

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

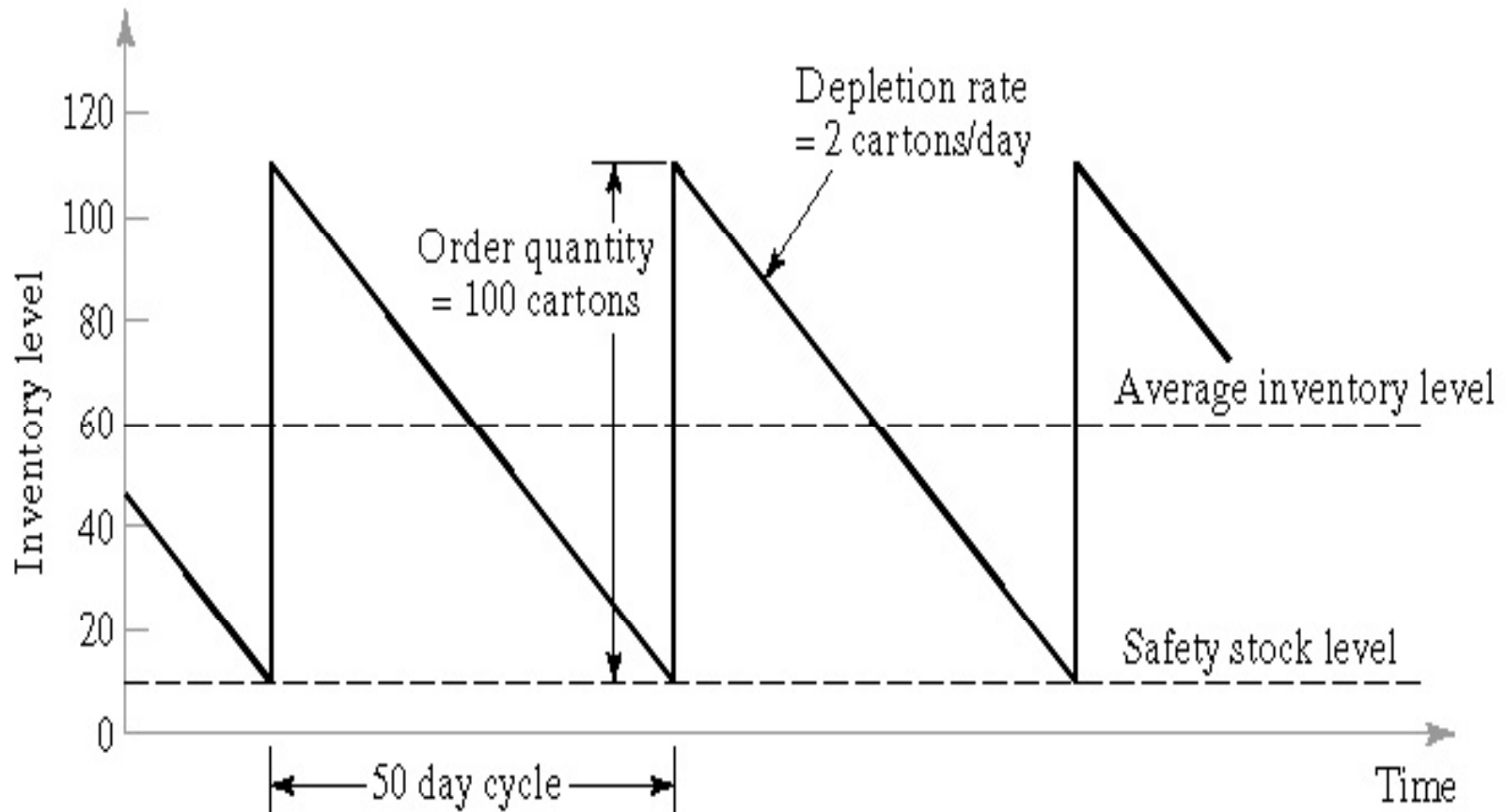
Performance measures for storage systems:

