

Logistics Systems Design: Material Handling Systems

13. **Material Handling Systems**
14. Material Handling Models
15. Warehousing Systems
16. Storage Models
17. Order Picking Models

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Material Handling Systems Overview

- * Definition
- * Classifications

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Material Handling Definition

Material handling is concerned with the

- Movement
- Storage, and
- Control

Of materials in a process

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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

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Material Handling in Early Automotive Assembly



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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

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Stages in M.H.S. Design

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

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Nine Rights of Material Handling

| | |
|-------------------------------|--------------------------|
| ① Uses the right METHOD | ⑤ At the right TIME |
| ② To provide the right AMOUNT | ⑥ In the right SEQUENCE |
| ③ Of the right MATERIAL | ⑦ In the right POSITION |
| ④ To the right PLACE | ⑧ In the right CONDITION |
| | ⑨ At the right COST |

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Material Handling Systems Overview

- * Definition
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Classification of Material Handling

- 1 by Material
- 2 by Method
- 3 by Equipment

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Categories of Materials

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

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Unit Load Definition

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

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Unit Load Advantages

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

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Unit Load Disadvantages

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


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Unit Load Examples

- * *Pallet*
- * *Drum*
- * *Truck*
- * *Ocean going intermodal container*

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Unit Load Example: Ocean Going Intermodal Container



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Classification of Material Handling

- ❶ by Material
- ❷ by Method
- ❸ by Equipment



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Categories of Methods

- * Manual
- * Mechanized
- * Automated

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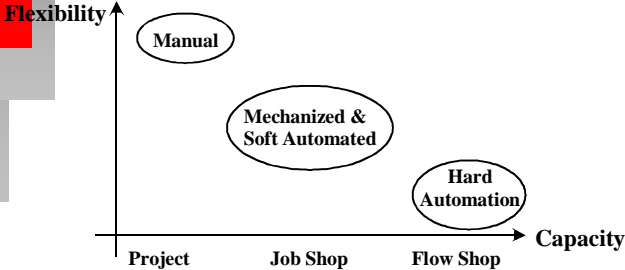
Labor And Control Providers

| Type | Capability | |
|------------|------------|---------|
| | Labor | Control |
| Manual | Human | Human |
| Mechanized | Machine | Human |
| Automated | Machine | Machine |



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Method Characteristics



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Characteristics of Material Handling Methods

| Characteristic | Type | | |
|------------------|--------|------------|-----------|
| | Manual | Mechanized | Automated |
| Weight | Low | High | High |
| Volume | Low | High | High |
| Speed | Low | Medium | High |
| Frequency | Low | Medium | High |
| Capacity | Low | Medium | High |
| Flexibility | High | Medium | Low |
| Acquisition cost | Low | Medium | High |
| Operating cost | High | Medium | Low |

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Manual Handling Illustration: Postman and Farmer

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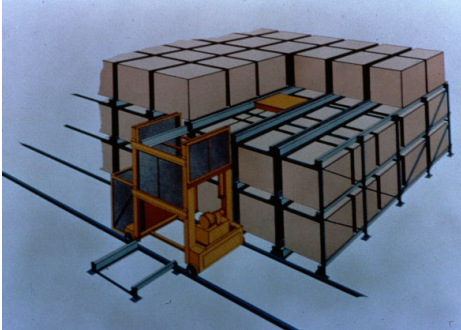
Manual Handling Equipment: Wheelbarrow

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Mechanized Handling Illustration: Forklift Truck

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Automated Illustration: Deep Lane Storage Detail



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Classification of Material Handling

- 1 by Material
- 2 by Method
- 3 by Equipment

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CICMHE-MHIA Taxonomy of Material Handling Equipment



