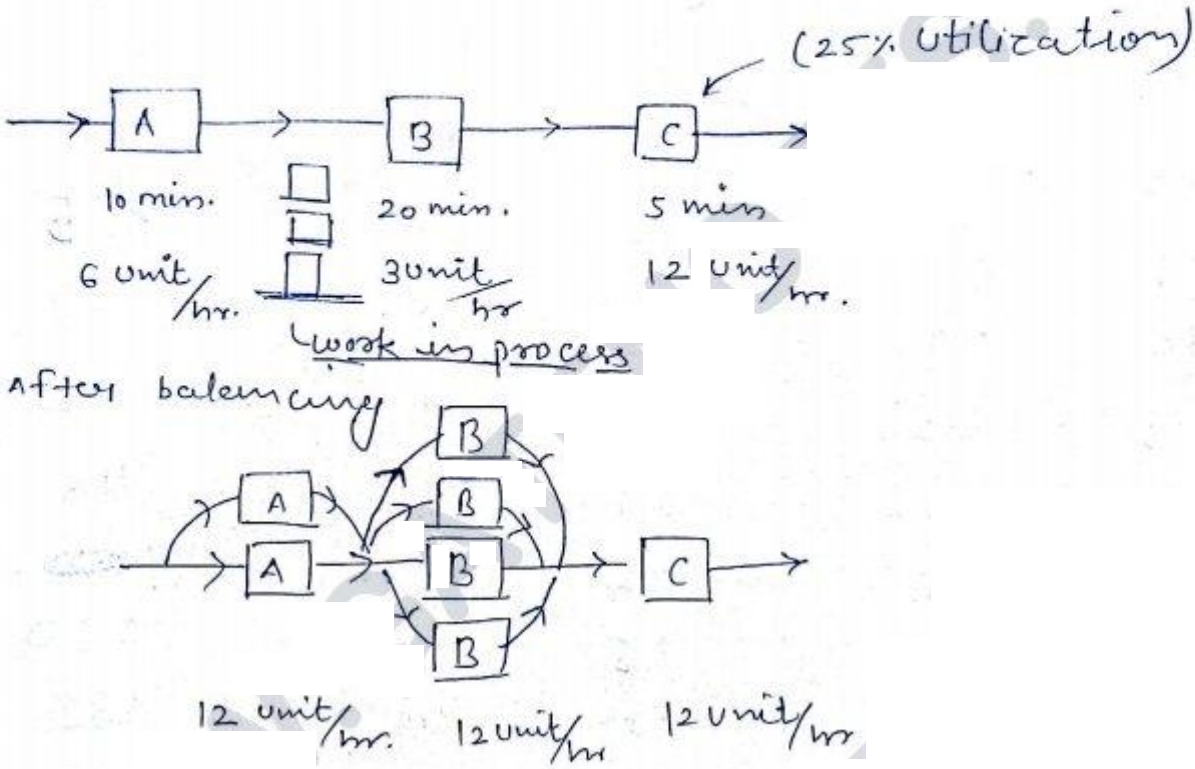
Line Balancing

(Assembly line Balancing)



$$\eta_{system} = \frac{\text{Actual output}}{\text{Installed Capacity}}$$

The aim of assembly line is to group different facalities and equipment into different work station in such a manner that idle time is minimize and utilization is optimise.

Advantages :-

1) Reduction in work in processes inventory
2) Decreasing in material handling
3) Effective utilization of man power and machine

4) Uniform rate of production.

