



Ch 17 Automated Assembly Systems

Sections:

1. Fundamentals of Automated Assembly Systems
2. Quantitative Analysis of Assembly Systems



Automated Assembly - Defined

“The use of mechanized and automated devices to perform the various assembly tasks in an assembly line or cell”

- Fixed automation usually
 - Most automated assembly systems are designed to perform a fixed sequence of assembly steps on a specific product that is produced in very large quantities



Automated Assembly - Application Characteristics

- *Where is automated assembly appropriate:*
 - High product demand
 - Stable product design
 - The assembly consists of no more than a limited number of components
 - The product is designed for automated assembly



Typical Products

Alarm clocks

Ball bearings

Ball point pens

Cigarette lighters

Door mechanisms

Gear boxes

Light bulbs

Locks

Mechanical pencils

PCB assemblies

Small electric motors

Wrist watches



Assembly Processes in Automated Assembly

Adhesive bonding

Insertion of components

Placement of components

Riveting

Screw fastening

Snap fitting

Soldering

Spot welding

Stapling

Stitching



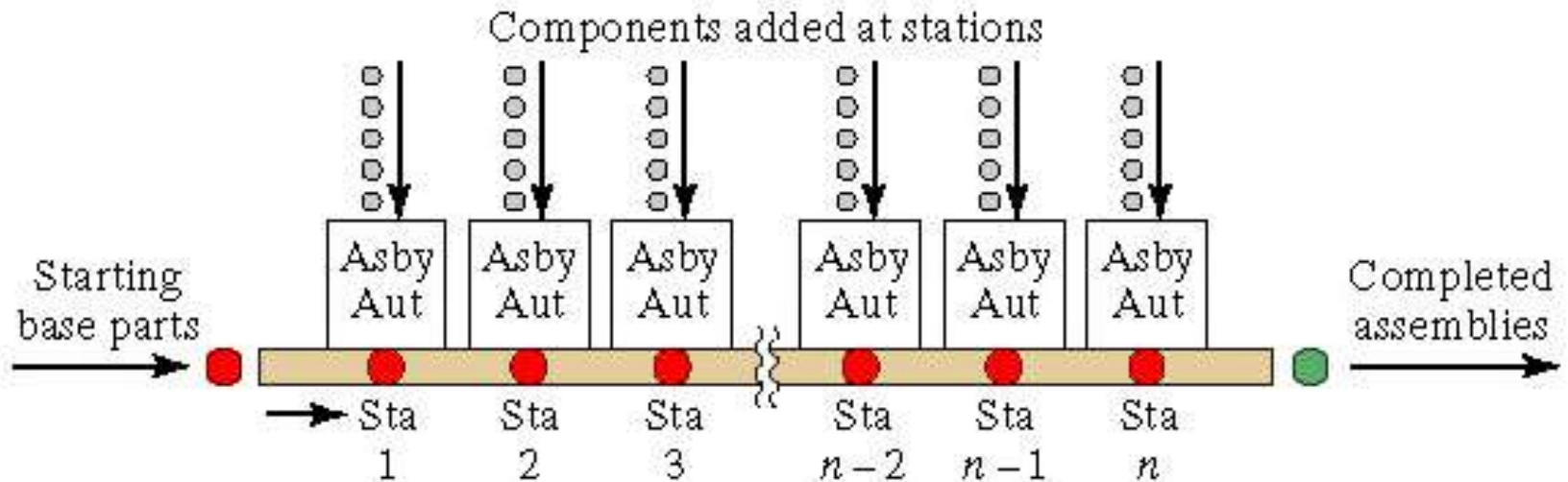
System Configurations

1. In-line assembly machine
2. Dial indexing machine
3. Carousel assembly system
4. Single-station assembly cell



In-Line Assembly Machine

“A series of automatic workstations located along and in-line transfer system”

