REPUBLIC POLYTECHNIC

P11
Handling and Storage

E212 - Facilities Planning and Design

SCHOOL OF ENGINEERING

Material Handling

- Is the art and science of moving, storing, protecting and controlling material.
- Means providing the:
  - Right amount of Material
  - For the right Condition
  - In the right Place
  - In the right Position
  - With the right Sequence
  - With the right Cost
  - Using the right Method

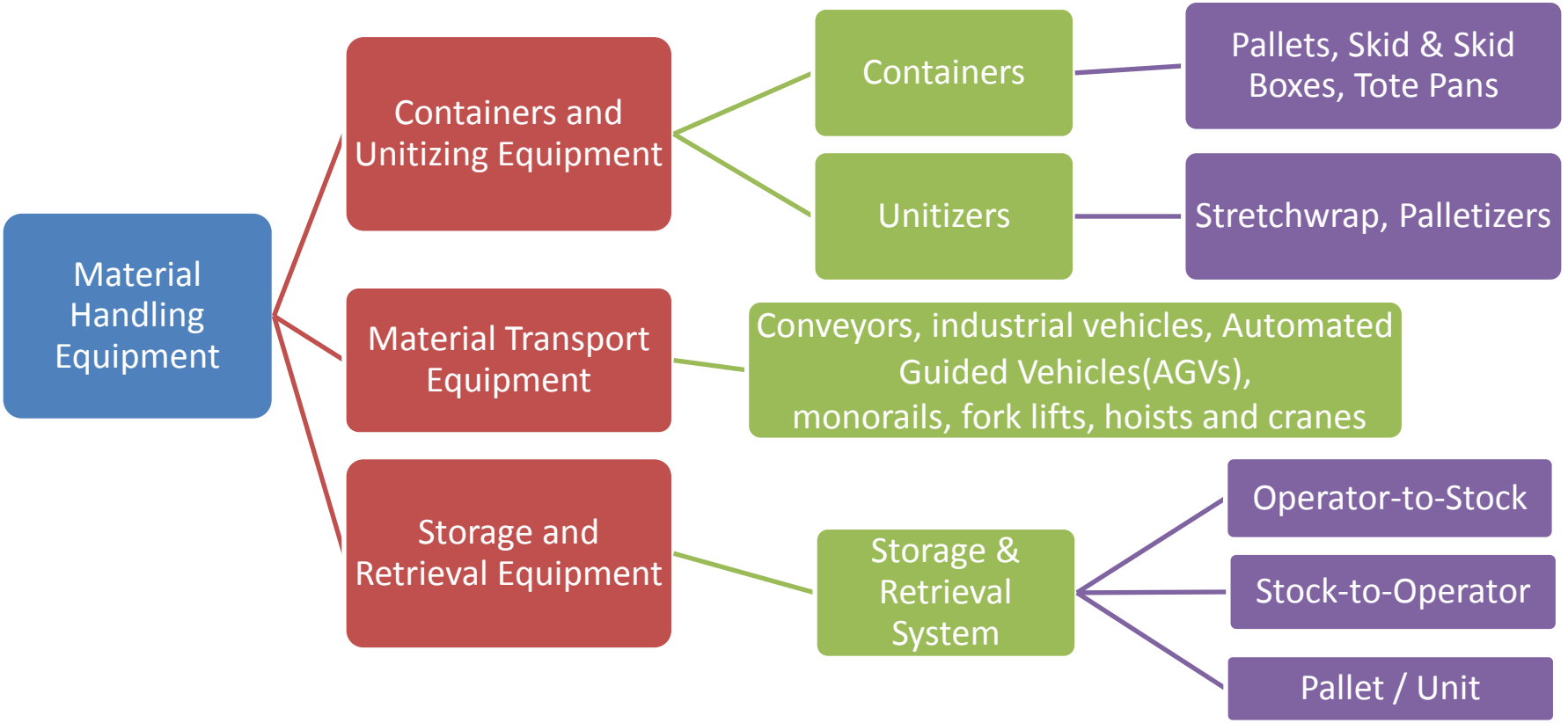
Materials Handling Principles

(1) Planning Principle	• Material handling plan defines the material, the moves and together they define the method
(2)Standardization Principle	• Less variety and customization in methods and equipment employed
(3) Work Principle	• The measure of work = Material flow (volume, weight, or count per unit time) x Distance moved
(4) Ergonomic Principle	• Human capabilities and limitations must be considered
(5) Unit Load Principle	• A unit load is one that can be stored or moved as a single entity at one time (pallet, container or tote) regardless of the number of individual items that make up the load

