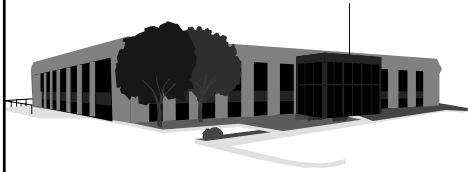


Chapter 8

Warehousing Decisions



- Nature and Importance
- Basic Functions
- Strategic DC Decisions
- Ownership Decisions
- Layout & Design
- Summary

Nature and Importance

Warehouse

- Accountable Amount of Inventory
- Basic Functions
 - Movement
 - Storage
- Utilities Created
 - Time
 - Place

Distribution Center (DC)

- More Modern Term
- Emphasize “Flow” and “Movement”
- Stresses Rapidity of Product Movement
- More Accurately Characterizes Today’s Logistics Environment

Basic Functions

- Consolidation
- Product Mixing
- Service / Product Availability
- Protection Against Contingencies
- Smoothing Manufacturing Operations

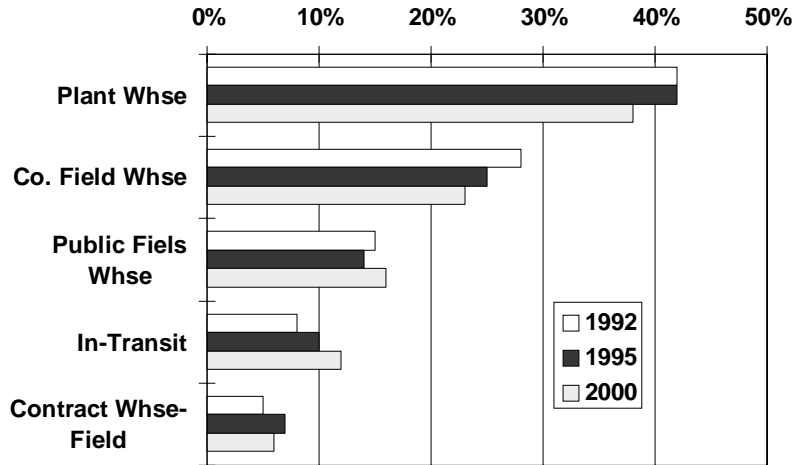
Throughput

- = basic measure of DC activity
- = Quantity (volume) into a DC
 - + Quantity out of a DC over a period of time
- = Cases per month (for example)

Strategic DC Questions

- How many and where located?
 - Centralized (few) vs. decentralized (many)
 - Large vs. small
 - Location factors
- Which products to be carried at each?
- Which customers to be serviced by which DC?
- Target customer service objectives for each facility and the network?
- Role of Private vs. Public vs. Contract operations.

Percent of Goods Stored by Location



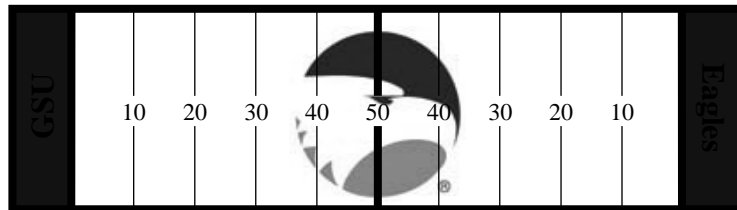
Source: LaLonde, Bernard J. and Delaney, Robert V., *Trends in Warehousing Costs, Management and Strategy*, Warehousing Education and Research Council, 1993.

Distribution Center Size and Location

Basic Question: “How Large is Large?”

Example: “Large” DC may be 2 million sq.ft.

