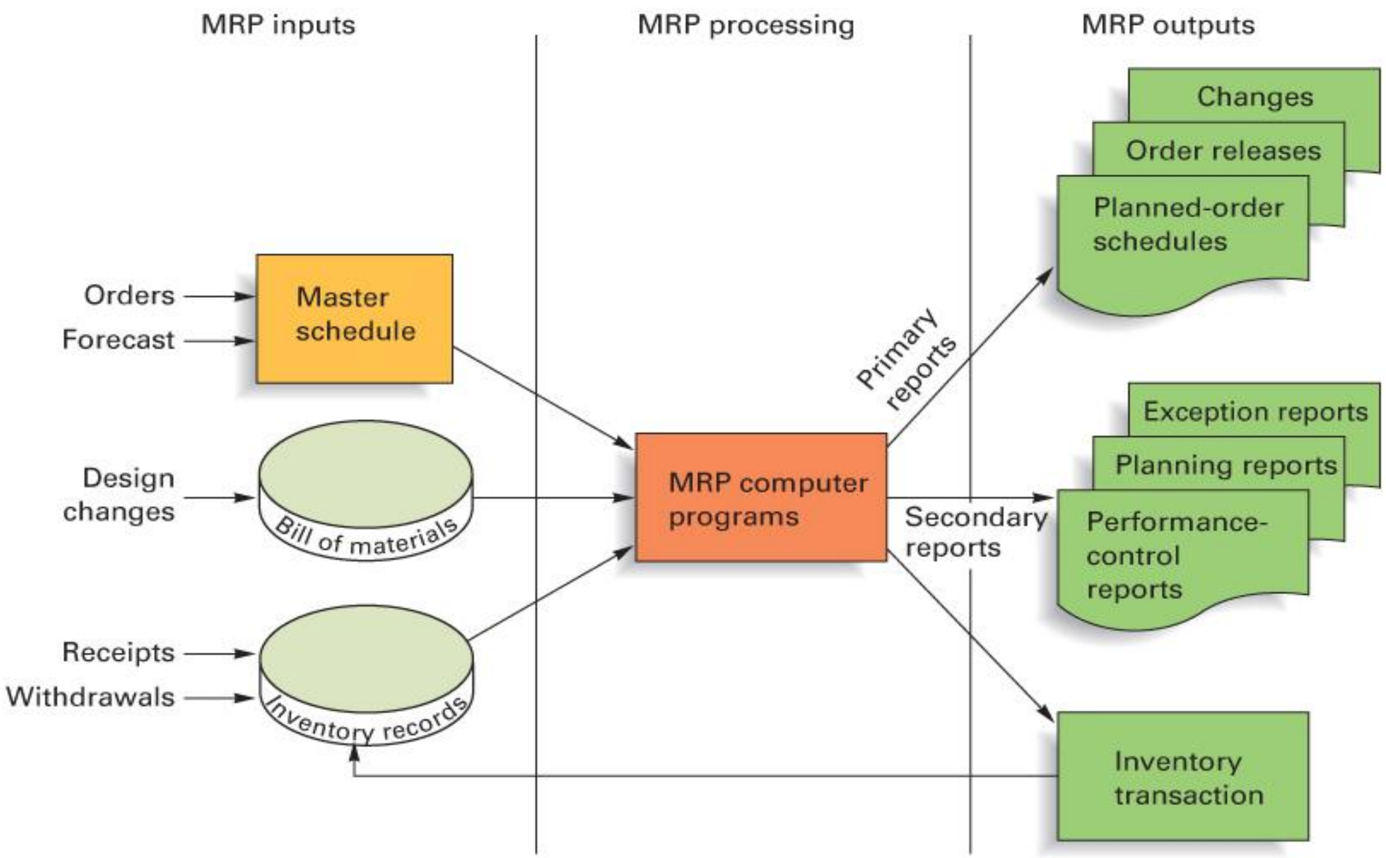
1. **Better response to customer orders**
2. **Faster response to market changes**
3. **Improved utilization of facilities and labor**
4. **Reduced inventory levels**

Inputs to MRP

- MRP is a dependent demand technique that uses
  - Bill-of-Material (BOM)
  - On-hand inventory data
  - Expected receipts (outstanding purchase orders)
  - Master Production Schedule (MPS)
  - Lead Time information

  to determine material requirements.