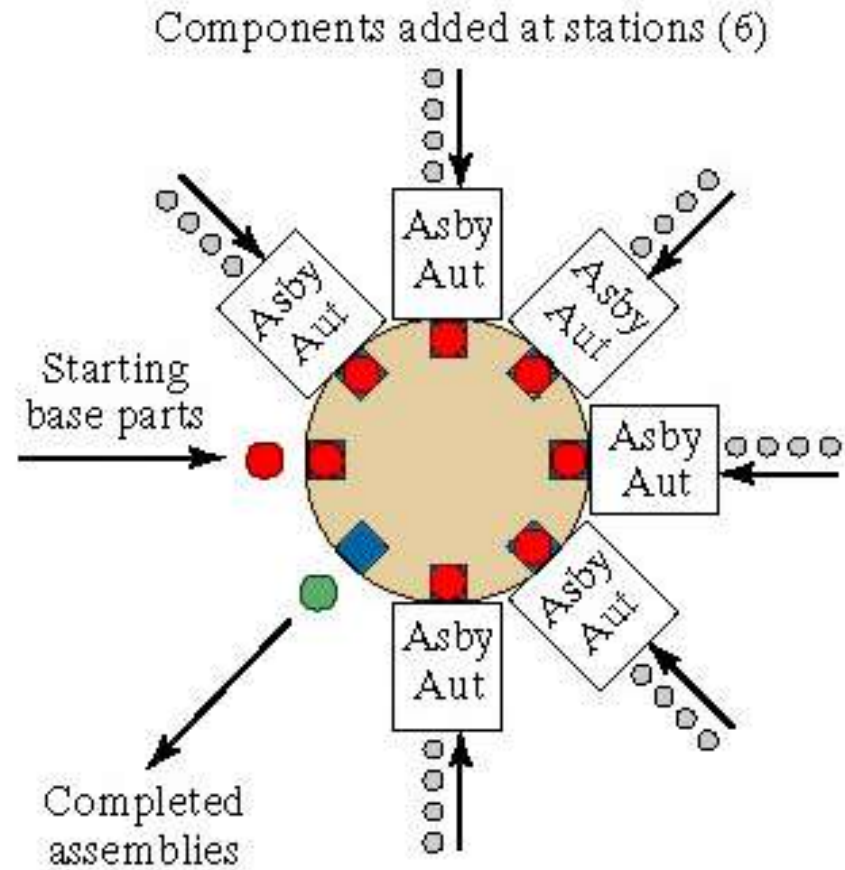


Either synchronous or asynchronous work transfer used.



