Material Handling and Storage

CIM Test 1 – 2022023-2

Written Test with One Question Only

Topic:
Up to Topic 2

Time:
4:00 pm - 5:00 pm

Location:
Embedded Lab, Level 5 MJIIT

Outline

- Introduction to Material Handling System
- Automated Guided Vehicle System
- Analysis for Material Handling System
- Automated Storage System
- Automated Storage/Retrieved System
- Automated Data Capture
- Application

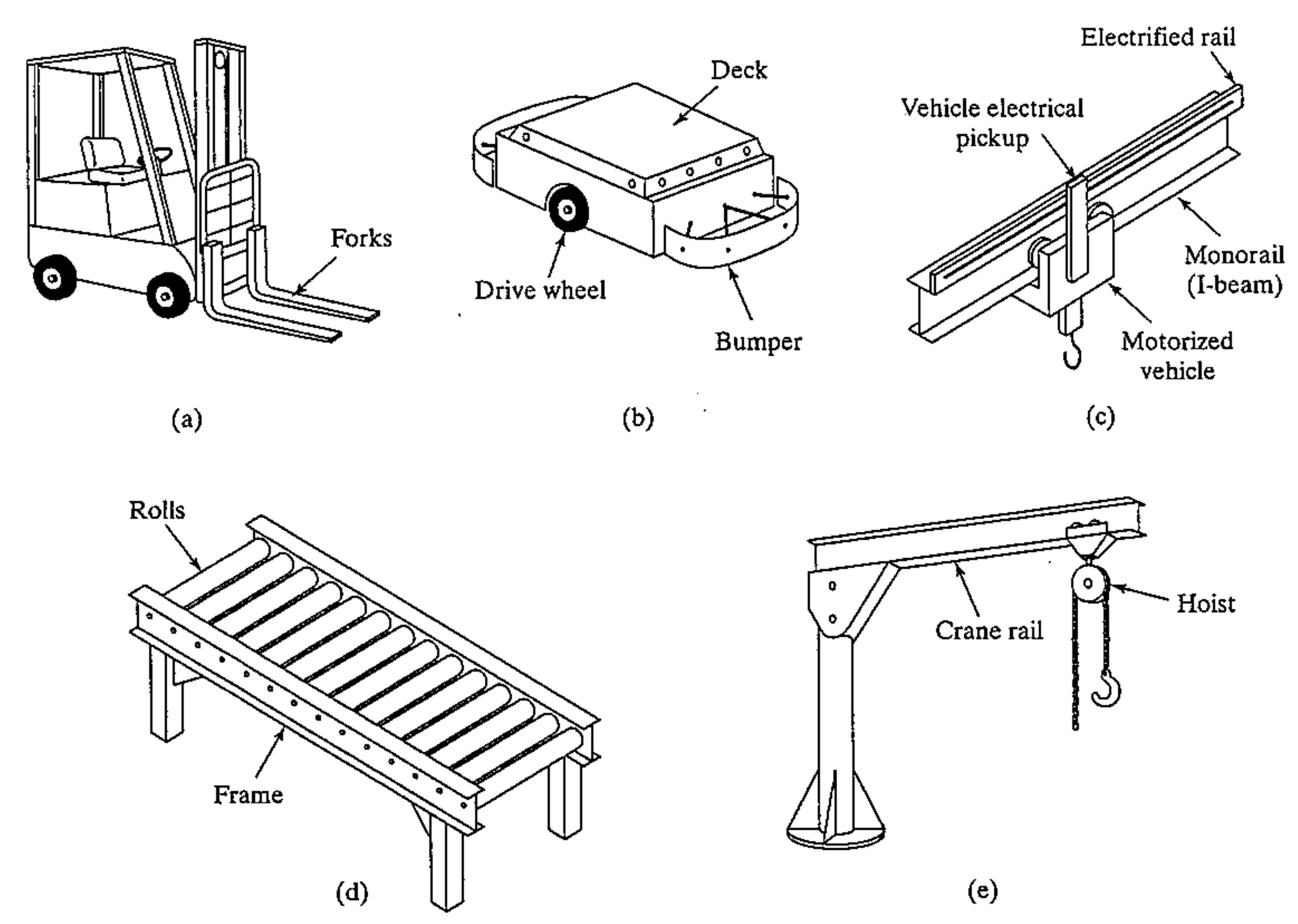
Introduction

- The movement, storage, protection and control of materials throughout the manufacturing and distribution process including their consumption and disposal.
- Must be performed safely, efficiently, at low cost, in a timely manner, accurately and without damage to the material.

Types of Material Handling Equipment

- Transport equipment
- Storage systems
- Utilizing equipment
- Identification and tracking systems

Transport Equipment



(a) fork lift truck, industrial truck (b) unit load automated guided vehicle (c) monorail (d) roller conveyor (e) jib crane with hoist

Storage Systems

- Raw materials and work-in-process will spend some time being stored for waiting/queueing next particular process.
- Companies must give consideration to the most appropriate methods for storing materials and product prior to, during and after manufacture.
- Storage methods and equipment can be classified,

Storage Systems[1]

- Bulk storage – pallet loads
- Rack systems – a structural frame designed to stack unit loads vertically.
- Shelving and bins – steel shelving included bins.
- Drawer storage – used for tool and other small items
- Automated storage systems – consists of automated storage/retrieval systems and carousel systems.