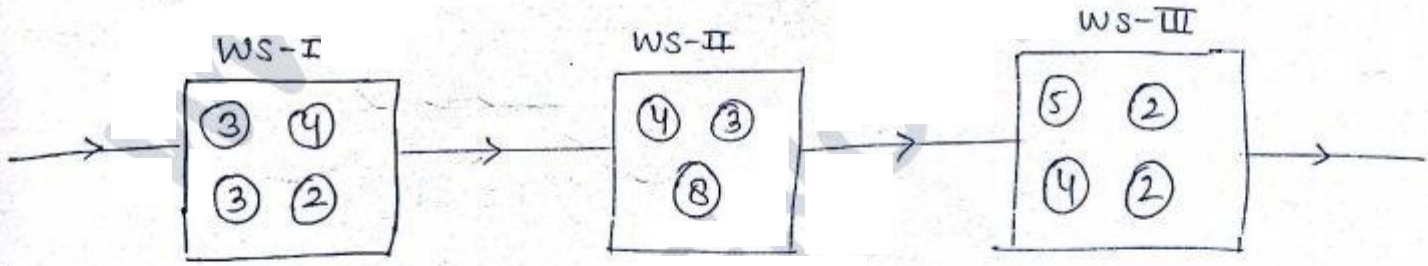
5) Easy production control.

Term in line balancing :-

1. Work element :- Every job is completed by a set of operation and each operation which is performed on the job is called work element.

2. Task Time :- (T_i) It is a standard time require to complete work element.

3. Work station :- It is a specific location on the assembly line where the given amount of work element are completed within a fix period of time.



T_{SI} = 12 min T_{SII} = 15 min T_{SIII} = 13 min

TWC = 40 min total 11 work element

4. Station time (T_{si}) It is the time require to complete work element assigned in a work station.

5. Total work Content (TWC) It is the time require to complete one set of job it is given by either the summation of all the station time or the summation of elemental task time. $TWC = \Sigma T_{si} = \Sigma T_i$

6) Cycle time :- (T_c) It is the amount of time for which a job is to be assembled remain in a work station. It is the time gap between two successive product coming out from the assembly line.

$$T_c \geq (T_{si})_{max}$$

7) Balance Delay (BD):- It is the ratio of idle time of the job on the assembly line to the total time spend by the job on the assembly line.

Balance delay

$$B.D.\% = \left(\frac{n\,T_c - TWC}{n\,T_c}\right) \times 100$$

n – no. of work station

TWC - total work content

T_c - cycle time

e.g. $n = 3$, $T_c = 16$ min, $TWC = 40$ min

$$B.D. = \left(\frac{3 \times 16 - 40}{48}\right) \times 100 = 16.67\%$$

8) line efficiency :- (η_L)

$$\eta_L = \frac{TWC}{n.T_C} \times 100 = 100 - B.D.\%$$

9) Smoothness index (SI) :- It is a term used to represent the load distribution between the different work station compare to station consuming maximum time.

$$SI = \sqrt{\sum_{i=1}^{n} (\text{Maximum station time} - \text{station time})^2}$$

$$SI = \sqrt{\sum_{i=1}^{n} \left[(T_{si})_{max} - T_{si}\right]^2}$$

e.g. :- $SI = \sqrt{(15-12)^2 + (15-15)^2 + (15-13)^2}$

$$SI = \sqrt{13}$$

10) Minimum Number of work station require.

$$\eta_{min} = \frac{TWC}{T_C}$$

e.g. $\eta_{min} = \frac{40}{16} = 2.5 \simeq 3$

(Always higher side)