Overview of MRP



Master Production Schedule (MPS)

- **Time-phased plan specifying *how many* and *when* the company plans to produce each *end item***

Aggregate Plan (Product Groups)

MPS (Specific End Items)

Master Production Schedule (MPS)

- **MPS is established in terms of specific products**
- **The MPS is a statement of what is to be produced, not a forecast of demand**
- **Must be in accordance with the aggregate production plan**
- **Before it is executed, MPS must be tested for feasibility (Capacity**

MPS Example – 1

One possible MPS…

Month		October				November				December			
Week		41	42	43	44	45	46	47	48	49	50	51	52
Product	Tricycle	300	300	300	300	300	300	300	300	250	250	250	250
	Wagon	300		300		300		300		250		250	
	Scooter		300		300		300		300		250		250
Totals		2,400				2,400				2,000			

MPS Example – 2

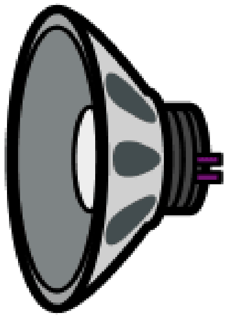
Months	January				February			
Aggregate Production Plan (Shows the total quantity of **amplifiers**)	1,500				1,200			
Weeks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Master Production Schedule (Shows the specific type and quantity of amplifier to be produced)								
240-watt amplifier	100		100		100		100	
150-watt amplifier		500		500		450		450
75-watt amplifier			300				100	

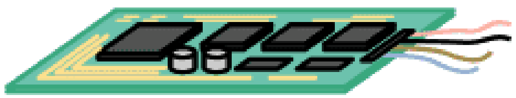
Figure 14.2

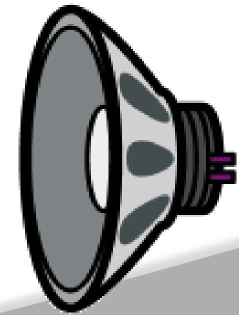
Bills of Material (BOM)

- List of components, ingredients, and materials needed to make product
- Provides product structure
  - Items above given level are called parents
  - Items below given level are called children

BOM Example (Determine requirements for all components to satisfy demand for 50 Awesome peaker Kits)







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MRP Outputs: Primary

- **Planned orders**
  - **A schedule indicating the amount and timing of future**
    - **production and/or**
    - **purchasing orders**

MRP Outputs: Secondary

- **Secondary Outputs**
  - **Performance-control reports**
    - **e.g., missed deliveries and stockouts**
  - **Planning reports**
    - **Data useful for assessing future material requirements**
      - **e.g., purchase commitments**
  - **Exception reports**
    - **excessive scrap rates,**

MRP Processing

- MRP processing takes **the end item requirements** specified by the **master production schedule (MPS)** and "**explodes**" them into ***time-phased*** **requirements for assemblies, parts, and raw materials offset by lead times**

MRP Record

Week Number	1	2	3	4	5	6
Gross Requirements						
Scheduled Receipts						
Projected on hand						
Net requirements						
Planned-order-receipt						
Planned-order release						

Gross requirements

Scheduled receipts

Projected On Hand

each time period

MRP Record

Week Number	1	2	3	4	5	6
Gross Requirements						
Scheduled Receipts						
Projected on hand						
Net requirements						
Planned-order-receipt						
Planned-order release						

Net requirements

Planned-order receipts

Planned-order releases

order in each time period

MRP: Processing

- The MRP is based on the product structure tree diagram
- Requirements are determined level by level, beginning with the end item and working down the tree
  - The timing and quantity of each “parent” becomes the basis for determining the timing and quantity of the “children” items directly below it.
  - The “children” items then become the “parent” items for the next level, and so on

Example MRP

Master schedule for shutters:	Week number	Beg. Inv.	1	2	3	4	5	6	7	8
	Quantity					100				150