CICMHE
COLLEGE-INDUSTRY COUNCIL
ON MATERIAL HANDLING EDUCATION

MH Taxonomy

| Material Handling Equipment | | | |
|-----------------------------|-------------------------------|-------------------|----------------------------|
| Transport Equipment | | | |
| Conveyors | Cranes | Industrial Trucks | No Equipment |
| Positioning Equipment | Unit Load Formation Equipment | Storage Equipment | Identification and Control |

www.mhia.org/et/mhe_tax.htm

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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

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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

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Pipeline Characteristics

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

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Conveyors Characteristics

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

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Conveyor Examples

- * Synchronous
 - Belt
 - Roller
 - Power and free
- * Asynchronous
 - Automated electrified monorail (AEM)

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Bulk Belt Conveyor in Gold Mining Leach Removal



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Bulk Belt Conveyor in Wood Chip Removal



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Belt Conveyor in Electronics Assembly



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Belt Conveyor With Diverter Bar in Electronics Assembly

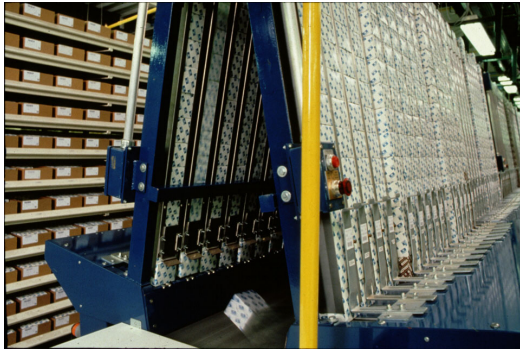


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Belt Conveyor in A-Frame Order Picking System



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Conveyor Network in Electronics Manufacturing



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Roller Conveyor With Diverter in Electronics Manufacturing



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Roller Conveyor in Order Picking



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Power and Free Buffer in Automotive Assembly



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Power and Free in Automotive Engine Assembly



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Power and Free in Automotive Final Assembly



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Automated Electrified Conveyor in Typewriter Manufacturing



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Cranes and Hoists Characteristics

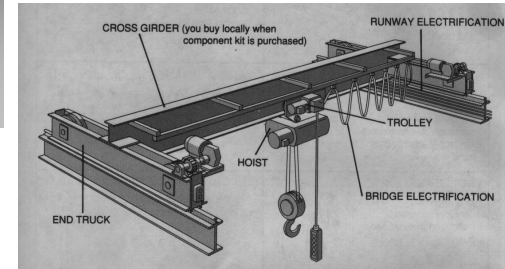
- * *Overhead devices with vertical movement*
- * *Intermittent movement*
- * *Limited access area*
- * *Medium hardware costs*
- * *Medium volume*

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Bridge Crane Illustration

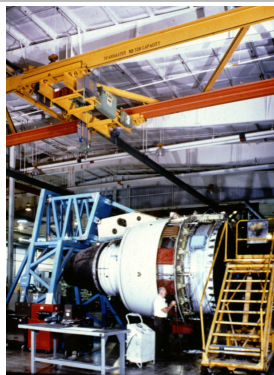


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Bridge Crane for Aircraft Engine Transport

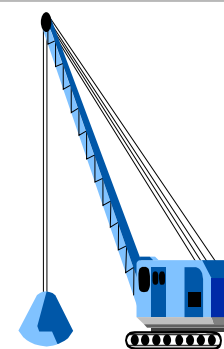


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Moveable Bulk Crane Illustration



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Mobile Harbor Crane



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Gantry Cranes Unloading a Container Ship

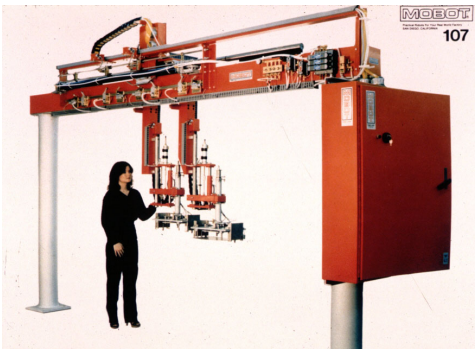


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Gantry Crane Example




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Cranes and Hoists Access Areas