Utilizing Equipment

- There two categories;

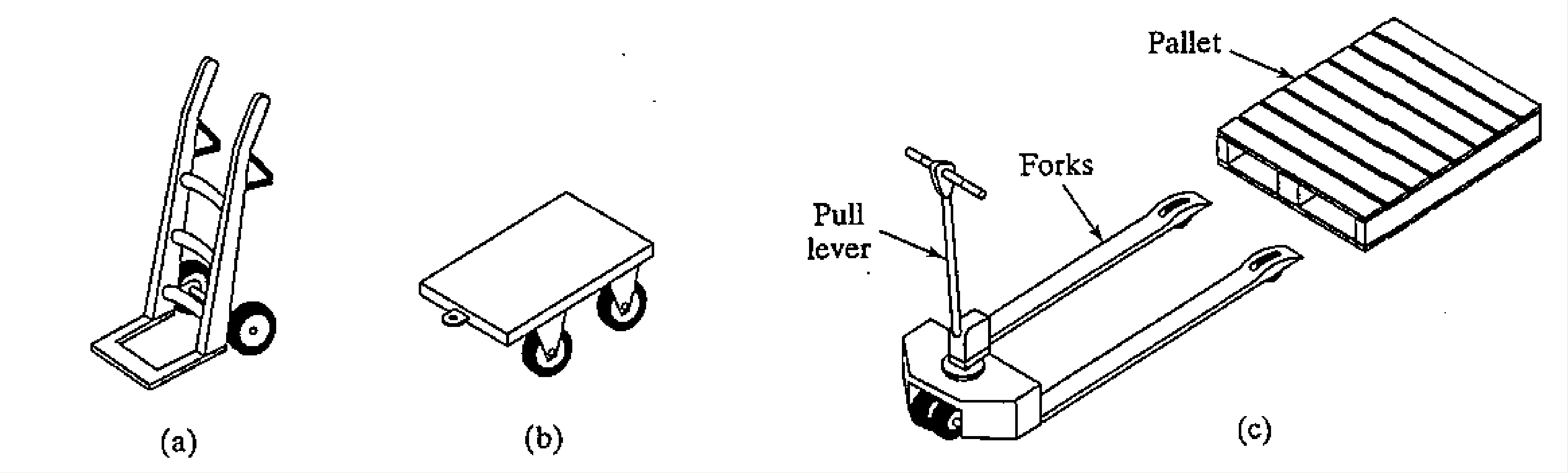
1) Containers used to hold individual items during handling
2) Equipment used to load and package the containers, includes palletizers and depalletizers.

Identification and Tracking Systems

- The function is for keeping track of the materials being moved and stored by affixing some kind of label to the item.
- The labels consist of bar codes, magnetic stripes and radio frequency tags.

