

Unit 2

- **Work Study:** it investigates the work done in an organization & it aims at finding the best & most efficient way of using available resources like men, material, money & machinery

Advantages: 1) Uniform & improved product flow

2) Higher productive efficiency.

3) Reduced manufacturing cost.

4) Fast & accurate delivery

5) Better employer & employee relationship

6) " Service to the customers.

Objectives : 1) To analyze the present method of doing a job systematically in order to develop a new & better method

2) To measure the work content of a job by measuring the time required to do the job by a qualified worker & then to establish standard time.

3) To improve the op. efficiency

4) To increase the productivity by ensuring the best possible use of human machine & material resources & to achieve best quality product or service at min. cost

To imp.

- **Method study:** It is a component of work study & aims in developing a method of doing a job. It improves method efficiency by eliminating unnecessary operations, avoidable delays & other forms of waste & reducing fatigue.

Date:

- ① Unscrew cap.
- ② Unscrew cap.
- ③ Remove the old refill.
- ④ Assemble the spring on new refill.
- ⑤ Place the refill in barrel.
- ⑥ Screw the neck.
- check if the ball pen writes.
- ⑦ Screw the cap.

2) Flow process chart: Flow process chart, it is a detailed version of activity process chart & it records all the events

- i) It sets out sequence of flow of a product or procedure
- ii) It records all the events in sequence using process chart symbols.
- iii) It marks distances travelled & time taken for completing an activity
- iv) It mentions other info points if any.

There are 3 types of flow process chart

- a) Man type
- b) Machine type
- c) Equipment or material type

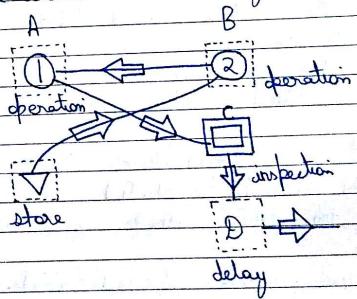
Flow process chart symbols:

Event	Symbol	Exptl Exampl
1) Operation	○	change in location or condition of prod
2) Storage	△	milling cutters injury is tool store
3) Delay	D	Power failure 2) Light/dust/traffic jam
4) Transport	←	Oil flowing through a pipe stock.
5) Inspection	□	Checking hardness of a piece

3) Two handed process chart: It records the activities of the left & right hand of the operator as related to each other. The activities of the two hands can be synchronised by providing a time scale on a chart.

• Flow diagram: It is a diagram which is drawn to scale. It shows the relative position of "fixed" machines, fixtures etc. & marks the path allowed by men & material. Steps in drawing the flow diagram.

- i) Draw to the Scale the plan of the work area
- ii) Mark the relative positions of machine tools, benches, racks etc.
- iii) From different observations draw the actual path movement of the material or the worker on the diagram & indicate the direction of movement. Process symbols may also be added onto the diagram.



- Time study (Work measurement): It is an application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance. It involves determination of process time required for the job & that is why it is known as time study.

Objectives of work measurement:

- 1) To assist the future planning of department
- 2) To set standard time for a job.
- 3) To improve the method of doing work.
- 4) To reduce or eliminate the ineffective time.

Advantages:

- 1) Work measurement provides the relevant data for efficient work planning & control.
- 2) It facilitates effective placement of different kinds of people on plant & equipment.
- 3) It determines the normal time for the job & thereby serves as a basis of sound incentive system.

Steps in work measurement/time study:

- 1) Selection of the work to be studied
- 2) Establishing standardised methods, equipment & working conditions.
- 3) Selecting the avg. workers who is to be studied while performing work.
- 4) Division of work into elements suitable for time study studying the operator doing the job. For the validity of time study results, it is necessary that analysts should take readings not once but a no. of times.

- 5) Recording the time with the help of stop watch on time study board for the required no. of work cycles.
- 6) After the time values for each element for sufficient no. of cycles have been recorded the mode value is selected. The mode value represents the most frequently appearing time value for an element of the job. Mode value of different elements will be added to get the normal time for doing a job.
- 7) Adding all allowances to the normal time to get the standard time. Relaxation allowances include personal fatigue, delay allowance etc.