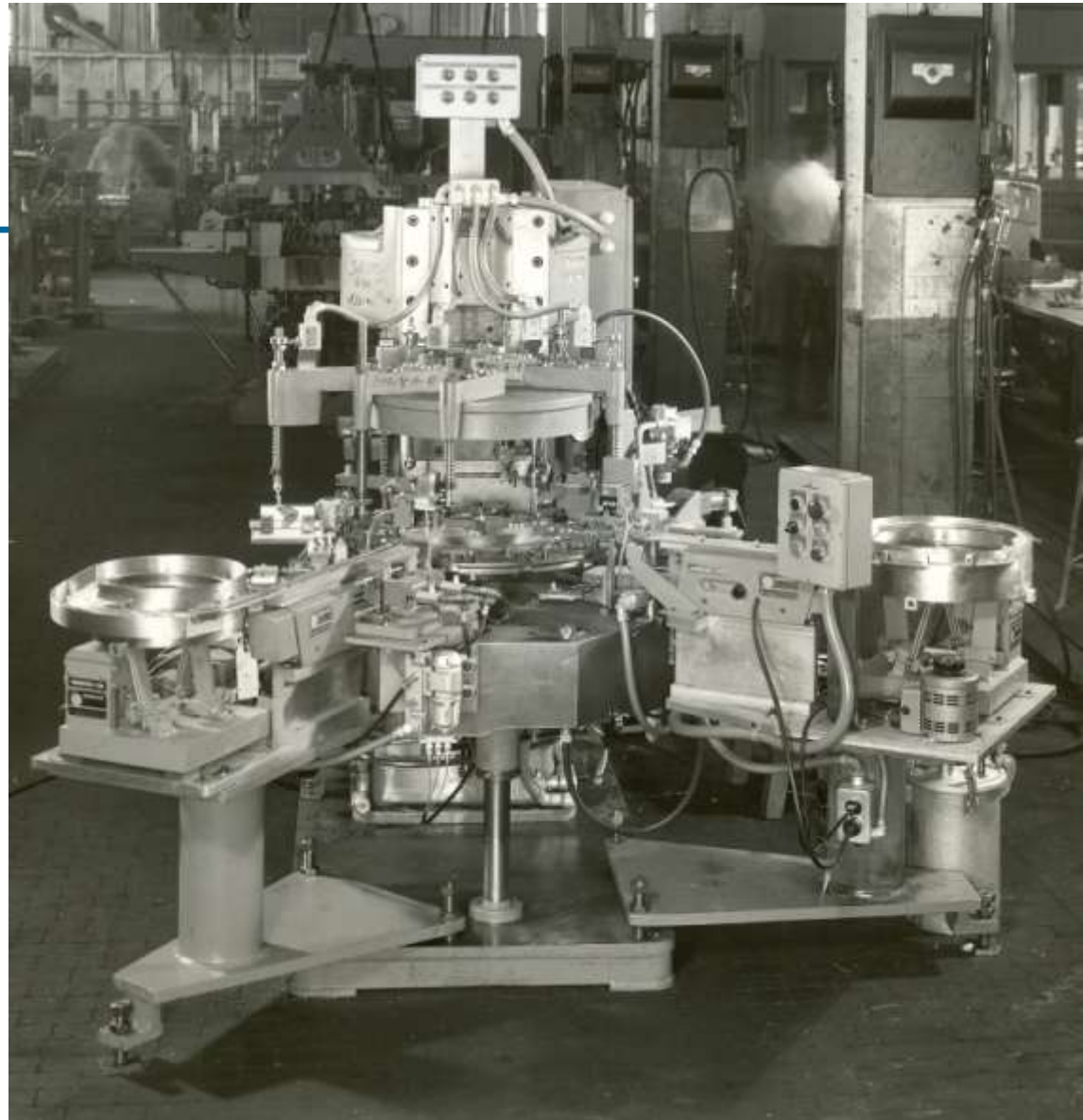
Dial Indexing Machine

Base parts are loaded onto fixtures or nests attached to a circular dial table, and components are added at workstations located around the periphery of the dial as it indexes from station to station.





Dial indexing assembly machine (Bodine Corp.)

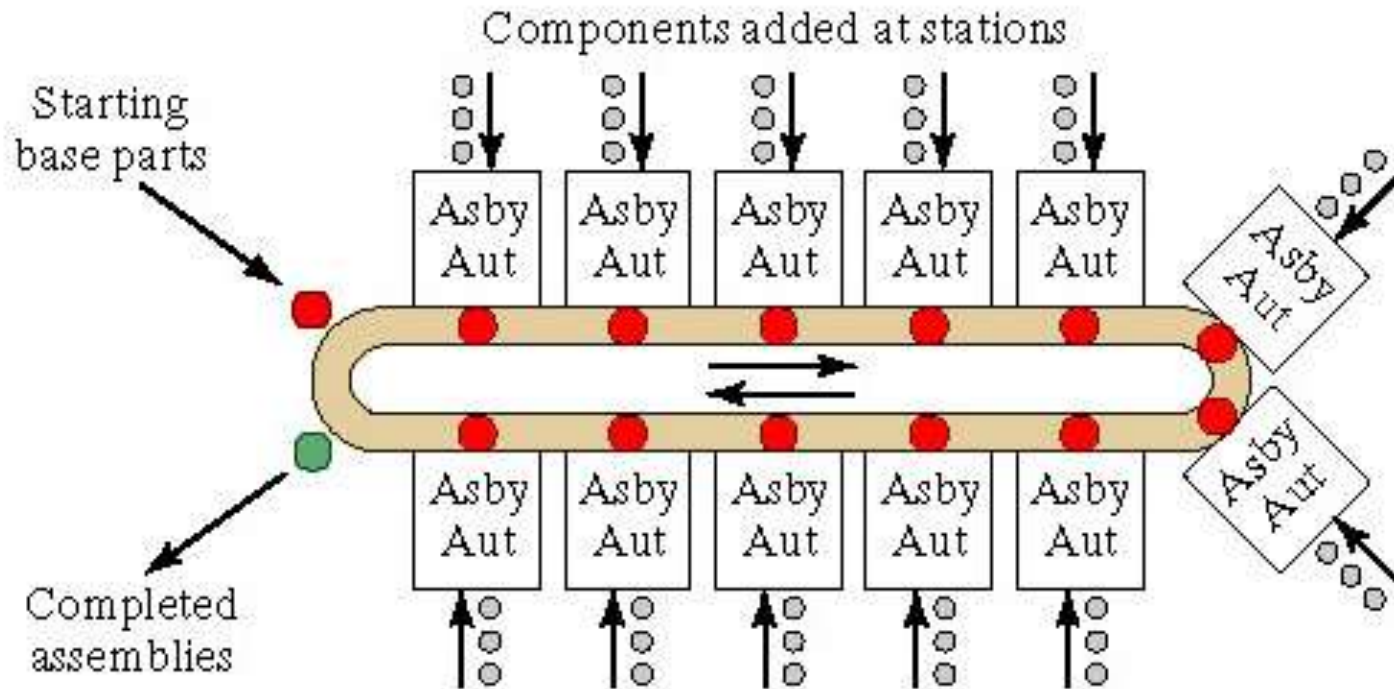


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Carousel Assembly System

“A hybrid between circular work flow of dial indexing machine and straight work flow of in-line system”