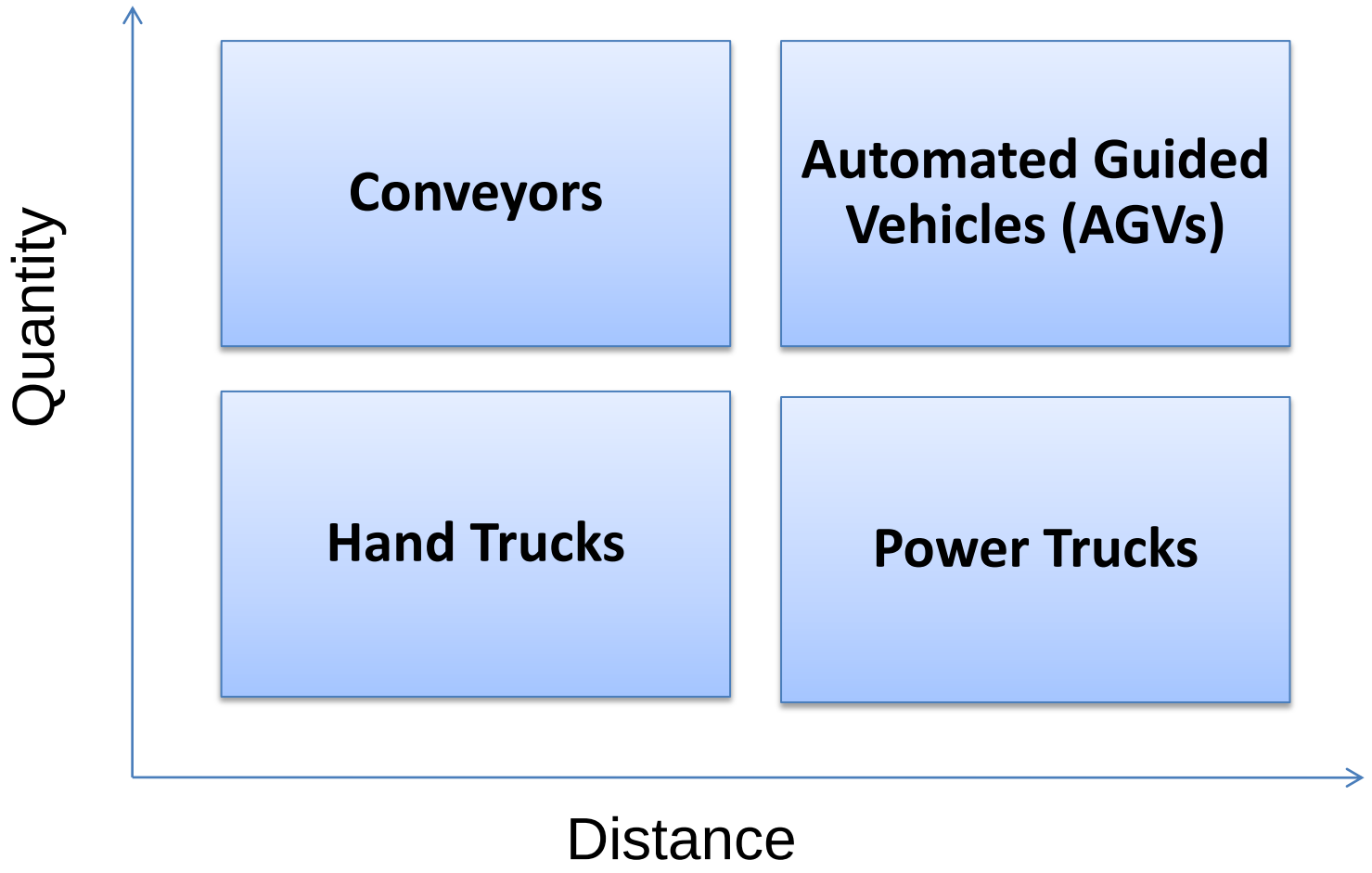
Materials Handling Principles

(6) Space Utilization Principle	• Space in material handling is three dimensional and therefore is measured in cubic space
(7) System Principle	• A system is a collection of interacting and/or interdependent entities which form a unified whole
(8) Automation Principle	• Suggests the linking of multiple mechanical operations to create a system that can be controlled by programming
(9) Environmental Principle	• Environmental impact and energy consumption must be addressed
(10) Life Cycle Cost Principle	• Consider all cash flows from first dollar spent on planning, procurement, installation, training to implementation until operation