		Beg. Inv.	1	2	3	4	5	6	7	8
Shutters: LT = 1 week	Gross requirements					100				150
	Scheduled receipts									
	Projected on hand									
	Net requirements					100				150
	Planned-order receipts					100				150
	Planned-order releases				100				150	

times 2   times 2

		Beg. Inv.	1	2	3	4	5	6	7	8
Frames: LT = 2 weeks	Gross requirements				200				300	
	Scheduled receipts									
	Projected on hand									
	Net requirements				200				300	
	Planned-order receipts				200				300	
	Planned-order releases		200				300			

times 4   times 4

		Beg. Inv.	1	2	3	4	5	6	7	8
Wood sections: LT = 1 week	Gross requirements				400				600	
	Scheduled receipts		70							
	Projected on hand		70	70	70					
	Net requirements				330				600	
	Planned-order receipts				330				600	
	Planned-order releases			330				600		

Updating the MRP System

- An MRP is not a static document
  - As time passes
    - Some orders get completed
    - Other orders are nearing completion
    - New orders will have been entered
    - Existing orders will have been altered
      - Quantity changes
      - Delays
      - Missed deliveries

Updating the System

- Two basic systems
  - Regenerative system: MRP records are updated periodically
    - Essentially a batch system that compiles all changes that occur within the time interval and periodically updates the system
  - Net-change system: MRP records are updated continuously

    The production plan is modified to reflect changes as they occur

Safety Stock

Theoretically, MRP systems should not require safety stock

- Variability may necessitate the strategic use of safety stock
  - A *bottleneck process* or *late delivery of raw materials* may cause shortages in downstream operations
  - When lead times are variable, the concept of safety time is often used
  - Safety time: Scheduling orders for arrival or completions sufficiently ahead of their need so that the probability of shortage is eliminated or significantly reduced

Periodic Order Quantity

- **The EOQ attempts to minimize the total cost of ordering and carrying inventory and is based on the assumption that demand is uniform.**
- **Often demand is not uniform, particularly in material requirements planning, and using the EOQ does not produce a minimum cost.**
- **The period-order quantity lot-size rule is based on the same theory as the economic-order quantity.**
- **It uses the EOQ formula to calculate an economic time between orders. This is calculated by dividing the EOQ by the demand rate.**