- * Circular jib access area
- * Rectangular bridge crane access area




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Industrial Trucks Characteristics

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



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Industrial Trucks Illustration: Counterbalanced Lift Truck




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Pallet Jack and Tractor



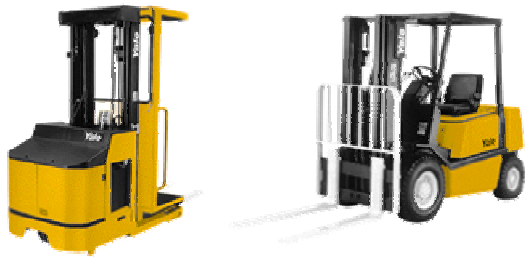
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Tractor Trailer Example



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Straddle and Counterbalanced Forklift Trucks



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Block Stacking Operation With Counterbalanced Truck



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Order Picking Truck

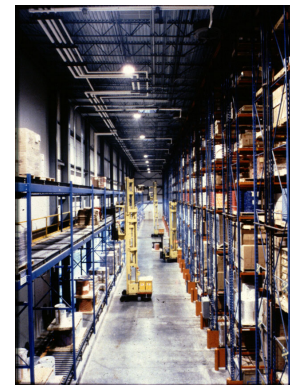


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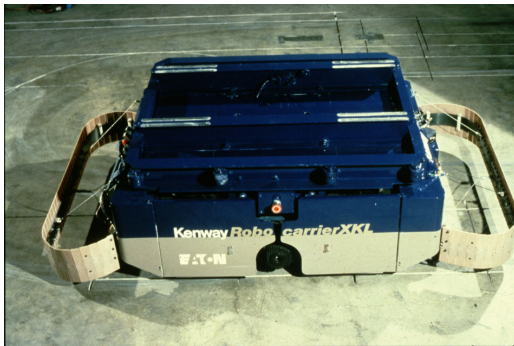
Stacker Cranes Example



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AGV With Collision Bumpers



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AGVS With Load Station



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AGV Load Station



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AGVS to ASRS Interface



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Multiload AGV in Semiconductor Manufacturing

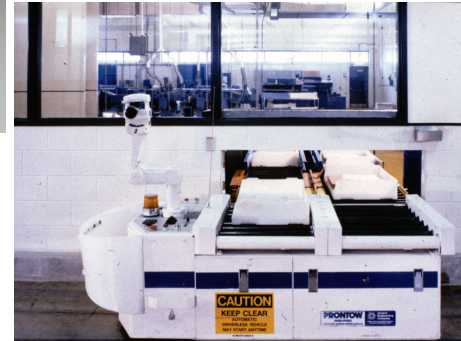


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Multiload AGV Interfacing With Clean Room



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AGVs and Gantry Cranes for Intermodal Containers



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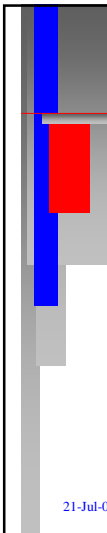
Stacker Cranes for Intermodal Containers



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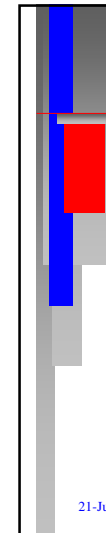
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Containers Characteristics

- * *To maintain a unit load*

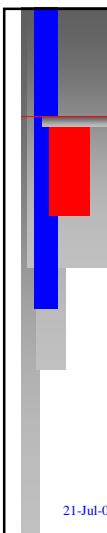
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Container Examples

- * *Pallet*
- * *Tote box*
- * *Intermodal container*

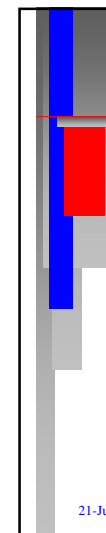
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Storage Equipment Characteristics

