Semester - 6 (1625604) Production technology / Production planning and control & Process planning (Unit - 03, 04)

- Production planning involves management decisions on the resources that the organization will require for its manufacturing operations and the selection of these resources to produce the desired goods at the appropriate time and at the least possible cost.

- It is the judicious utilization of the resources in order to meet the desired quality standards, to meet the quantity levels desired as well as focus on the cost and time aspects also.

Objectives of PPC.

- To determine the requirements of men, material and equipment.
- Arranging production schedules according to the needs of marketing demand.
- Arranging various inputs at a right time and in right quantity.
- To ensure maximum utilization of all resources.
- To maintain optimum level inventory.
- Coordinate between labour and machines and various supporting departments.

Process planning

For manufacturing a product, required process needs to be planned. Process planning is used in determining the most economical method of performing an activity.

- For carrying out process planning following informations are required:

(i) Quantity of work to be performed
(ii) Detailed specification of the product.
(iii) Quality of work
(iv) Availability of equipments, tools and manpower with period
(v) Sequence of operations to be performed.
(vi) Standard time for each operation.

Steps involved in process planning.

1. Most economical process is selected depending upon: current production commitments, delivery date, quantity to be produced, quality standards.
2. Selection of materials, right quality, shape and size of raw material.
3. Selection of jigs, fixtures and special attachments.
4. Selection of cutting tools.
5. Selection of inspection gauges.
6. Documentation of process i.e. for operation, route sheet etc.

: Factors affecting process planning :

1. Volume of production
2. Delivery rates of products
3. Accuracy and process capabilities of machines
4. The skill and expertise of man power.
5. Material specifications
6. Accuracy requirements of components and parts.

* Operation sheet – A detailed listing of all components related to a particular process. often including elements like design, manufacturing and distribution.

- A standard operation sheet will provide an estimate of the time required to complete each stage.

* Functions of Production, planning and control: –

1. Planning
2. Routing
3. Scheduling
4. Despatching
5. Follow up
6. Inspection

1. **Planning**: Before starting any work, it is necessary to plan the things properly for getting best results.
   - Planning department decides about each element of the job in anticipation that what work shall be done, where, how and when it shall be done.

* The functions of planning are grouped as under:

(a) Investigation about the complete details and requirements of the product to be manufactured.
(b) Pre determination of future achievements.
(c) Planning and design of product going to be manufactured.
(d) Planning about the quality and quantity of materials which are to be consumed.
(e) planning about sequence of operation, capacity of equipments and internal transportation etc

2. **Routing** :- Routing lays down the flow of work in the plant. It determines what work is to be done and where and how it will be done. Taking from raw material to the finished, routing decides the path and sequence of operations to be performed on the job from one machine to another.

- The difference between ~~and~~ an operation sheet and a route sheet is that an operation sheet remains same for the components if the order is repeated but the route sheet may be revised if certain machines are already commited to other orders on hand.

3. **Sequencing and Scheduling** :—

Scheduling. - Scheduling is used to allocate resources over time to accomplish specific tasks. It should take account of technical requirements of tasks, available capacity and forecasted demand. The forecasted demand determines plan for the output, which tells us when products are needed. The output plan should be translated into operations, timing and schedule on the shop floor. This envolves loading, sequencing, detailed scheduling, expediting and input/output Control.

Sequencing :- When number of jobs are waiting in a queue before an operational facility (ex- a milling machine), there is a need to decide the sequence of processing all the waiting jobs.

- Sequencing is basically an order in which the jobs, waiting before an operational facility, are processed. For this, priority rule, processing time etc. are needed.

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Unit - 04 continued.....

* Rules of sequencing :-

1. one job on one machine at a time.
2. One job will be processed only if the previous job is completed.
3. Time taken for one job for moving from one machine to another is negligible.
4. If no order is mentioned, then processing order given will be fixed.
5. The processing time for the job remains unchanged irrespective of the order.