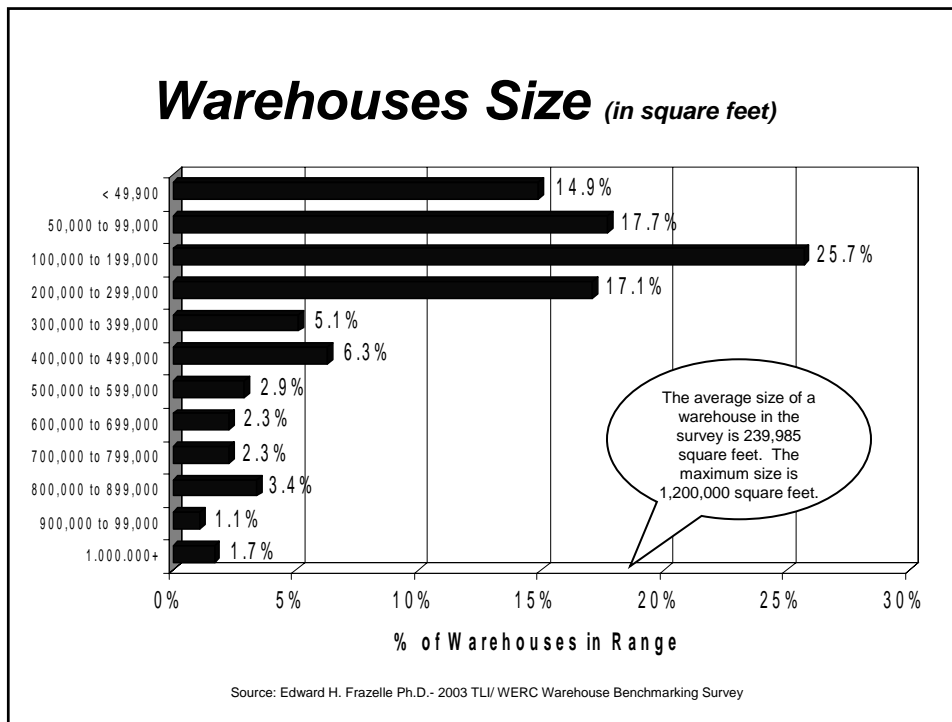
1 acre approximately equals 1 football field



Also: 1 acre = 43,560 sq.ft.

So: $2,000,000 \text{ sq.ft.} = \frac{2,000,000}{43,560} = 45.9 \text{ acres}$

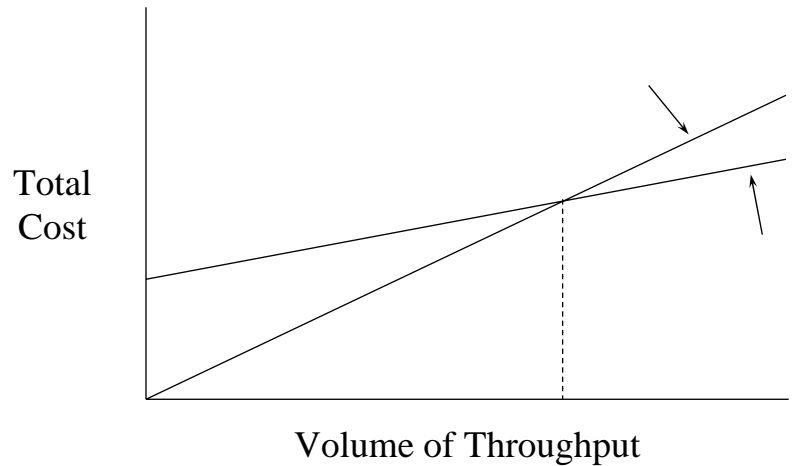
= football fields



Ownership Decision Factors to Consider

- **Cost**
 - Level of throughput will be critical
 - Fixed vs. variable cost (next slide)
- **Flexibility**
 - Ability to adapt quickly
 - Reduce risk
- **Services Available**
- **Managerial Responsibilities/Degree of Control Desired**

Cost Comparison Between Private and Public Warehousing



Factors Affecting the Ownership Decision

Firm Characteristics	Private	Public
Throughput volume		
Demand variability		
Market density		
Special physical control		
Customer service required		
Security requirements		
Multiple use needed		

Types of Public Warehouses

- General Merchandise
- Refrigerated
- Household Goods and Furniture
- Special Commodity
- Bulk Storage



Special Types

- “Bonded”
- “Foreign Trade Zones” (FTZ’s)
- “Field” Warehouse

Factors Influencing Public Warehouse Rates

- Space basis per time period
- Product value
- Fragility
- Damage to other goods
- Volume and Regularity
- Weight density
- Services

Example Services of Public Warehousing Operations

- Marketplace coverage
- Satisfy critical customer service or storage requirements
- Service parts distribution
- Break-bulk/broken case handling
- Reverse distribution/recalls/returns
- Cross-docking

Interesting Examples of Public Warehousing

- Product has unique storage requirements
- Unique customer service demands
- Insurance policy won't permit storage in private warehouse (e.g., tires)
- Broken case handling needed.
- Products with high transportation costs for small orders
- Excess product from recalls

What is Third Party Contract Logistics?

