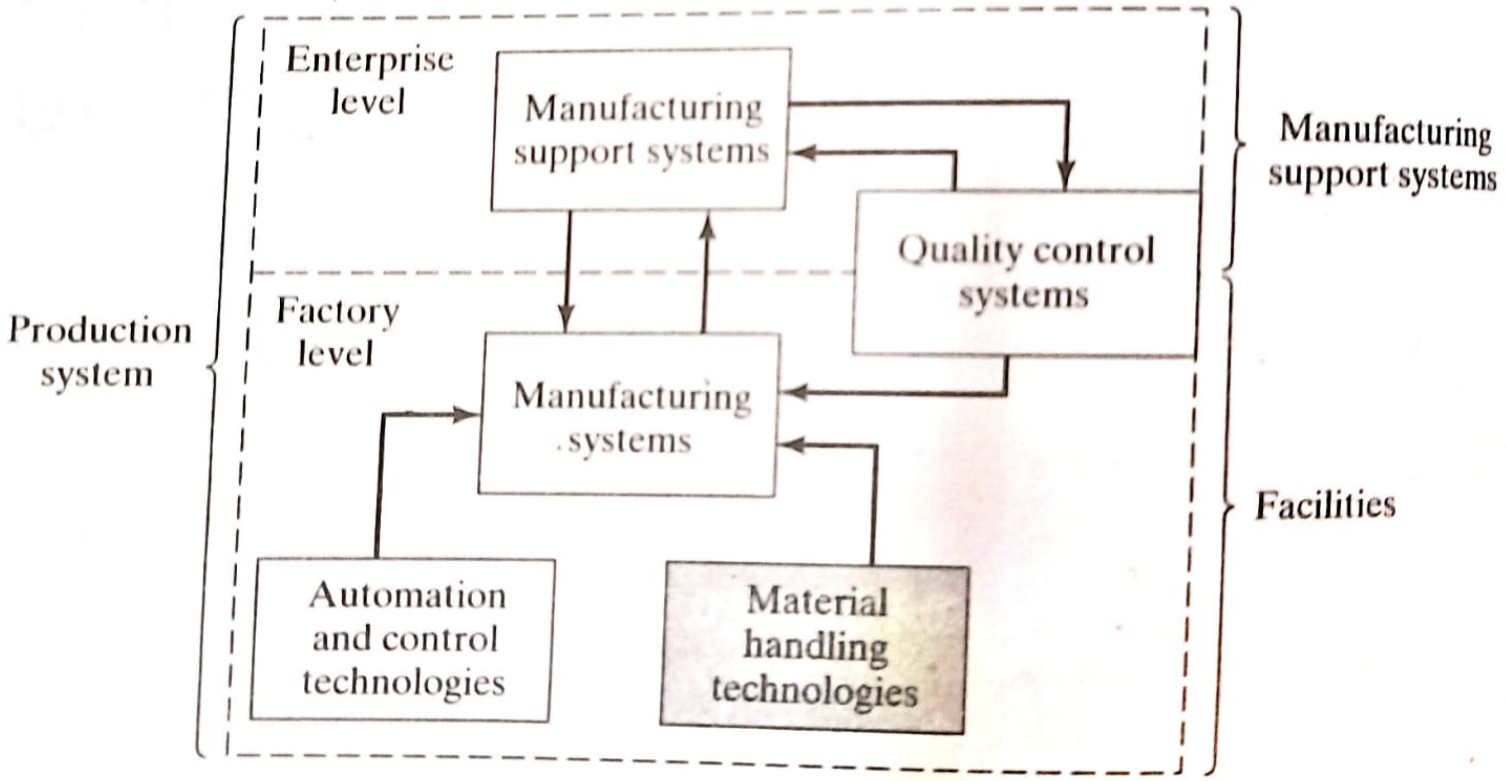
# Automated Material Handling

L-11

# Material Handling

- Material handling is defined by the material handling industry of America as the movement, storage, protection and control of materials throughout the manufacturing and distribution process including their consumption and disposal
- The handling of materials must be performed safely, efficiently, at low cost, in a timely manner, accurately ( the right materials in the right quantities to the right locations), and without damage to the materials

