Textbook:-

* Work System and Methods measurment and managment of work by Mickell, MP Groover, 2007.

Ch # 1 :-

① Work measurment
② Methods Engineering.
③ Work managment.

Work System:-

A physical entity in which machine, System, human Collaborate to form a give thing.

Work measurment:-

① Time Study

Machine take
Atonomous. Decision.

(3) Fully Automated System.

Human give Decision and Goals.

Costly
We dont get a payback.

Trade off:-

Capital Cost
Labour Cost

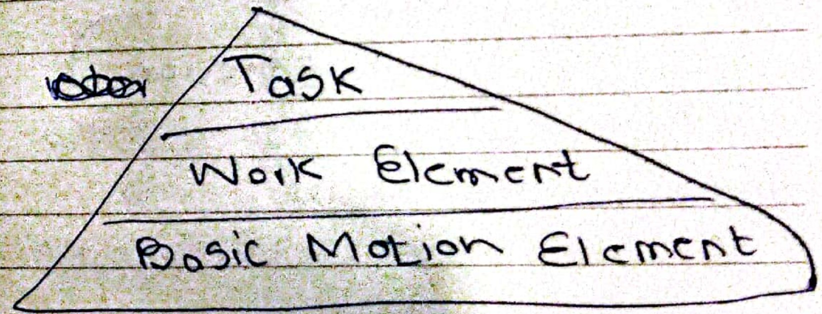
* It is decision of goverment that where to apply those system required as ....

* Henry Ford:-
Moving Assembly line.

* Frank Taylor &
Lillion Gilbreth.
Motion Study

* Fredrick
Time Study

* Work Study:-
To study how much work content is being done by worker.



* To start work we should firstly reach to it.

Basic Operation Element

Reach
↓
Grasp → Move
Operation Element
Remove

Work Element
↓
Task
↓
Work Completion

* Adopt
* Production Line
* Time Study.
* If any bad situation happen then Methods Engineering.

$$LPR = \frac{WU}{LH}$$

LPR = Labour Productivity.
WU = Work Unit.
LH = Labour Hour.

$$LPI = \frac{LPR_t \rightarrow \text{period } t}{LPR_b \rightarrow \text{base period.}}$$

LPI ↓ Index.

the task activities in the element is called work

* Work System:-

It is a physical entity because all the worker are working on a given system as input to give a required output.

*

1. Service Operators.
2. Logic Operators.
3.

Productivity:-

* Production Line related.

Shift Time:- Routine in office.

* 8 hours.

Problem # 1.1:-

Labour = 5 Worker
Production = 500
22 days in a month.

$$LPR = \frac{500}{22 \times 8 \times 5}$$

$$\boxed{LPR = 0.57} \text{ unit/hour.}$$

$$LPI = \frac{0.57}{0.75}$$

$$\boxed{LPI = 0.763 \text{ unit/hour}}$$

* Manual Work System- In which manual tools are used.

* Determining Worker and machine requirements- It is related with line balancing.

* Manual Work Systems-

Manual Time-

[illegible]

normal time:-

It is the average time.

* Rating is checked in it.

Ex:-

Cycle.

Allowances:-

Personal Allowances:-

واش روم، پانی

Standard time:-

Personal, Normal

Quota. کوٹہ

Irregular :-

* جو cycle کے بعد ایبل آتا ہے۔

* جو cycle کے بعد Extra

$$T_n = 3.23 + \frac{1.25}{5}$$

$$= 3.48 \text{ min.}$$

$$\boxed{\begin{aligned} T_{std} &= 3.48(1+0.15) \\ &= 4 \text{ min} \end{aligned}}$$

↓ Planning.

$$Q_{std} = \frac{8(60)}{4}$$

$$\boxed{Q_{std} = 120 \text{ work unit}}$$

Basic میں Normal Add
is it then میں جاتا ہے
called Standard time.

Question # 2.1 :-

$T_n = 1.30$.
$PAFD = 12$.

$T_{std} = 1.30(1 + 0.12)$
$\boxed{T_{std} = 1.456 \text{ min}}$

$Q = \frac{8 \times 60}{1.456}$.