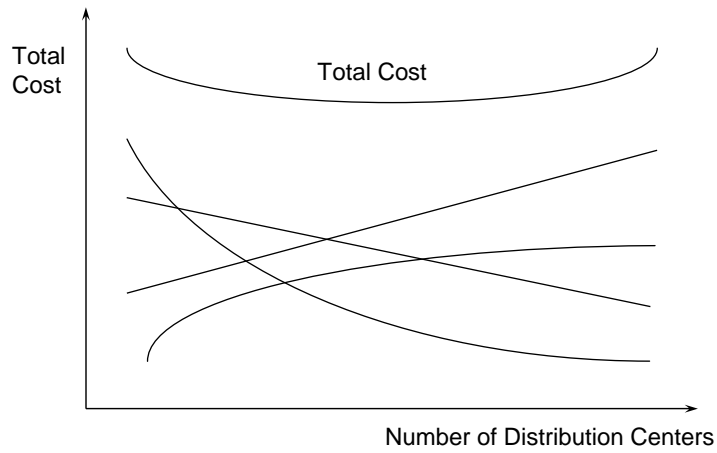
- Use of outside distribution companies (carriers, warehouses, or third-party freight managers) to perform all or part of a company's material or product distribution functions
 - Transportation
 - Storage
 - Inventory control
 - Customer service
 - Logistics information networks



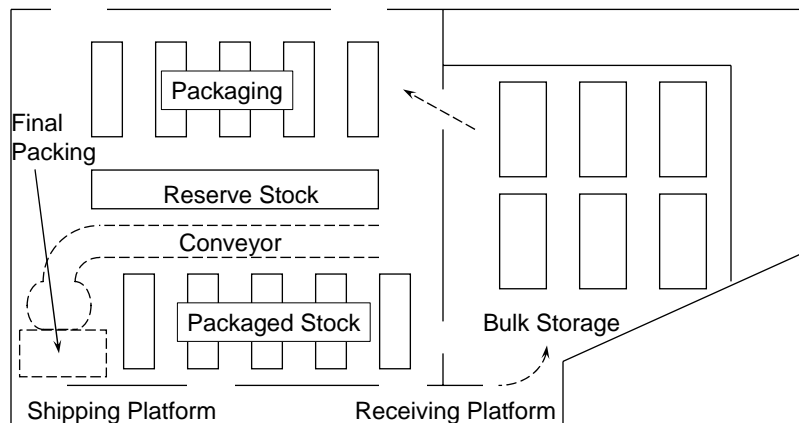
Reasons for Using Contract Warehousing

- Seasonality
- Increase Geographic Coverage
- Flexibility in Testing New Markets
- Gain Management Expertise
- Permit Off-Balance-Sheet Financing
- Reduce Transportation Costs