# Material handling in the production system



# Overview of Material Handling Equipment

The material handling equipment includes:

1)Transport equipment

a) Industrial Trucks b) Automated Guided vehicles (AGVs) c) Monorails and other rail guided vehicles d) Conveyors e) cranes and hoists

2) Storage systems

a)Bulk storage b) Rack systems c) Shelving and bins d) Drawer storage e) Automated storage systems

3) Unitizing equipment

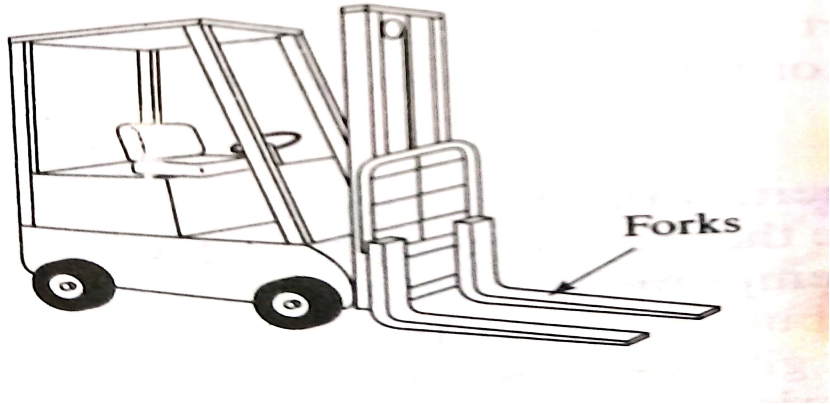
4) Identification and Tracking Systems

# 1) Transport Equipment

a) Industrial truck : They are of two types – i) non-powered ii) powered

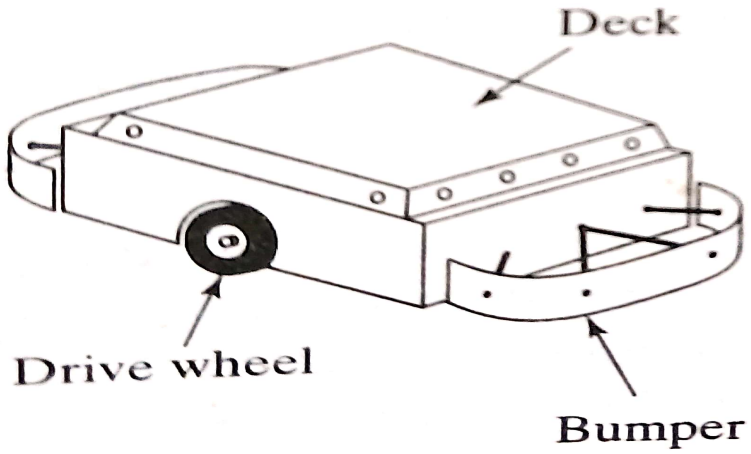
- The non powered trucks are platforms or containers with wheels that are pushed or pulled by human workers to move materials

- Powered industrial trucks are steered by human workers. They provide mechanized movement of materials