Rules: (1) Shortest processing time :-

ex

Jobs	Processing time	Due date
1	5	10
2	8	12
3	3	11
4	7	18

Seq^n based on this rule:

Jobs	Processing time	Job flow time	Due date	Lateness
3	3	3	11	0
1	5	8	10	0
4	7	15	18	0
2	8	23	12	11
	23	49		11

Make span time = 23 days

Total job flow time = 49 days

Average job flow time = $\frac{49}{4} = 12.25$

Total lateness/tardiness = 11 days

Average lateness/tardiness = $\frac{11}{4} = 2.75$ days

* jobs will be completed in increasing order of their processing time.

J_3	J_1	J_4	J_2

- **Job flow time:-** It is the time period between the starting point and the time when the job is completed.

- **Make span time:-** It is the time from when processing begins on the first job until the last job is completed from the set.

- **Due date :-** It is the date given to the customer after which order can be collected.

- **Average number of job in the system :-** It is used to represent the avg. number of jobs present all the time within which entire set of job is completed. In other words it is the ratio of total job flow time over make span time.

  ∴ Avg. no. of jobs in the system = $\frac{\Sigma TFT}{MST} = \frac{49}{23} = 2.13$ days

Rule 2 **Earliest due date (EDD) :-**

jobs will be completed in increasing order of its due date.

J_1	J_3	J_2	J_4

Rule 3 **Critical ratio rule (CRR) :-**

$C.R. = \frac{\text{Due date}}{\text{Processing time.}}$

J_2	J_1	J_4	J_3

→ in increasing order of its C.R.

Rule 4 **Slack time remaining (STR) :-**

Slack time = Due date − Processing time.

J_2	J_1	J_3	J_4

Rule 5

First come first serve (FCFS)

J_1	J_2	J_3	J_4

Last come first serve (LCFS)

J_4	J_3	J_2	J_1

Que. Find the proper sequence of jobs for the given processing times-

Job	Processing time	Due date
1	4	6
2	7	9
3	2	19
4	8	17

Sol: A/c to shortest processing time, sequence of job -

J_3	J_1	J_2	J_4

Job	processing time	Due date	job flow time	Tardiness
3	2	19	2	0
1	4	6	6	0
2	7	9	13	4 (13-9)
4	8	17	21	4 (21-17)
	21		42	

Total tardiness = 8 days

A/c to earliest due date, sequence of job -

J_1	J_2	J_4	J_3

Job	Processing time	Due date	Job flow time	Tardiness
1	4	6	4	0
2	7	9	11	2
4	8	17	19	2
3	2	19	21	2
			Total job flow time = 55	6 days

(3)

* N-jobs - 2 Machine (Johnson's Rule)

Ex Give table shows processing time of different jobs on different machines

Jobs	M1	M2
J_1	3	5
J_2	6	4
J_3	8	7
J_4	2	9
J_5	4	3

Determine % idle time and % utilization time for each machine.

Soln

Step-1 - select the minimum time of the matrix and if it appears for the first machine, process it first and if it appears for the second machine, process it last.

Step2 - If there is a tie, see the processing time of the other machine and whichever product has got minimum ~~processing~~ processing time then take the decision on that job first.

So,

J_4	J_1	J_3	J_2	J_5

Jobs	M_1	M_2
J_4	2	9
J_1	3	5
J_3	8	7
J_2	6	4
J_5	4	3
	23	28

Jobs	M_1		M_2	
	In	out	In	out
J_4	0	2	2	11
J_1	2	5	11	16
J_3	5	13	16	23
J_2	13	19	23	27
J_5	19	23	27	30

Make span time = 30 hour

% utilization of M_1 = $\frac{23}{30} \times 100 = 76.67\%$

% " " M_2 = $\frac{28}{30} \times 100 = 93.3\%$

% idle time for M_1 = 23.33% ⇒ 7 hours

% idle time for M_2 = 6.7% ⇒ 2 hours

Gantt chart

- charts used to represent the idle time of a machine.

Ex: IES-97

There are two machines M_1 and M_2 which process jobs A, B, C, D, E, F their processing times are given below. Sequence the jobs and also prepare Gantt chart.