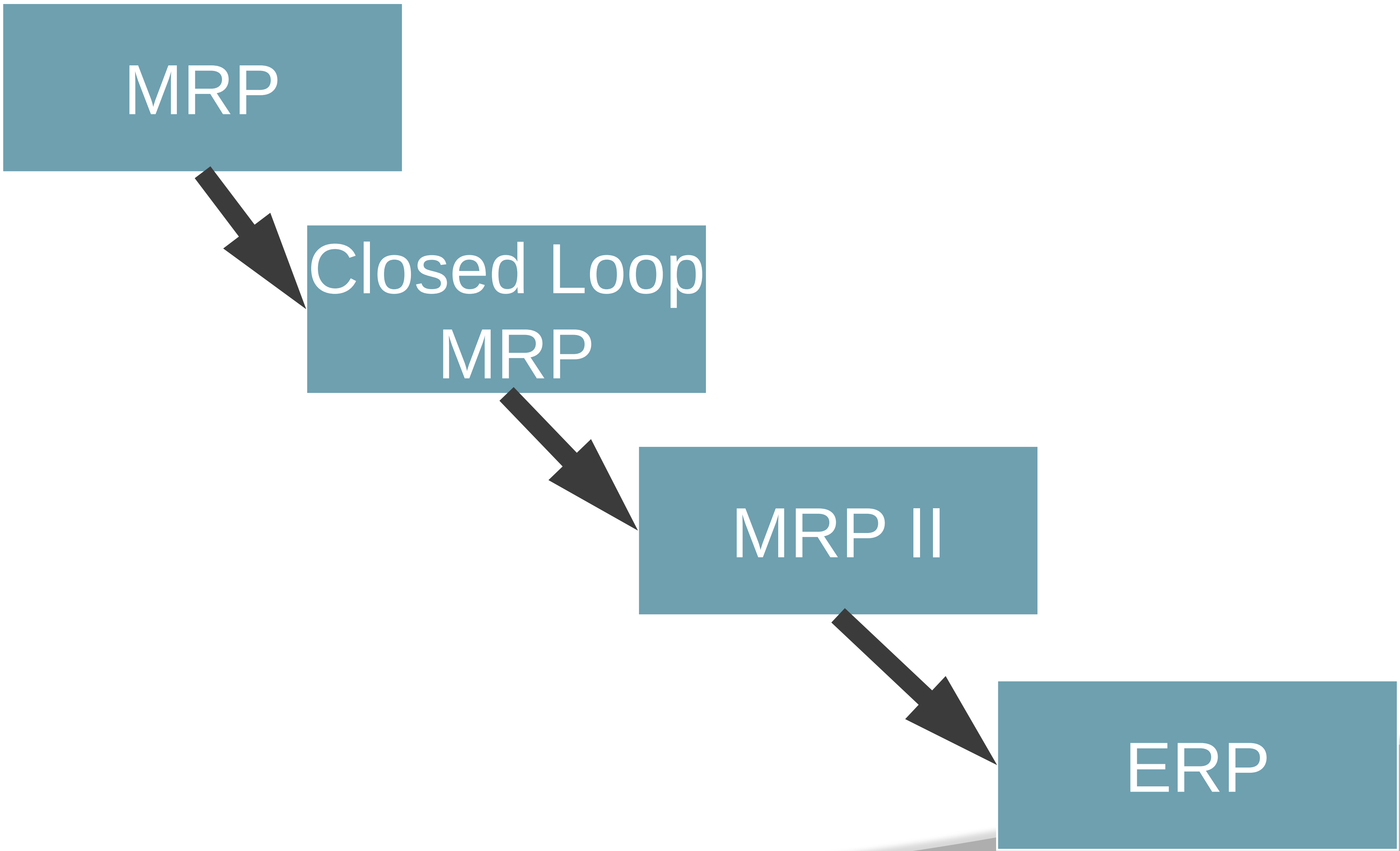
Periodic Order Quantity

- Periodic order quantity (POQ) method sets:
  - the size of each production lot equal to the requirements for a fixed number of periods
- Interval (period) = EOQ / average demand per period
- Order quantity is set to cover the interval