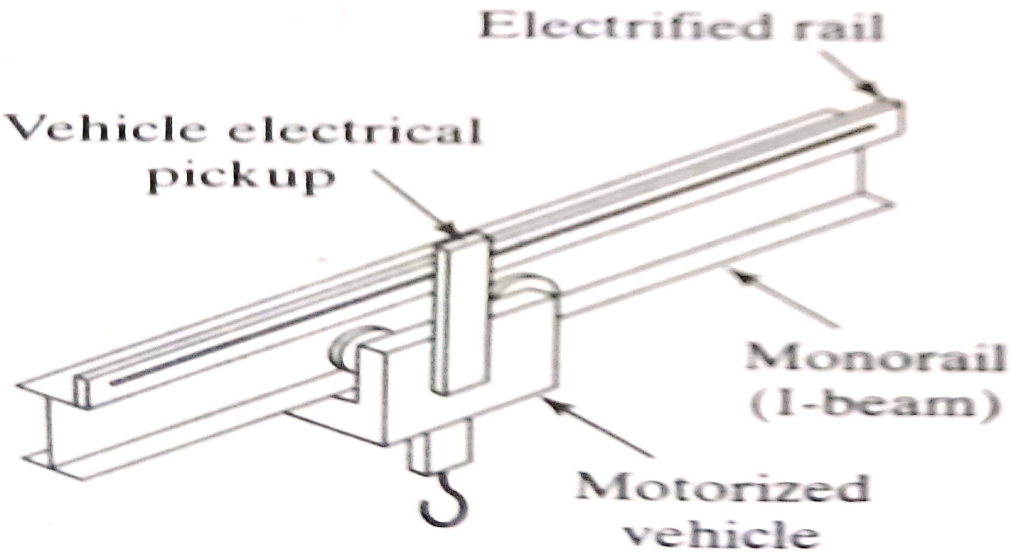
# b). Automated guided vehicles (AGVs)

- AGVs are battery-powered, automatically steered vehicles that follow defined pathways in the floor
- The pathways are unobstructive
- They are used to move unit loads between load and unload stations on the facility



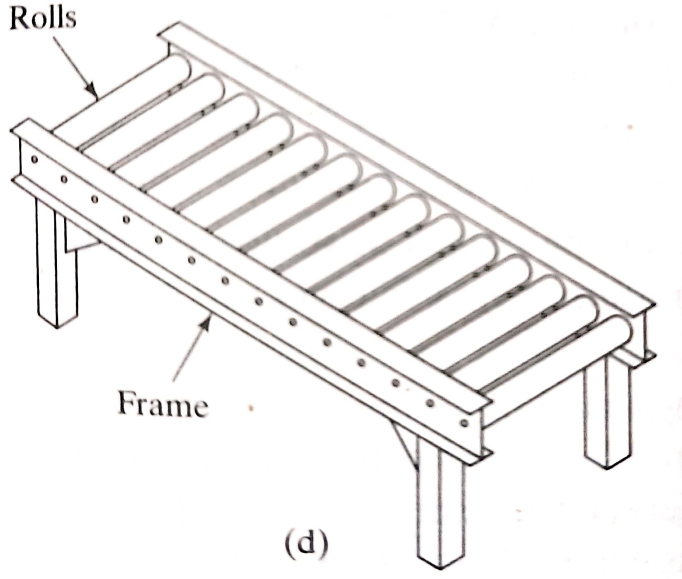
# c) Monorails and other rail guided vehicles

- They are self-propelled vehicles that ride on a fixed rail system that is either on the floor or suspended from the ceiling
- The vehicle operate independently and are usually driven by electric motors that pick up power from an electrified rail.



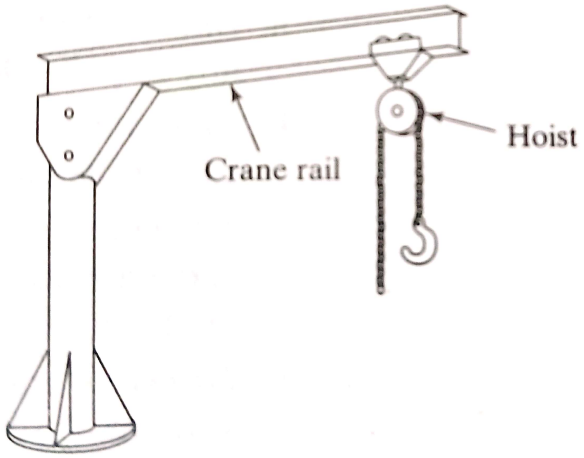
# d) Conveyors

- Conveyors are designed to move materials over fixed paths, generally in large quantities or volumes. Examples include roller, belt, and tow-line conveyors
- Conveyors can be powered ( mechanical drive system is built to foxed path) and nonpowered ( activated by human workers or gravity)