Logistics Costs Related to the Number of Distribution Centers

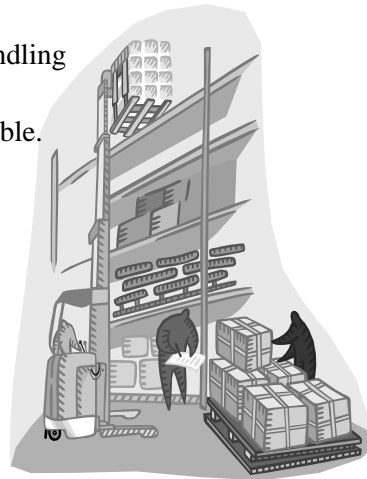


Example Distribution Center

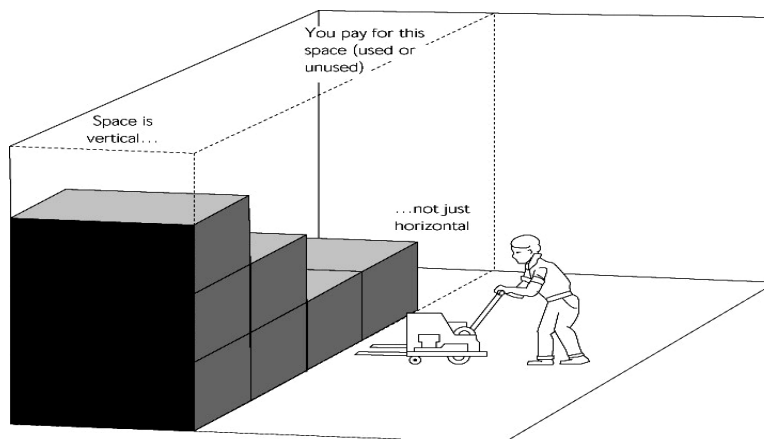


DC Layout and Design

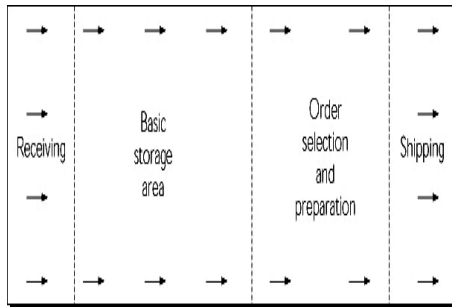
- Layout and Design Principles:
 1. Use the most efficient materials handling equipment.
 2. Use one story facilities where possible.
 3. Move goods in a straight-line.
 4. Minimize aisle space.
 5. Use full building height.
- Item-location strategies
 - Randomized vs. dedicated storage
 - Complementarily
 - Compatibility
 - Popularity



Utilization of a Warehouse's Cubic



Warehouse Layout and Design



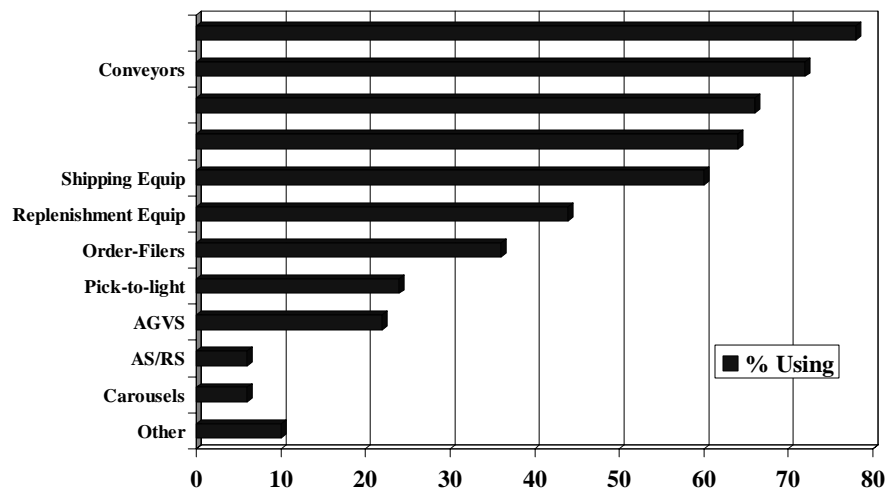
- Basic needs:
 - Receiving
 - Basic storage area
 - Order selection and preparation
 - Shipping

Straight Line Flow

Increased Automation in DC Operations

Technology	% that Use	
	1992	2000
Automated Carousels	8	20
High Stackers	26	41
Conveyors	44	56
Flow Racks	40	54
Robotics	3	12
Automated Storage/Retrieval Systems	8	21
Automated Inventory Controls Systems	26	58
Dedicated Computers in the DC	24	56
Bar Coding/Scanning	17	69

Technology in Warehousing, 1999



Source: Warehousing Management Magazine, Oct. 99, p. 30

Example: Cracker Barrel DC

- Gift Shop items of \$760m or 22% of rev.
- 100k items per day to 260k at Xmas peak
- 1 DC ships to 250+ stores in 28 states
- 250k sq.ft. with 130k increase in 1997
- Equipment includes:
 - bar coding, conveyors, inv. system, high stackers, paperless pick system
- Stores items by size and popularity
- One story with aisles for fork lifts

The “Perfect” Warehouse

- A building 671 feet long, 447 feet wide, 30 feet clear with 300,000 square feet in a rapidly appreciating area inside a free trade zone within 24 hour delivery of all U.S. zip codes and in close proximity to a highly skilled and motivated workforce.
- The building is 80% occupied during “normal” inventory levels and 90% occupied during “peak” inventory levels.
- The operation is a hybrid insource-outsourced model with the perfect outsource provider(s) chosen to perform those activities inside the warehouse that SHOULD BE outsourced.
- The operation is supported by a WMS provided by an ASP enabling all world-class warehousing practices and integrating with a wide variety of paperless communication devices chosen perfectly to meet the unique needs of each activity within the warehouse.

