ODD	X	EVEN		
2004	-2	2004	-2.5	-5
2005	-1	2005	-1.5	-3
* 2006	0	2006	-0.5	-1
2007	1	2007	0.5	+1
2008	2	2008	1.5	+3
	$\Sigma x = 0$	2009	2.5	+5

72

k

LINE BALANCING (Assembling)

It aims at grouping the task or workers. In an effective manner in order to obtain optimum utilisation of Man-Power & machine & to minimise Ideal time.

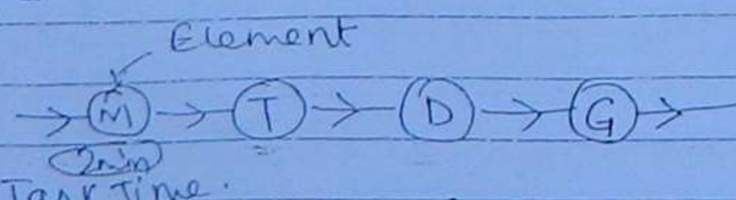
Task are grouped so that there total time is preferrably equal to or a little lesser than the time available at each work station. This reduces the ideal time.

Advantages :-

1. Uniform rate of production.
2. less material handling.
3. Less work in process inventory.
4. Effective Utilisation of man power & machine.
5. Easy production control.
6. less ~~tran~~ conjestion within production system.

Terminology :-

1. Work Element :



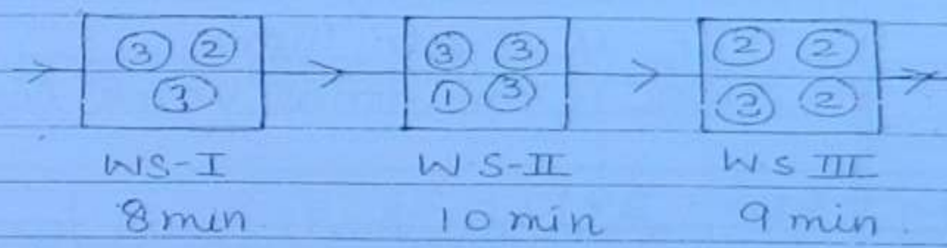
* Cycle time ≥ max. Workstation Time.

Each job is completed by a set of operations & each operation which is to be performed on the job is called Work Element or ~~Straight~~ simply Element

(73)

2. Task Time : It is the standard time require to complete elemental task. (T_i)

3. Work Station :
(2) ⇒ time (2 mins)



It is a specific location on the assembly line where given amount of elemental task are performed and the summation of all elemental task time is known as Work station time.

4. Total Work Content : It is equal to the sum of processing time of each operation that is to be performed on the job

5. Cycle Time : It is the amount of time for which a given job remains with an operator on the assembly line or it may be defined as the time between two successive product coming out of assembly line.

NOTE : Minimum possible cycle time can be equal to maximum work station time.

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

Date :

BALANCE DELAY (B.D)

It is the measure of line ineffectiveness. It is the ratio of total ideal time over the total time spend by the job on the assembly line.

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

74

Where, n is no. of workstations
T_c is cycle Time.
TWC is the total Work Content.

e.g. $BD = \frac{3 \times 10 - 27}{3 \times 10} = \frac{3}{30} = \frac{1}{10} \Rightarrow 10\%$

LINE EFFICIENCY

$$\text{Line } \eta = \left(\frac{T.W.C}{n \cdot T_c}\right) \times 100 = 100\% - BD\%$$

e.g. 90%

SMOOTHNESS INDEX (S.I)

$$S.I = \sqrt{\sum_{i=1}^{n} (\text{Maximum station time} - \text{Station time})^2}$$

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

It tells how the load is distributed between diff. work station.

e.g. $S.I = \sqrt{(10-8)^2 + (10-10)^2 + (10-9)^2} = \sqrt{5}$

Page No.
Date :

THEORITICALLY MIN NO. OF W.S REQUIRE

Theoretically, minimum No. of Work Station Required

$$n_{min} = \frac{TWC}{T_c}$$

e.g $n_{min.} = \frac{27}{10} = 2.7$

75

Methods of Line Balancing :-

Under Heuristic approach, there are 2 methods of Line balancing :-

*1. Largest Candidate Rule: (Prefered one)
2. Rank positioned Weighted (RPWM) (Helgeson & Bernie) Method

1. Largest Candidate Rule: In this method, the work elements are assigned to the workstation on the basis of their elemental time values.

The steps involved are :-

(i) Draw the precedence diagram of given elements.
(ii) List all the elements in decreasing order of their elemental time values.
(iii) Starting from the first element in the list moving downwards search first feasible element which can be placed in a work station. For a feasible element, there are 2 conditions :-
a) All the elements prior to it must be completed.
b) When that element is placed in the work station, the summation of all elemental task time in the station must not exceed the cycle time.
iv) The element which is assign to a work station, strike it off so that it cannot be considered again

v) Repeat the above steps untill all the elements are assigned to the workstation.

vi) RANK POSITION WEIGHTED METHOD (76)

In this method Elements are assign in the work station acc. to their positional rate. The positional weight of an element correspond to the time of the longest path ~~to the remai~~ from the begining of element through the remainder of network.

The elements are arrange in decreasing order of their positional weight. The procedure of assignment to the workstation is similar to Largest Candidate Rule, the only difference the skipping of positional weight is not allowed.