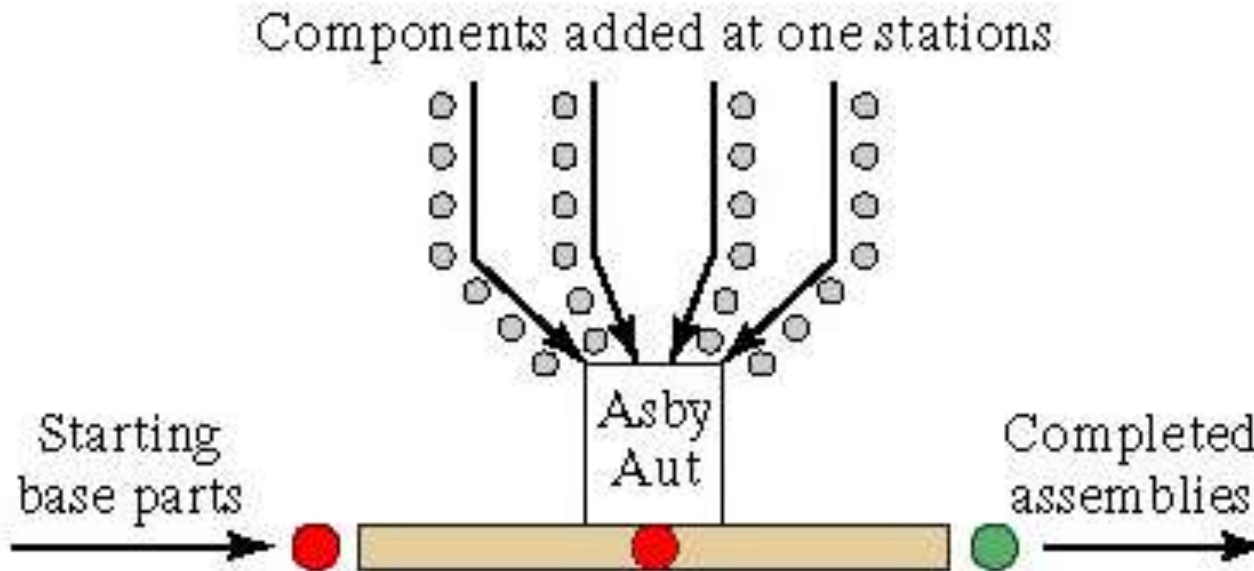
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Single-Station Assembly Cell

“Assembly operations are performed on a base part at a single location”

- A robot is sometimes used as the assembly machine.





Multi-Station vs. Single-Station

- Multi-station assembly machine or line
 - Faster cycle rate
 - High production quantities
 - More operations possible
 - More components per assembly
- Single-station assembly cell
 - Suited to robotic assembly
 - Intended for lower production quantities