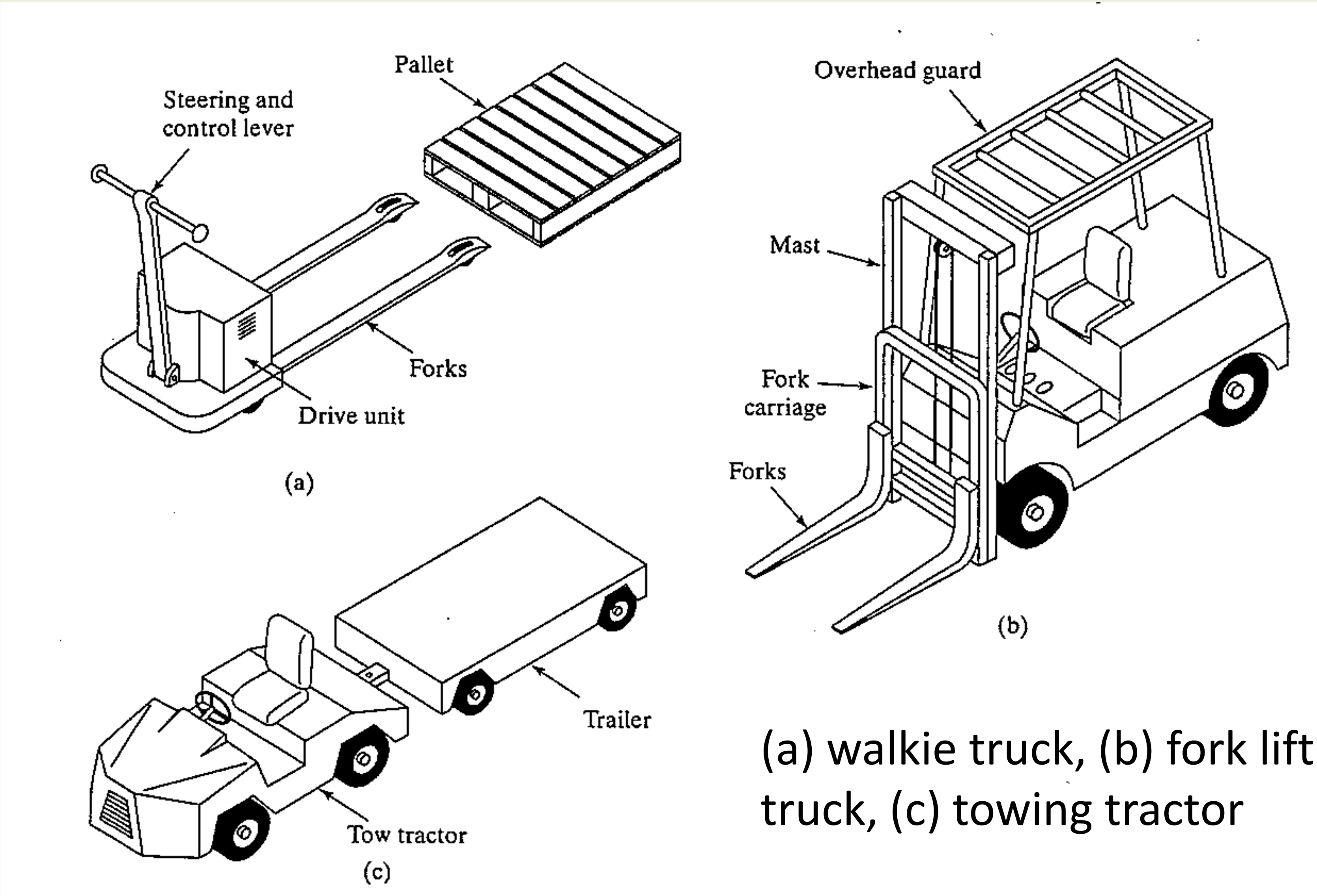
Industrial Trucks

- There are two categories of the truck: non-powered and powered.



(a) Two-wheel hand truck, (b) four-wheel dolly, (c) hand-operated low-lift pallet truck

Industrial Trucks2

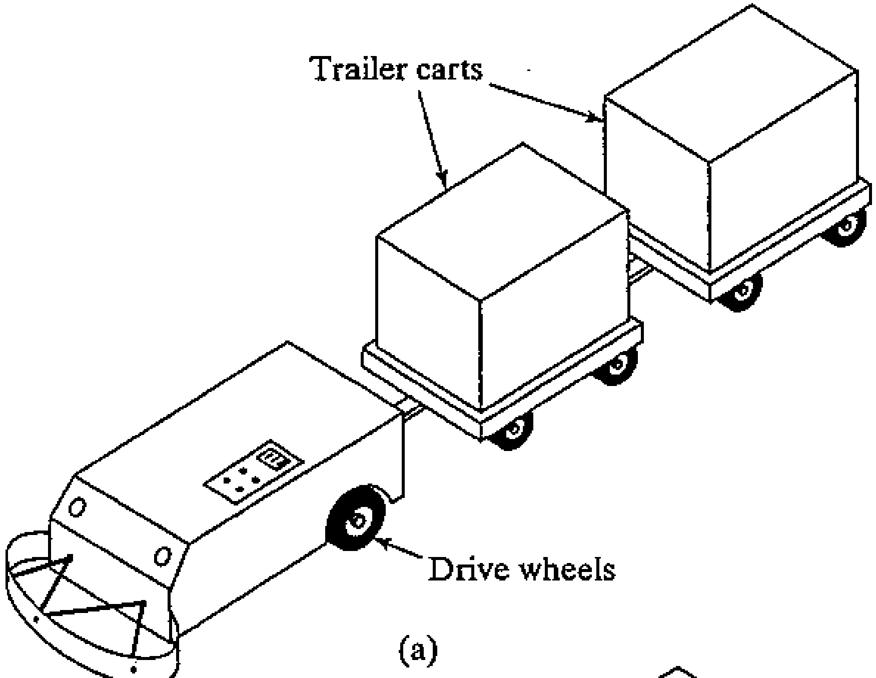


(a) walkie truck, (b) fork lift truck, (c) towing tractor

Automated Guided Vehicle System

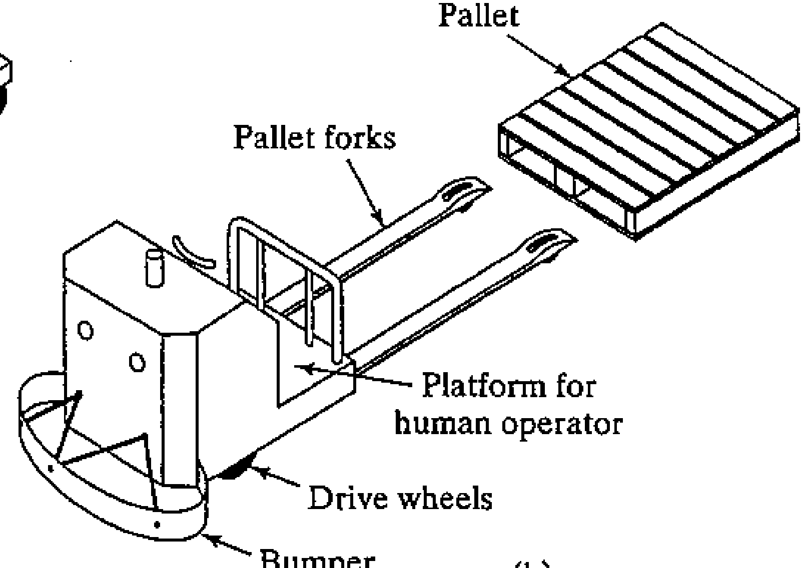
- The material handling uses independently operated along defined pathways that are unclear.
- With condition where different material are moved from various load points to various unload points.