Material Handling Equipment



Material Transport Equipment



Material Transport Equipment - Conveyors

- A conveyor is a form of material transport equipment in the same category as industrial vehicles, hoists and cranes
- Conveyors are used when material is to be moved frequently between specific points over a fixed path
- Bases to classify conveyors:
  - The type of product being handled (bulk or unit) and
  - the location of the conveyor (overhead or floor)
- Such classification systems are not mutually exclusive, that is, the same conveyor can convey both bulk and unit materials, and can be located overhead or on the floor
- Bulk materials such as grain, dry chemicals, etc. might be conveyed using flat-belt, chute or vibrating conveyors
- Unit materials such as machined parts, materials in carton boxes, etc might be conveyed using roller, trolley or flat-belt conveyors
- Conveyors characterize the product line layout in a continuous manufacturing environment

Main Conveyor Types

1. Flat-belt conveyor

- A wide belt pulled over a flat framework or rollers by a driving pulley, with the slack taken up by a driven pulley
- The belt can be made from rubber or fabric, or composed of slats or wire mesh, depending on application requirements

2. Roller conveyor

- Commonly used for packaged materials or materials on pallets
- The minimum package size is 2 roller width
- Gravity rollers (non-powered) can be applied for slight inclines
- Conveyor can be powered by running a belt below the rollers

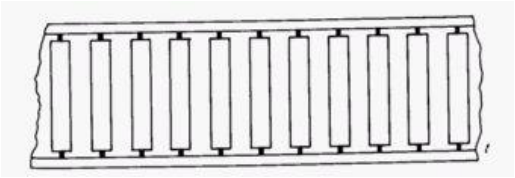
3. Trolley conveyor

- Built on I-beam, acting as the track, like a monorail
- The lower flange supports wheeled trolleys spaced at regular intervals via a chain
- The chain is pulled at constant speed by a drive mechanism located along the conveyor route
- Material is moved by placement on hooks, racks, hangers, etc attached to wheeled trolleys
- Can act as in-process storage due to conveyor variable height characteristic
- The conveyor forms a (variable height) loop within the plant, eventually returning to its starting point

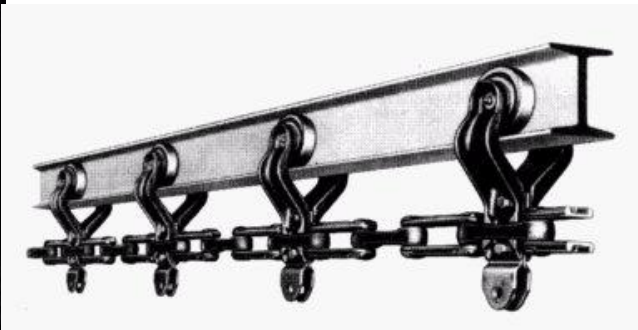
Material Transport Equipment - Main Conveyor Types

- **Flat-belt**

- **Roller**



- **Trolley**



Application Challenges

	Flat-belt	Roller	Trolley
1	Belt stretch or shrinkage -> use 'take-up' device	Flow management for non-powered rollers	Low conveyor location flexibility- the I-beams are usually welded and integrated to the facility building structure
2	Maximum angle of elevation -> increase friction factor	Slippage of packages	Number of powered drives for the chain - usually 1 drive is required for every 1200 feet of conveyor length
3	Turning in and out of corners -> use turntable Jamming at intersections -> use divider/sorter on main conveyor	Maintenance of rollers	In-process storage along the conveyor- can lead to production time loss along downstream stations if upstream processes are disrupted due to machine breakdown or supply lapse