Source: Edward H. Frazelle Ph.D.- 2003 TLI/ WERC Warehouse Benchmarking Survey

The “Perfect” Warehouse

- The workforce is cross-trained with an operator to supervisor ratio of 12 where QUALITY is the key success driver and 8 where PRODUCTIVITY is the key success driver and where operators are delighted with average to above-average pay.
- The SKUs would be highly active, yielding 1000+ hits per year on average.
- An APPROPRIATE level of material handling technology is in place, each device chosen to perfectly match the handling requirements of the task.
- A holistic set of financial, productivity, quality and cycle time metrics work together to motivate and maintain world-class warehouse performance.

Source: Edward H. Frazelle Ph.D.- 2003 TLI/ WERC Warehouse Benchmarking Survey

Largest North American Warehousing Companies (2001)

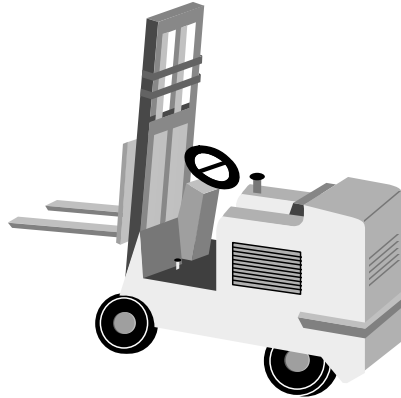
Rank	Company	Headquarters Location	NA Space (mil)	Type	2000 Rank
1	Defense Logistics Agency	Fort Belvoir, VA	78.6	Private	-
2	United Parcel Service	Atlanta, GA	67.0	Contract	1
3	Wal-Mart Stores*	Bentonville, AR	50.0	Private	-
4	Exel	Westerville, OH	45.0	Contract	2
5	Kmart	Troy, MI	25.0	Private	-
6	General Motors	Detroit, MI	23.9	Private	3
7	APL Logistics	Oakland, CA	21.0	Pub./Cont.	4
8	Sysco	Houston, TX	20.0	Private	6
9	Fleming Co.	Oklahoma City, OK	19.5	Private	8
10	Tibbett & Britten Group NA	Etobicoke, Canada	19.0	Public	9
11	AmeriCold Logistics	Atlanta, GA	17.5	Pub./Cont.	7
12	USCO Logistics	Hamden, CT	15.9	Public	14
13	Kenco Logistics Services	Chattanooga, TN	15.0	Public	12
14	Target Stores*	Minneapolis, MN	14.4	Private	10
15	JCPenney**	Plano, TX	14.1	Private	-

Source:
Warehousing Management
"Big 50" Oct. 2001

Overall Trends in Warehousing/DCs

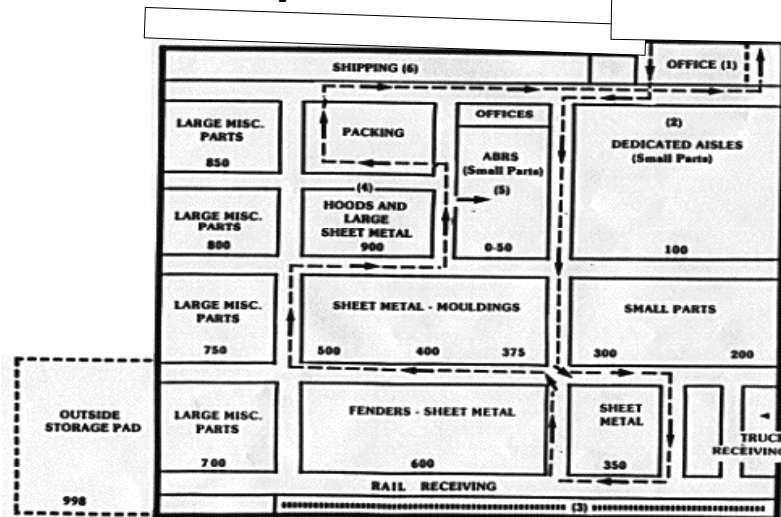
- Expansion beyond traditional services
- Third party providers
 - new and growing industry
 - emphasis on dedicated/customized services
- Reduced labor intensity
- Integrate warehouse information systems into logistics information systems
- Emphasis on “flexibility” to changing market conditions

Chapter 8a Materials Handling & Packaging



- Introduction
- Objectives of Materials Handling
- Equipment Categories and System Design
- Equipment Selection Factors