AGVS
-Categories-



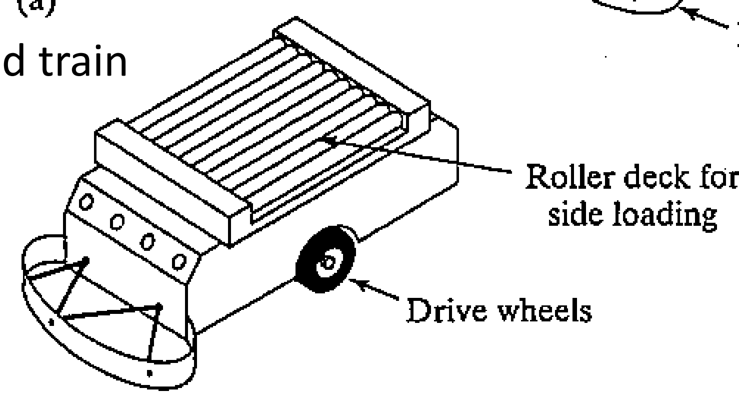
(a)

Driverless automated guided train



(b)

AGV pallet truck



(c) Unit load carrier

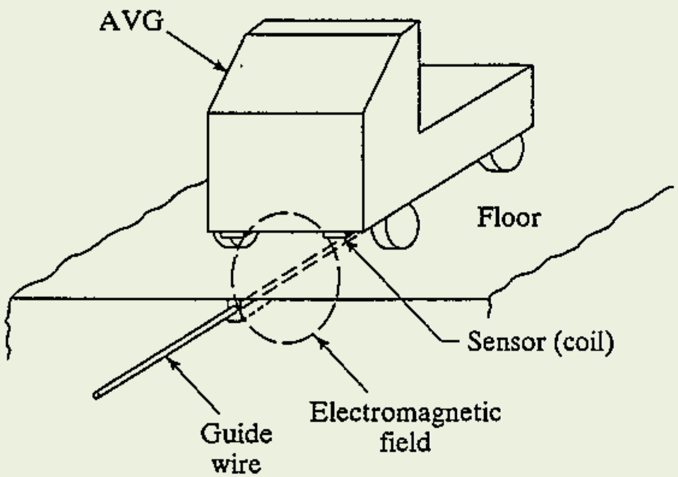
AGVS
-Technologies-

- The methods for defining AGVS pathways and controlling vehicles to follow the pathways.

1. Imbedded guide wires
2. Paint strips, and
3. Self-guided vehicles.

Imbedded Guide Wires

- Electrical wires are grounded in a small channel cut into the surface of the floor as well as vehicle pathways.
- The wires are connected to a frequency generator to induce a magnetic field along the pathway that can be followed by sensors on-board each vehicle.



Operation of the on-board sensor system that uses two coils to track the magnetic field in the guide wire. Please see reference book for the detail!!

Paint Strips

- The vehicle uses an optical sensor system capable of tracking the paint (fluorescent particles that reflect an ultraviolet light source from the vehicle).
- Optical sensor will detect the reflected UV to control the steering to follow pathways.
- Always maintain the shining of the strips and keep clean and periodically repainted.

Self-Guided Vehicle

- This system operates without continuously define pathways.
- It works by using a combination of dead-reckoning and beacons located throughout the plant.
- Dead-reckoning refers to the capability of a vehicle to follow a given route.
- Along the route, movement of the vehicle is controlled by computing the required number of wheel rotations in a sequence of specified steering angles (pathways software).
- Positioning accuracy of dead-reckoning must be periodically verified by comparing the calculated position with one or more known positions.
- These known positions are established using beacons (bar-coded beacons and magnetic beacons).

AGVS
-Safety-

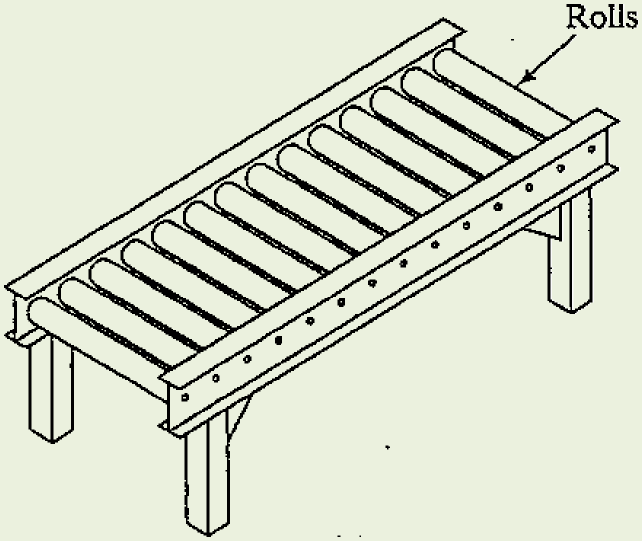
- Its traveling speed is slower than the normal walking pace of a human.
- Automatic stopping of the vehicle if it strays more than a few inches from guide path.
- Obstacle detection sensor located on each vehicle.
- Providing an emergency bumper on each vehicle.
- Providing a warning lights (blinking or rotating lights) and/or warning bells, which alert humans that the vehicle is present.