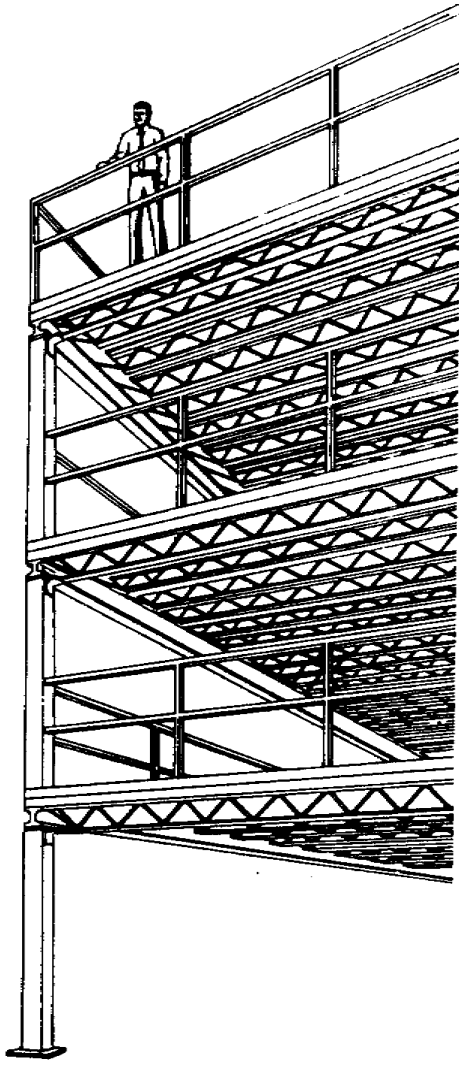
Storage and Retrieval Equipment

Small Load		Unit Load	
Operator-to-Stock Storage Systems	Stock-to-Operator Storage Systems	Pallet/Unit Storage Systems	Pallet/Unit Retrieval Systems
➢ Bin shelving systems ➢ Modular storage drawers/cabinets ➢ Gravity flow rack ➢ Space saving systems •Mezzanines •Mobile storage systems	➢ Carousels 1. Horizontal 2. Vertical ➢ Miniload Automated storage and retrieval (AS/RS)	➢ Block stacking ➢ Pallet stacking frames ➢ Single-deep pallet rack ➢ Double-deep pallet rack ➢ Drive-in rack ➢ Drive-thru rack ➢ Flow rack ➢ Push-back rack ➢ Mobile pallet rack ➢ Cantilever rack	➢ Walkie stackers ➢ Counterbalanced lift trucks ➢ Straddle trucks ➢ Straddle reach trucks ➢ Sideloader trucks ➢ Turret trucks ➢ Hybrid trucks ➢ Automated storage and retrieval (AS/RS) machines

Operator-to-Stock Storage System
- Example: Space Saving System (Mezzanine)

Operator-to-Stock Storage System
- Example: Space Saving System (Mezzanine)

- Nearly twice as much material can be stored in the original square footage
- Cost: $10-$20 / ft^2
- Key implementation issue: Slot the products so that most of the picking activity takes place at the floor level

