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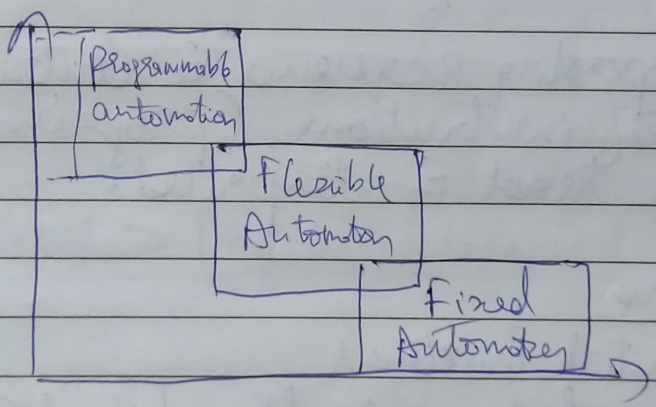
Unit I

Introduction to Automation

def. Automation is the technology concerned with the application of mechanical, electronic and computer based systems to operate and control production.

Types of Automation

(i) Fixed automation.
(ii) Programmable automation.
(iii) Flexible automation.



1) Fixed automation

* The sequence of production is fixed by the configuration of equipment.
- fixed layout
- Specialized equipment.
- Tools used are fixed
- Product is fixed.
- Operations are fixed.

Features
(i) High initial investment
(ii) High production rate
(iii) Suitable for mass production
(iv) Inflexible when compared to other

Ex: Steel industry, automobile, cement

2) Programmable automation

* The production equipment is designed with the capacity to change the sequence of operations to accomodate different product configurations.

* The operating sequence is controlled by a set of instructions (program) that can be read & interpreted.

Features
(i) High initial investment
(ii) Lower production rate than fixed automation
(iii) Flexible to deal with change in product
(iv) Time consuming.

Ex. Automobile auxiliary units.

3) Flexible Automation

* It is an extention of programmable automation.

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A flexible automated system is capable of producing a variety of parts or products with relatively no change in equipment and change in design.

→ Same system can produce different parts

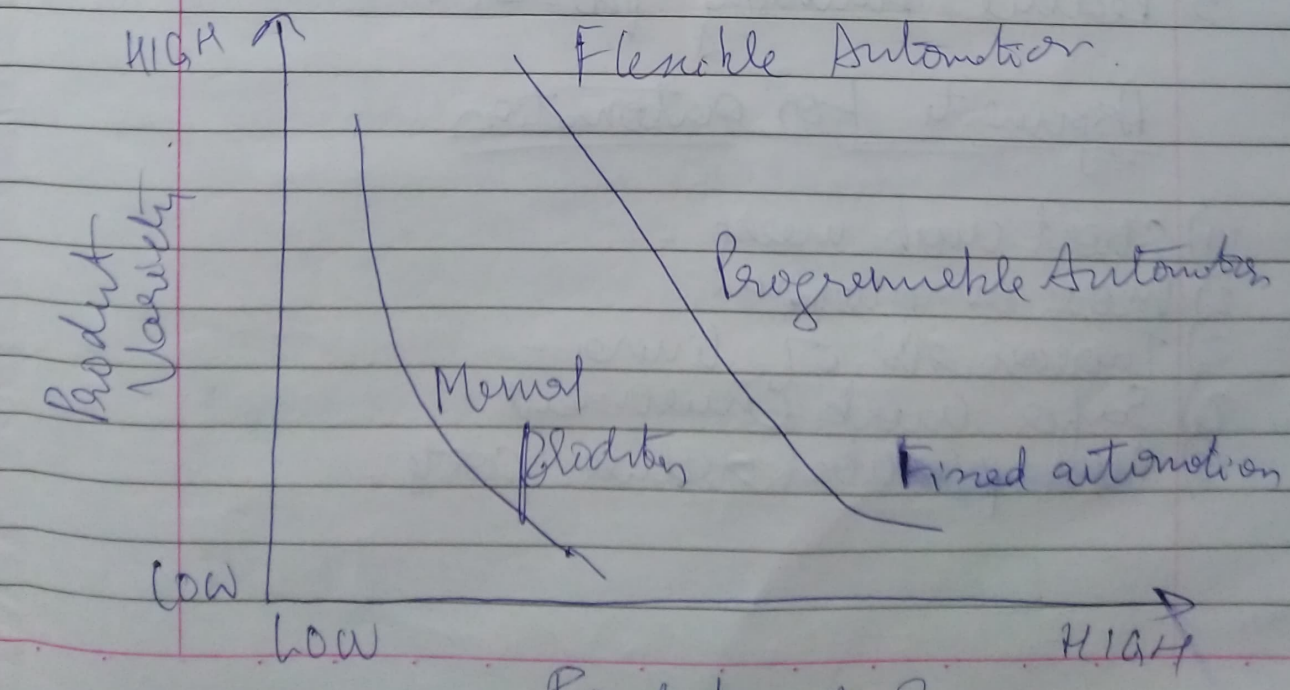
Features

(i) High initial investment
(ii) Continuous production of products that are different
(iii) Medium production rate.
(iv) Flexibility to deal with variations.