Time study equipments:

- 1) Stopwatch 2) Study board 3) Time study forms.

- Difference b/w time & motion study
- 1) Measurement of time say 1) Observing & recording the to do the different parts movements of man, material & of a job. equipment
- 2) Concerned with increasing 2) It is concerned with minimization productivity of labourers. of movement of operations
- 3) Purpose is to determine 3) Purpose is to determine the best fair days work way of doing a job
- 4) Conducted with a stopwatch 4) Conducted with a many cameras
- Principles of motion economy: There are 3 principles of motion economy.
 - i) Principles that apply to the use of human body: i) Two hands should begin & complete their motion at the same time (ii) 2 hands should not be idle at the same time (iii) Work should be arranged to permit an easy & natural rhythm wherever possible.

i) Motion of the arms shud be made in opposite & symmetrical direction & shud be made simultaneously.

2) Principles that apply to the work place layout.

i) There shud be a definite & fixed place for all tools & materials.

ii) Tools, materials & controls shud be located close to the hand uses.

iii) Materials & tools shud be located to permit the best sequence of motions.

iv) A chair of the type & height to permit good posture shud be provided for every worker.

3) Principles that apply to the design of tools & equipment.

i) The hands shud be relieved of all work that can be done more advantageously by a foot operated device.

ii) 2 or more tools shud be combined whenever possible.

iii) Where feasible perform the operation on multiple parts simultaneously.

• Other Methods:

1) Cyclograph: i) Gilbert has developed the technique of cyclograph

ii) They are the graphic techniques for the study of motion path of an operator's hand or finger.

iii) A small electric bulb is attached to the finger, hand or other part of the body of the operator & it is photographed to record the path of the motion.

iv) With a still camera the path of the light so photographed is called a cyclograph.

It can be used for improving a motion pattern & training purposes. In that 2 cyclographs maybe

shown with 1 indicating a better motion pattern than the other.

2) Chronograph: i) If an interrupter is placed in the electric circuit with the bulb & the light is flashed quickly & off slowly then the path of the bulb in the photograph will appear as a dotted line with pear shaped dots indicating the direction of motion.

ii) The space b/w the dots will be acc to the speed of the hand or finger of the body.

iii) Size & shape of the pear shaped dot will show whether body part is in acceleration or in retardation.

iv) The no. of dots will give the time taken by that part. Such a record is called chronograph.

The world of sports has used this analysis tool updated to the videos. Eg: LBW - in case of cricket is shown by the dotted lines

3) Micromotion study: i) Some motions require very small time & it is difficult to measure time for these motions accurately. But the time reqd. by these motions cannot be neglected because they are repeated lots of times. Therefore the motions are taken on the picture films with the picture camera.

ii) Very small time upto 0.005 minutes can be measured by this system.

iii) When picture camera is used the procedure is known as micromotion study. It has the following imp. advantages:

- It provides permanent record of motion study with the help of films.

- Films can be demonstrated at any desired speed.

- It gives very accurate time for each motion or operation.

then that noted by the stopwatch.

- i) Therbligs: i) Frank Gilbreth developed a set of 17 elementary motions commonly found in manual operations & called them therbligs. The reverse spelling of his name
- ii) For the purpose of recording the motions he splitted up different motions of a process into 17 fundamental elements made by various members of human body & each event was plotted a symbol & letter abbreviation.
- iii) These can be classified as effective therbligs & ineffective therbligs.
- iv) Effective therbligs: it take the work progress towards completion, attempts can be made to shorten them but they cannot be eliminated.
- v) Ineffective therbligs: they do not advance the progress of the work & therefore attempts should be made to eliminate them by applying the principles of motion economy.

Use of Therbligs:

- i) It comprises a system for analyzing the motions involved in performing a task.
- ii) The identification of individual motions as well as moments of delay in the process was designed to find unnecessary or inefficient motions & to utilize or eliminate even split seconds of wastage time.