Monorail and Other Rail

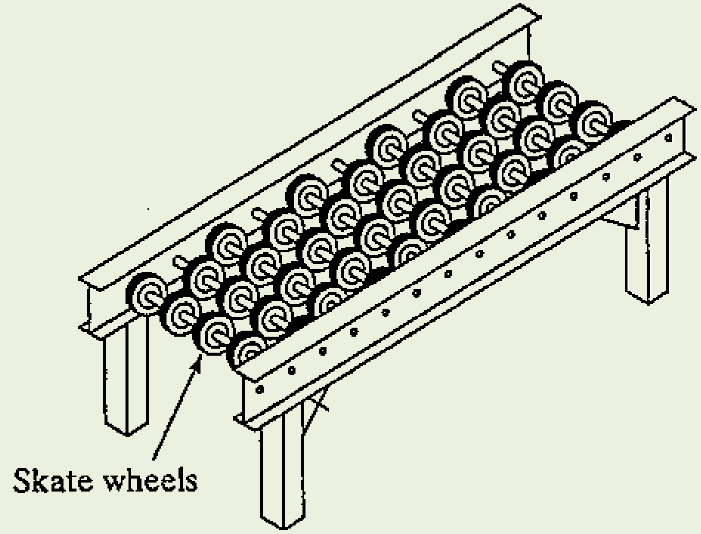
- The equipment consists of motorized vehicle that are guided by a fixed rail system. It consists of either one rail or two parallel rails.
- Rail guided system are generally considered to be more versatile than conveyor systems but less versatile than AGVS.

Conveyor Syster[redacted]

- There are two categ[redacted]
  powered and non-p[redacted]

