AUTOMATED ASSEMBLY SYSTEM

→ Assembly involves joining together of two or more separate parts to form a new entity

→ Automated assembly refers to the use of mechanized and automated devices to perform the various functions in an assembly line or cell

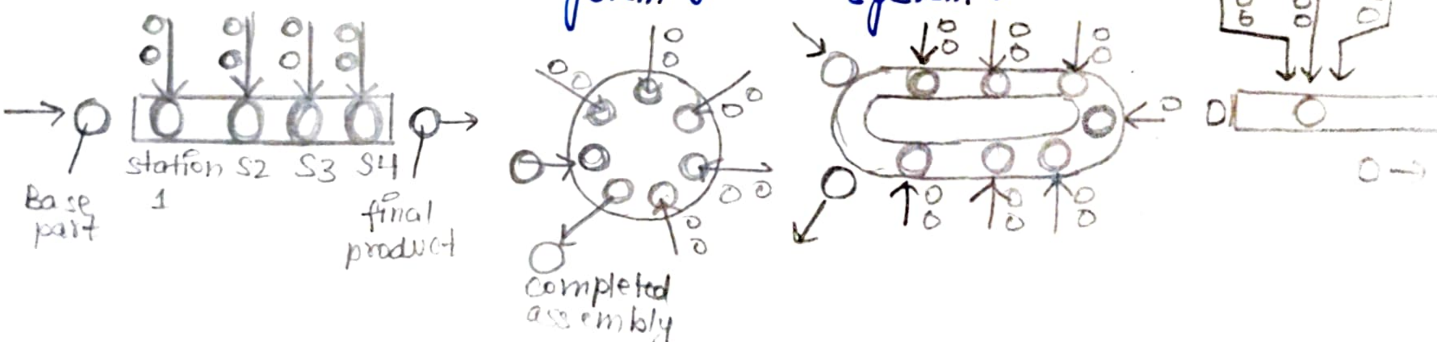
→ Automated assembly performs a sequence of automated operations to combine multiple components in a single entity.

DESIGN FOR AUTOMATED ASSEMBLY

- Reduce the amt. of assembly required
- Use modular design
- Reduce the no. of fasteners required
- Reduce the need for multiple components to be handled at once
- Limit the dirn of access
- High quality components
- Implement hopperability

TYPES OF ASSEMBLY SYSTEM

In line assembly system | Dial type assembly system | Carousel assembly system | Single station



PART DELIVERY AT WORKSTATION

→ HOPPER → container into which the components are loaded at workstation
A separate hopper for each component type
components are usually loaded into hopper in bulk
Parts are randomly oriented in hopper

→ PART FEEDER → It is a mechanism that removes the components from hopper one at a time for delivery to assembly work head. The hopper and the part feeder combine together into 1 operating mechanism.

The vibratory bowl feeder is a common example for hopper-feeder combination

→ SELECTOR AND ORIENTER → A selector is a device that acts as a filter permitting the parts only in correct orientation to pass through. The rejected parts are sent back to hopper
orienter is a device that allows properly oriented parts to pass thro' and reorients the parts that are not oriented initially.

→ FEED TRACK → A feed track moves the components from hopper and feeder to the location of assembly work head
↳ Gravity and powered

ESCAPEMENT AND PLACEMENT DEVICE ... track at time intervals that are consistent with the cycle time of assembly work head

various types
- horizontal and vertical devices for placement of parts onto dial indexing table
- escapement of rivet shaped parts
- pick and place mechanisms

MULTISTATION ASSEMBLY SYSTEM

Assumptions
- Assembly operations have const. time element, although time for different station may vary
- synchronus part transfer
- No internal storage

$$\cancel{P_i =} \; m_i q_i$$

m_i: probability that the defect causes jam

q_i: defect rate $0 \le q \le 1$ — probability that the current part is defective

The component is defective + causes jam

$$p_i = m_i q_i \quad \text{—} (1)$$

component is defective + does not cause jam

$$p_i = (1-m_i) q_i \quad \text{—} (2)$$

component is not defective

$$p_i = 1 - q_i \quad \text{—} (3)$$

All these 3 must sum to (1) + (2) + (3) = 1

$$m_i q_i + (1-m_i) q_i + 1 - q_i = 1$$

Probability of a good yield

$$P_{ap} = \underbrace{1-q_i}_{\text{only good components}} + \underbrace{m_i q_i}_{\text{causes jam so no defective component is added}}$$

$$\underset{\text{(frequency of downtime occurences)}}{f} = \Sigma m_i q_i$$

Avg production time = Ideal cycle time + (Average downtime)$(m_i q_i)$

$$T_p = T_c + \Sigma m_i q_i T_d$$

Production Rate.

$$R_p = 1/T_p$$

Production Rate of acceptable product

$$R_{ap} = R_p P_{ap} = \frac{P_{ap}}{T}$$

Line efficiency → $E = \dfrac{R_p}{R_c} = \dfrac{T_c}{T_p}$

proportion downtime → $D = 1 - E$

$$C_{pc} = \frac{\text{cost of material} + (\text{operating cost})(\text{production time}) + \ldots}{\text{yield}}$$

cost per good assembly

SINGLE STATION ASSEMBLY

Ideal assembly time   Handling time   Element time

$$T_c = T_h + \sum T_{ej}$$

Average production time

$$T_p = T_c + \sum m_i q_i T_d$$

↓ when machine stops

AUTOMATED FLOW LINES

- PROCESS TECHNOLOGY – Refers to the body of knowledge about the theory and principle of manufacturing processes
- SYSTEM TECHNOLOGY – It includes the metallurgy and machinability of the work material

TERMINOLOGY AND ANALYSIS OF TRANSFER LINES WITH NO INTERNAL STORAGE

Assumptions
- workstations perform operations and not assembly
- processing time at each station are constant though may not be equal
- synchronous transfer of parts
- No internal storage of buffers

$$T_c = T_{si} + T_r$$

T_r → Transfer time / Repositioning time

T_c → Ideal cycle on the line

T_{si} → slowest process's processing time

REASONS FOR DOWNTIME

- Tool failure
- Tool adjustments
- Scheduled tool charges
- Mechanical failure of work station
- Mechanical failure of transfer line
- stock out of i/ps
- Insufficient space for completed parts

Average production time = Ideal cycle time + Downtime frequency

$$T_p = T_c + F\,T_d$$

T_d → Downtime per line stops

Average production rate $R_p = 1/T_p$ Ideal producⁿ rate $R_c = 1/T_c$

Line efficiency

$$E = \frac{T_c}{T_p} = \frac{R_p}{R_c} = \frac{T_c}{T_c + F T_d}$$

proportion of downtime

$$D = \frac{F T_d}{T_p}$$

$$E + D = 1.0$$

cost per piece = cost per minute + [capital cost / equipment cost] T_p + cost Tooling price

UPPER BOUND APPROACH

P_i = probability or frequency of a failure at a station

$n \rightarrow$ no. of workstations

$$F = \sum_{i=1}^{n} P_i$$

expected frequency of line stops per cycle

LOWER BOUND APPROACH

probability that the part will not jam station

$(1 - P_i)$

ANALYSIS OF TRANSFER LINE WITH STORAGE

$$E_0 = \frac{T_c}{T_c + FT_d}$$

0 capacity storage buffer

$$E_\infty = \frac{T_c}{T_c + FT_d}$$

∞ capacity storage buffer