GM Reno/Sparks Distribution Center



Objectives of Materials Handling

- Increase Facility's Useable Capacity
 - Six design principles (height, aisle, etc.)
- Reduce No. of Times a Product is Handled
 - Less costly
 - Less damage
- Effective Working Conditions
 - Safety
 - Eliminate unnecessary movements
- Customer Service

Equipment Categories

- Dock Equipment
 - Forklifts; Bumpers, levelers; Pallets; Trailer restraint systems
- Other Equipment
 - Conveyors / scanning systems
 - Cranes
 - Automated guided vehicle systems (AGVS)
 - Automated storage and retrieval systems (AR/RS)
- Order Picking and Storage Equipment
 - Picker-to-part or Part-to-picker systems
 - Case-picking and item-picking equipment
 - Order packing vehicles / robots
 - Horizontal / vertical carousels
 - AR/RS

Dock Equipment

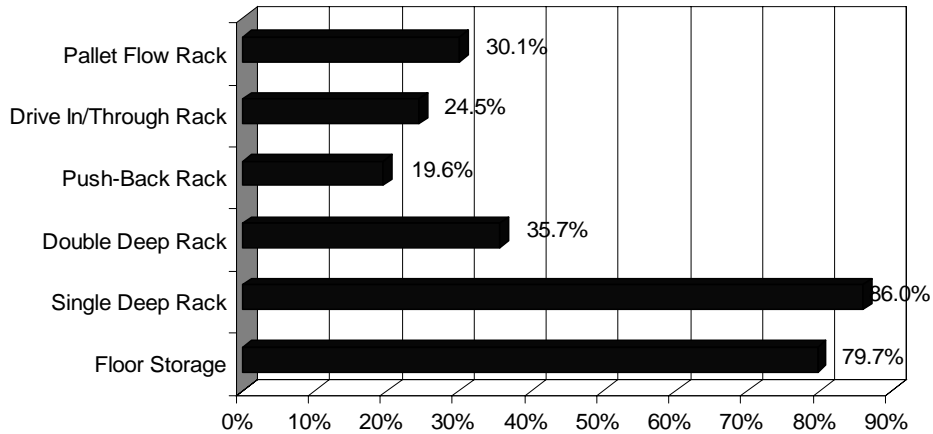
- Forklifts
- Dock bumpers
- Dock levelers
- Dock seals
- Trailer restraint systems
- Pallets



Fork Lifts/Trucks



Pallet Storage Modes



Source: Edward H. Frazelle Ph.D. - 2003 TLI/ WERC Warehouse Benchmarking Survey

Other Materials Handling Equipment: Conveyors

- Types
 - Roller or gravity style
 - Belt style
- Advantages
 - Assist in keeping inventory records an location
 - Ability to move goods quickly and efficiently
- Disadvantages
 - Very expensive
 - Relatively inflexible