- 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



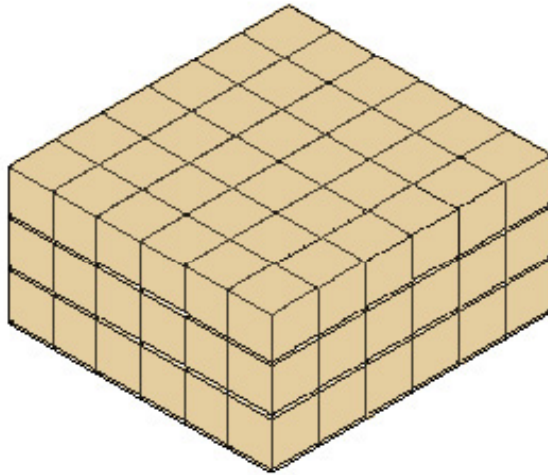
Comparison of Storage Strategies

- 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

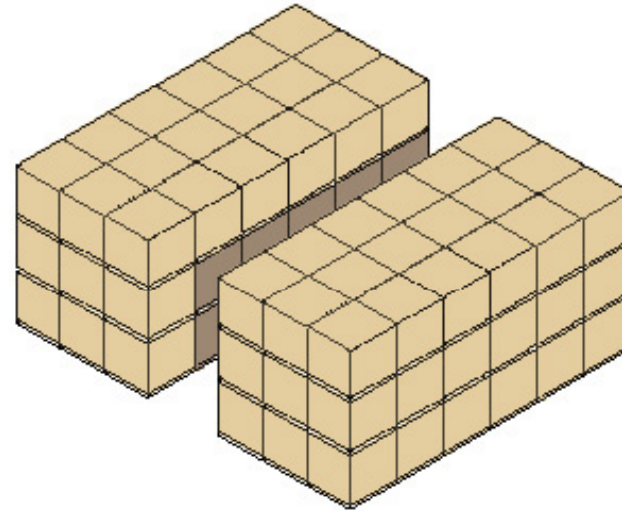
Conventional Storage Methods

- 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



(a)

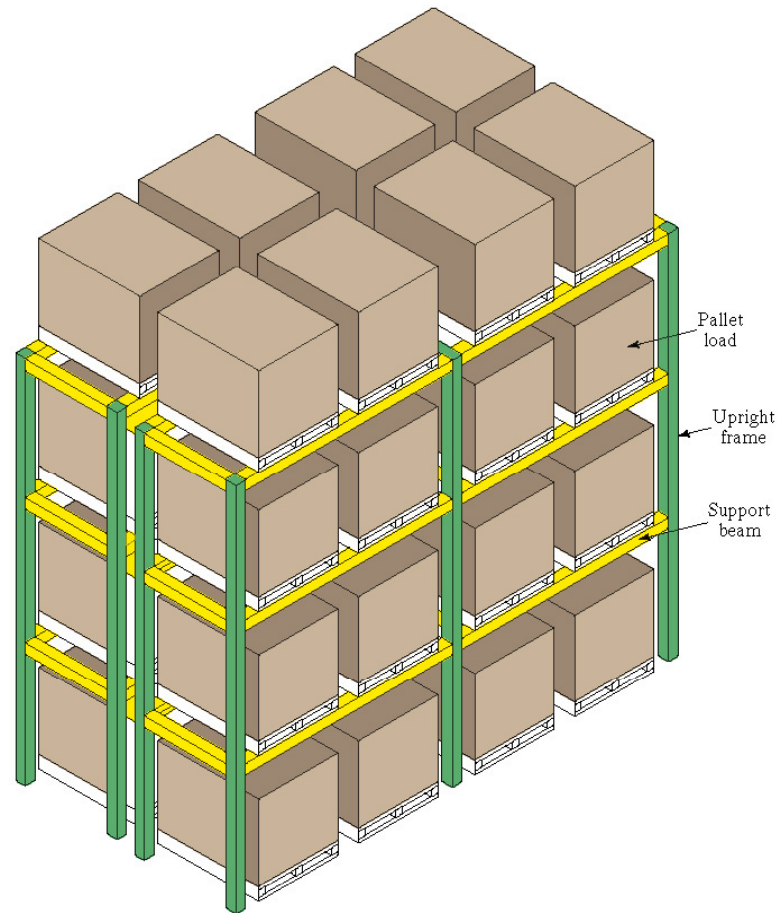


(b)