Jobs	M_1	M_2
A	4	11
B	7	7
C	3	10
D	12	8
E	11	10
F	9	13

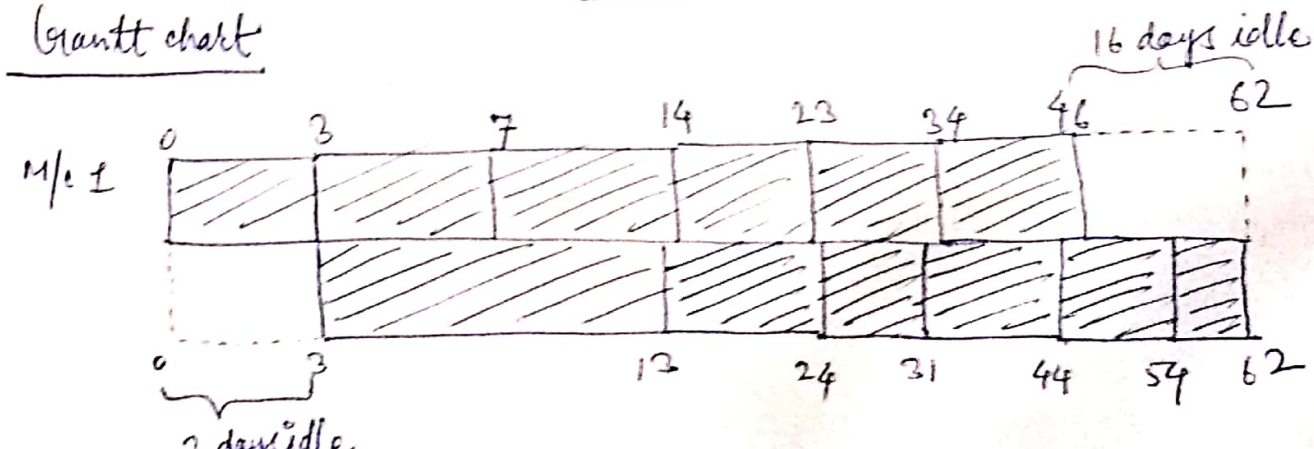
Soln

C	A	B	F	E	D

Jobs	M_1	M_2
C	3	10
A	4	11
B	7	7
F	9	13
E	11	10
D	12	8

Jobs	M_1		M_2	
	In	out	In	out
C	0	3	3	13
A	3	7	13	24
B	7	14	24	31
F	14	23	31	44
E	23	34	44	54
D	34	46	54	62

Gantt chart



Idle time for M/c 1 = 16 days, idle time for M/c 2 = 3 days (5)

Despatching :- It is the physical handing over of a manufacturing order to the operating facility (a worker) through the release of orders and instructions in accordance with a previously developed plan of activity (time and sequence) established by the scheduling section of the production, planning and control department.

- It excludes planning function.
- It is concerned with getting the work started.
- Dispatching ensures that the plans are properly implemented.

Line balancing (or) Assembly line balancing.

- It is also known as assembly line balancing.
- **Assembly line** → In an assembly line the work facilities are grouped into particular work station so as to minimize the idle time and increase the utilization of man power and machine.
- By this method idle time is reduced.

Terminology

1. **Work element**: Every job is completed by a set of operation. Each job which is to be performed on the workpiece is known as work element.
2. **Task time** (T_e): Standard time to perform on work element.
3. **Work station**: Specific location on assembly line, where given amount of work is performed.
4. **Station time**: (T_{si}) - It is equal to the sum of processing time of operation on a particular work station.
5. Total work content (T_{wc}) - It is equal to the sum of processing time of each operation that is to be performed on the job.

$$T_{si} = \sum T_i \qquad T_{wc} = \sum T_{si}$$

6. **cycle time** – (T_c) – It is the time between two successive assemblies coming out of a line.