Ex: Toys, consumer goods, CNC.

In terms of production rate & Size

Fixed > Programmable > Flexible



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Reasone for automating

1) Increase productivity
2) Reduce labor cost
3) Labor shortage
4) Safety
5) Improve quality
6) Reduce manufacturing lead time
7) Reduce in process inventory
8) High cost of non automating
9) Increase system efficiency
10) Edge over competetion

Arguments against automation

1) Automation will result in subjugation of humans by machines.
2) It will reduce labor force.
3) Reduce purchasing power.

Arguments for automation

1) Short work weeks.
2) More employment.
3) Increase std of living.
4) Safer work Environment.
5) Mass production reduce costs.

Production Concepts associated With Automation

1) Manufacturing lead time
2) Components of operating time
3) Rate of production
4) Plant capacity
5) Utilization & Availability
6) Work in progress
7) WIP ratio.
8) TIP ratio.

1) Manufacturing Lead Time

→ Total amt. of time spent by a part on a line. Time.

Total operations = processing + Assembly + Material handling + Inspection + Storage + - - - -

2 types Operational & Non operational

Operational → machining process

Non operational → Material handling, Storage, Inspection.

Df. T_o is Operation Time
T_{no} is Non-operation time
n_m = Number of individual machining process
T_{su} = Set up time. Q = Batch Size

$$MLT = \sum_{n=1}^{n_m} [T_o + QT_m + T_{su}] \quad i = 1, 2, 3 \ldots$$

$$MLT = n_m [T_{su} + QT_o + T_{no}]$$

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Components of Operating time

T_o = operating time T_m = Machine time
T_{th} = Tool loading time T_{wh} = Work handling time

$$T_o = (T_m + T_{th} + T_{wh}) \text{ min}$$

Rate of production (R_p)

Batch time/machine = $T_{su} + QT_o$
Batch time/machine = $T_{su} + QT_o/(1-q)$

(T_p) Avg production time/part = (Batch Time/Machine)/Q

Avg. Rate of production (R_p) = $1/T_p$

Plant Capacity (PC)

Depends on constraints such as:-
(i) Number of shifts per day
(ii) Number of days in the week
(iii) Employment Level.
(iv) Over time allowed.
(v) Number of machines present

$$P.C. = WS_w H R_p$$
$$P.C = \frac{WS_w H R_p}{n_m}$$
$$D_w = \frac{WS_w H R_p}{n_m}$$

$$WS_w H = (D_w \times n_m)/R_p$$

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Utilization & Availability

Utilization (U) = $\frac{\text{Output}}{\text{Capacity}}$

Availability = (MTBF − MTTR) / MTBF

where,
MTBF = Mean time between failures
MTTR = mean time to repair

Work in process

☆ WIP is the number of products currently being processed or is between processing station.

☆ It represents the investment by the firm that cannot be converted into a profit without being completly processed.

$$WIP = \frac{PC \cdot U}{Sw \times H} \cdot MLT$$

WIP ratio gives the portion of the product that is still being processed.

Number of M/c processing = $(OT_o / T_{su} + OT_o) \times W$

where,
W = no. of available work centers
U = plant utilization
T_o = Operating time
T_{su} = Set up time

WIP ratio = $\frac{WIP}{No. \text{ of Machines}}$

Ideally 1:1 , Highest 50:1

TIP ratio

This gives an estimate of the total time spent against the processing time.

$TIP = MLT / N_m * T_o$

Ideal 1:1 Highest 20:1

Automation Strategies

1) Specialization of operations : $\downarrow T_o$
2) Combined operations $\downarrow N_m, T_h, T_{no}$
3) ~~Sitcom~~ Simultaneous operations $\downarrow N_m, T_o, T_h, T_{no}$
4) Integration of operations $\downarrow N_m, T_h, T_{no}$
5) Increased flexibility $\downarrow T_{su}, MLT, WIP, \uparrow U$
6) Improved Material handling & Storage $\downarrow T_{no}, MLT, WIP$
7) Process control & optimization. $\downarrow T_o, q$
8) Automated online inspection. $\downarrow T_{no}, q$

9) Plant operators control: ↓ To, MLT, ↑ U

10) Computer integrated Manufacturing: ↓ To, MLT; design time, production planning, ↑ U