- * *To hold materials*

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Storage Equipment Examples

- * *Person-to-part*
 - *Block stacking*
 - *Pallet rack*
 - *Gravity flow rack*
 - *Bin shelving*
- * *Part-to-person*
 - *Carousels*
 - *Miniload*

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Block Stacking Storage of Household Appliances



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Bin Shelving



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Order Picking From Bin Shelving



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Pallet Rack

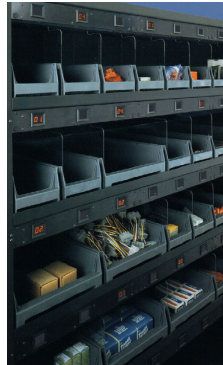


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Shelves With Quantity Displays (Pick-to-light)



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Small Parts Carousel Example



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Auxiliary Equipment Types

- * Bar code readers
- * Stretch wrappers
- * Palletizers
- * Lift tables
- * Measuring frames
- * Air film handling equipment
- * Radio frequency terminals
- * ..

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Pallet Positioners



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Voice Communications for Hands-free Order Picking



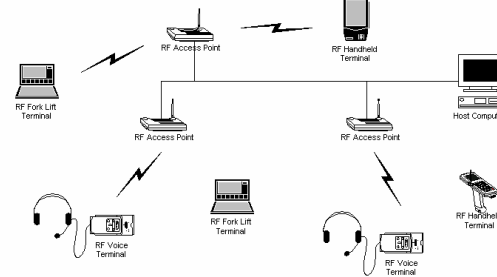
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Radio Frequency Communications Terminals

Talkman-OPEN Wireless Architecture



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Storage & Retrieval Characteristics

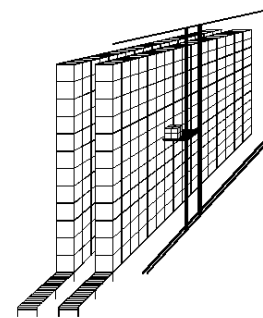
- * Combined handling and storage

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Unit Load AS/RS Illustration



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Storage & Retrieval Types

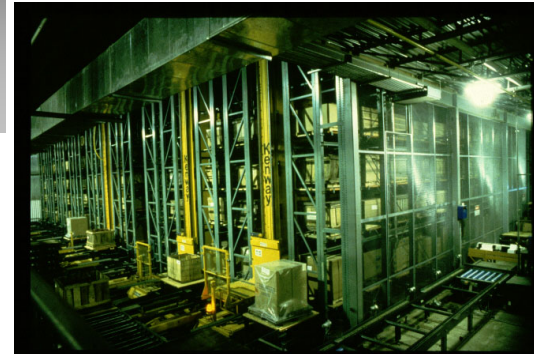
- * **Part-to-person**
 - Unit load AS/RS
 - Miniload (storage drawer)
 - Microload (tote stacker)
 - Carousel with extractor
 - V and A frame order picking
 - Deep lane storage
- * **Person-to-part**
 - Person-aboard

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Unit Load Storage System With Multiple Aisles



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Unit Load System Example

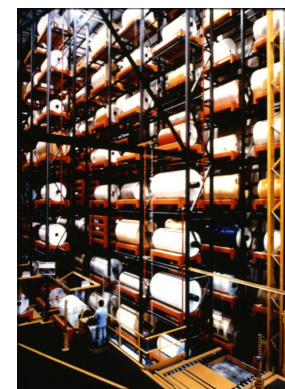


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Unit Load ASRS for Paper Rolls



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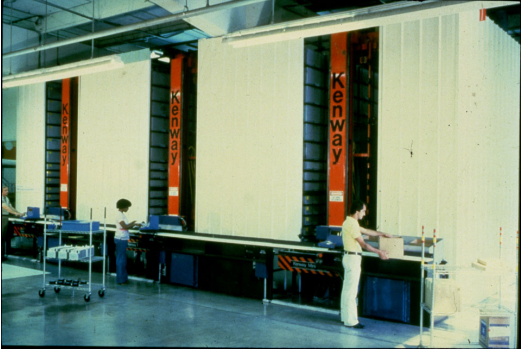
Unit Load ASRS for Thread Coils