# e) Cranes and hoists

- These are handling devices for lifting, lowering and transporting materials, often as very heavy loads.
- Hoists accomplish vertical lifting: both manually operated and powered types are available
- Cranes provide horizontal travel and generally include one or two hoists



# 2) Storage System

a) Bulk storage: This consist of simply storing materials in an open floor area, generally in pallet loads or other containers

b) Rack systems: Rack systems are structural frames designed to stack unit loads vertically, thus increasing the vertical storage efficiency compared to bulk storage

c) Shelving and bins : Steel shelving comes in standard widths, depths and heights to serve a variety of storage requirements. Shelves can include bins, which are containers for loose items.

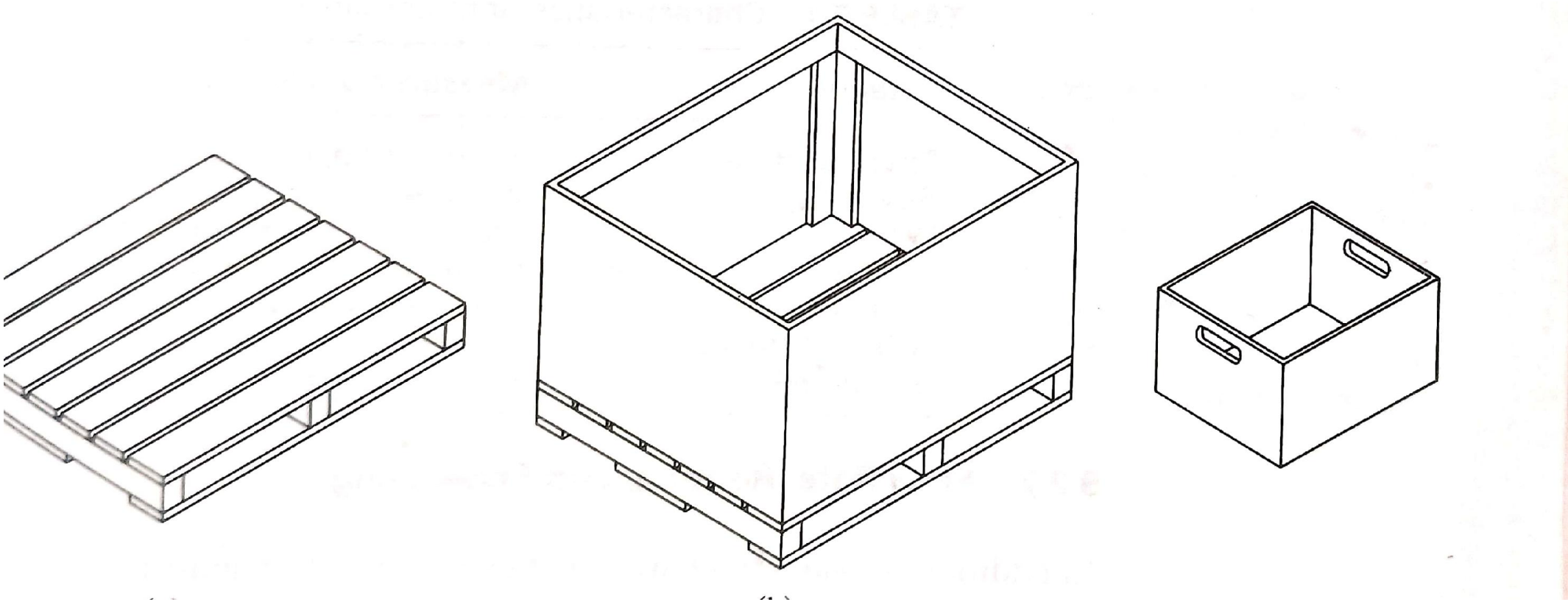
d) Drawer storage: This storage medium is more costly then shelves, but more convenient. Finding items stored in shelves can be difficult if the shelve level is too high or too low or too deep. Drawers compensate it by pulling the drawer and reveal their entire contents. Drawer storage is generally used for tools, hardware and other small items

e) Automated storage systems: It is used to deposit and withdraw items from storage compartments. They are of two types (1) automated storage and retrieval systems consisting of rack and shelf systems that are accessed by an automated or mechanized crane (2) carousel systems that rotate storage bins past a stationary load/unload station.