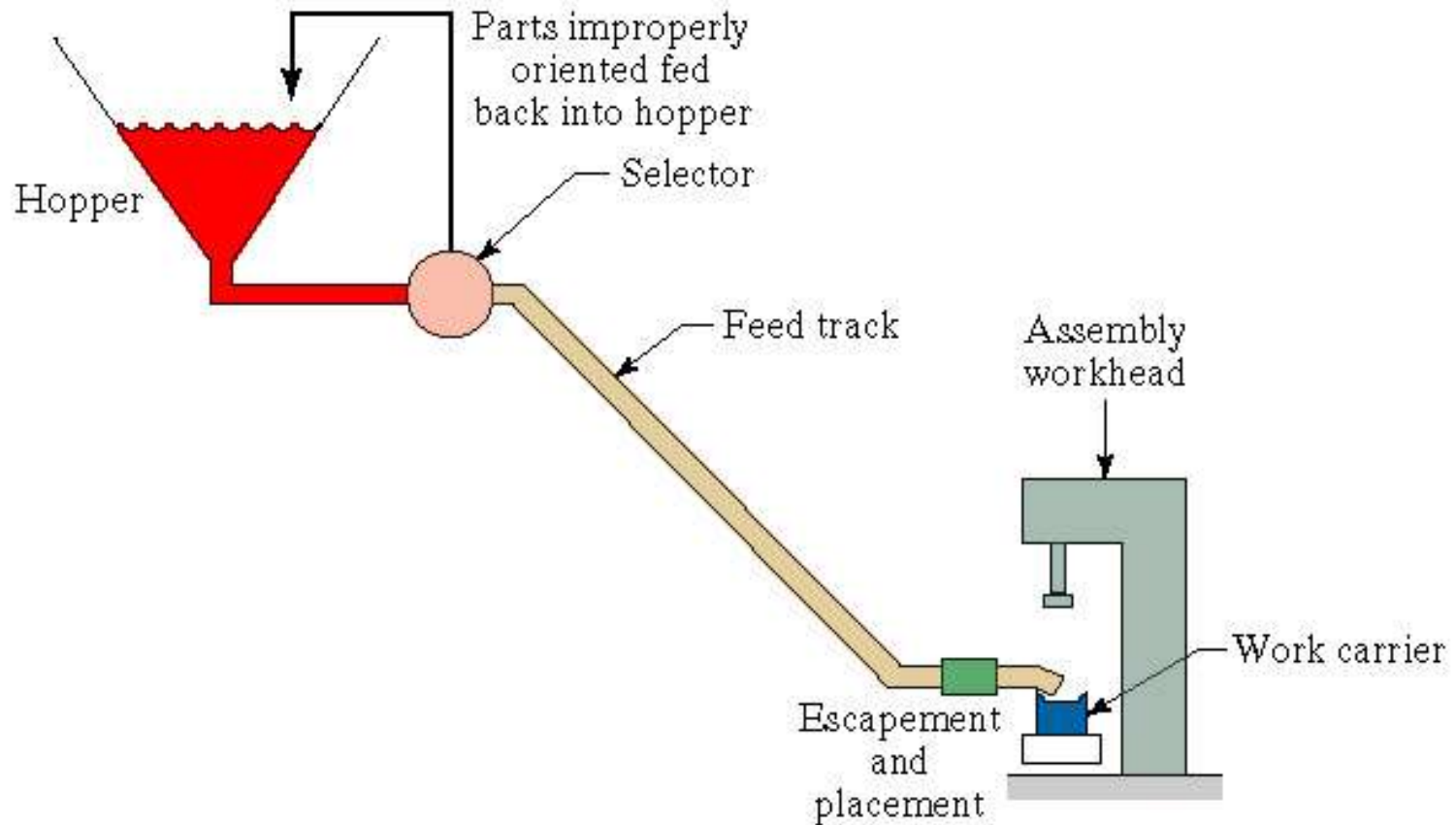


Parts Delivery at Workstations

- Typical parts delivery system at a workstation consists of the following hardware components:
 1. Hopper - container for parts
 2. Parts feeder - removes parts from hopper
 3. Selector and/or orientor - to assure part is in proper orientation for assembly at workhead
 4. Feed track - moves parts to assembly workhead
 5. Escapement and placement device - removes parts from feed track and places them at station