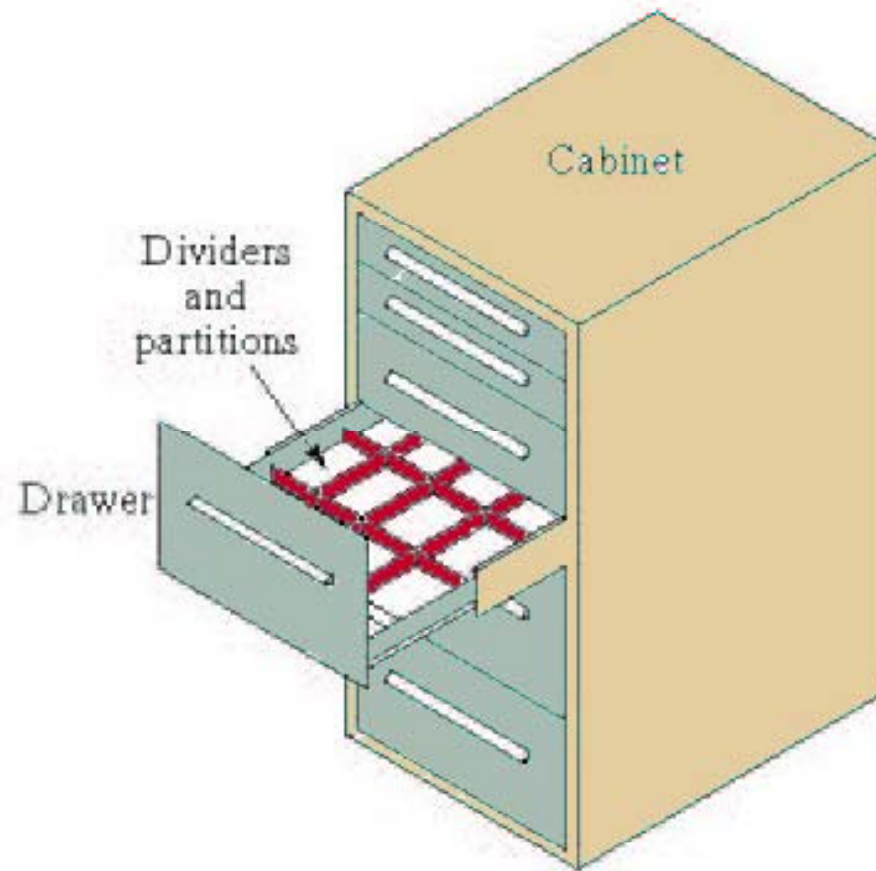
Bulk storage arrangements: (a) high-density bulk storage provides low accessibility, (b) bulk storage with loads forming rows and blocks for improved accessibility

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

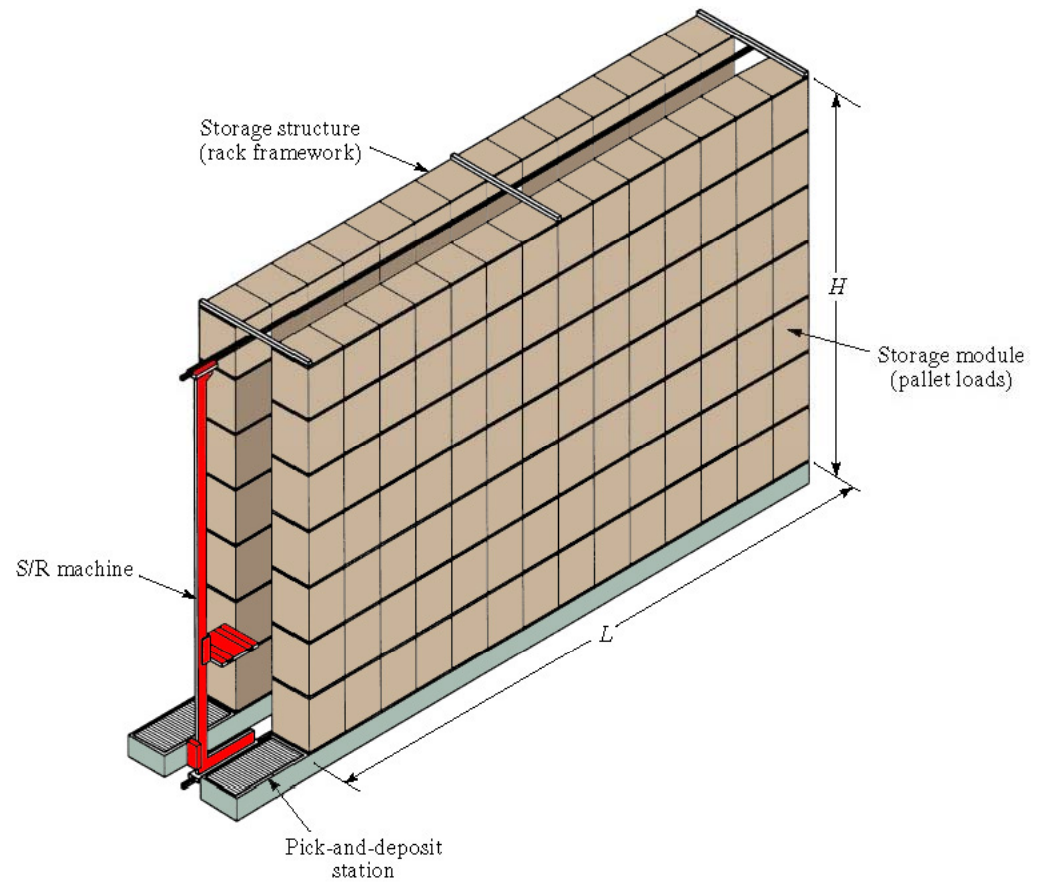
- To increase storage capacity
- To increase storage density
- To recover factory floor space currently used for WIP
- To improve security and reduce pilferage
- To reduce labor cost and/or increase productivity
- To improve safety
- To improve inventory control
- To improve stock rotation
- To improve 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