# 3) Unitizing Equipment

- The term unitizing equipment refers to (1) containers used to hold individual items during handling (2) equipment used to load and package the containers
- Containers include pallets, boxes, baskets, barrels, pails and drums
- It is used to efficiently move a unit load rather than individual items
- The second category of unitizing equipment, loading and packaging equipment, includes palletizers, designed to automatically load cartons onto pallets and shrink-wrap plastic film around them for shipping.
- Also used as depalletizers, designed to unload cartons from pallets.

# Unitizing Equipment



# 4) Identification and Tracking Systems

- To track the material information, some kind of label to the item, carton or unit load that uniquely identifies it.
- The most common label used today consists of bar codes that can be read quickly and automatically by bar code readers.
- Other types of labels include magnetic stripes and radio frequency tags that are generally capable of encoding more data than bar codes.

# Considerations and factors in material handling system design

1) Material Characteristics
2) Flow rate
3) Routing
4) Scheduling
5) Plant layout

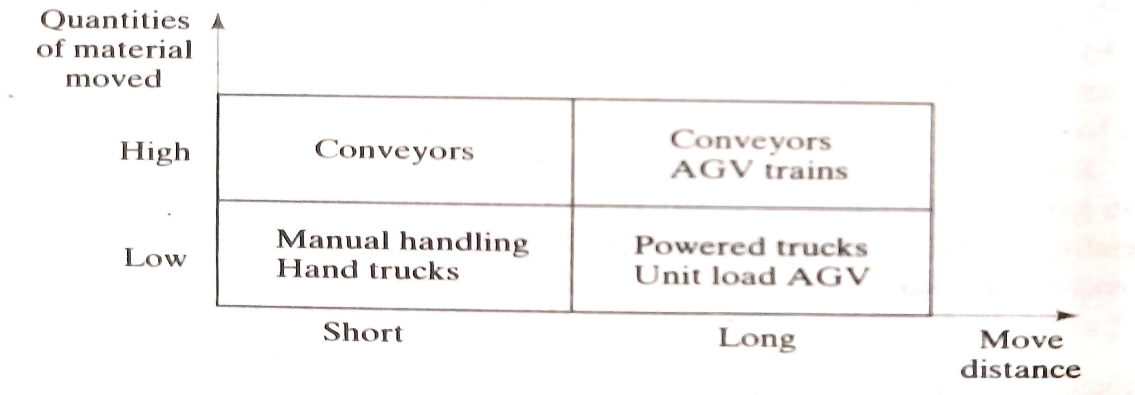
# 1) Material Characteristics

| Category | Measures or Descriptors |
|---|---|
| 1. Physical state | Solid, liquid or gas |
| 2. Size | Volume, length, width, height |
| 3. Weight | Weight per piece, weight per unit volume |
| 4. Shape | Long and flat, round, square etc |
| 5. Condition | Hot, cold, wet, dirty, sticky |
| 6. Risk of damage | Fragile, brittle, sturdy |
| 7. Safety risk | Explosive, flammable, toxic, corrosive, etc |

# 2) Flowrate  3) routing

Flowrate: It refer to the amount of material moved per unit time as the flow rate. Depending on the form of the material, flow rate is measured in pieces/hr, pallet load/hr, tons/hr.