$\boxed{Q = 329.67 \text{ min}}$

Question # ~~2~~ 2.3. :-

a) $T_n = \frac{3.47 + 3.70}{\cancel{} 10}$

$T_n = 3.84 \text{ min}$

$T_{std} = 3.84(1 + 0.14)$

$\boxed{T_{std} = 4.378 \text{ min}}$

b) $Q = \frac{8 \times 60}{4.378}$

$\boxed{Q = 109.64 \text{ ~~unit~~}}$

c) $T_c = \frac{3.84}{1.20}$

$\boxed{T_c = 3.2 \text{ min}}$

Question # 2.4 :-

a) $T_n = \dfrac{4.25\,min + \dfrac{1.75}{8}}{2}$

$\boxed{T_n = 2.234\ min.}$

$T_{std} = 2.234(1.16)$

$\boxed{T_{std} = 2.59\ min}$

b) $Q = \dfrac{8 \times 60}{2.59}$

$\boxed{Q = 185.33\ Pc}$

c) $T_c = \dfrac{2.234}{0.16}$

$\boxed{T_c = 13.96\ min}$

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Work content is normal time.

c) $T_c = \dfrac{403.2}{0.16}$

$T_c =$

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-: **Normal Manual Work:-**
Tools but no power tool.

-: **Worker ~~machine~~ System:-**

Internal Element
Work, Machine
External Element — Simultaneously
↓
When sequentialy work is need to be done.

Standard hour:-

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Work efficiency:- We relate with the shift hours.

Production Line:- Standard hours and work time.

Normal Time:-

$T_n = T_{nw} + T_m$

Standard Time:-

$T_{std} = T_{nw}(1 + A_{pfd}) + T_m(1 + A_m)$.

personal, Fatigue delay.

Basic Motion Element
↓
Work Element
↓

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- Internal Work Element performed simultaneously with machine cycle.

- **Normal Time:-**

$$T_n = T_{nw} + \mathrm{Max}\{T_{nwi}, T_m\}$$

- **Standard Time:-**

$$T_{std} = T_{nw}(1 + A_{pfd}) + \mathrm{Max}\{T_{nw}(1 + A_{pfd}).\ T_m(1 + A_m)\}.$$

- **Standard Time for Cycle:-**

$$T_{std} = T_{nw}(1 + A_{pfd}) + T_m(1 + A_m).$$

Problem # 2.5 :-

$$T_{std} = T_n(1 + A_{pfd})$$

$$T_c = \frac{T_n}{P_N}$$

$E =$

(a) ~~Data given~~

$H_{std} = Q\, T_{std}.$

$H_{std} = 214 \times 2.5$

$= 552.12$ min.

$= 9.2$ hours.

$\cancel{Q = \frac{9.2}{}}$

$\cancel{Q = 220.8}.$

$$\boxed{E_N = \frac{9.2}{8} = 1.15 \quad 115\%}$$

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(F) $Q = 24$

$T_{std} = T_n(1 + [illegible])$

$2.58 = T_n(1 + [illegible])$

$T_n = \frac{2.58}{1.183}$

$\boxed{T_n = 2.18}$

$480 - 53 = 427$ min.

$\frac{427}{24} = 1.99$ min/cycle.

$P_w = \frac{T_n}{T_c} = \frac{2.18}{1.99}$

$\boxed{P_w = 114\%}$

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2.7

$T_{std} = T_{mm}(1 + A_{pfd})$

$+ T_n(1 + A_n)$

$T_{mm} = 0.24$ min

[illegible]

$T_c = 0.84$ min

$T_m =$ constant

$A_{pfd} = 10\% = 0.10$

$A_n = 30\% = 0.30$

$h = 8$

$T_{st} = 0.84(1.10) + (0.55)(1.30)$

$= 6.88$

$$E_w = \frac{H_{std}}{H_{sn}} = \frac{85 \times 6.88}{6}$$

$$= 121\%.$$

$$P_w = \frac{T_n}{T_c}$$

$$T_{std} = T_n(1.16)$$

$$\frac{6.88}{1.16} = T_n.$$

$$\boxed{T_n = 5.93 \text{ min}}$$

$$480 - 42 = 438 \text{ min}.$$

$$P_w = \frac{T_n}{T_c} = \frac{5.93}{0.6}.$$

$$\boxed{P_w = 9.88}$$

Problem # 2.9 :-

$T_n = 0.42$ min.

$T_m = 1.12$ min.

$T_{nw} = 1.04$

$$T_{std} = T_{nw}(1.15) +$$

$$+ \text{Max}\{[T_{nw}(1.15)], T_m(10.30)\}$$

$T_{nw} = 0.42$ min.