$$T_c \geq \max\{T_{si}\}$$

7. Precedence diagram :- This a diagram in which the work elements is shown as per their sequence relations.

8. Balance delay (BD) - It is the measure of line-inefficiency. It can't be negative.

$$B.D. = \frac{n \cdot T_c - T_{wc}}{n \cdot T_c}$$

where, n = No. of work stations

9. Line efficiency (η_L) :-

$$LE = \frac{\sum_{i=1}^{n} T_{si}}{n \times T_c} \times 100\% = 100 - B.D.\%$$

$$\Downarrow$$

$$\frac{T_{wc}}{n \cdot T_c} \times 100\%$$

10. Smoothness index (S.I.) -

$$S.I. = \sqrt{\sum_{i=1}^{n} \left(Max^m T_{si} - T_{se} \right)^2}$$

11. Idle time at each work station :- $T_c - T_{si}$

12. Theoretically minimum no. of work station -

$$n_{min.} = \frac{T_{wc}}{T_c}$$

S.N.	T_i	Precedence
1	4	—
2	3	1
3	6	2
4	3	3
5	5	4
6	4	1
7	7	6
8	2	7
9	3	7
10	3	8, 9
11	6	10

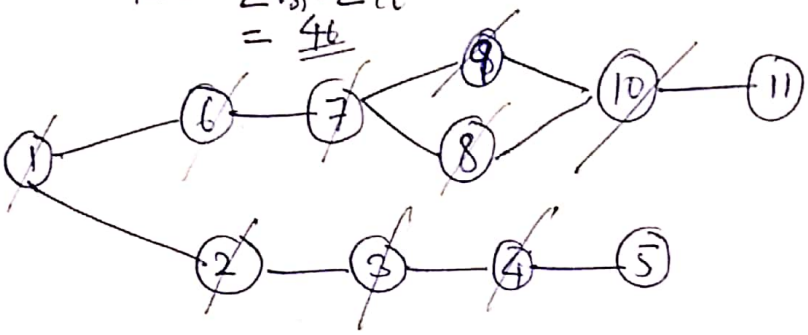
Let cycle time (T_c) = 12 min.

Calculate suitable number of Work stations, Balance delay, Line efficiency and Smoothness index.

$T_{we} = \sum T_{si} = \sum T_i$

$= 46$

Ref:



minimum no. of Work stations $= \frac{T_{we}}{T_c} = \frac{46}{12} = 3.83 \rightarrow 4$

Work stations	Work element	T_i	T_{si}	$(T_c - T_{si})$ idle time (ex) Delay
I	1	4	11	12 − 11 = 01
	6	4		
	2	3		
II	7	7	12	12 − 12 = 0
	9	3		
	8	2		
III	3	6	12	12 − 12 = 0
	4	3		
	10	3		12 − 11 = 1
IV	11	6	11	
	5	5		

Now Balance delay (BD) $= \frac{n \times T_c - T_{wc}}{n \times T_c} = \frac{4 \times 12 - 46}{4 \times 12} =$ 4.16 %