Parts Delivery System at Station



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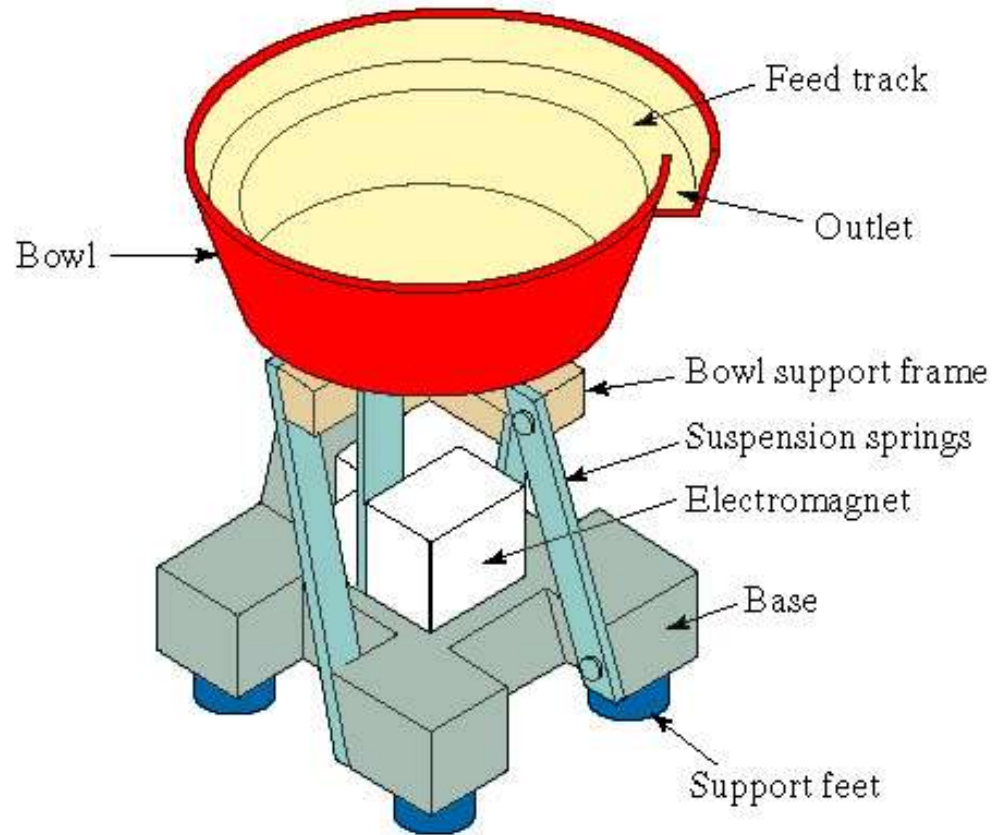


Vibratory Bowl Feeder

- Most versatile of hopper feeders for small parts
- Consists of bowl and helical track
 - Parts are poured into bowl
 - Helical track moves part from bottom of bowl to outlet
- Vibration applied by electromagnetic base
 - Oscillation of bowl is constrained so that parts climb upward along helical track



Vibratory Bowl Feeder



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Vibratory Bowl Feeder

Photo courtesy
Syntron Inc.



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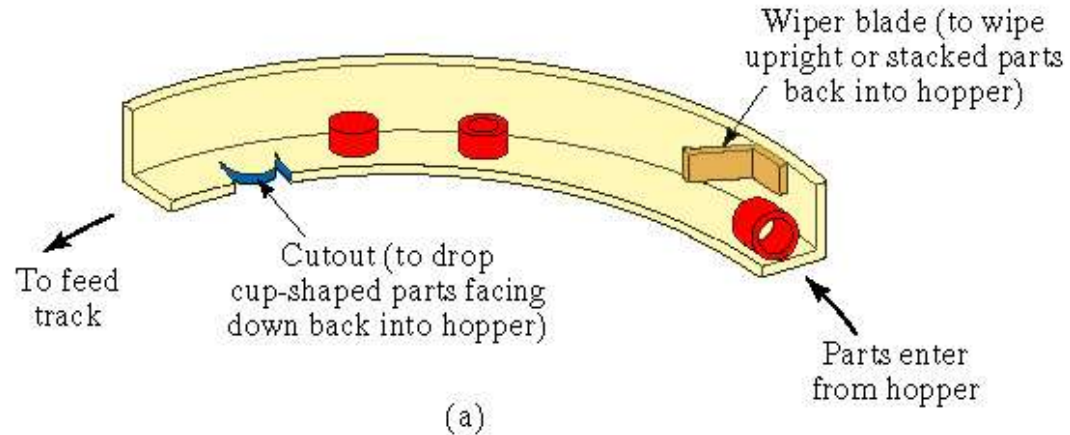
Selector and/or Orientor

- Purpose - to establish the proper orientation of the components for the assembly workhead
- Selector
 - Acts as a filter
 - Only parts in proper orientation are allowed to pass through to feed track
- Orientor
 - Allows properly oriented parts to pass
 - Reorients parts that are not properly oriented

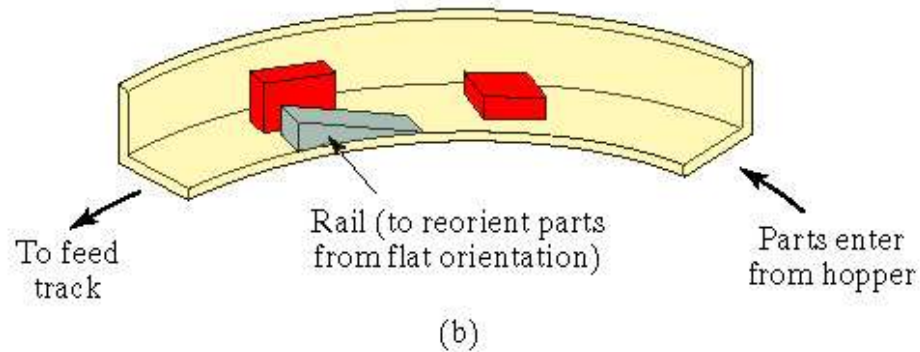


Parts Selection and Orientation

(a) Selector



(b) Orientor





Feed Track

- Moves parts from hopper to assembly workhead
- Categories:
 1. Gravity - hopper and feeder are located at higher elevation than workhead
 2. Powered - uses air or vibration to move parts toward workhead