$T_m = 1.12$.

$$T_{std} = 0.42(1.15) +$$

$$\max\{1.04(1.15), (1.12)(1.30)\}.$$

$$\boxed{T_{std} = 1.93 \text{ min}}$$

$Q = \frac{8 \times 60}{1.93}$

M W
M W

$\boxed{Q = 248.70}$

$Q = 2.11$

$T_n = 6.27$ min.

$A_{pfd} = 0.12$

$A_m = 0.25$

$T_n = 5.92$ min.

Internal Time.

$\boxed{5.92 - 0.65 = 5.27}$

$T_m = 6.27 - 0.65 = 5.62$

$T_{std} = T_{nm}(1 + A_{fd})$

$+ \text{Max}\{(T_{nw})(1+A_{fd}),$

$T_m(1+A_m)\}.$

$T_{std} = 5.27(1.12)$

$+ \{5.27(1.12),$

$5.62(1.25)\}$

$+\{5.9024;$

$7.025\}.$

$\boxed{T_{std} = 5.9024 + 7.025}$

~~$T_{std} = 11.9274$~~

$\boxed{T_{std} = 7.753}$

~~[illegible]~~
01-09-2023.

-: Lec # 2 :-

Part 2 :-

$$W = \frac{WL}{AT}$$

WL = Work Load / # of units.
W = # of workers.
AT = available time.

$WL = \sum Q T_{std}.$

$$W = \frac{\sum Q T_{std}}{AT}$$

Example :-

$T_{std} = 11.5$ min.
$Q = 800$
$AT = 40$ hours.

$WL = 800(11.5) = 9200$ min.
$= 153.33$ hrs.

$$W = \frac{153.33}{40}$$

$W = 3.833$

Problem # 2.13 :-

$Q = 1000$ unit.
$T_{std} = 11.65$.
$AT = 8 \times 4 = 32$.

$$W = \frac{Q\ T_{std}}{AT}$$

$$W = \frac{1000 \times 11.65}{60 \times 32 \times 1.15}$$

$\boxed{W = 5.27}$

$$\frac{\ldots Std}{E_W(1-q)}$$

Problem # 2.14:-

$Q = 20,000$

$$\cancel{W = \frac{20,000 \times 7.3}{8 \times 250}}$$

$$W = \frac{(20,000 \times 7.3) + (32,000 \times 4.9) + (47,000 \times 8.4)}{8 \times 250 \times 0.98}$$

$$\frac{n}{1 \times 0.96}$$

$$WL = \frac{697600}{1 \times 0.96}$$

$$\boxed{W = 370.7}$$

Up time:-

اگر available Machine نہیں ہے

Down time:-

اگر کام نہیں کیا گیا Given Time میں -

Problem # 2.15:-

$$Setup = \frac{20,000,000}{5000}$$

Batches = 4000 batches.

$4000 \times 3 = \boxed{12000 hrs}$

$$Setup = \frac{20,000,000 \times 0.1}{60}$$

$= 33333.3$

$$n = \frac{WL}{AT} = \frac{n}{8\times50\times5\times0.95} + \text{———}$$

x———x

07-09-2023.

Lec #3

Part 1

Ch #3

Sections:-

① Sequential Operation and Work Flow.

② Batch Processing

③ Defects in Sequential Operations and Batch Processing

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4 Work Cell.

-: Sequential Operation:-

We cannot perform latest operation before completing the previous one.

-: Work Flow Pattern:-

* Pure Sequential :- All work units follow the same exact sequence of operation and work stations

↳ Where the number of orders are huge.

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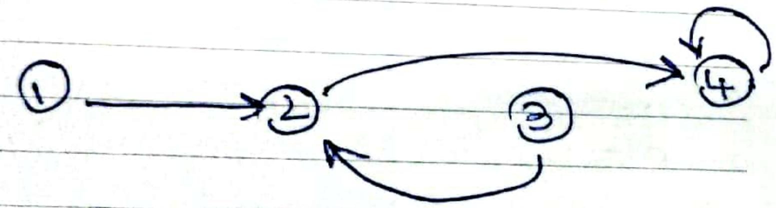
-: Work Flow Patterns:-

$\rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow$

-: Moves in Sequential Work Flow:-

- In Sequence
- Bypassing move.
- Repeat
- Batch Flow.