ASRS

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

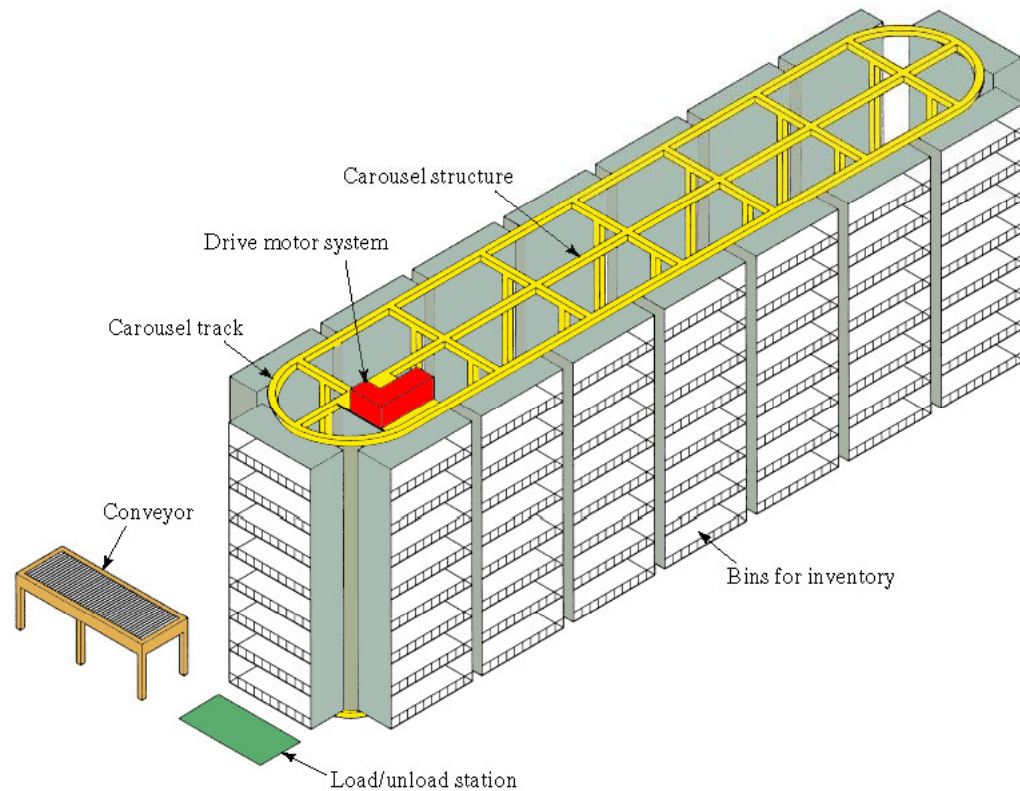
1. Unit load storage and retrieval
 - Warehousing and distribution operations
 - AS/RS types: unit load, deep lane (food industry)
2. Order picking
 - AS/RS types: miniload, man-on-board, item retrieval
3. Work-in-process storage
 - Helps to manage WIP in factory operations
 - Buffer storage between 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

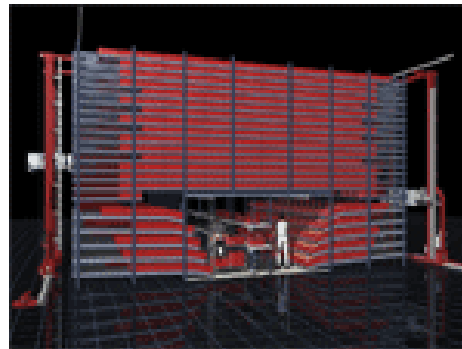
2. Carousel storage systems

- Storage capacity
- Throughput analysis

http://www.yourlogisticstv.com/viewVideo.php?video_id=209&title=Animated_Curve_Going_Stacker_Crane

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**