Routing: The factors include pick up and drop off locations, move distances, routing variations and conditions that exist along the routes. It is directly related to distance of the move. The figure shows material quantity and distance moved



# 4) Scheduling

Scheduling:

- It relates to the timing of each individual delivery
- The material must be picked up and delivered promptly to its proper destination to maintain peak performance and efficiency of overall system
- The handling system must be responsive to this need for timely pick up and delivery of the items
- Scheduling urgency is often mitigated by providing space for buffer stocks of materials at pickup and drop-off points. This allows a float of materials to exist in the system, thus reducing the pressure on the handling system for immediate response to a delivery request.

# 5) Plant Layout

- Plant layout is an important factor in the design of a material handling system. In the case of a new facility, the design of the handling system should be considered part of the layout design
- In this way, there is a greater opportunity to create a layout that optimizes material flow in the building and utilizes the most appropriate type of handling system.
- The plant layout design should provide the following data for use in the design of the handling system (i) Total area of the facility and areas within specific departments in the plant(ii) arrangement of equipment in the layout (iii)Locations where materials must be picked up and delivered (iv) possible routes between these locations and distance travelled.

# Contd.

Different material handling systems are generally required for three layout types:

1) Fixed Position Layout: the product is large and heavy and therefore remains in a single location during most of its fabrication
2) Process layouts : In this, variety of different products are manufactured in small and medium batch sizes. The handling system must be flexible to deal with the variations
3) Product layout: It involves production of a standard or nearly identical types of product in relatively high quantities

# Contd.

| Layout Type | Characteristics | Typical Material Handling Equipment |
|---|---|---|
| Fixed-position | Large product size, low production rate | Cranes, hoists, industrial trucks |
| Process | Variations in product and processing, low and medium production rates | Hand trucks, forklift trucks, automated guided vehicle systems |
| Product | Limited product variety, high production rate | Conveyors for product flow, trucks to deliver components to stations. |

# Principles of Material Handling

- Overtime certain principles have been found to be applicable in the analysis, design and operation of material handling systems. Implementing these principles will result in safer operating conditions, lower costs and better utilization and performance of material handling systems

# 1)Planning Principle:

--All material handling should be the result of a deliberate plan where the needs, performance objectives, functional specification of the proposed methods are completely defined at the outset.

- The plan should be developed in consultation between the planner and all who will use and benefit from the equipment to be employed
- Success in planning large-scale material handling projects generally requires a team approach involving suppliers, consultants when appropriate, and end user specialists from management, engineering, computer and information systems, finance, and operations
- The plan should promote concurrent engineering of product, process design, process layout and material handling methods as opposed to independent and sequencial design practices
- The plan should reflect the strategic objectives of the organization as well as the more immediate needs

# 2) Standardization Principle

--Material handling methods, equipment, controls and software should be standardized within the limits of achieving overall performance objectives and without sacrificing needed flexibility, modularity, and throughput.

- Standardization means less variety and customization in the methods and equipment employed
- Standardization applies to sizes of containers and other load forming components as well as operating procedures and equipment.
- The planner should select methods and equipment that can perform a variety of tasks under a variety of operating conditions and in anticipation of changing future requirements
- Standardization, flexibility, and modularity must not be incompatible

# 3) Work Principle

--Material handling work should be minimized without sacrificing productivity or the level of service required of the operation

- The measure of material handling work is flow rate (volume, weight, or count per unit of time) multiplied by distance moved.
- Consider each pickup and set-down, or placing material in and out storage, as distinct moves and components of distance moved
- Simplifying processes by reducing, combining, shortening, or eliminating unnecessary moves will reduce work
- Where possible, gravity should be used to move materials or to assist in their movement while respecting consideration of safety and the potential for product damage
- The work principle applies universally, from mechanized material handling in a factory to over- the road trucking.
- The work principle is implemented best by appropriate layout planning: locating the production equipment into a physical arrangement corresponding to flow of work. This arrangement tends to minimize the distances that must be travelled by the materials being processed.