* Possible variable in a from to chart:-

- Quantities moving between operations (Q_{ij})

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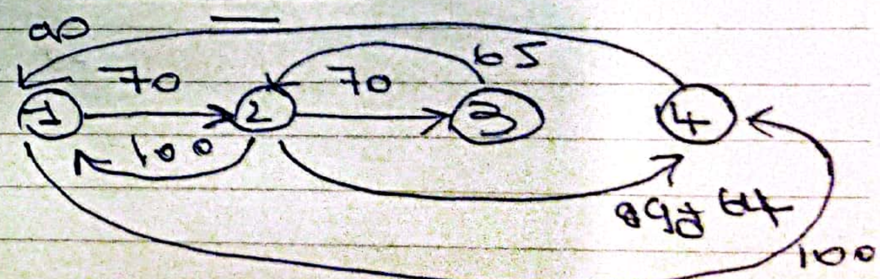
- Flow Rate of material (R_{fij})

From to chart

i \ j	1	2	3	4	5
1	–	40		15	
2		–	30		
3		10	–	20	
4				25	50
5					–

$1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5$

Problem # 3.1:-



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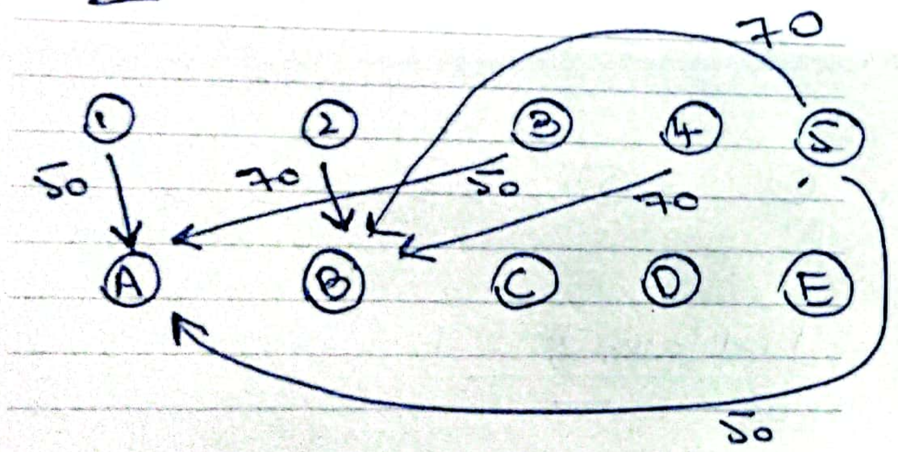
From\To	1	2	3	4
1		70		100
2	100		70	155
3		~~[illegible]~~ 65	-	
4	90	-	-	-

Q#2



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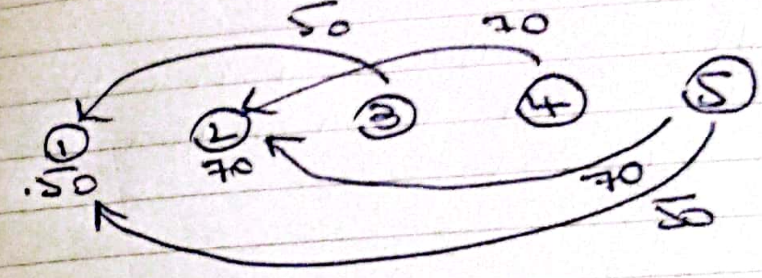

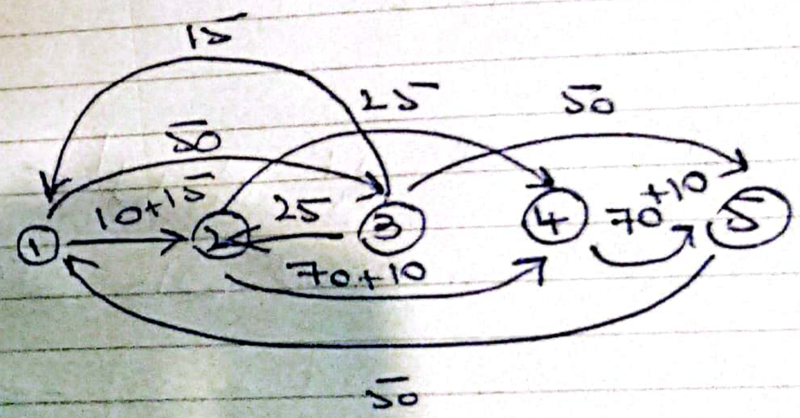

From/To	1	2	3	4	5
1	-	25	50	-	-
2	-	-	-	~~[illegible]~~ 105	-
3	15	25	-	-	50
4	-	-	-	-	80
5	50	-	15	-	-

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Batch Production:-

* It is done when there is finite number of quantities

Down Stream:-

جہاں پر پیچ کئے ہیں اس سے آگے جانے کو Down Stream کہا جاتا ہے۔

Production Rate of upstream operator is limited to the downstream operator.