Steps in Therbligs analysis: i) Take time to carefully observe the overall observation. ii) Try to picture the act in your mind. iii) Write description about the

- iv) Observe the for & correct action description after converting it into just hand's motion.
- v) Describe motion in more detail & fill at therblig symbols.
- vi) The therbligs are then be plotted on a simo chart.

SIMO chart: simulation chart

- i) It is a graphic representation of sequence of therbligs performed by members of operator.
- ii) It is a 2 hand process chart.
- iii) It is more accurate than other methods useful in training personal & provides a permanent record free of errors.

Production Planning Control

- ↓ Planning (Plan your work).
 - Forecasting
 - Routing
 - Scheduling
 - Loading
- ↓ - Control (Work plan)
 - Dispatching
 - Expediting / follow up.
 - Corrective action.

	Therblig	Symbol	Definition
1)	Assemble	#	Putting objects together.
2)	Search	(A)	Hunting for an object.
3)	Plan	P	Mental reaction before action.
4)	Grasp	G	Taking hold of something.
5)	Release Load	L	Releasing an object.

• Production Planning : It consists of planning the prod' activities & involving management decision to how much to produce, what materials, parts & tools are needed, what steps should be followed in the prod' process, within what time limit the prod' is to be completed & how much work is to be done by each work station. Production planning is a pre prod' activities arranging the facilities & designing the prod' system. It is based on sales commitment as to quantify delivery dates, price, quality etc.

- Objectives of production planning :
 - 1) To determine the sequence of operations which will ensure continuous prod' with least possible info.
 - 2) To issue coordinated work schedule of the prod' to the foremen of various workshops
 - 3) To maintain prod' & employment levels.
 - 4) To follow up prod' schedule to ensure that delivery promises are kept.
 - 5) To evaluate the performance of various work & individuals

Advantages of prod' planning

- 1) Efficient use of the resources.
- 2) Coordination
- 3) Achieving economy & cost saving
- 4) Customer satisfaction.
- 5) Maintenance of adequate level of inventories

Process Planning : It is a necessary step before proceeding with routing, scheduling & loading. Process planning refers to the preparation of detailed work plan, it determines the most economical method of performing the operation, it develops the broad plan of manufacturing for the component. The activities which are planned during process planning are as follows:

- 1) Selection of process
- 2) " of material
- 3) " machine tools & equipment
- 4) Sequencing of the operation
- 5) Time required for each operation
- 6) Grading of workmen required.

- Process sheet : all the particulars of process planning are entered in a sheet known as process sheet.

Process sheet

Description : Component no:
Drawing no: Assembly no:
Mat specification: Issued by:

S.No	Description of Machine Tool	Labor	Speed	Feed	Set up	standard
	code	code	code	code	time	time

- Steps of prod' planning :
- 1) Forecasting : Forecasting means estimation of the type, quantity & quality of the future works like sales. It plays a crucial role in development of plans for the future. Forecasting is required bcz it gets info. of new materials, fashion or trend.

change, competition, weather change, general economic trend in country & foreign threats

3) Routing : Routing deals with laying down of path along which material are to travel in the process of production. It determines the sequence in which various operations will be performed. Kimball & Kimball has defined the routing as the selection of path or route over which each piece is to travel being transformed from raw material into finished product. Routing includes the following activities.

- i) The volume of prod" is decided.
- ii) Available machinery & machine capacity are found out.
- iii) Path of the flow of material is decided.
- iv) On the basis of process sheet the rout sheet is prepared.

Rout Sheet : It is a map or the blue print of the manufacturing process in a "prod" unit. A route sheet determines the sequence or order of arrangement of various departments in a facility. For a new product the routing procedure consists of the following:

- i) To analyse the product into constituent parts & then decide which part is to be manufactured & which is to be purchased.
- ii) To analyse the product into components & to determine the type, grade, quality/ quantity of material to be used.
- iii) To determine the manufacturing operation & their sequence of performance.
- iv) To decide the required process time for each operation & to decide the type & no. of machines necessary to produce the parts.

v) To determine the lot size of ordered quantity
vi) To design the job cards, inspection cards, tool ticket etc

• Loading : After the rout has been established the work can be loaded against the concerned machines & equipment. Loading deals with the type of work assigned to a machine crew. It consists of the assignment of the work to the operators at their machines or work places as per the route charted out. So loading determines who will do the work as it determines where & scheduling determines when it shall be done.