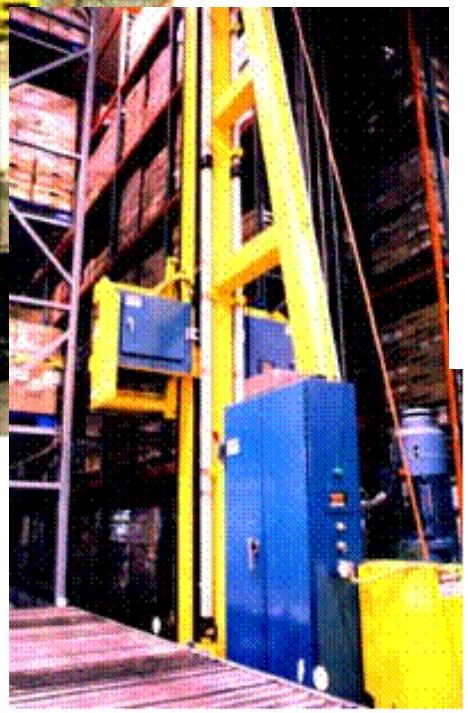


Stock-to-Operator Storage System
- Example: Automated Storage/Retrieval System

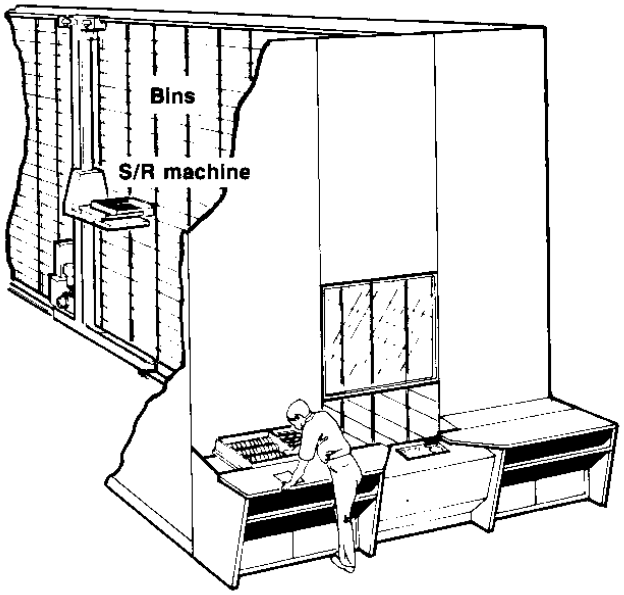
- Computer algorithms in the AS/RS control computer determine storage locations such that total distance traveled is minimized.
- When storing materials/parts, the system delivers the items to an open random location appropriate for the characteristics (i.e. size, weight, etc.) of the items and records the location for future reference so that the items may be retrieved.
- The items retrieved are accumulated at a staging area, where they are transferred to various materials handling devices for delivery to other work areas.
- Use AS/RS to
  - Increase storage capacity
  - Improve productivity
  - Improve safety
  - Improve security
  - Better inventory control
  - Increase throughput