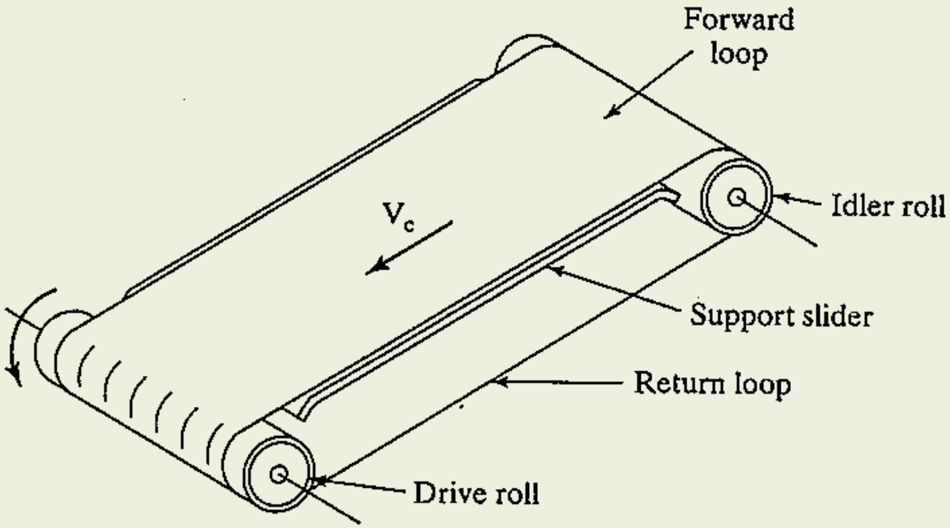


Roller conveyor

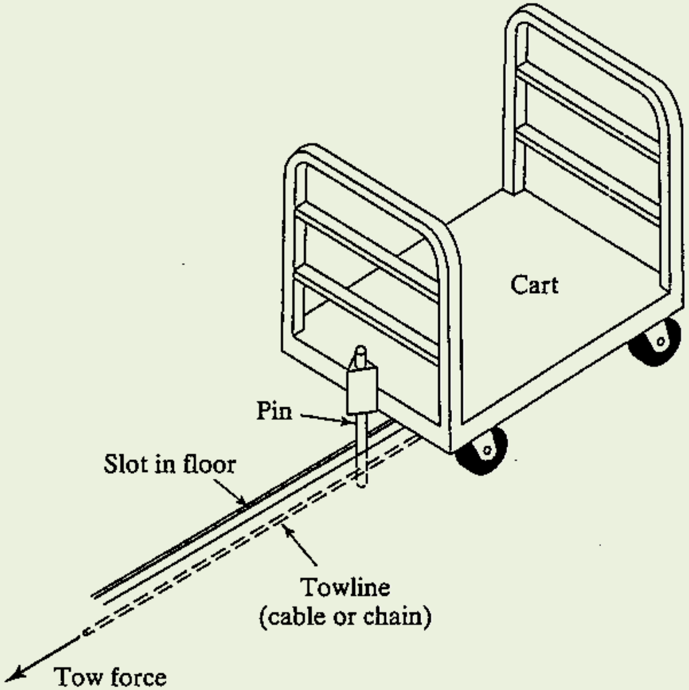


Skate wheel conveyor

Conveyor Systems2



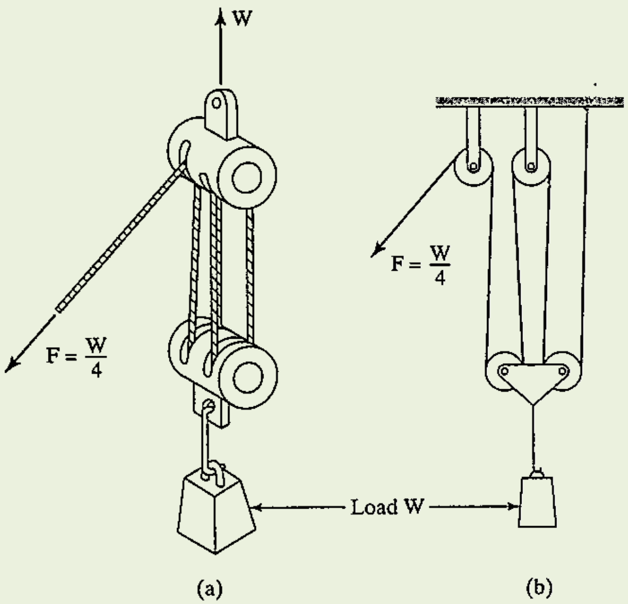
Belt (flat) conveyor



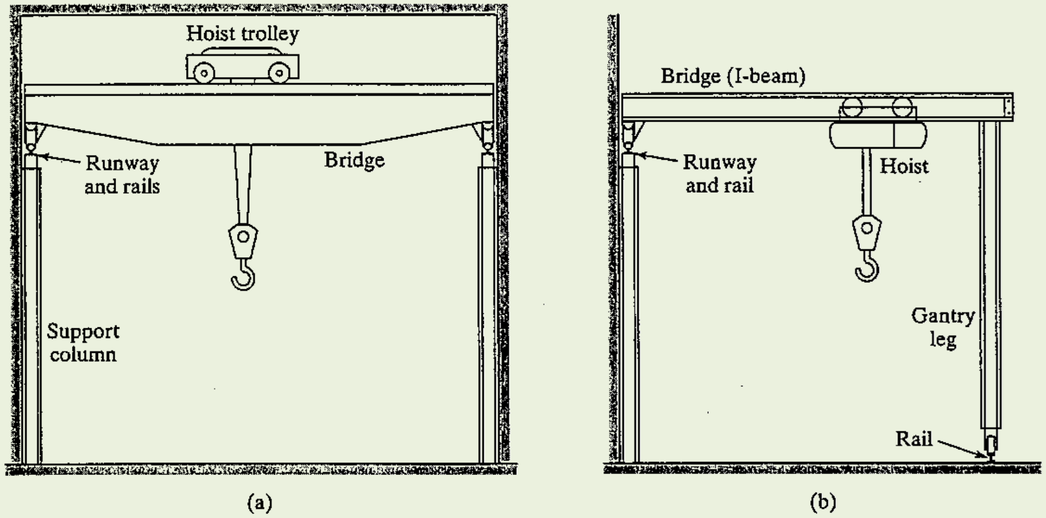
In-floor towline conveyor

Cranes and Hoists

- Cranes are used for horizontal movement of materials, whereas hoists are used for vertical lifting.



Hoists



(a) Bridge crane, (b) Gantry crane

Analysis for MHS

- There are three analysis will be looked on such,

1) Charting technique in material handling.
2) Analysis of vehicle-based systems.
3) Conveyor analysis.

Charting Technique

From-To Chart Showing Flow Rates, loads/hr (Value Before the Slash Mark) and Travel Distances, *m* (Value After the Slash Mark) Between Stations in a Layout

	To	*1*	*2*	*3*	*4*	*5*
From	1	0	9/50	5/120	6/205	0
	2	0	0	0	0	9/80
	3	0	0	0	2/85	3/170
	4	0	0	0	0	8/85
	5	0	0	0	0	0

Vehicle-Based Systems

- Mathematical equations can be developed to show the operation of a vehicle-based delivering systems in term of time for a typical delivery cycle.
- There are four stages of time delivering such,

1) Loading at the pickup station
2) Traveling to the drop-off station
3) Unloading at the drop-off station, and
4) Empty traveling between deliveries.

Vehicle-Based Systems[1]

Total cycle time per delivery per vehicle is given by;

$$T_c = T_L + \frac{L_d}{v_c} + T_U + \frac{L_e}{v_e} \qquad (10.1)$$

where T_c = delivery cycle time (min/del), T_L = time to load at load station (min), L_d = distance the vehicle travels between load and unload station (m, ft), v_c = carrier velocity (m/min, ft/min), T_U = time to unload at unload station (min), and L_e = distance the vehicle travels empty until the start of the next delivery cycle (m, ft).

This delivery cycle time is an ideal value due to ignores any time losses.

Vehicle-Based Systems[2]

- By determining T_c, two parameters can be determined; rate of deliveries per vehicle and number of vehicle required.
- The hourly rate of deliveries per vehicle is 60 min divided by Tc, adjusting for any time losses during the hour.
- Possible time losses are availability, traffic congestion and efficiency of manual drivers.
- By considering these factors, the available time per hour per vehicle as 60 min adjusted by A, T_f and E,

$$AT = 60\, A\, T_f E$$

AT = available time (min/hr per vehicle, A = availability, T_f = traffic factor and E = worker efficiency

Vehicle-Based Systems[3]

The rate of deliveries per vehicle,

$$R_{dv} = \frac{AT}{T_c}$$

hourly delivery rate per vehicle (del./hr per vehicle)

The total number of vehicles,

$$WL = R_f T_c$$

workload (min/hr), specified flow rate of total deliveries per hour for the system (del/hr) and delivery cycle time (min/del).

The number of vehicles required to accomplish the workload,

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

number of carriers required, workload (min/hr) and available time per vehicle (min/hr per vehicle)

Example[1]

To determine the number of vehicle in an AGVS

Given the AGVS layout shown in Figure 10.15. Vehicles travel counterclockwise around the loop to deliver loads from the load station to the unload station. Loading time at the load station = 0.75 min, and unloading time at the unload station = 0.50 min. It is desired to determine how many vehicles are required to satisfy demand for this layout if a total of 40 del/hr must be completed by the AGVS. The following performance parameters are given: vehicle velocity = 50 m/min, availability = 0.95, traffic factor = 0.90, and operator efficiency does not apply, so E = 1.0. Determine: (a) travel distances loaded and empty, (b) ideal delivery cycle time, and (c) number of vehicles required to satisfy the delivery demand.

