Material Handling Definition

Material handling is concerned with the

- Movement
- Storage, and
- Control

Of materials in a process

Material Handling Is Expensive

- 10 % to 80 % of product cost
- Physical distribution costs 25 % of product cost
- More than 90 % of flow time in job shop production systems
Material Handling in Early Automotive Assembly

Traditional Versus Modern View

- **Traditional**
  - Not value adding, only cost adding
  - Minimize as much as possible
  - Support automation

- **Modern**
  - Provides space and time utility
  - Maximize flexibility
  - Support integration

Stages in M.H.S. Design

1. Why?
2. What?
3. When and where?
4. How?
5. By whom?

Nine Rights of Material Handling

1. Uses the right METHOD
2. To provide the right AMOUNT
3. Of the right MATERIAL
4. To the right PLACE
5. At the right TIME
6. In the right SEQUENCE
7. In the right POSITION
8. In the right CONDITION
9. At the right COST
**Material Handling Systems Overview**

- **Definition**
- **Classifications**

**Classification of Material Handling**

- **by Material**
- **by Method**
- **by Equipment**

**Categories of Materials**

- Gasses
- Liquids
- Bulk materials
- Discrete (unit) loads
- Documents & money
- Livestock
- People

**Unit Load Definition**

*A collection of materials so arranged and restrained that it can be handled, stored, and controlled as a single entity*
**Unit Load Advantages**

- Standardized handling equipment
- Standardized storage equipment
- Reduced information & control burden
- Efficient macro space utilization

**Unit Load Disadvantages**

- Cost of assembly and disassembly
- Cost of container and wrappings
- Cost of empty container handling & disposal
- Inefficient micro space utilization

**Unit Load Examples**

- Pallet
- Drum
- Truck
- Ocean going intermodal container

**Unit Load Example: Ocean Going Intermodal Container**
Classification of Material Handling

- by Material
- by Method
- by Equipment

Categories of Methods

- Manual
- Mechanized
- Automated

Labor And Control Providers

<table>
<thead>
<tr>
<th>Type</th>
<th>Capability</th>
<th>Labor</th>
<th>Control</th>
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<tr>
<td>Mechanized</td>
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<tr>
<td>Automated</td>
<td>Machine</td>
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Method Characteristics

- Flexibility
- Capacity
- Hard Automation
- Mechanized & Soft Automated
- Project
- Job Shop
- Flow Shop
### Characteristics of Material Handling Methods

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Type</th>
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<tr>
<td>Acquisition cost</td>
<td>Low</td>
</tr>
<tr>
<td>Operating cost</td>
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### Manual Handling Illustration: Postman and Farmer

### Manual Handling Equipment: Wheelbarrow

### Mechanized Handling Illustration: Forklift Truck
Classification of Material Handling

1. by Material
2. by Method
3. by Equipment

CICMHE-MHIA Taxonomy of Material Handling Equipment

Equipment Categories

1. Conveyors
2. Cranes and hoists
3. Industrial trucks
4. Containers and supports
5. Storage equipment
6. Auxiliary equipment
7. Storage/retrieval systems
8. Robots
9. Pipelines
**Pipeline Systems**

- Liquids, gasses, slurries, documents
- High fixed cost, very low operational cost, high volume
- Slow transportation speed but continuous movement
- Dependable and low time variance
- Larger diameters are more efficient
- Water, waste, documents

**Pipeline Characteristics**

- Continuous movement
- Fixed paths - ceiling suspended
- Very limited access area
- Very high hardware cost
- Very high volume
- Synchronous or asynchronous with containers

**Conveyors Characteristics**

- Continuous movement
- Fixed paths
- Very limited access area
- Very high hardware cost
- Very high volume
- Asynchronous versus synchronous

**Conveyor Examples**

- Synchronous
  - Belt
  - Roller
  - Power and free
- Asynchronous
  - Automated electrified monorail (AEM)
Belt Conveyor in A-Frame Order Picking System