Bottleneck = Slowest operation in sequence.

e.g.

Starving operation

Blocking operation.

Problem # 3.3 :-

(i)

$$T_B = 25 + (4000 \times 0.03)$$

$$= 145$$

$$\boxed{R_p = \frac{4000}{145} = 27.5 \ Pc/min}$$

(ii) $T_B = 30 + \left(\frac{2000 \times 2.5}{60}\right)$

$\boxed{T_B = 113.333}$

$R_p = \frac{2000}{113.3} = 17.65$

$R_p =$

(iii)

$T_B = 40 + \left(\frac{2000}{30}\right)$

$\boxed{T_B = 106.67}$

$R_b = \frac{2000}{106.67}$

$R_b = 18.75$

$= 40 \times 1058.4$

$= \boxed{42336}$

Problem # 3.4

$T_B = \frac{25 + (4000 \times 0.03) \times 0.8}{0.8}$

$=$

Bottle neck :- It will define the production of factory per week, per day, per year.

Lecture #3 08-09-2023.

Part 2

From/To	1	2	3	4	5	From Sum
1	–	25	50			75
2		–		105		105
3	15	25	–	–	50	90
4				–	80	80
5					–	50
To Sum	65	50	50	105	130	
From/To ratio	$\frac{75}{65} = 1.15$	2.1	1.8	0.76	0.38	

-: Ascending Order:-

2 3 1 4 5

-: Work Cell:-

A Group of machine that are doing similar type of operation but not identical.

Part Family/Group technology:-

~~Group together~~:- Similar type of work.

Example:-

Tyre of Motor bike.

Problem # 3.28:-

From\To	1	2	3	4	From Sum
1		10		40	50
2					0
3	50			20	70
4		50			50
To Sum	50	60	0	60	

$\frac{From}{To}$ ratio:- $\frac{50}{50} = 1$ $\quad \frac{0}{60} = 0$ $\quad \frac{70}{0} = \infty$ $\quad \frac{50}{60} = 0.833.$

3 1 4 2

$$Q = EOQ = \sqrt{\frac{2 D_a C_{su}}{C_h}}$$

- C_h = holding cost.
  C_{su} = Setup Cost
- D_a = Annual Demand.

$$TIC = \frac{C_h Q}{2} + \frac{C_{su} D_a}{Q}.$$

TIC = ~~[illegible]~~
Total Inventory Cost.

Q = Economic Order Quantity.

3.8

$D_a = 22500$
$C_h = 15\%$

$C_{su} = 3500\$$

$$EOQ = \sqrt{\frac{2(22500)(650)}{35 \times 0.15}}$$

$$Q = EOQ = 2360.387$$

-: MSQC :-

-: Lec # 5 :-

-: Part 2 (Cont....) :-

$\mu = 0.297\,kg.$

$\sigma = 0.024\,kg.$

$x = 0.347.$

$$z = \frac{0.347 - 0.297}{0.024}$$

$$\boxed{z = 2.083.}$$

11-09-20..

NAME

Lecture # 4:-

$$Q_f = Q_o(1-q_1)(1-q_2)\ldots(1-q_n)$$

Q_f = final quantity at the conclusion of the sequence.

Defects: $D_f = Q_o - Q_f$

Yield = $Y = \dfrac{Q_f}{Q_o}$

* We can locate the defective part effectively if our in line layout is perfect.

U-shaped layout:-

It is used when there is a need of collaboration and communication.

Rectangular type layout:-

This is needed when work is being done in batches. It gives more flexibility to manager to develop same or different product in short time.

Loop layout:-

It is used when the production is done in repetition.

* It works in a technique that when the work get it's operation then it performs that operation.
* In loop layout conveyer belt may be used which may be automated or manual.