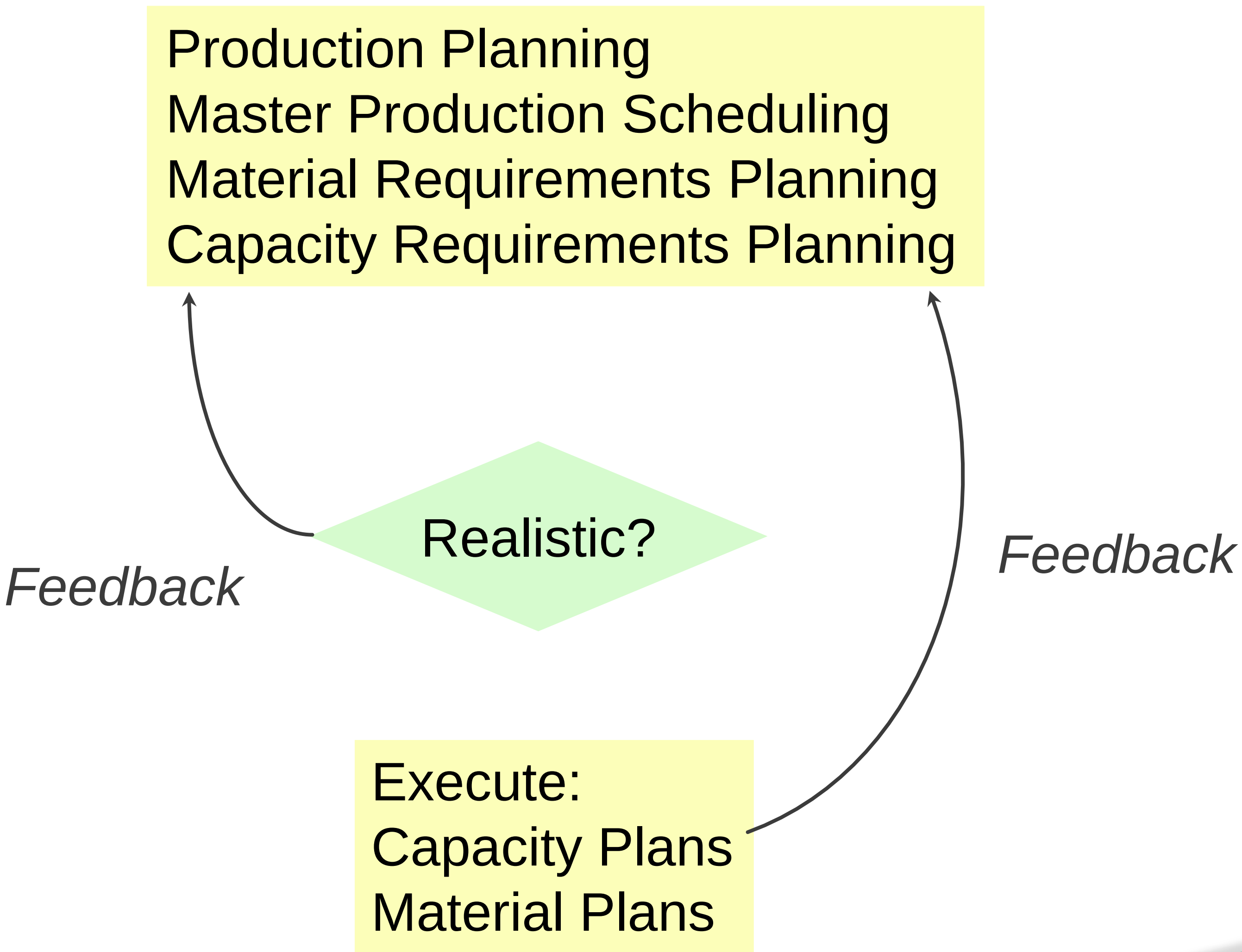
Allocations

- Allocated items refer to the number of units in inventory that have been assigned to specific future production but not yet used or issued from the stock room.
- The following slide illustrates how allocated items increase gross requirements

MRP Evolution



Closed-Loop MRP



Manufacturing Resource Planning (MRP II)

- **Goal: Plan and monitor all resources of a manufacturing firm (closed loop):**
  - **manufacturing**
  - **marketing**
  - **finance**
  - **engineering**
- **Simulate the manufacturing system**

Enterprise Resource Planning (ERP)

- A computer system that integrates application programs in accounting, sales, manufacturing, and other functions in the firm
- This integration is accomplished through a common database shared by all the application programs
- Produces information in real time and ties in customers and suppliers

Enterprise Resource Planning (ERP)

- ERP modules include
  - Basic MRP
  - Finance
  - Human resources
  - Supply chain management (SCM)
  - Customer relationship management (CRM)

Risks Associated with ERP Implementation

- **High Cost and Cost Overruns**
  - **Common areas with high costs:**
    - **Training**
    - **Testing and Integration**
    - **Database Conversion**
- **Disruptions to Operations**
  - **ERP is reengineering--expect major changes in how business is done**

Advantages of ERP Systems

1. Provides integration of the supply chain, production, and administration
2. Creates commonality of databases
3. Improves information quality
4. May provide a strategic advantage

ERP Drawbacks

1. **Very expensive to purchase and even more so to customize**
2. **Implementation may require major changes- Resistance to change**
3. **So complex that many companies cannot adjust to it**
4. **Involves an ongoing, possibly never completed, process for implementation**
5. **Training is an on-going activity**