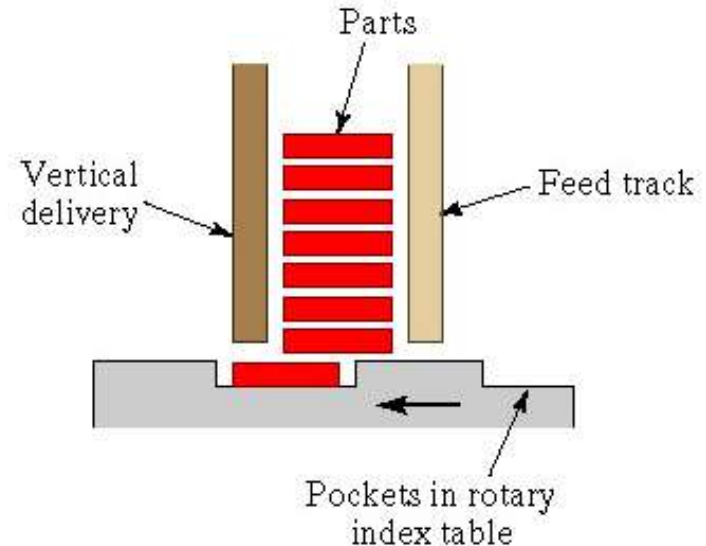
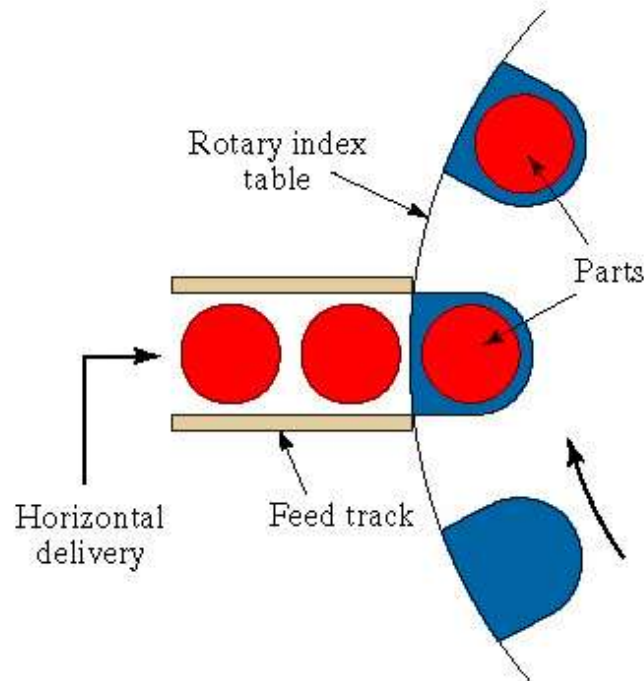


Escapement and Placement Devices

- Escapement device
 - Removes parts from feed track at time intervals that are consistent with the cycle time of the assembly workhead
- Placement device
 - Physically places the parts in the correct location at the assembly workstation
- Escapement and placement devices are sometimes the same device, sometimes different devices