Fraction defect Rate:-

Problem # 3.16 :-

a) $Q_f = Q_o(1-0.03)^8$

$Q_f = 5000(1-0.03)^8$

$\boxed{Q_f = 3918.7\text{ pcs}}$

b) $Y = \dfrac{Q_f}{Q_o}$

$Y = \dfrac{3918}{5000}$

$\boxed{Y = 78\%}$

Problem # 3.17 :-

$Q_f = Q_o(1-0.04)^6$

~~$Q_f = 10{,}000(1-0.04)^6$~~

~~$Q_f = 7827$~~ pcs.

$Q_f = 10,000$

Problem # 3.18:-

Problem # 3.19:-

$Q_0 = 20,000$

$Q_f = 20000(1-0.05)^7$

Problem # 3.20:-

$Q_f = 25000(1-0.04)(1-0.05)(1-0.$

$\boxed{Q_f = 20520 \text{ parts}}$

$D_1 = 25000(0.04)(1-0.05)(1-0.1)$

$D_1 = 855$

$D_2 = 25000(1-0.04)(1-0.05)(0.1)$

$D_2 = 2280$

$D_3 = 25000(1-0.04)(0.05)(1-0.1)$

$D_3 = 1080$

$D = D_1 + D_2 + D_3$.

$D = 855 + 2280 + 1080$

$\boxed{D = 4215}$

One defective

Chapter # 4 :-

Mannual Assembly Line :-

it is the mixture of pure mannual system.

1. Fundamental of Manual Assembly Lines.
2. Analysis of Single Model Assembly Line.
3. Line Balancing Algorithm.
4. Other Consideration in Assembly Line Design.
5. Alternative Assembly Lime. System.

Learning Curve:-

As the number of product, practice increases skill level of worker increases.

Work Flow:-

— Products are [illegible] to the worker

Assembly Line:-

Continuous production

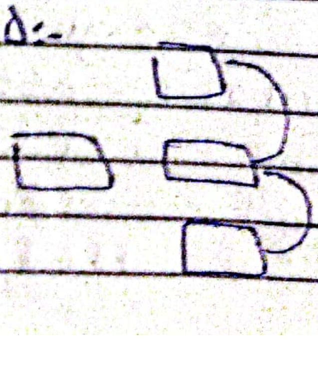
Line Pacing:-

Worker must complete their work in given cycle time.

① Same Worker, Efficient Worker

* Mechanized Work Transport
* Synch Transport
* Asynchronized Transport.

Synchronized:-



↳ Single Model Assembly Line:
* Every Work unit is Same.

↳ Batch Model Assembly Line:-
* Two or more different products.
* Products are so different that they must be made in

x———x

Lec #5:-

21-09-23.

Production Rate R_p is converted to a Cycle Time T_c.

$$T_c = \frac{60E}{R_p}$$

* Where 60 converts hourly production rate.

$$W^* = \text{Minimum Integer} \geq \frac{T_{wc}}{T_c}$$

T_{wc} = Work content time, min
T_c = Cycle Time, min/worker.

* No of worker does not mean no of machines. it is known as maning level.

* Utility operators are not performing the work on machine but they are just helping / supervising

* Repositioning losses occur on a production line because some time required each cycle to reposition the worker, the work unit or both

Service Time = $T_s = T_c - T_R$.

Repositioning Efficiency

$$E_r = \frac{T_s}{T_c} = \frac{T_c - T_r}{T_c}.$$

T_r = Reposition Time.
T_s = Service Time.

$$T_{wc} = \sum_{k=1}^{n_e} T_{ek}.$$

Line balance efficiency E_b

$$E_b = \frac{T_{wc}}{w T_s}.$$

Balance delay d :-

$$d = \frac{WT_S - T_{WC}}{WT_S}$$

$$E_b + d = 1.$$

Worker Requirment:-

$$W^{\circ} = \text{Minimum Integer} \geq \frac{T_{WC}}{T_C}.$$

$$W = \text{Min Int} \geq \frac{R_p T_{WC}}{60 E E_r E_b} = \frac{T_{WC}}{E_R E_b T_C}.$$

