Definition:

“The movement, storage, protection and control of materials throughout the manufacturing and distribution process including their consumption and disposal”
Material Handling Objectives

- 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

Categories of Material Handling Equipment

1. **Material transport equipment** - to move materials inside a factory, warehouse, or other facility
2. **Storage** - to store materials and provide access to those materials when required
3. **Unitizing equipment** - refers to (1) containers to hold materials and (2) equipment used to load and package the containers
4. **Identification and tracking systems** - to identify and keep track of the materials being moved and stored
Unit Load Containers

(a) Wooden pallet, (b) pallet box, (c) tote box

Material Transport Equipment

Five categories:
1. Industrial trucks
2. Automated guided vehicles
3. Monorails and other rail guided vehicles
4. Conveyors
5. Cranes and hoists
Industrial Trucks

Two basic categories:
1. Non-powered
   - Human workers push or pull loads
2. Powered
   - Self-propelled, guided or driven by human
   - Common example: forklift truck

Nonpowered Industrial Trucks (Hand Trucks)

(a) Two-wheel hand truck, (b) four-wheel dolly, (c) hand-operated low-lift pallet truck
Powered Trucks: Walkie Truck

- Wheeled forks insert into pallet openings
- No provision for riding; truck is steered by worker using control handle at front of vehicle

Powered Trucks: Forklift Truck

- Widely used in factories and warehouses because pallet loads are so common
- Capacities from 450 kg (1000 lb) up to 4500 kg (10,000 lb)
- Power sources include on-board batteries and internal combustion motors
Powered Trucks: Towing Tractor

- Designed to pull one or more trailing carts in factories and warehouses, as well as for airport baggage handling
- Powered by on-board batteries or IC engines

Automated Guided Vehicles

An Automated Guided Vehicle System (AGVS) is a material handling system that uses independently operated, self-propelled vehicles guided along defined pathways in the facility floor

- Types of AGV:
  - Driverless trains
  - Pallet trucks
  - Unit load AGVs
Automated Guided Vehicles:
Driverless Automated Guided Train

- First type of AGVS to be introduced around 1954
- Common application is moving heavy payloads over long distances in warehouses and factories without intermediate stops along the route

Rail-Guided Vehicles

- Self-propelled vehicles that ride on a fixed-rail system
- Fixed rail system
  - Overhead monorail - suspended overhead from the ceiling
  - On-floor - parallel fixed rails, tracks generally protrude up from the floor
**Conveyor Systems**

Large family of material transport equipment designed to move materials over fixed paths, usually in large quantities or volumes

1. Non-powered
   - Materials moved by human workers or by gravity
2. Powered
   - Power mechanism for transporting materials is contained in the fixed path, using chains, belts, rollers or other mechanical devices

**Conveyor Types**

- Roller
- Skate-wheel
- Belt
- In-floor towline
- Overhead trolley conveyor
- Cart-on-track conveyor
Roller Conveyor

- Pathway consists of a series of rollers that are perpendicular to direction of travel
- Loads must possess a flat bottom to span several rollers
- Powered rollers rotate to drive the loads forward
- Un-powered roller conveyors also available

Skate-Wheel Conveyor

- Similar in operation to roller conveyor but use skate wheels instead of rollers
- Lighter weight and unpowered
- Sometimes built as portable units that can be used for loading and unloading truck trailers in shipping and receiving
Belt Conveyor

- Continuous loop with forward path to move loads
- Support slider or rollers used to support forward loop
- Two common forms:
  - Flat belt (shown)
  - V-shaped for bulk materials

In-Floor Tow-Line Conveyor

- Four-wheel carts powered by moving chains or cables in trenches in the floor
- Carts use steel pins (or grippers) to project below floor level and engage the chain (or pulley) for towing
- This allows the carts to be disengaged from towline for loading and unloading
Overhead Trolley Conveyor

- A trolley is a wheeled carriage running on an overhead track from which loads can be suspended.
- Trolleys are connected and moved by a chain or cable that forms a complete loop.
- Often used to move parts and assemblies between major production areas.

Cart-On-Track Conveyor

- Carts ride on a track above floor level.
- Carts are driven by a spinning tube.
- Forward motion of cart is controlled by a drive wheel whose angle can be changed from zero (idle) to 45 degrees (forward).
Cranes and Hoists

Handling devices for lifting, lowering and transporting materials, often as heavy loads

- Cranes
  - Used for horizontal movement of materials
- Hoists
  - Used for vertical lifting of materials
- Cranes usually include hoists so that the crane-and-hoist combination provides
  - Horizontal transport
  - Vertical lifting and lowering

Hoist

Hoist with mechanical advantage of four:
(a) sketch of the hoist
(b) diagram to illustrate mechanical advantage

\[ F = \frac{W}{4} \]
Some Types of Cranes

Bridge Crane  Gantry Crane  Jib Crane

Storage Systems

Function – to store materials (e.g., parts, work-in-process, finished goods) for a period of time and permit retrieval when required

- Used in factories, warehouses, distribution centers, wholesale dealerships, and retail stores
- Important supply chain component
- Automation available to improve efficiency
Storage Methods

- Conventional Storage Systems
  - **Bulk storage**
  - **Rack systems**
  - **Shelving and bins**
  - **Drawer storage**

- Automated Storage System
  - **Automated Storage/Retrieval System (AS/RS)**
  - **Carousel Storage System**

Bulk Storage

Storage in an open floor area. The main problem is achieving proper balance between storage density and accessibility.

Bulk storage arrangements: (a) high-density bulk storage provides low accessibility, (b) bulk storage with loads forming rows and blocks for improved accessibility
Pallet Rack System

Pallet loads placed on racks in multi-rack structure permits vertical stacking of materials.

Drawer Storage

Entire contents of each drawer can be viewed. Suitable for small items.
Automated Storage Systems

Mechanized and automated storage equipment to reduce the human resources required to operate a storage facility

- Significant investment
- Level of automation varies
  - In mechanized systems, an operator participates in each storage/retrieval transaction
  - In highly automated systems, loads are entered or retrieved under computer control

Unit load AS/RS with one aisle

Rack system with mechanized or automated crane to store/retrieve loads
Carousel Storage Systems

- **Horizontal**
  - Operates around a horizontal conveyor loop
  - Lengths range between 3 m and 30 m

- **Vertical**
  - Operates around a vertical conveyor loop
  - Less floor space required, but overhead room must be provided

**Horizontal Carousel Storage System**

Oval conveyor system with bins to contain individual items