Stock-to-Operator Storage System
- Example: Automated Storage/Retrieval System

Front View of AS/RS



Side View of AS/RS



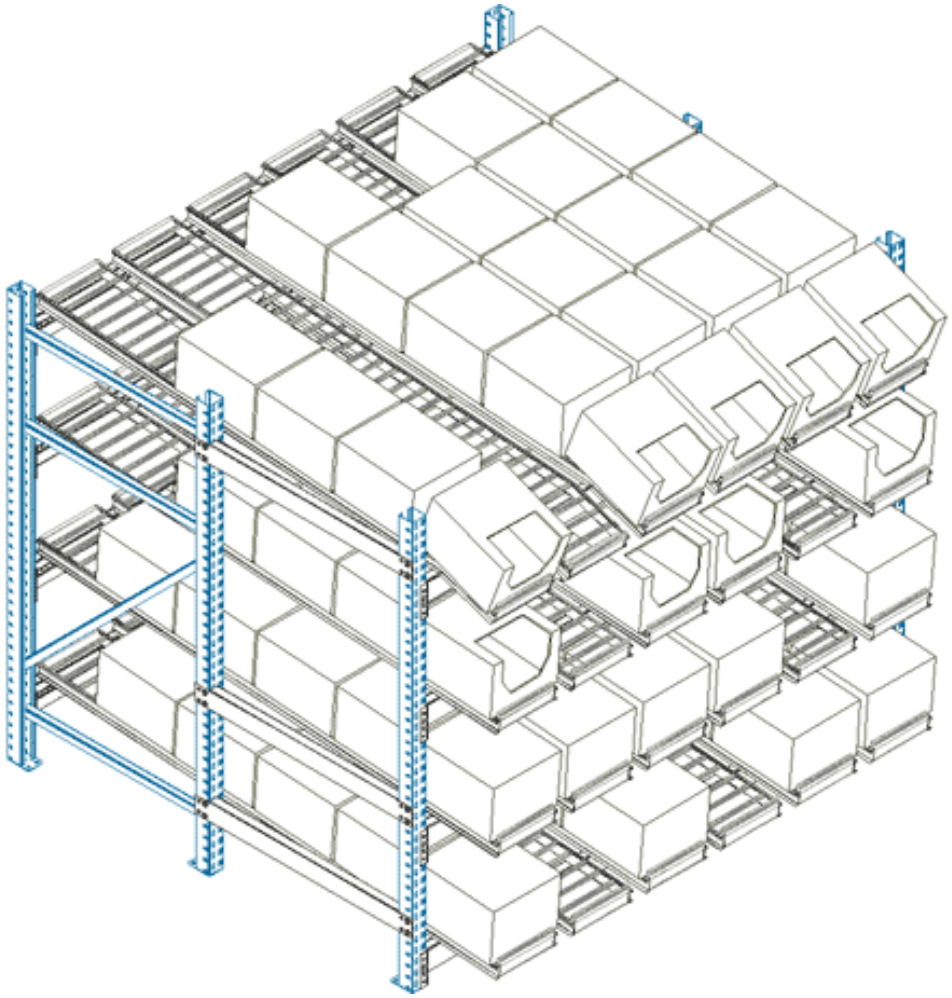
Miniload AS/RS

Miniload AS/RS

Stock-to-Operator Storage System
- Example: Automated Storage/Retrieval System (Miniload)

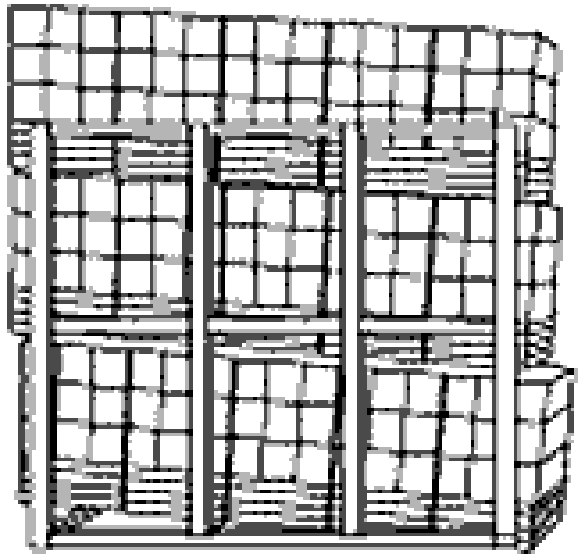
- Pick Rate: 40-200 picks/person hr
- Vary in length from 40 to 200 feet and height from 8 feet to 50 feet
- Storage containers are transported to and from an order picking station
- Cost: $150,000-$300,000 /aisle
- S/R machine: 500 feet/minute horizontal speed and 120 feet/minute vertically

Pallet Storage System
- Example: Flow Rack



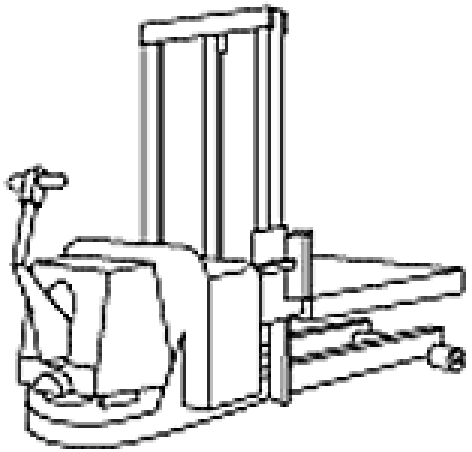
Pallet Storage System
- Example: Flow Rack

- Based on a **First-In-First-Out (FIFO)** concept
- As the load is removed from the front of a storage lane, the next load advances to the pick face.
- High-throughput unit storage and retrieval *and* good space utilization
- Used for items with high inventory turnover and with several units on hand



Pallet Retrieval System
- Example: Walkie Stacker

- Operator steers from a walking position behind the vehicle
- Can stack loads 3 loads high
- Offers both pallet retrieval/putaway and truck loading/unloading
- Advantage: Low cost
- Disadvantage: Short distances
- Used when low throughput, short travel distances and low vertical storage height and low cost requirements