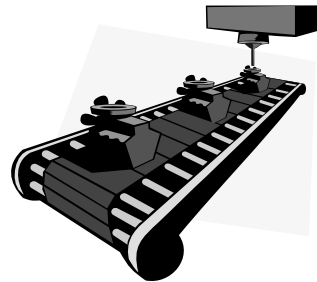


Figure 8A-3 Materials-Handling Equipment Top-running

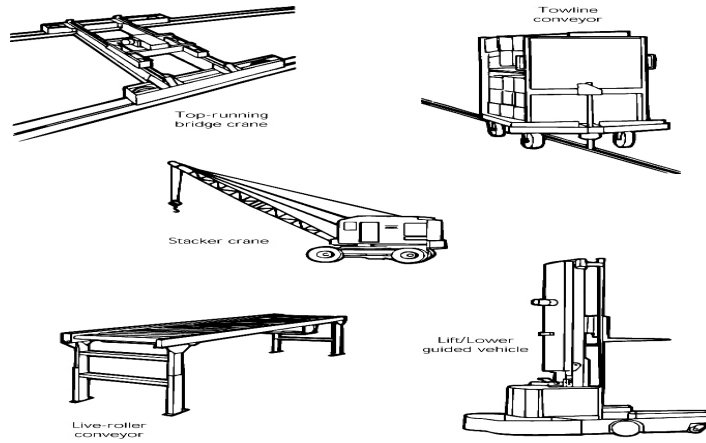
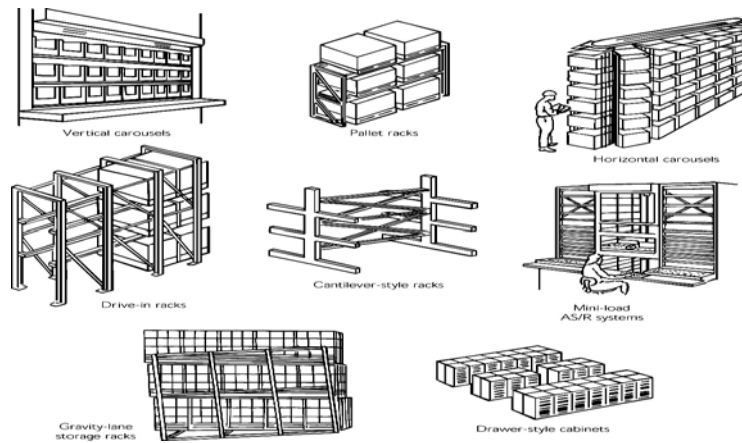
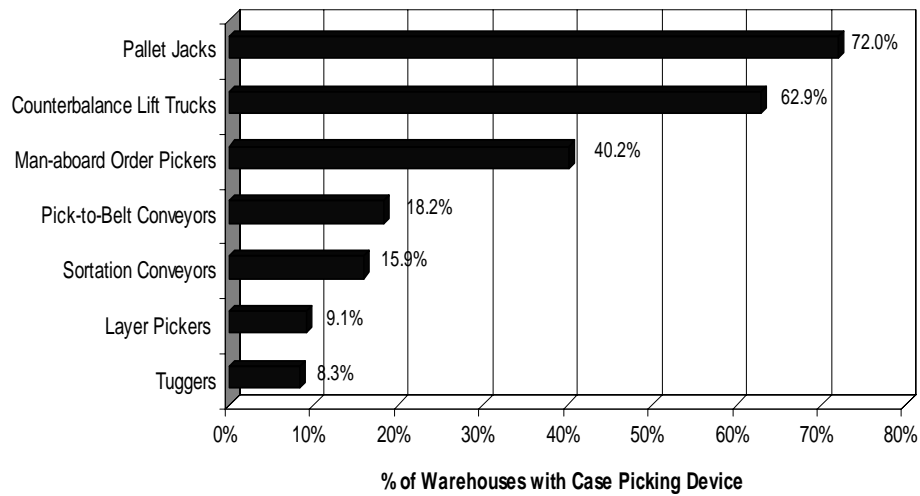


Figure 8A-4 Order-Picking Equipment



Case Picking Devices



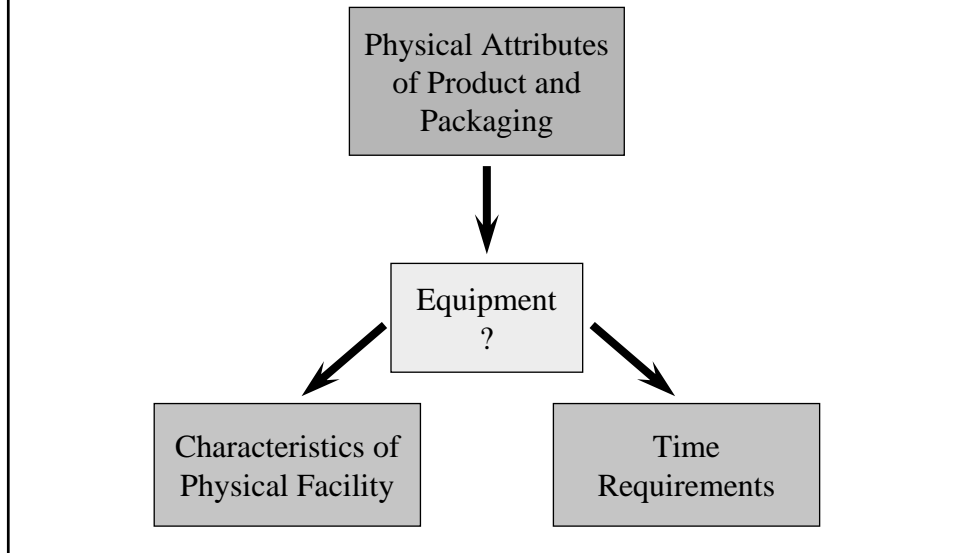
Source: Edward H. Frazelle Ph.D.- 2003 TLI/ WERC Warehouse Benchmarking Survey