UNIT – IV
SCHEDULING

Scheduling Learning Objectives

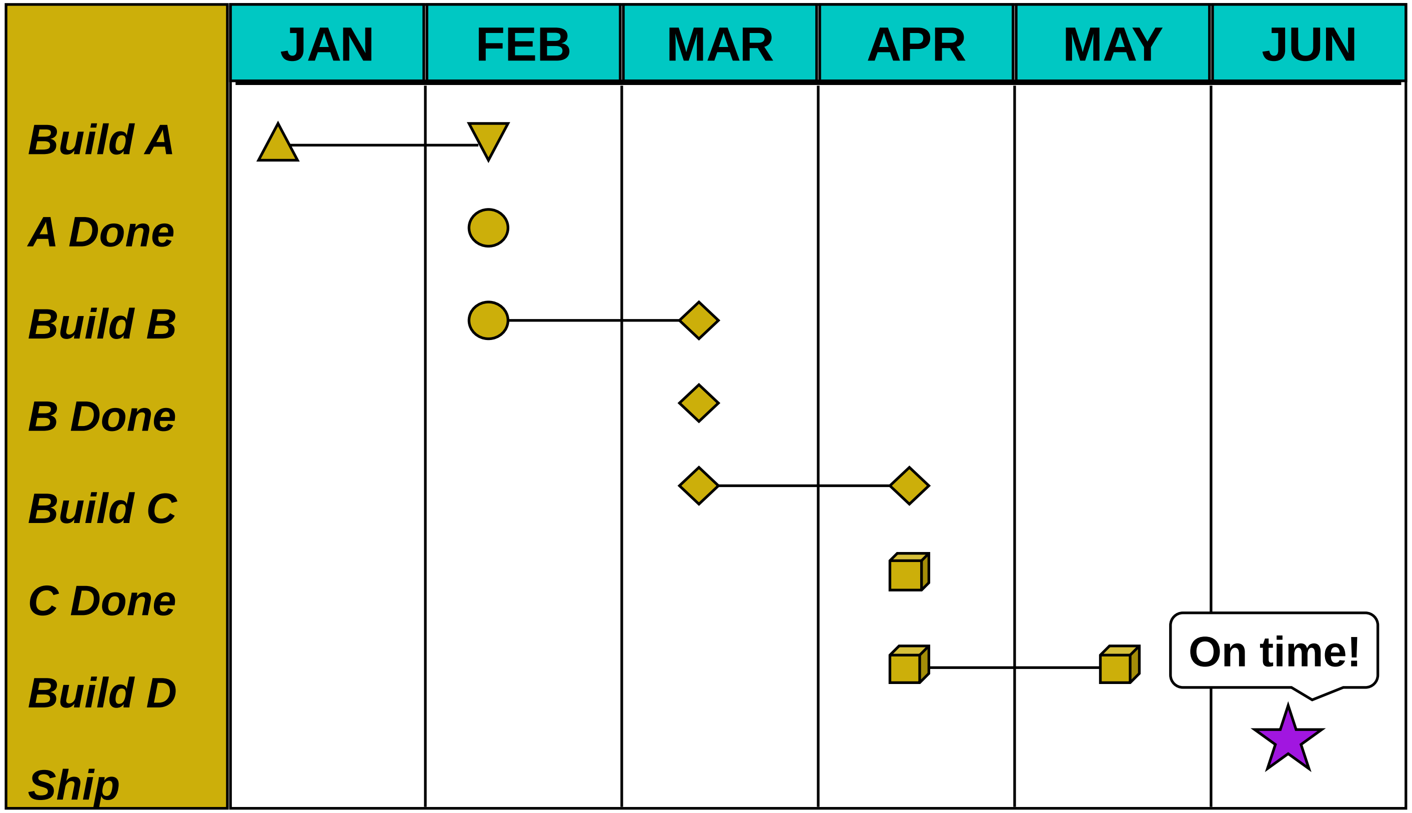
- Explain what scheduling involves and the importance of good scheduling.
- Discuss scheduling needs in high-volume and intermediate-volume systems.
- Discuss scheduling needs in job shops.
- Use and interpret Gantt charts, and use the assignment method for loading.
- Discuss and give examples of commonly used priority rules.

Scheduling

- Scheduling: Establishing the timing of the use of equipment, facilities and human activities in an organization
- Effective scheduling can yield
  - Cost savings
  - Increases in productivity