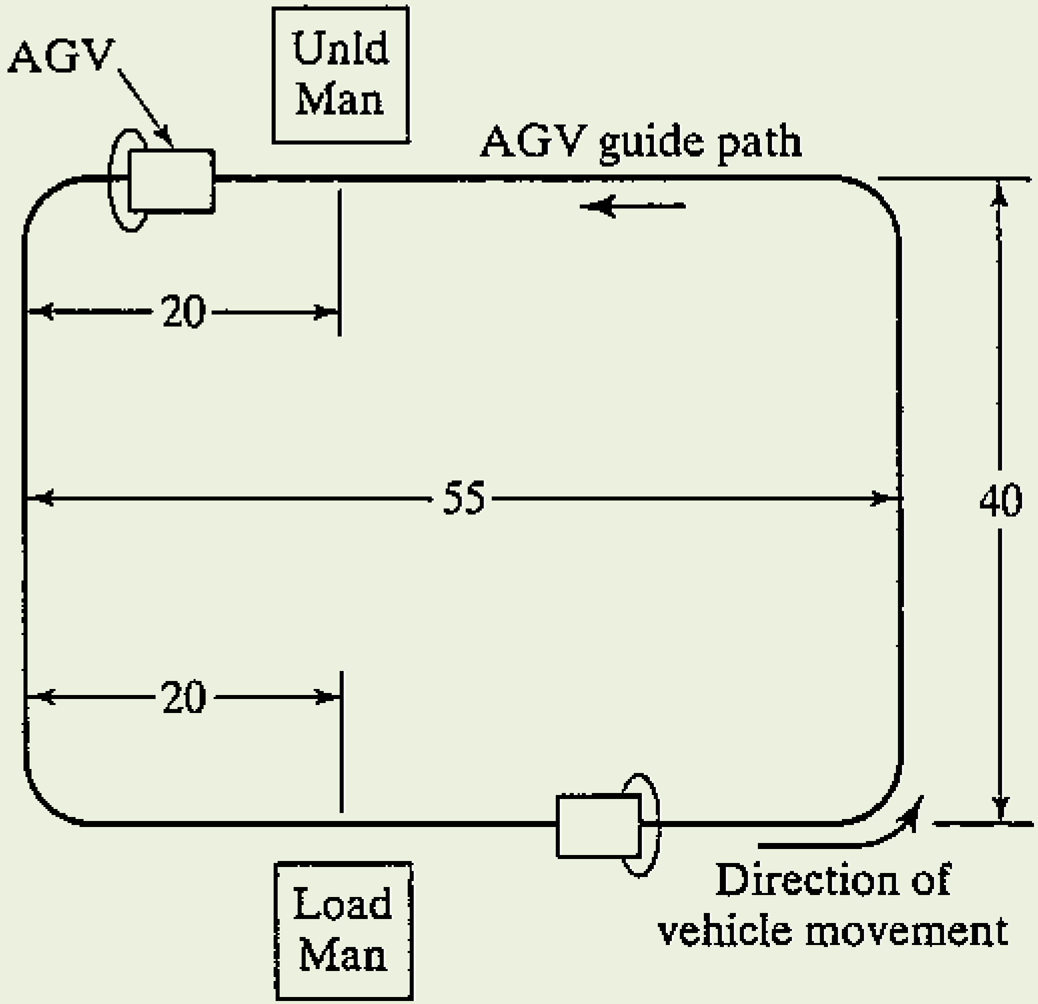


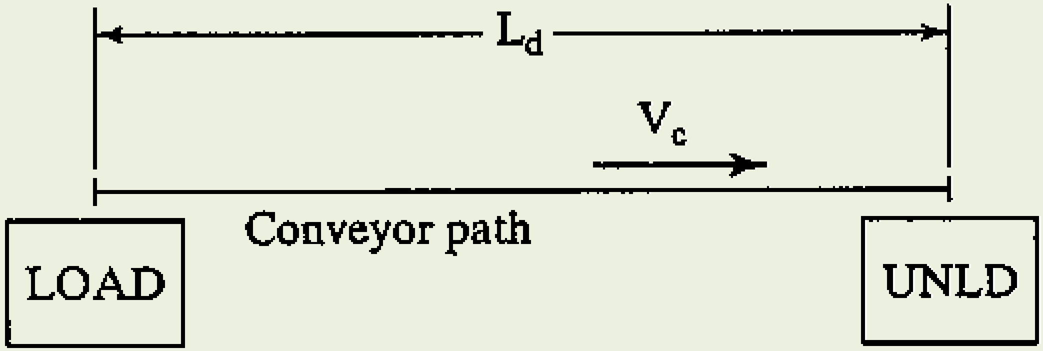
Figure 10.15 AGVS loop layout for Example 10.1. Key: Unld = unload, Man = manual operation, dimensions in meters (m).

Conveyor Analysis

- Three basic type of conveyor operations are considered;

1) Single direction conveyors,
2) Continuous loop conveyors and
3) Recirculating conveyors.