The objectives of loading are:

- 1) To check the feasibility of "prod" programs.
- 2) To plan new work orders on the basis of space capacity available.
- 3) To balance the work load in the plant.
- 4) To assist in fixing of reliable delivery date promises.

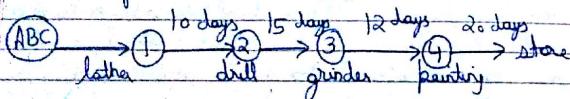
Load chart : It helps in assessing the spare capacity under load of certain department may also arise from ineffective planning. If the load chart indicate sufficient spare capacity, efforts should be directed to the sales department to obtain more orders for the utilization of spare capacity but if on the other hand there is an overload in any work station then the following actions maybe taken:

- i) Arrangement of overtime work.
- ii) Intro. of an additional shift.
- iii) Transfer of operation to another shop.
- iv) Sub contracting of excess work load.

- Scheduling : it means when & in what sequence the work will be done. It involves deciding as to when the work will start & in a certain duration of time how much work will be finished. It is concerned with time table of prod". Scheduling arranges the different manufacturing operations in order of job fixing the time & date for the commencement & completion of each operation. Objectives:
 - Meeting customer due dates.
 - Minimize the response & completion time.
 - Maximize the machine or labor utilization
 - Minimize the work in progress inventory.

The other info required to draw prod" schedule include

- Date of delivery
- Time interval required to manufacture
- Part prod" records
- Prod" capacity
- Availability of work force equipment & material
- Sales forecast

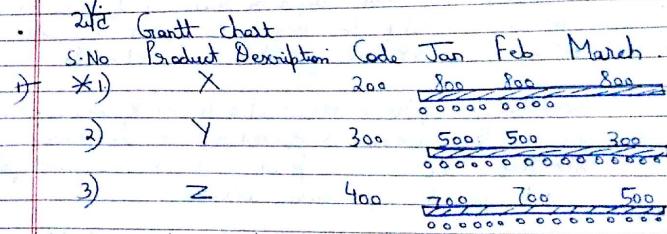


Rating & Scheduling chart.

There are 3 types of scheduling as follows:

- Master schedule : It gives the no. of units of different products to be produced for the whole year. It gives the units of prod" for every month for different products.

- Part Schedule : it gives the no. of units of different parts to be produced for the given product. The schedule is prepared for a month. It gives details of prod" for every week. This schedule is prepared on the basis of master schedule.
- Machine loading schedule : it involves allocating work load for various machines. It is time table for working of various machines. This schedule is prepared for a period of 1 week. It gives details of machine loading for everyday of the week. This scheduling is prepared on the basis of part schedule.



Master schedule for the quarter ending March 2010.

- Production Control : It is the process that measures current performance & ensures that it is as per quality standard laid down in advance, production control involves in 3 steps:

- Dispatching
- Expediting / follow up
- Corrective action

The main purpose of prod" control is that the prod" should be produced by the best & cheapest methods & it should be of the required quality & produced at right

A good control leads to less work in progress, inventory & increased prodⁿ turnover.

- Activities of production control group:

- 1) It receives work progress report.
- 2) It compares " " with schedule plan.
- 3) It removes the causes of delay in production.
- 4) It modify the schedule of plant capacities.

Dispatching is releasing of the work orders & other documents to different work to start prodⁿ activities. Expediting involves follow up of operations of various workshop to ensure that prodⁿ of goods takes place as per predetermined schedule.

Corrective measures are needed to make any system of production planning & control effective. By taking corrective measures the prodⁿ manager maintains full control over the production activities.