System Design

- Key is to identify facility requirements *1st* then design the facility, system and select equipment

	Equipment	Rational
“Flexible” Path		
Continuous Flow		
Intermittent Flow		

Equipment Selection Factors



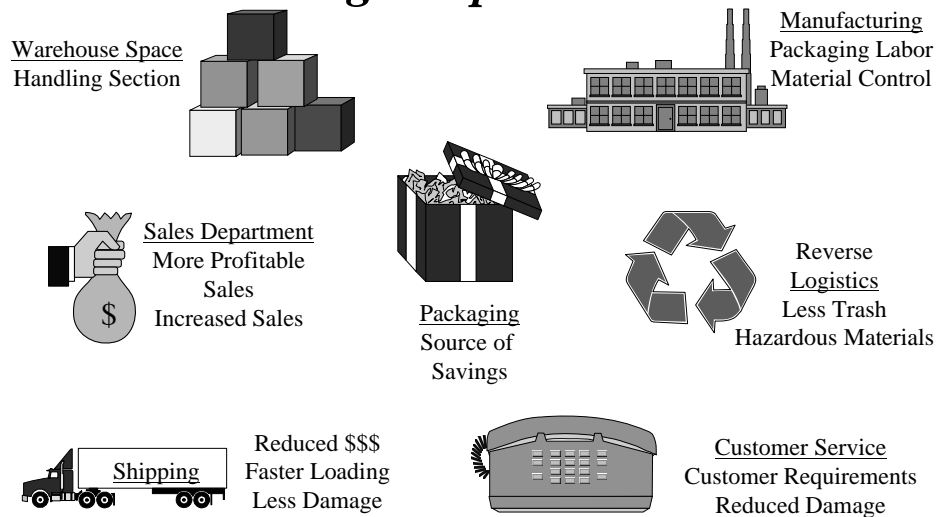
Packaging

- Principle Functions
- Types of Packaging
 - Consumer or Interior packaging
 - Industrial or Exterior packaging
- Key Packaging Considerations
 - Packaging materials and requirements
 - Hazardous materials
 - Labeling and price marking
 - Bar coding
 - Containerization
 - Recycling / Reverse Distribution

Comparison of Cushioning Materials

Material	Material Costs	Static Loading	Resiliency	Typical Applications
Air bubble	Low	Light to Med.	Good	Void fill Wrapping Keyboards
Cellulose wadding	Low	Light to Med.	Fair	Surface prot. Furniture Plastic parts
Corrugated	Low	Light to Med.	Fair	Blocking Bracing Rugged parts
Expanded Polystyrene	Low	Light to Med.	Fair	Void fill Books Plastic parts
Polyurethane	High	Light to Med.	Excellent	Computers Electronics Medical Inst.
Foam-in-place	Medium	Med. to Hev.	Good	Electronics Service Cts Spare Parts
Polyethylene	High	Med. to Hev.	Excellent	Disk drives Fragile elect. Printers

Major Areas to Benefit from Package Improvements

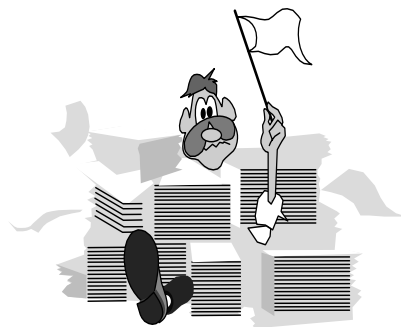


Factors That Affect Package Design Decisions

Factor	% Consider
Minimize damage to package contents	77%
Minimize shipping/packaging cost	73%
Design package for handling with lift trucks	63%
Protect contents from shock, impact	63%
Minimize shipping cost	55%
Meet carriers' requirements	47%
Identification of contents	43%
Weights and shapes appropriate for manual handling	41%
Column strength of package, for stacking	41%
Meet needs for export	40%
Meet customers' specifications	39%
Compatibility with handling systems	37%
Protection from external moisture	36%
Conform to regulations on hazardous materials	36%
Dimensions for good pallet patterns	35%
Protection of contents from vibration	33%
Dimensions for vest use of space in trans. Vehicles	33%

Source: Stock and Lambert, *Strategic Logistics Management*

End of Section #2



- Exam 2 will cover material to this point
- Study guide will be posted on the Internet
- Exam will be approx. 35-40 multiple choice
- Remember page 2 of the *Language of Logistics*