$$= \frac{T_{WC}}{E_b T_S}.$$

-: Workstation Manning Level:-

* For a Single Station i, $M_i = W_i$

-: Line Balancing Objective:-

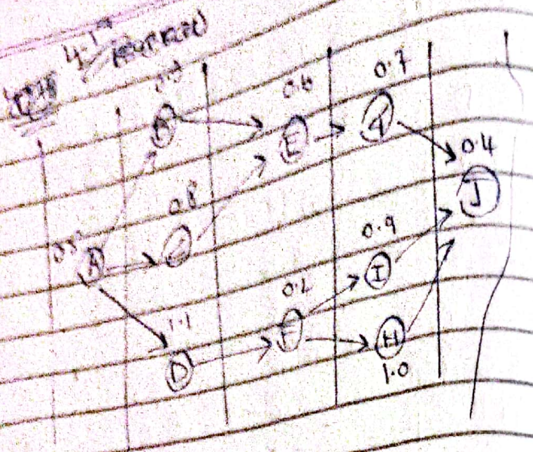
- Minimize

(A)

Element	To	Precendence
D	1.1	A
H	1.0	F
I	0.9	F
C	0.8	A
G	0.7	E
E	0.6	B, C.
A	0.5	—
I	0.4	G, H, I
B	0.3	A
F	0.1	D

Station	Element	Tc	ΣTc.
1	A	0.5	1.3.
	C	0.8	
2	D	1.1	1.4
	B	0.3	
3	E	0.6	
	G	0.7	1.5
	F	0.1	
4	H	1.0	1.0
5	I	0.9	1.3
	J	0.4	

4.17



Element	Tc	Precedence
A	0.5	-
D	1.1	A
C	0.8	A
B	0.3	A
E	0.6	B, C
F	0.2	D
G	0.7	E
I	0.9	F
H	1.0	F
J	0.4	G, I, H.

4.18

RPN	Elements	Tc	Precedence
	A		
0.4	J	0.4	H, I, G

Production Rate $\boxed{4.1-4.20}$

Snap Dag Timing Method:-

If their is

$T_m = T_n + (1 + Apfd)$.

13.1

$T_n = 2.40(1.10)$

13.2

$\overline{T_n} = 0.22 \times 0.9 + 0.4 \times 12 + 0.30 \times 1 + 0.37 \times 0.9$.

13.3.

$T_{std} = T_n(1 + Apfd)$

$\overline{T_n} = 4.80(0.9) + \left(\frac{1.60}{8}\right) * 1.20$

$\boxed{T_n = 4.56}$

$T_{std} = 4.56(1 + 0.15)$

$\boxed{T_{std} = 5.244 \text{ min}}$

$\boxed{T_{std} = 314.64 s}$

Scanned with CamScanner

Problem # 13.10 :-

$a = 0.25$ min

$\boxed{b = 1.25 \text{ min}}$

$c = 0.25$ min.

$d = 0.55$ min

$e = 0.10$ min.

$T_n = T_{nw} + T_{nm}$

$(0.25 + 0.25 + 0.55 + 0.10)$

$T_n =$

$T_{std} = T_n(1 + A_{pfd}) + T_m(1 + A_m).$

Internal $\longrightarrow$ Simultaneously

External $\longrightarrow$ After

- Normal Time :-

$T_n = T_{nw} + \max(T_{nm} + T_m)$

Labour Production $= \frac{\text{Output}}{\text{Input}}$

$HQ = QT_{std}.$

Shift Time:-

Start

End.

8 hour → Include

Tact Time:-

How much

pace a line must have to complete the target.

Standard Time:- Operation

Normal Time

$Tc \times$ Rating.

Average worker ← $Tc = Tn$

The Tc* Rating.

Lead Time :-

As the order recieve lead, time start and it ends the order was factory outed.

On-Standard Time :-

7:00 On standard time

7:30 off-standard time.

Up-Time :-

Machine Availability

Down-Time :-

Machine is not Available.

Set-up Time

Before the start of the work machine start-up time.

$\boxed{3}$ 2000

$\boxed{2}$ 3000

$\boxed{1}$ 5000

Bottleneck is the Station that determine production rate.

Work Cell:- In case of emergency Similar type of work.

1. To Suppress any type of motion of material.

Synchronous Part move will allow all the parts to move at same time.

Semi-Automated.

Asynchronous:-
In Asynchronous worker operates independently.

Machine Cluster:-
No Internal
It is such a production system in which worker need not so much attention.

* machine is performing similar type of operation and worker is attending 2 or 3 quantities.

* The machines are closed enough.

* movement is less in it in which worker do less work.