Line efficiency $(\eta_L) = 100 - BD\%$

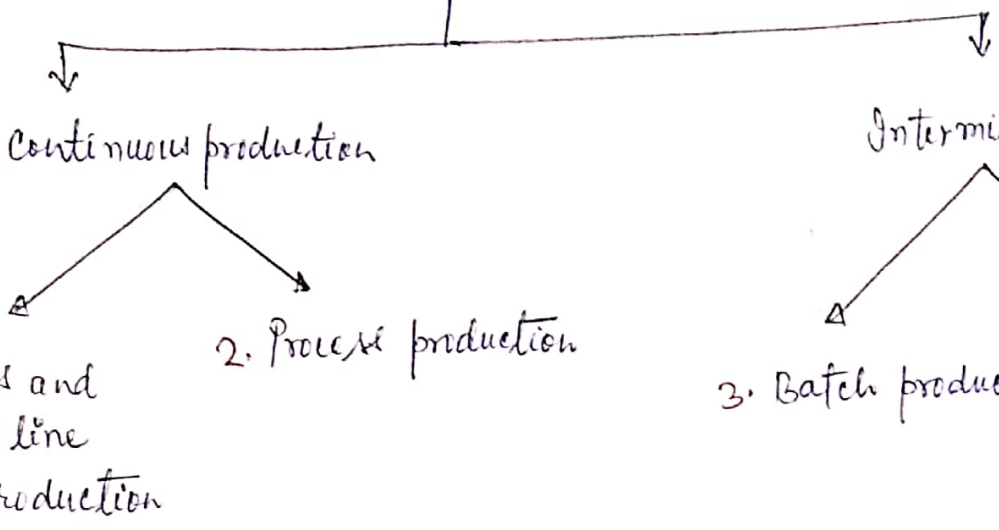
$= 100 - 4.16 =$ 95.84 %

$$\frac{\text{Smoothness index}}{\sqrt{\sum_{i=1}^{n} \left(\text{Max } T_{si} - T_{si}\right)^2}} = \sqrt{(12-11)^2 + (12-12)^2 + (12-12)^2 + (12-11)^2} = \sqrt{2}$$

(4)

Types of production

- production can be continuous or intermittent.



- **Continuous production** → It involves a continuous physical flow of material.
  - → It uses special purpose machine.
  - → It produces product in large quantity.

- **1. Mass production**
  - → It involves large volume and low variety. In mass production the production cycle involves one or more operation on a single machine. eg. Bottles, cans, nuts, bolts, screws etc.
  - → If multiple operation are performed on more than one machine then it is known as flow-line production. eg. Automobiles, Air conditioners, TV sets etc.
  - → Machinery is laid as per the sequence of production.
  - → It offers lowest production cost per unit.

characteristics of mass or flow line production —

1. High volume low variety
2. Flow of material is continuous.
3. Material handling is mechanized.

4. Lower work in process inventory.
5. Special purpose machine is used.
6. Shorter cycle time due to line balancing.
7. Low skilled person can manage work.
8. Flexibility of machine and man is less.

2. Process production

- Process production is useful where the product gets consumed fast such as electricity, petrol, chemicals etc, and has continuous demand.
- Plant layout is as per the requirements of production.

characteristics of Process production –

1. Fully automatic material handling.
2. Shorter lead time.
3. Both type of workers, i.e semiskilled and skilled are employed.
4. Zero flexibility and dedicated plants are required.

Intermittent production :

- In this production material flow will be intermittent (रुक-रुक कर).
- It uses general purpose machines.
- Production volume involves small quantity, ex- Machine repair shop, maintenance shop, welding stores etc.
- It can be classified as – Batch production & job-order production.

3. Batch production -

- In batch production the manufacturer produces limited number of products at regular intervals.
- This type of production is used when the production rate exceeds the demand rate.

The quantity in batch production are decided on the basis of two costs-

1. set-up cost 2. Inventory cost.

Characteristics of batch production :-

1. Shorter production runs.
2. Articles are manufactured in batches or lots as per order.
3. Plants and machines are flexible.
4. High work in process inventory.
5. Material flow is intermittent.
6. Plant layout is of the process type.
7. Process and product planning is done for each batch.
8. Expediting and corrective ~~actb~~ actions are very necessary.