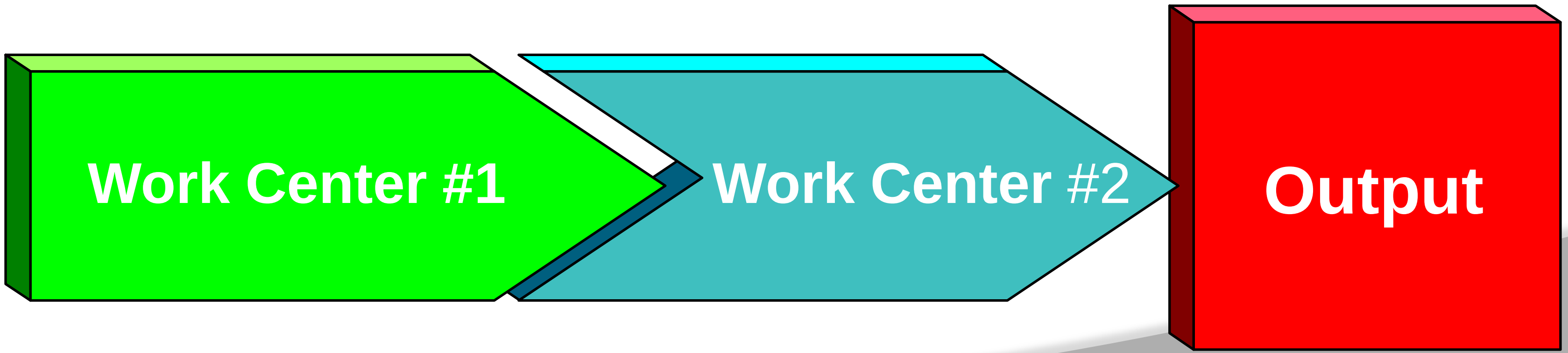
Scheduling Manufacturing Operations

- High-volume
- Intermediate-volume
- Low-volume
- Service operations



High-Volume Systems

- ***Flow system***: **High-volume system with Standardized equipment and activities**
- ***Flow-shop scheduling***: **Scheduling for high-volume flow system**
  - **Line Balancing**
  - **Forecasts**



High-Volume Success Factors

- Process and product design
- Preventive maintenance
- Rapid repair when breakdown occurs
- Optimal product mixes
- Minimization of quality problems
- Reliability and timing of supplies

Intermediate-Volume Systems

- **Outputs are between standardized high-volume systems and made-to-order job shops**
  - **Run size, timing, and sequence of jobs**
- **Economic run size:**

$$Q_0 = \sqrt{\frac{2DS}{H}}\sqrt{\frac{p}{p-u}}$$

p **– production rate**

u **– usage rate**

Scheduling Low-Volume Systems

- ***Loading*** - assignment of jobs to process centers
- ***Sequencing*** - determining the order in which jobs will be processed
- ***Job-shop scheduling***
  - Scheduling for low-volume systems with many variations in requirements

Job Shops

Gantt Load Chart

- ***Gantt chart*** **- used as a visual aid for loading and scheduling**

Work Center	Mon.	Tues.	Wed.	Thurs.	Fri.
1	Job 3			Job 4	
2		Job 3	Job 7		
3	Job 1			Job 6	Job 7
4	Job 10				

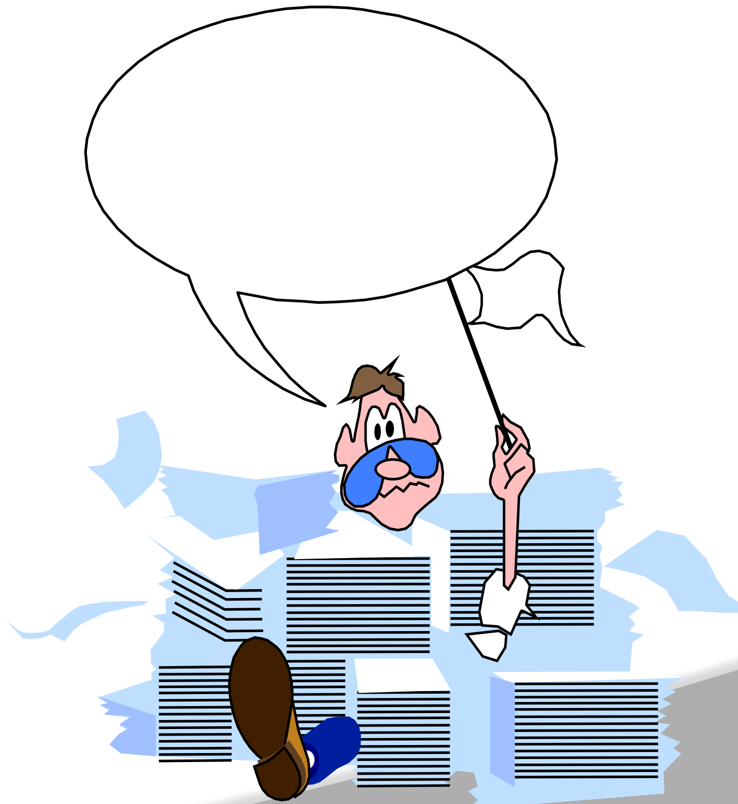
Sequencing

- ***Sequencing***: **Determine the order in which jobs at a work center will be processed.**

- ***Workstation***: **An area where one person works, usually with special equipment, on a specialized job.**

Sequencing

- ***Priority rules***: Simple heuristics used to select the order in which jobs will be processed.
- ***Job time***: Time needed for setup and processing of a job.



