Storage and Retrieval System

CIM

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Storage System

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 System Performance

Performance measures for storage systems:

- **Storage capacity** - two measures:
  - Total volumetric space
  - Total number of storage compartments (e.g., unit loads)

- **Storage density** - volumetric space available for storage relative to total volumetric space in facility

- **Accessibility** - capability to access any item in storage

- **System throughput** - hourly rate of storage/retrieval transactions

- **Utilization and availability** (reliability)
Storage Strategies

• **Randomized storage** - incoming items are stored in any available location
  – Usually means nearest available open location

• **Dedicated storage** - incoming items are assigned to specific locations in the storage facility
  – Typical bases for deciding locations:
    • Items stored in item number sequence
    • Items stored according to activity level
    • Items stored according to activity-to-space ratios
Inventory Level as function of time

- Order quantity = 100 cartons
- Depletion rate = 2 cartons/day
- Average inventory level
- Safety stock level
- 50 day cycle
Comparison of Storage Strategies

• Less total space is required in a storage system that uses a randomized storage strategy
  – Dedicated storage requires space for maximum inventory level of each item

• Higher throughput rates are achieved in a system that uses dedicated storage strategy based on activity level
  – The most active items can be located near the input/output point
  – Compromise: Class-based dedicated storage
    • Items divided into classes according to activity level
    • Random storage strategy used within each class
Conventional Storage Methods

• Bulk storage - storage in an open floor area
  – Problem: achieving proper balance between storage density and accessibility
• Rack systems - structure with racks for pallet loads
  – Permits vertical stacking of materials
• Shelving and bins - horizontal platforms in structural frame
  – Steel shelving comes in standard sizes
  – Finding items can be a problem
• Drawer storage - entire contents of each drawer can be viewed
Bulk Storage

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
Drawer Storage
Automated Storage System

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
Reasons for Automated Storage

• To increase storage capacity
• To increase storage density
• To recover factory floor space currently used for WIP
• To improve security and reduce pilferage
• To reduce labor cost and/or increase productivity
• To improve safety
• To improve inventory control
• To improve stock rotation
• To improve customer service
• To increase throughput
Types of Automated Storage System

1. Automated Storage/Retrieval System (AS/RS)
   – Rack system with mechanized or automated crane to store/retrieve loads

2. Carousel Storage System
   – Oval conveyor system with bins to contain individual items
Unit load
AS/RS with one aisle
ASRS Types

• Unit load AS/RS - large automated system for pallet loads
• Deep-lane AS/RS - uses flow-through racks and fewer access aisles
• Miniload AS/RS - handles small loads contained in bins or drawers to perform order picking
• Man-on-board AS/RS - human operator rides on the carriage to pick individual items from storage
• Automated item retrieval system - picks individual items
• Vertical lift storage modules (VLSM) - uses a vertical aisle rather than a horizontal aisle as in other AS/RS types
ASRS Applications

1. Unit load storage and retrieval
   – Warehousing and distribution operations
   – AS/RS types: unit load, deep lane (food industry)

2. Order picking
   – AS/RS types: miniload, man-on-board, item retrieval

3. Work-in-process storage
   – Helps to manage WIP in factory operations
   – Buffer storage between operations with different production rates
   – Supports JIT manufacturing strategy
Carousel Storage System

• Horizontal
  – Operation is similar to overhead conveyor system used in dry cleaning establishments
  – Items are stored in bins suspended from the conveyor
  – Lengths range between 3 m and 30 m
  – Horizontal is most common type

• Vertical
  – Operates around a vertical conveyor loop
  – Less floor space required, but overhead room must be provided
Horizontal Carousel Storage System

Manually operated horizontal carousel storage system
Carousel Applications

1. Storage and retrieval operations
   – Order picking
   – Kitting of parts for assembly

2. Transport and accumulation
   – Progressive assembly with assembly stations located around carousel

3. Work-in-process
   – WIP applications in electronics industry are common

4. Unique applications
   – Example: time testing of electrical products
Analysis of Storage System

1. Automated Storage/Retrieval Systems
   - Sizing the AS/RS
   - AS/RS throughput analysis

2. Carousel storage systems
   - Storage capacity
   - Throughput analysis

Current State

- Maximize storage space more quickly
- Handle Longer and heavier loads
- 3D AS/RS
- Stacking Capabilities
- Tunneling AS/RS
Uses

- Manufacturing
  - Automotive
  - Aerospace
  - Electronics
  - Plastics
  - Parts
- Foods
  - Frozen
- Libraries
- Hospitals
- Retail Distribution