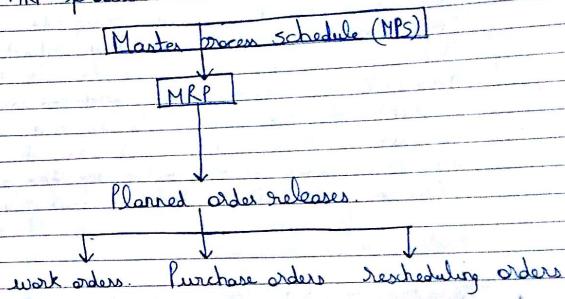
- Specifications of production requirements:

- 1) Material requirement Planning (MRP)
- 2) Enterprise Resource planning (ERP)
- 3) Capacity requirement planning (CRP)

- MRP: It is a prodⁿ planning & environment control system. It was introduced in 1970's as computerized inventory control system that would calculate the demand for component items keep the track when they are needed & generate work & purchase order that take into account the lead time required to make the items in

house or buy them from any supplier. MRP's main objective is to ensure that material is available when require & to maintain the lowest possible level of inventory.

The MRP process:



Unit 3 Inventory Management

Inventory is defined as the list of movable goods which helps directly or indirectly in a broad of goods for sale. Inventory is a stock of item kept by an organization to meet internal or external customer demand. Virtually every type of organization maintains some form of inventory. Department stores carry inventories of all the detail items they sell. A nursery have inventories of different plants, trees & flowers. Car rental agencies has inventories of car. The purpose of inventory mgmt is to determine the amount of inventory to keep a stock i.e. how much to order & when to order so that sum of all inventory cost can be minimized.

• **Inventory Control:** It means making the desired item of required quality & in required quantity available to various department when needed.

- Objectives or advantages of inventory control:
 - 1) It ensures adequate supply of material, stores etc. There is no shortage of any item at any stage of production.
 - 2) It reduces the investment in ~~inventory~~ inventory cost & losses.
 - 3) The material are protected from spoilage etc.
 - 4) There is an increase in overall efficiency of organization.
 - 5) Production schedule & delivery dates are maintained.

Types of inventories:

- 1) **Direct inventories:** The inventory which plays a direct role in manufacture of product & become an integral part of the finished product are called direct inventories. Direct inventories are classified as:
 - a) **Raw materials:** These are materials which are machined or processed before they are ready to be used in assembly of finished product. In other words they are basic material from which components, parts & products are manufactured by company. Eg: steel, copper, cotton, wood etc.
 - b) **In process inventories (work in progress inventories):** They are semi finished goods at various stages of manufacture the raw materials become work in progress at the end of first operation & remain in that classification until they become piece parts of finished goods. Work in progress can be found on conveyors & around the machines & in temporary storage awaiting for next operation.
 - c) **Purchased part:** These are some purchased items purchased from outside suppliers instead of manufacturing in the factory it self. Eg: screw, nut, ties, bolts etc.
 - d) **Finished goods:** They contain the output of production places. These are final products ready for dispatching to customers.
- 2) **Indirect inventories:** They are those materials which help the raw materials to get converted into finished products but do not become an integral part of finished product. They are classified as:

- 1) Tools: various tools used for processing are classified as
- Standard tools: used on machines such as drills, milling cutters, taps etc.
 - Hand tools: such as hammers, pliers, punch etc.
- 2) Supplies: it includes the materials used in running the plant but do not go into the product. Supplies include:
- Miscellaneous Consumable stores such as blooms, cotton waste etc.
 - Welding, soldering materials such as welding rods such as electrodes etc.
 - Oil & grease greases such as Kerosene, petrol diesel etc.
 - General office supplies such as candles, files, glasses etc.
 - Printed forms such as envelope, letter head, inquiry forms, Vouchers etc.
- Inventory cost: There are 3 basic cost associated with inventory.
- Carrying / holding cost:** These are the cost of holding the inventory. These cost vary with the level of inventory & occasionally with the length of time the item is held i.e. the greater the level of inventory over the period of time the higher carrying cost. Carrying cost can include the cost of direct storage such as rent, heating, cooling, lighting, security, refrigeration, record keeping, transportation, interest on loans used to purchase inventory, product deterioration & spoilage & taxes. Carrying cost are normally specified in 2 ways:
The usual way is to calculate total carrying cost by summing up all individual costs mentioned above on per unit & time basis. Eg: ₹ 10/unit per year, the other way is to express as the % of the value.