# 4) Ergonomic Principle

--Human capabilities and limitations must be recognized and respected in the design of material handling tasks and equipment to ensure safe and effective operations

- Ergonomics is the science that seeks to adapt work or working conditions to suit the abilities of the worker
- The material handling workplace and the equipment must be designed so they are safe for people
- The ergonomic principle embraces both physical and mental tasks
- Equipment should be selected that eliminates repetitive and strenuous manual labor and that effectively interacts with human operators and users

# 5) Unit Load Principle

--Unit loads shall be appropriately sized and configured in a way which achieves the material flow and inventory objectives at each stage in the supply chain

- A unit load is one that can be stored or moved as a single entity at one time, such as pallet, container or tote, regardless of the number of individual items that make up the load.
- Less effort and work are required to collect and move many individual items as a single load than to move many items one at a time
- Large unit loads are common both pre- and post manufacturing in the form of raw materials and finished goods
- Smaller unit loads are consistent with manufacturing strategies that embrace operating objectives such as flexibility, continuous flow and just-in-time delivery. Smaller unit loads (as few as one item) yield less in-process inventory and shorter item throughput times

# 6) Space Utilization Principle

--Effective and efficient use must be made of all available space.

- Space in material handling is three-dimensional and therefore is counted as cubic space
- In storage areas, the objective of maximizing storage density must be balanced against accessibility and selectivity
- When transporting loads within a facility, the use of overhead space should be considered as an option. Use of overhead material handling systems saves valuable floor space for productive purposes.

# 7) System Principle

--Material movement and storage activities should be fully integrated to form a coordinated, operational system that spans receiving, inspection, storage, production, assembly, packaging, unitizing, order selection, shipping, transportation, and the handling of returns

- Systems integration should encompass the entire supply chain, including reverse logistics. It should include suppliers, manufacturers, distributors and customers.
- Inventory levels should be minimized at all stages of production and distribution while respecting considerations of process variability and customer service
- Information flow and physical material flow should be integrated and treated as concurrent activities.
- Methods should be provided for easily identifying materials and products, for determining their location and status within facilities and within the supply chain, and for controlling their movement.

# 8) Automation Principle

--Material handling operations should be mechanized and/or automated where feasible to improve operational efficiency, increase responsiveness, improve consistency and predictability, decrease operating costs and eliminate repetitive or potentially unsafe manual labor

- In any project in which automation is being considered, pre-existing processes and methods should be simplified and or re-engineered before any efforts to install mechanized or automated systems. Such analysis may lead to elimination of unnecessary steps in the method. If the methods can be sufficiently simplified, it may not be necessary to automate the process.
- Items that are expected to be handled automatically must have standard shapes and /or features that permit mechanized and or automated handling
- Interface issues are critical to successful automation, including equipment to equipment, equipment to load, equipment to operator and in control communications
- Computerized material handling systems should be considered where appropriate for effective integration of material flow and information management

# 9) Environmental Principle

--Environmental impact and energy consumption should be considered as criteria when designing or selecting alternative equipment and material handling systems.

- Environmental consciousness stems from a desire not to waste natural resources and to predict and eliminate the possible negative effects of our daily actions on the environment
- Containers, pallets and other products used to form and protect unit loads should be designed for reusability when possible and/or biodegradability after disposal
- Materials specified as hazardous have special needs with regard to spill protection, combustibility, and other risks.

# 10) Life Cycle Cost Principle

--A thorough economic analysis should account for the entire life cycle of all material handling equipment and resulting systems

- Life cycle costs include all cash flows that occur between the time the first dollar is spent to plan a new material handling method or piece of equipment until that method and /or equipment is totally replaced
- Life cycle costs include capital investment, installation, setup and equipment programming, training, system testing and acceptance, operating (labor, utilities , etc), maintenance and repair, reuse value and ultimate disposal.
- A plan for preventive and predictive maintenance should be prepared for the equipment, and the estimated cost of maintenance and spare parts should be included in the economic analysis.
- A long-range plan for replacement of the equipment when it becomes obsolete should be prepared.
- Although measurable cost is a primary factor, it is certainly not the only factor in selecting among alternatives. Other factors of a strategic nature to the organization and that form the basis for competition in the market place should be considered and quantified whenever possible.