QUEUING THEORY

The aim of Queuing Model is achievement of an economic balance b/w the cost of providing service & the cost associated with the wait required for that service. These models are used in service oriented organisation, m/c repair shop, Food chain restaurant etc.

Date :

4) SDE control [Scarce, Difficult & Easily Available]

- Classified on the easiness or difficulty of availability of Inventory item.

(38)

5) Seasonal- Offseasonal

- Classified on the availability of Inventory based on seasonal variation

SEQUENCING

Sequencing problem comes when we are concerned with situation where is a choice as to the order in which a no. of task on jobs can be performed so that utilisation of man, power and Machine can be optimised and their idle time is minimised.

Assumptions:-

1. One job on one machine at a time.
2. Given processing order for the machine will remain constant
3. Each job once started on a machine must be fully completed.
4. The processing time for the different jobs remains constant irrespective of their order.
5. Time taken by job from one machine to other is negligible.

Page No.
Date:

TERMINOLOGY

1. ~~N job on 1 Machine~~ (39)

1) Job flow time: It is the time from some starting time untill that ~~complete~~ particular job is completed.

2) Make Span time: It is the time from when processing begins on the first job in the set untill the last job is completed.

3) Tardiness: It is the amount of time after its due date that a particular job is completed.

4) Average No of Jobs in System = $\frac{\text{Total Job flow time}}{\text{Make Span time}}$

2. Sequencing Rules for N Job on 1 machines

1) Shortest Processing Time (S.P.T) Rule

In this rule, Jobs are sequenced in order of their increasing processing time i.e least time first & longest time in the last.

2) Earliest Due Date (EDD) Rule

Jobs are sequenced in order of Increasing due date

E.g.

	Jobs	Processing Time	Due date		CR
(4)	1	11	34	(3)	34/11
(1)	2	7	39	(5)	39/7
(5)	3	14	31	(2)	31/14
(3)	4	9	36	(4)	36/9
(2)	5	8	29	(1)	29/8

Date :

3 Critical Ratio (C.R) Rule

$$C.R = \frac{\text{Due Date}}{\text{Processing Time}}$$

(1/40)

Jobs are sequenced in order of increasing Critical Ratio.

4. Slack Time Remaining (STR) Rule

Slack Time = Due Date − Processing Time

Jobs are sequenced in order of Increasing Slack Time Remaining.

2. N Jobs on 2-Machines:-

Machine	A	B	i = (1, 2, 3 -- N)
Jobs	Ai	Bi	
Ex:- 1	6	9	1, 3, 2
2	11	4	
3	13	6	
	6	13	3, 1, 2
1	11	9	
1	6	11	
N	13	6	2 1 3
	11	9	
	12	6	
	13	6	2 3 1 or
	11	9	2 1 3
	13	6	

In these problem, Only 2 machines are inv
let there processing time are Ai and B
i is from 1,2,3 ....-N. The problem is
a sequencing order which minimises ideal t
machine and man power. This is done by
Johnson's Rule or Johnson's Algorithm. (only
2 machines)

The steps involved are:-

1. Find out the minimum of Ai & Bi.
2. If the minimum is for A_r i.e for the rth job on Machine A. Then perform the rth job first.
3. If the minimum is for B_s i.e for the sth job on Machine B. Then perform the sth job in the Last
4. In Case of a tie between A_r & B_s, do the rth job first and the sth job in the Last.
5. Strike of the job, which is assigned so that it cannot be considered again.
6. Continue the process of assigning until all jobs are assigned.

3. Sequencing of N jobs on 3- Machines :-

Machine → Jobs	A	B	C
	Ai	Bi	Ci
1			
2			
3			
⋮			
N			

Date :

i) | Min $A_i \geq$ Max B_i | ~~Any Two~~ any one is satisfied.
ii) | Min $C_i \geq$ Max B_i |

X   Y

$X_i = A_i + B_i$

$Y_i = B_i + C_i$

(42)

In these problems, there are 3 machines, A, B & C with their respective processing time, A_i, B_i & C_i for applying Johnson's Rule, we need to convert these 3 machines into two imaginary machines X & Y. If out of the two conditions, Atleast one is satisfy. The two imaginary machines 'X' & 'Y' are such that $X_i = A_i + B_i$ & $Y_i = B_i + C_i$

We find the sequence of two imaginary machines, then after finding sequence make span time is calculated on the original 3 machines.

N Jobs on M- Machines

Date [redacted]

Machine A_1, A_2 - - - - B_i A_{m-1}, A_m

A_{m-2}

Jobs

1

2

3

:

N

CONDITIONS:-

1. Min $A_1 \geq$ max. $[A_2, A_3 - - A_{m-1}]$
2. Min $A_m \geq$ max $[A_2, A_3 - - - A_{m-1}]$

Any one out of 2 can satisfy

$X = A_1 + A_2 + - - - + A_{m-1}$

$Y = A_2 + A_3 + - - - - + A_{m-1} + A_m$

PERT & CPM

(43)

Project : Project is a group of Inter-related activities which must be executed in a certain order before the entire task can be completed. The activities are related in a logical and sequential order in the sense that some activities cannot start untill all the activities prior to them are completed. When all the activities are executed then only the project is completed.

Event : The events are point in time & denotes the begining and the end point of an activity. An Event defines an accomplishment occuring at an instantaneous point of time which neither consumes any time nor resources for its completion.

Activity : It is a recognizable and identifiable part of a project which consumes time & resouces for its completion and may involve physical or mental work.