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of an item or as a % of avg. inventory value. Eg: 10% of the value

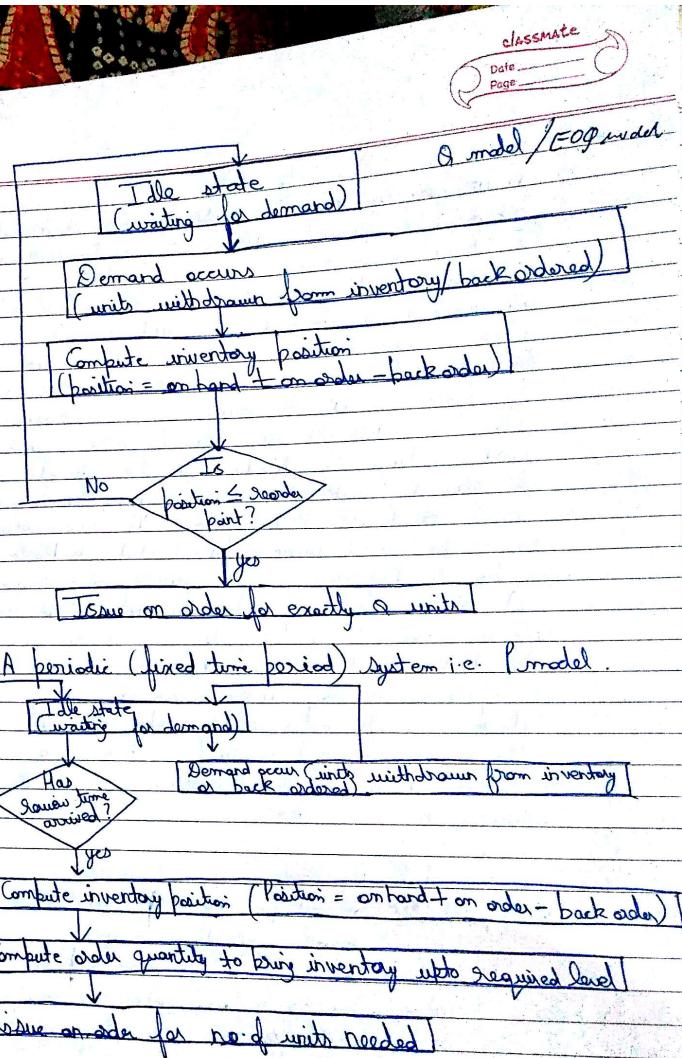
2) **Ordering Costs:** They are associated with replenishing the stock of inventory being held. These are normally expressed as a fixed amount per order. Ordering cost vary with the no. of orders made. As the no. of order increases the ordering cost increases. Cost incurred each time an order is made can include Requisition & purchasing orders, transportation & shipping, inspection, accounting & auditing etc. Ordering cost generally react inversely to the carrying cost. As the size of the order increases fewer orders are required reducing ordering costs, however ordering larger amounts results in higher inventory levels & higher carrying costs. In general as order size increases ordering cost decreases & carrying cost increases.

3) **Shortage / Stockout cost:** It occurs when customer demand cannot be met because of insufficient inventory. If these shortages result in a permanent loss of sales, shortage cost include the loss of profit. It can also cause customer dissatisfaction & the loss of goodwill that can result in permanent loss of customer & future sales. In some cases the inability to meet customer demand or lateness in meeting demand results in penalties in the form of price discounts or rebates. When demand is intermittent the shortage can cost work stoppages in the "lead" process & create delays resulting in the cost of lost production. Cost resulting from lost sales because demand cannot be met are more difficult to determine than carrying or ordering costs. Shortages occur because of carrying inventory is costly as a result shortage cost have an inverse relationship with carrying cost.