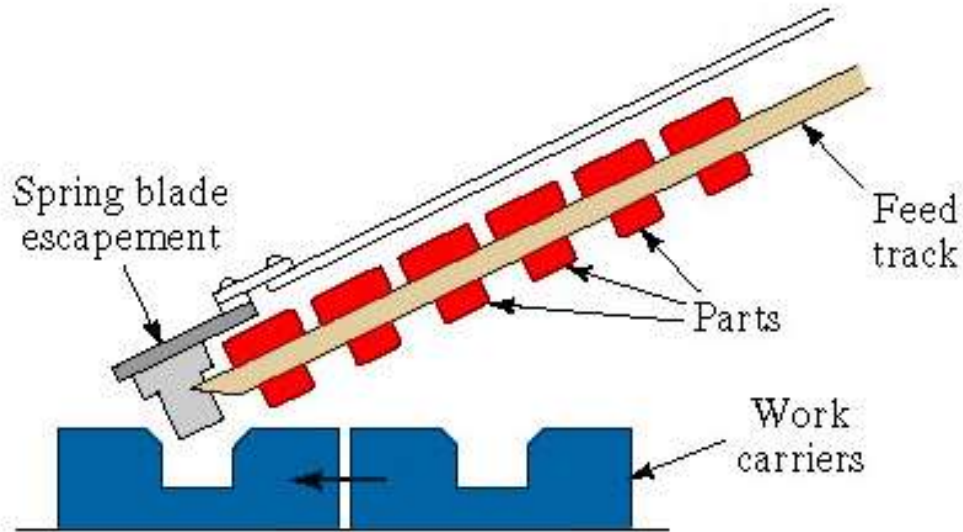
Escapement and Placement Devices



(a) Horizontal and (b) vertical devices for placement of parts onto dial-indexing table



Escapement and Placement Devices

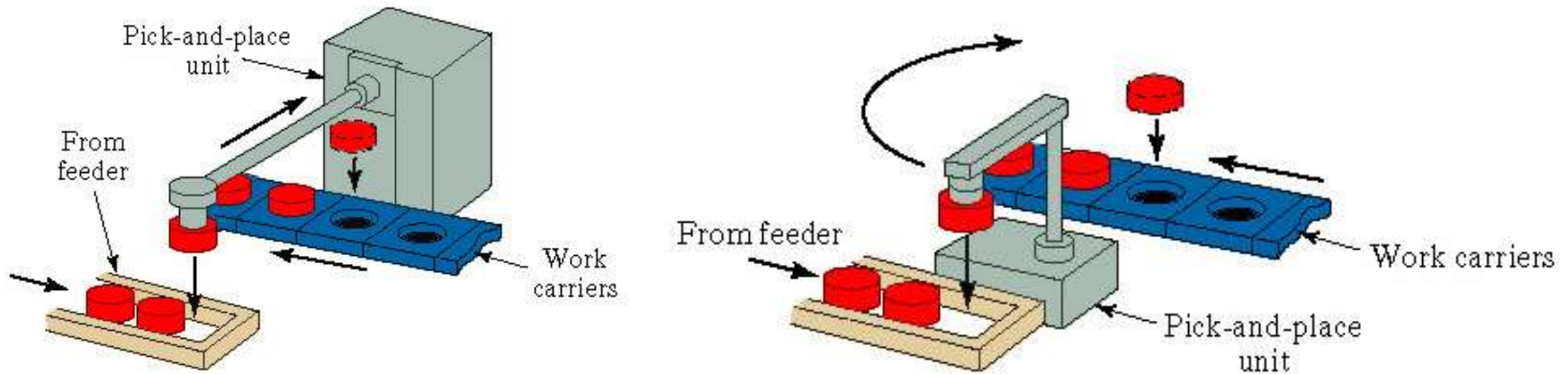


Escapement of rivet-shaped parts actuated by work carriers

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Escapement and Placement Devices



Two types of pick-and-place mechanisms for transferring base parts from feeders to work carriers



Quantitative Analysis of Assembly Systems

1. Parts delivery system at workstations
2. Multi-station assembly machines
3. Single-station assembly cells
4. Partial automation



What the Equations Tell Us

- The parts delivery system at each station must deliver components to the assembly operation at a net rate that is greater than or equal to the cycle rate of the assembly workhead
 - Otherwise, assembly system performance is limited by the parts delivery system rather than the assembly process technology
- Component quality has an important effect on system performance - poor quality means
 - Jams at stations that stop the entire assembly system
 - Assembly of defective components in the product



What the Equations Tell Us

- As the number of stations increases, uptime efficiency and production rate are adversely affected due to parts quality and station reliability effects
- The cycle time of a multi-station assembly system is determined by its slowest station
- By comparison with a multi-station assembly system, a single-station assembly cell with the same number of assembly tasks has a lower production rate but a higher uptime efficiency



What the Equations Tell Us

- Multi-station assembly systems are appropriate for high production applications and long production runs
- By comparison, single-station assembly cells have a longer cycle time and are more appropriate for mid-range quantities
- Storage buffers should be used on partially automated production lines to isolate the manual stations from breakdowns at the automated stations
- An automated station should be substituted for a manual station only if it has the effect of reducing cycle time sufficiently to offset negative effects of lower reliability