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Miniload Example

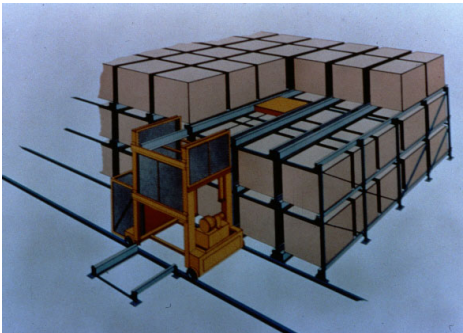


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Deep Lane Storage System Detail

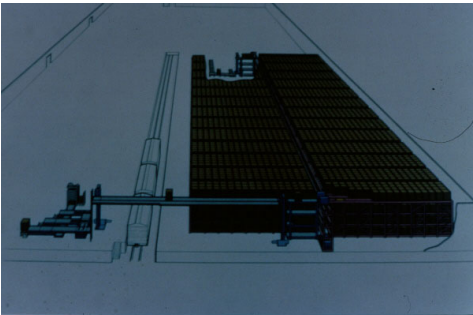


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Deep Lane Storage System

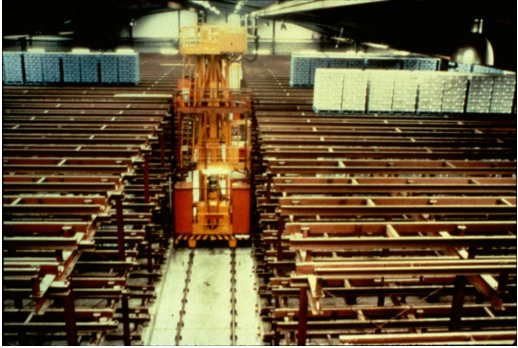


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Deep Lane Storage Example



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This photograph shows a deep lane storage system in a warehouse. A forklift is positioned in a narrow aisle between tall racks filled with unit loads. The racks are made of metal and extend deep into the warehouse, maximizing storage space.

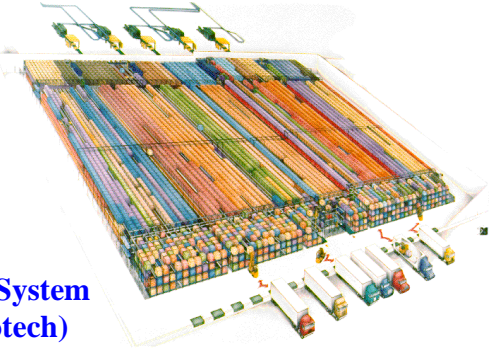
Unit Load, Deep Lane, Storage Retrieval System Detail



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This 3D CAD model illustrates a storage retrieval system. It shows a deep lane of storage racks with a retrieval mechanism. The system is designed for efficient access to unit loads stored in a deep lane.

Unit Load, Deep Lane, Automated Staging Warehouse



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This 3D CAD model depicts an automated staging warehouse. It features a large, multi-colored storage area with automated retrieval systems. The system is designed for efficient handling and staging of unit loads.

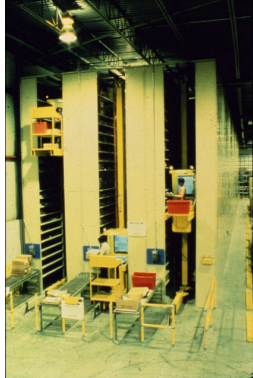
A-Frame Automatic Order Picking Example Detail



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This photograph shows an A-frame automatic order picking system. A forklift is positioned in a narrow aisle between tall racks filled with unit loads. The system is designed for efficient order picking in a deep lane storage system.