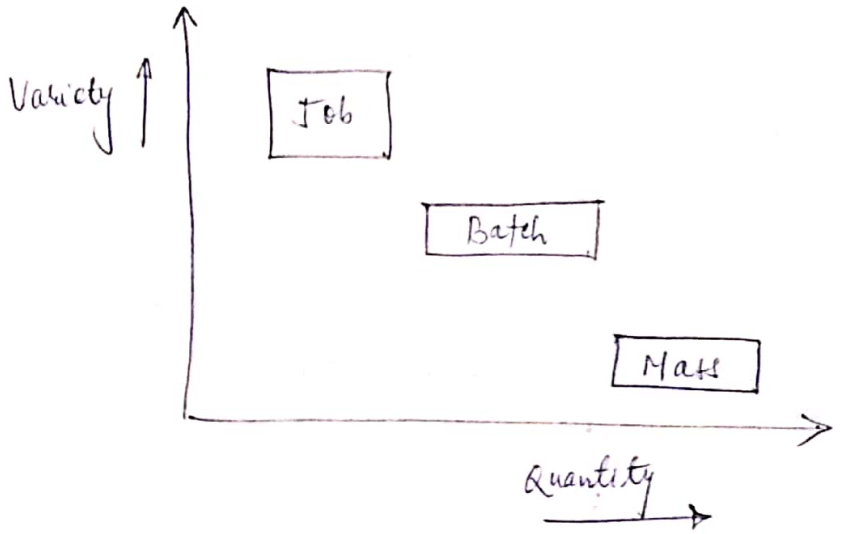
4 Job-order production

- Flow of material and parts from one location to another is intermittent or discontinuous.
- Each job order is different from previous at regard its type, specifications, quality and quantity.
- The manufacturing quantity will be less but all the specifications will be met.
- High variety and low production volume. The number of items to be manufactured is very small, it may be even one.
- Products like a special purpose machine equipment, an uncommon material handling device, a special heat treatment furnace, space vehicles, construction equipment, Aircraft manufacturing etc are job-order production items.

Characteristics of job-order production —

1. Flow of material is discontinuous.
2. High variety - low volume.

3. General purpose machines and flexible layout are preferred
4. Highly skilled labour is required.
5. Large work in process inventory.
6. Lead time is large.
7. Manufacturing cycle time will be more.
8. Flexible material handling system.



Plant layout

- Plant layout begins with the design of factory building and goes up to the location and movement of the work table. All the facilities like equipments, raw materials, machinery, tools, fixtures, workers etc are given a proper place.
- In a good plant layout bottlenecks and points of congestions are eliminated so that it permits materials to move through the plant at the desired speed with the lowest cost.
- The types of layout are —

1. Process (or) Functional layout
2. Product (or) Line layout
3. Combination (or) Mixed layout
4. Fixed position layout

Process or Functional layout :

- It is characterized by keeping similar machines or similar operations at one location. In other words, all lathes will be at one place, all milling machines at another and so on--
- Process layout generally employed for industries engaged in job order production and non-repetetive kind of maintenance or manufacturing activities.

Advantages :

(1) Flexibility of equipment (2) Low investment (3) Higher utelization of production facilities (4) workers of one section are not effected by the operation at another section.

(5) It gives better product quality, because supervisors and workers attend to one type of machine and operation.

Disadvantge:

1. work in process inventory is large.
2. Automatic material handling is difficult.
3. More space required.
4. Movement of jobs will be long and due to which material handling becomes difficult and idle time increases.

2. Product or line layout :—

- It implies that various operations on raw materials are performed in a sequence and the machines are placed along the product flow line, i.e. machines are arranged in which the raw materials will be operated upon.
- This type of layout is preferred for continuous production i.e. involving a continuous flow of in process material towards the finished product stage.

Advantages:

1. Material handling cost is less due to straight flow.

5. Product is processed at a lesser time due to reduced idle time.
3. Work in process inventory is less.
4. Less space requirements.
5. Unskilled workers can manage the production.
6. Smooth and continuous product flow.

Disadvantage ?

1. Large capital invested
2. Lack of layout flexibility
3. Use of C.P.M. will increase the cost.
4. If one of the machine in line fails then the entire line will come to a stand still.

3. Combination (or) Hybrid (or) Mixed layout —

- It is a combination of process and product layout.
- It takes advantage from both types of layout.
- In combination layout, the process layout is used to produce different parts in various operations and then final assembly of the product is done by product layout.
- Therefore it can be said that in combination layout the processing involves process layout and assembly involves product layout.

4. Fixed-position layout: —

- In fixed position layout the man, machine and equipments ~~with~~ are moved to the place where large workpiece is kept. Such as railway coaches, aircrafts, ship buildings, big pressure-vessel fabrication etc.
- In fixed layout the product will be manufactured at stationary position, where as machine will move from point to point in case of production flow.

Advantage:

1. It involves least movement of material

2. Layout capital investment is lower.
3. Possible to assign one or more skilled workers to a project in order to ensure the continuity.

Disadvantage:

1. Low utilization of labour and equipment.
2. Involve high equipment handling cost.