Priority Rules

- FCFS - first come, first served
- SPT - shortest processing time
- EDD - earliest due date
- CR - critical ratio
- S/O - slack per operation
- Rush - emergency

Theory of Constraints

- The Theory of Constraints Goal is to maximize flow through the entire system
- Emphasizes balancing flow
- Improve performance of bottleneck:
  - Determine what is constraining the operation
  - Exploit the constraint
  - Subordinate everything to the constraint
  - Determine how to overcome the constraint
  - Repeat the process for the next constraint

Scheduling Applications

- **Boeing – Sequencing panels on parallel rivet machines with long setups and a single setup crew**
- **Radar Warning Receiver – Minimizing time to defect multiple threats across multiple frequencies**
- **Louis Martin-Vega bus repair facility case study**
- **Social Golfer Problem – Dinner Club**

UNIT-V
DISPATCHING

DESPATCHING

- ***The term dispatching refers to the process of actually ordering the work to be done. It involves putting the plan into effect by issuing orders. it is concerned with starting the process and operation on the basis of route sheets and schedule charts.***
- ***"Dispatches put production in effect by releasing and guiding manufacturing order in the sequence previously determined by route sheets and schedule."***

PROCEDURE:

- ***1.Moving of materials from process to process.***
- ***2.Assigning of work to machines.***
- ***3.Issuing of tools to production departments.***
- ***4.Issuing of job orders.***
- ***5.Recording of time taken.***
- ***6.Ensuring necessary changes.***
- ***7.Having proper liaison with routing***

IMPORTANT DOCUMENTS

1.Material requisitions

2.work order

3.control sheet

4.Internal delivery note

5.Tool and gauge ticket

FOLLOW UP AND EXPDITING

Follow up or expediting is that branch of production control procedure which regulates the progress of materials and part through the production process".

PROCEDURE:

1.Progress should be checked

2.Causes of differences should be ascertained

3.Helping in removing the deviations

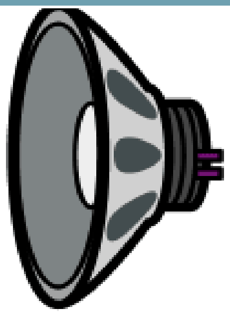
4.Report with departments supplying materials.

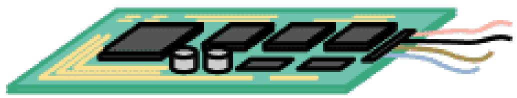
INSPECTION

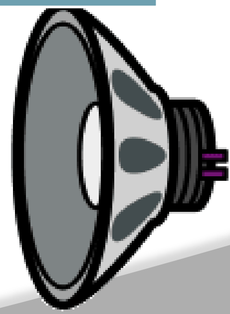
- ***Inspection is also an important function of control. the purpose of inspection is to see whether the products manufactured are of requisite quality or not. It is carried on at various levels of production process so that pre-determined standards of quality are achieved. Inspection is undertaken both of products and inputs.***

BOM Example

Part B:	2 x number of As =	(2)(50) =	100
Part C:	3 x number of As =	(3)(50) =	150
Part D:	2 x number of Bs + 2 x number of Fs =	(2)(100) + (2)(300) =	800
Part E:	2 x number of Bs + 2 x number of Cs =	(2)(100) + (2)(150) =	500
Part F:	2 x number of Cs =	(2)(150) =	300
Part G:	1 x number of Fs =	(1)(300) =	300







12” Speaker

Accurate Records for Outstanding Purchase Orders (Scheduled Receipts)

- Accurate inventory records are absolutely required for MRP (or any dependent demand system) to operate correctly
- Generally MRP systems require more than 99% accuracy
- Outstanding purchase orders must accurately reflect quantities and

Lead Times

- The time required to purchase, produce, or assemble an item
  - For production – the sum of the order, wait, move, setup, store, and run times
  - For purchased items – the time between the recognition of a need and the availability of the

Assembly Diagram and Product Structure Tree