Conveyor Network in Electronics Manufacturing

Roller Conveyor With Diverter in Electronics Manufacturing

Roller Conveyor in Order Picking
Power and Free Buffer in Automotive Assembly

Power and Free in Automotive Engine Assembly

Power and Free in Automotive Final Assembly

Automated Electrified Conveyor in Typewriter Manufacturing
Cranes and Hoists Characteristics

- Overhead devices with vertical movement
- Intermittent movement
- Limited access area
- Medium hardware costs
- Medium volume

Bridge Crane Illustration

Bridge Crane for Aircraft Engine Transport

Moveable Bulk Crane Illustration
Mobile Harbor Crane

Gantry Cranes Unloading a Container Ship

Gantry Crane Example

Cranes and Hoists Access Areas
- Circular jib access area
- Rectangular bridge crane access area
Industrial Trucks Characteristics

- Moving vehicles on wheels
- Intermittent movement
- Variable paths
- Very wide access area
- Low hardware cost
- Low volume

Industrial Trucks Illustration: Counterbalanced Lift Truck

Pallet Jack and Tractor

Tractor Trailer Example
Straddle and Counterbalanced Forklift Trucks

Block Stacking Operation With Counterbalanced Truck

Order Picking Truck

Stacker Cranes Example
Multiload AGV in Semiconductor Manufacturing

Multiload AGV Interfacing With Clean Room

AGVS and Gantry Cranes for Intermodal Containers

Stacker Cranes for Intermodal Containers
Containers Characteristics

- To maintain a unit load

Container Examples

- Pallet
- Tote box
- Intermodal container

Storage Equipment Characteristics

- To hold materials

Storage Equipment Examples

- Person-to-part
  - Block stacking
  - Pallet rack
  - Gravity flow rack
  - Bin shelving
- Part-to-person
  - Carousels
  - Miniload
Block Stacking Storage of Household Appliances

Bin Shelving

Order Picking From Bin Shelving

Pallet Rack
Shelves With Quantity Displays (Pick-to-light)

Small Parts Carousel Example

Auxiliary Equipment Types

- Bar code readers
- Stretch wrappers
- Palletizers
- Lift tables
- Measuring frames
- Air film handling equipment
- Radio frequency terminals
- ...
Voice Communications for Hands-free Order Picking

Radio Frequency Communications Terminals

Storage & Retrieval Characteristics

- Combined handling and storage

Unit Load AS/RS Illustration
Storage & Retrieval Types

- **Part-to-person**
  - Unit load AS/RS
  - Miniload (storage drawer)
  - Microload (tote stacker)
  - Carousel with extractor
  - V and A frame order picking
  - Deep lane storage

- **Person-to-part**
  - Person-aboard

Unit Load Storage System With Multiple Aisles

Unit Load System Example

Unit Load ASRS for Paper Rolls
Deep Lane Storage Example

Unit Load, Deep Lane, Storage Retrieval System Detail

Unit Load, Deep Lane, Automated Staging Warehouse

A-Frame Automatic Order Picking Example Detail
Person-aboard Example

Person-aboard Example: Inside the Aisle View

Robot Characteristics
- Programmable
- Anthropomorphic (gripper)
- General purpose (multifunctional)

Robot Degrees of Freedom
Six Degree of Freedom Robot Example

Fanuc 710i

Japanese Robot Classification

1. Manual manipulator
2. Fixed sequence robot
3. Variable sequence robot
4. Play back robot
5. Numerically controlled robot
6. Intelligent robot

Robot Application Areas

- 3 D areas
  - Dull
  - Dirty
  - Dangerous
- 70 % automotive industry

Robotic Processes

- Spot and arc welding
- Pick and place
- Paint spraying
Pick and Place Palletizing Robot Example

Motoman

Pick and Place Clean Room Robot

Motoman K3crpic

Robotic Part Unloading With Vacuum

Robotic Spray Painting in Automotive Assembly