Person-aboard Example



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Person-aboard Example: Inside the Aisle View



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Robot Characteristics

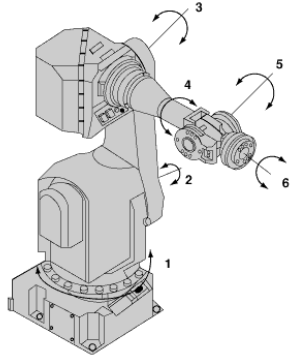
- * Programmable
- * Anthropomorphic (gripper)
- * General purpose (multifunctional)

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Robot Degrees of Freedom




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Six Degree of Freedom Robot Example



Fanuc 710i

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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*

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Robot Application Areas

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

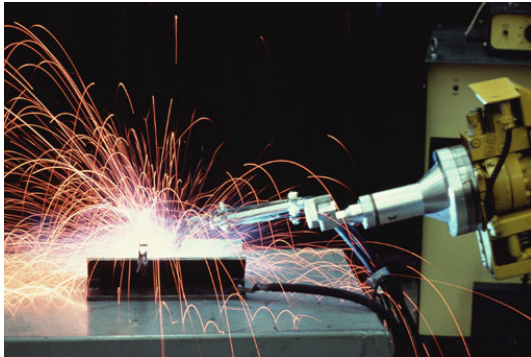
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Robotic Processes

- * *Spot and arc welding*
- * *Pick and place*
- * *Paint spraying*

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Welding Robot Example

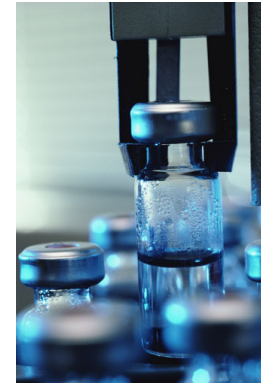


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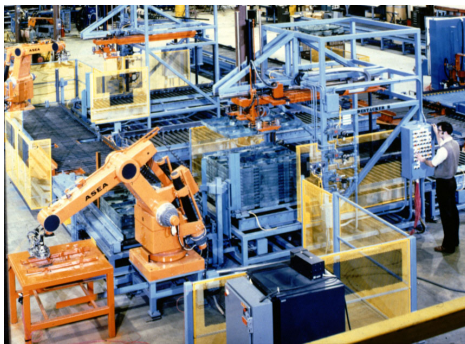
Pick and Place Robot Example



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Robotic Assembly

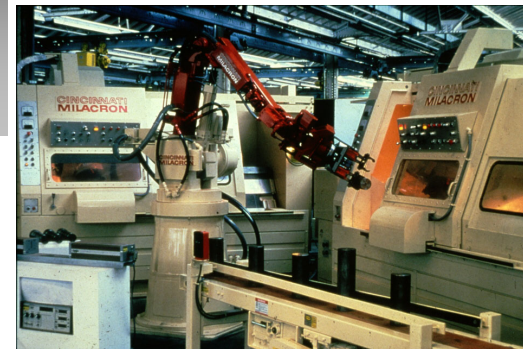


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Robotic Machine Part Loading



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Pick and Place Palletizing Robot Example



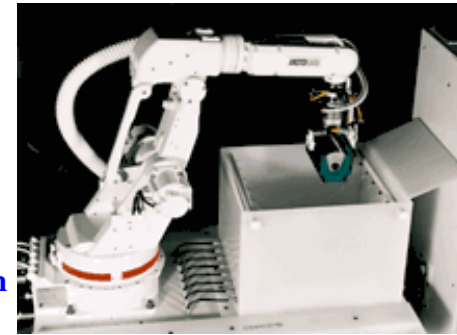
Motoman

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Pick and Place Clean Room Robot



**Motoman
K3crpic**

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Robotic Part Unloading With Vacuum



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Robotic Spray Painting in Automotive Assembly



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