Relationship to the carrying cost is the amount of inventory on hand increases the carrying cost increases whereas shortage cost increases.

- Inventory control system: A firm controls the level of inventory by determining how much to order & when to order. There are 2 basic types of inventory cycle.

- 1) A continuous (fixed order quantity system) i.e. Q model: It is also referred as perpetual system & a fixed order quantity system, a continual record of inventory level is maintained, whenever the inventory on hand decreases to a predetermined level referred to a reorder point - a new order is placed replenish the stock of inventory. The order i.e. placed is for a fixed amount that minimizes the total inventory costs. This amount is known as economic order quantity. A key feature of continuous system is that the inventory level is continually monitored so management always knows the inventory level or stock. This is advantageous for critical items such as replacement parts of raw materials & supplies. However maintaining a continual record of the amount of inventory on hand can also be costly. Eg: Computerized checkout system with a laser scanner used by many supermarkets & retail stores. The laser scanner reads the barcode from product packet. The transaction is instantly recorded & the inventory level updated. Such a system is not only quick & accurate. It also provides management with continuously updated info. on the status of inventory level.



In an periodic inventory system also referred to as fixed time period system or periodic review system. The inventory on hand is counted at specific time intervals. Eg: every week or at the end of each month. After the inventory in stock is determined an order is placed for an amount that will bring inventory back up to a desired level. In this system the inventory level is not monitored at all during the time interval b/w orders. So it has the advantage of little or not required record keeping. The disadvantages less direct control. This typically results in larger inventory levels for a specific periodic inventory system than in a continuous system to guard against unexpected stockouts early in the fixed period. Such a system also requires that a new order quantity be determined each time a periodic order is made. Eg: College or university book store, textbooks are normally ordered according to a periodic system where in an account of textbook in stock is made after session ends. An order for new textbooks for the next session is then made according to course enrollment for the next term & the amount remaining in the stock.

Feature	Q Model	P Model
Order Quantity	$Q = \text{Constant i.e. the same amount ordered each time}$	$Q = \text{Variable i.e. the amount varies each time order is placed}$
When to place order	when inventory position drops to the reorder level	when the review period arrives.

- 3) Record keeping each time a withdrawal or addition is made Counted only at a review period.
- 4) Size of the inventory less than P model larger than a model
- 5) Type of items higher priced, critical general items or a low item
- Economic Order: The economic order is a continuous or fixed order quantity system where inventory reaches a specific level referred to as reorder point a fixed amount is ordered. The most widely used for determining how much to order in a continuous system is EOQ model. The function of EOQ model is to determine the optimal order size that minimizes total inventory costs. Some of the assumptions under this model are as follows. Demand is known with certainty & is const. over time. No shortages are allowed. The order quantity is received all at once. Demand for the product is const. & uniform throughout the period.

Total annual cost = Annual purchase cost + Annual holding cost + annual holding cost.

$$TC = DC + D/Q \cdot S + \frac{Q}{2} \cdot H$$

TC = Total annual cost.

D = annual demand.

C = Cost per unit

Q = qty. to be ordered.

S = cost of placing an order.

H = annual holding cost.

$$\frac{\partial T_c}{\partial Q} = 0 + \left(-\frac{DS}{Q^2} \right) + \frac{H}{2} = 0$$

$$\text{EOQ. } Q_{\text{opt}} = \sqrt{\frac{2DS}{H}}$$

Deterministic Models:

These items are based on the assumption that the demand as well as lead time of an item are known with certainty. In these models the stock is replenished as soon as the stock reaches the point of exhaustion because of the assumptions underlying them. The various assumptions in deterministic models are as follows:

- 1) The demand of the item is known exactly for a given period of time.
- 2) Orders are received instantaneously.
- 3) Items can be purchased freely/without cost.
- 4) The cost of placing an order is fixed. It does not varies with lot size.
- 5) The inventory carrying charges are of ordered quantity.
- 6) The item has fairly longed shelf life. There is no fear of deterioration or spoilage.