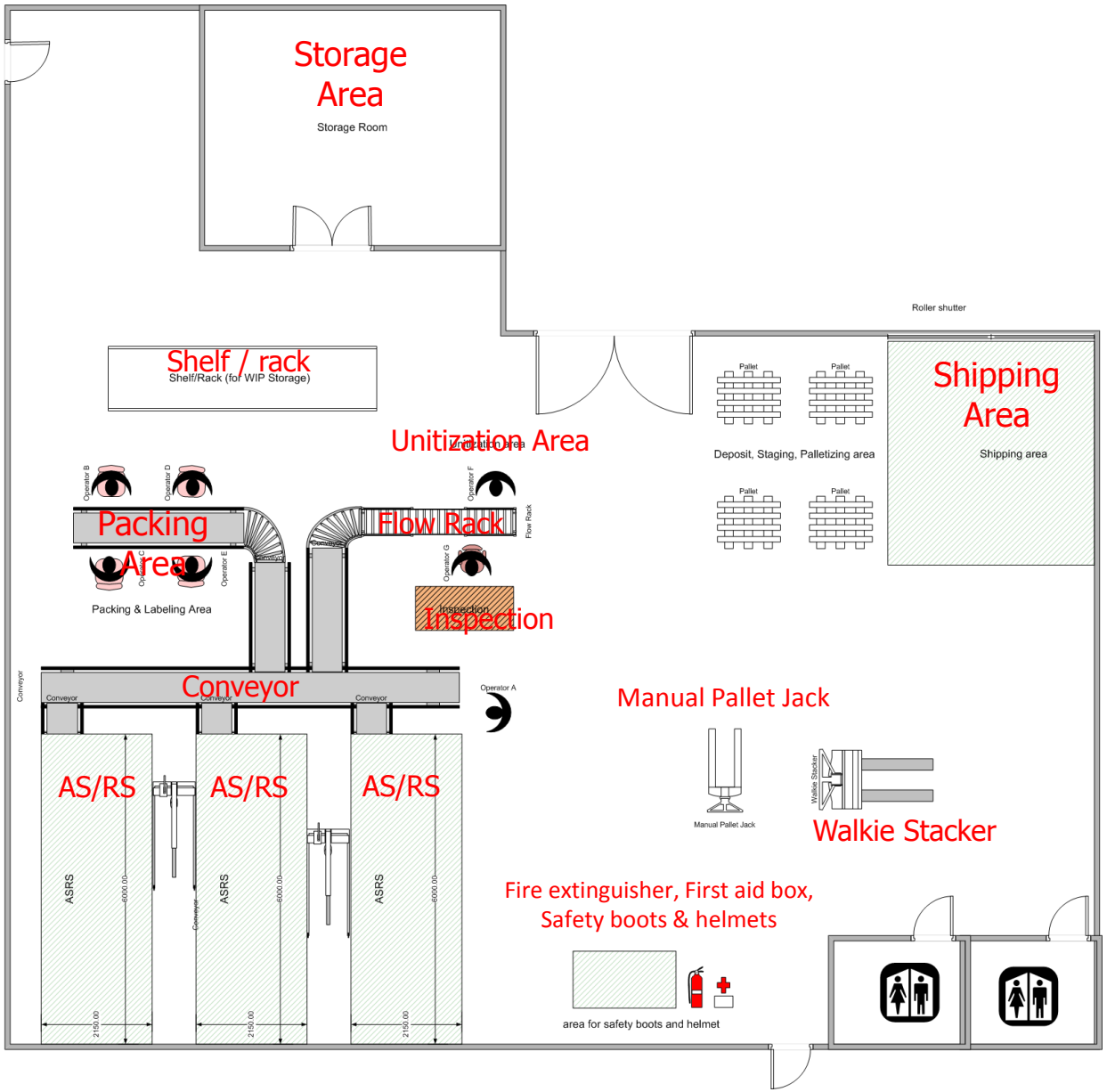
Suggested Solution

Suggested Solution to Today's Problem

1. Sam had applied the Planning Principle when selecting a material handling method.
2. He planned in a conveyor as the material transport equipment for small load product.
   - The conveyor (floor) can be designed with an angle of elevation by increasing the friction factor.
3. He had also planned in the following storage and retrieval systems:

Small Load		Unit Load	
Operator-to-Stock Storage System	Stock-to-Operator Storage System	Pallet/Unit Storage System	Pallet/Unit Retrieval System
Shelf/ Rack	Miniload Automated storage and retrieval (AS/RS)	Flow rack (FIFO concept)	Walkie stacker / Manual Pallet Jack

Proposed Layout



Learning Objectives

- Understand the objectives of selecting material handling equipment
- Evaluate the different types of material handling equipment and their suitability for the required function.
- Incorporate the considerations on material handling equipment for layout planning