Single Direction Conveyor



The time required to move materials from load station to unload station,

$$T_d = \frac{L_d}{v_c}$$

delivery time (min), length of conveyor (m, ft), conveyor velocity (m/min, ft/min)

Relationship between loading rate and spacing of materials on the conveyor,

$$R_f = R_L = \frac{v_c}{s_c} \leq \frac{1}{T_L}$$

material flow rate (parts/min, loading rate (parts/min), center-to-center spacing of materials (m/part, ft/part) and loading time (min/part)

Single Direction Conveyor2

An additional requirement for loading and unloading time,

$$T_U \leq T_L$$

unloading time (min/part)

When we have numbers of parts (n_p) rather than a single part,

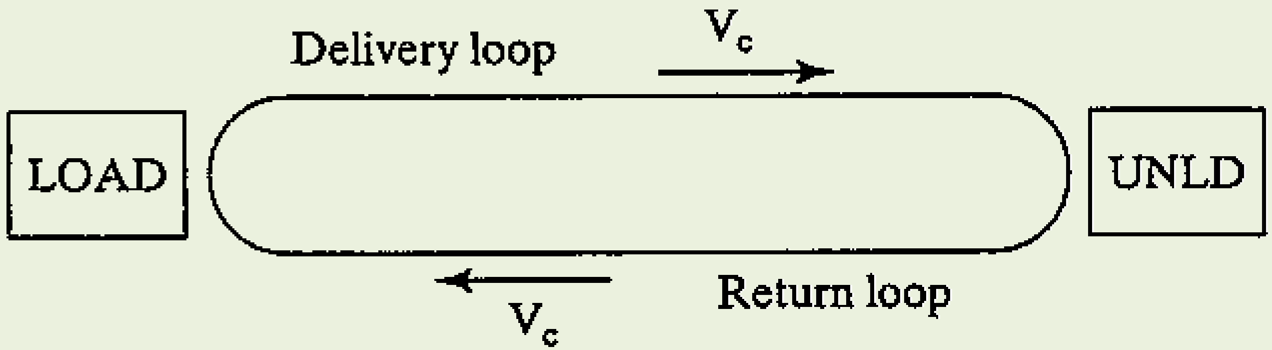
$$R_f = \frac{n_p v_c}{s_c} \leq \frac{1}{T_L}$$

flow rate (parts/min), number of parts per carrier, c-to-c spacing of carriers (m/carrier, ft/carrier), loading time per carrier (min/carrier)

Example2

A roller conveyor follows a pathway 35 m long between a parts production department and an assembly department. Velocity of the conveyor is 40 m/min. Parts are loaded into large tote pans, which are placed onto the conveyor at the load station in the production department. Two operators work the loading station. The first worker loads parts into tote pans, which takes 25 sec. Each tote pan holds 20 parts. Parts enter the loading station from production at a rate that is in balance with this 25-sec cycle. The second worker loads tote pans onto the conveyor, which takes only 10 sec. Determine: (a) spacing between tote pans along the conveyor, (b) maximum possible flow rate in parts/min, and (c) the minimum time required to unload the tote pan in the assembly department.

Continuous Loop Conveyors



The total time required to travel the complete loop,

$$L = L_d + L_e$$

$$T_c = \frac{L}{v_c}$$

Length of delivery loop (m, ft), length of return loop (m, ft), total cycle time (min), speed of the conveyor chain (m/min, ft/min)

The time a load spends in the forward loop,

$$T_d = \frac{L_d}{v_c}$$

delivery time on the forward loop (min)

Continuous Loop Conveyors2

The total number of carriers in the loop,

$$n_c = \frac{L}{s_c}$$

number of carriers, total length of the conveyor loop (m, ft), center-to-center distance between carriers (m/carrier, ft/carrier)

The maximum number of parts in the system at any one time,

$$\text{Total parts in system} = \frac{n_p n_c L_d}{L}$$

The maximum flow rate between load and unload station,

$$R_f = \frac{n_p v_c}{s_c}$$

parts per minute

Recirculating Conveyors

- According to KWO's analysis (T.T. Kwo, 1958), the case of a recirculating conveyor with one load station and one unload station is considered.
- There are two problems complicating the operation of the system,

1) The possibility that no empty carriers are immediately available at the loading station when needed
2) The possibility that no loaded carriers are immediately available at the unloading station when needed.

- Before designing the system, there are three basic principles that must be followed; Speed Rule, Capacity Constraint and Uniformity Principle.

Speed Rule

The conveyor speed must satisfy the following relationship;

$$\frac{n_p v_c}{s_c} \geq \text{Max}\{R_L, R_U\}$$

Required loading rate (parts/min), the corresponding unloading rate

The capabilities of the material handlers to perform the loading and unloading tasks are defined by the time required, so that

$$\frac{v_c}{s_c} \leq \text{Min}\left\{\frac{1}{T_L}, \frac{1}{T_U}\right\}$$

Time required to load a carrier (min/carrier), time required to unload a carrier

Capacity Constraint

The flow rate capacity of the conveyor system must be at least equal to the flow rate requirement, it can be expressed as follows,

$$\frac{n_p v_c}{s_c} \geq R_f$$

Uniformity Principle

The parts (loads) should be uniformly distributed in the carrier throughout the length of the conveyor.

Example3

A recirculating conveyor has a total length of 700 ft and a speed of 90 ft/min. Spacing of part carriers = 14 ft. Each carrier can hold one part. Automatic machines load and unload the conveyor at the load and unload stations. Time to load a part is 0.10 min and unload time is the same. To satisfy production requirements, the loading and unloading rates are each 2.0 parts per min. Evaluate the conveyor system design with respect to the three principles developed by Kwo.

Example4

A recirculating conveyor has a total length of 200m and a speed of 50 m/min. Spacing of part carriers = 5 m. Each carrier holds two parts. Time needed to load a part carrier = 0.15 min. Unloading time is the same. The required loading and unloading rates are 6 parts per min. Evaluate the conveyor system design with respect to the three Kwo principles.