Methods of line balancing :-

There are several method the most prefferd on

Largest Condidate Rule :-

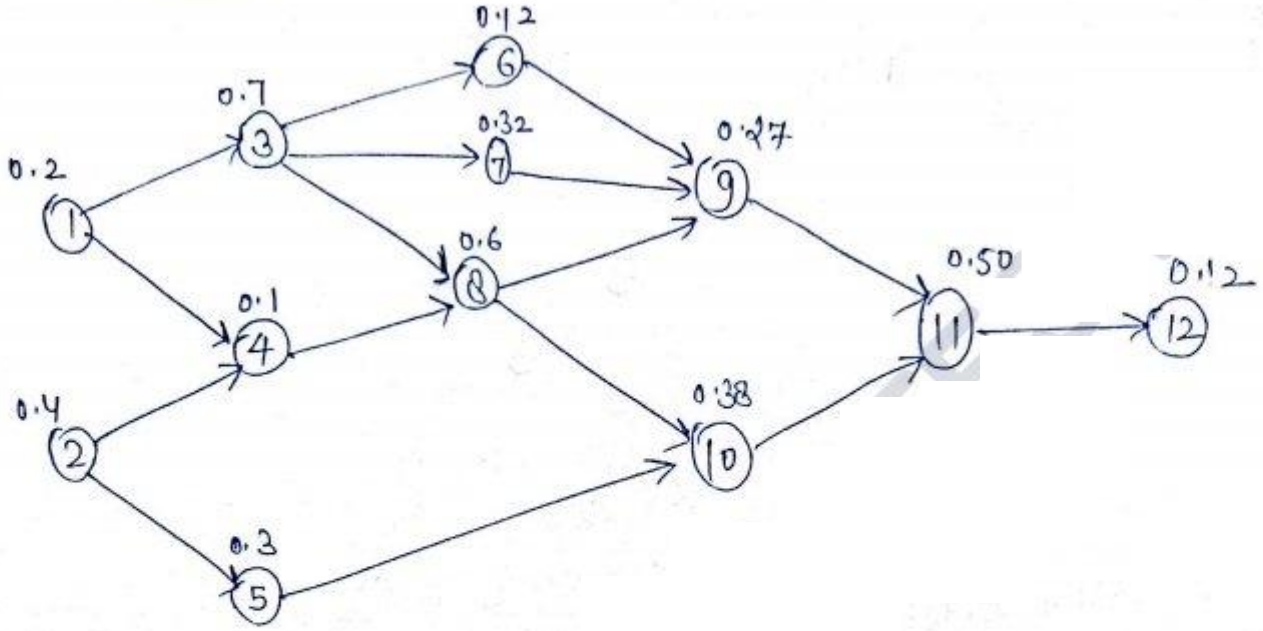
The steps involved are

1. List All the element in the decreasing order of ~~there~~ their task time
2. To assign an element in a work station Start from the begaining of the list moveing downward searching first feasible element which can be placed in a work station. Feasible element one that satisfied precedence requirment and when that element placed in work station. The total time of work station should not exceed the cycle time.
3. Strike of the element which is assigned so that it can not be considered again Continue in the similar manner until all the element are assigned to the work station

roblem 34 for the following set of element draw the precedence diagram balance the line and determine Balance delay, line efficiency, Smoothness index take the cycle teime at T_c = 1 min

element	1	2	3	4	5	6	7	8	9	10	11	12
Tume (min)	0.2	0.4	0.7	0.1	0.3	0.12	0.32	0.6	0.27	0.38	0.50	0.12
Precedence	–	–	1	1,2	2	3	3	3,4	6,7,8	5,8	9,10	11

Activity on Node



List all element in decreasing order of task time

Element	T_i (min.)	Precedence
3	0.7	1
8	0.6	3, 4
11	0.5	9, 10
2	0.4	—
10	0.38	5, 8
7	0.32	3
5	0.3	2
9	0.27	6, 7, 8
1	0.2	—
6	0.12	3
12	0.12	11
4	0.1	1, 2
	4.01	

T_c = 1 min.

WS	element	T_i	T_{si}	idle
I	2	0.4	1	0
	5	0.3		
	1	0.2		
	4	0.1		
II	3	0.7	0.82	0.18
	6	0.12		
III	8	0.6	0.98	0.02
	10	0.38		
IV	7	0.32	0.59	0.41
	9	0.27		
V	11	0.5	0.62	0.38
	12	0.12		

$$\text{Balance delay} = \left(\frac{nT_c - TWC}{nT_c}\right) \times 100$$

$$= \left(\frac{5 \times 1 - 4.01}{5}\right) \times 100$$

$$B.D.\% = 19.8\%$$

$$\text{Line efficiency} = \frac{TWC}{nT} \times 100 = \frac{4.01}{5} \times 100 = 80.2\%$$

$$\text{or } \eta_l = 100 - B.D = 100 - 19.8 = 80.2\%$$

$$SI = \sqrt{(1-1)^2 + (1-0.82)^2 + (1-0.98)^2 + (1-0.59)^2 + (1-.62)^2}$$

$$= \sqrt{0 + (0.18)^2 + (0.02)^2 + (0.41)^2 + (0.38)^2}$$

$$SI = 0.5876$$