Summary

This text focused on warehousing, the storage of inventories for varying periods of time. We began with a discussion of why warehousing exists in a logistics system. A key reason for warehousing is that production and consumption may not coincide, and warehousing can help smooth out imbalances between them. We discussed the differences among warehouses, distribution centers, and cross-docking facilities.

We also examined public, private, contract, and multiclient warehousing. Public warehousing managers have a number of established duties regarding the care of goods, and customers pay only for the space that is actually used to store their products. Private warehousing is owned by the firm using such facilities, and it is best used when an organization has large and steady demand patterns. Contract warehousing involves specially tailored warehousing services that are provided to one client on a long-term basis. Multiclient warehousing, a relatively new alternative, is a mixture of public and contract warehousing.

Various design considerations are relevant to warehousing, with trade-offs among them. For example, a decision to build up or out can affect a facility's utilization of labor, mechanization, and automation. Similarly, organizations that prefer a fixed slot location for merchandise may have to build larger facilities to have a sufficient number of storage slots.

The text concluded with an examination of some key issues in warehousing operations. The material in this section emphasized that commonsense, low-cost approaches can facilitate effective and efficient management of warehousing operations. For example, warehousing safety could be enhanced if employees refrain from jumping from one dock plate to another.

Key Terms

Accumulating (bulk-making)
Allocating (bulk-breaking)
Assorting
Contract warehousing
Cross-docking
Distribution centers
Dunnage
Fixed slot location
Fulfillment centers
Hazardous material(s)
Multiclient warehousing
Occupational Safety and Health Administration (OSHA)
Private warehousing
Public warehousing
Regrouping function
Sorting out
Throughput
Variable slot location
Velocity slotting
Warehouse automation
Warehouses
Warehousing

Questions for Discussion and Review

1 Why does warehousing exist in a supply chain?
2 Explain the four ways that warehousing facilitates the regrouping function.
3 Distinguish among warehouses, distribution centers, fulfillment centers, and cross-docking facilities.
4 Discuss the disadvantages to public warehousing.
5 What are the advantages and disadvantages of private warehousing?
6 Discuss why contract warehousing is a preferred alternative for many organizations.
7 How does multiclient warehousing mix attributes of public and contract warehousing?
8 Explain how common sense can be helpful in terms of warehousing design.
9 In terms of warehousing design, give examples of trade-offs involving space, labor, and mechanization.
10 Distinguish between fixed and variable slot locations. How might they affect warehousing design?
11 Discuss the trade-offs associated with order-picking versus stock-replenishing functions.
12 Explain the relevance of aisle width in warehouse design.
13 Discuss some key considerations associated with warehouse automation.
14 What are some potential nonstorage space needs that might impact warehousing design?
15 How can warehousing productivity be improved without significant investment in technology or equipment?
16 What is OSHA's role in warehousing safety?
17 Discuss how fires are a constant threat in warehousing.
18 What is a hazardous material? What design elements should be considered when storing hazardous materials?
19 Discuss how warehousing security can be enhanced by focusing on people, facilities, and processes.
20 How are cleanliness and sanitation relevant to warehousing operations?

One commonsense suggestion when hiring warehousing workers is not to hire people who might be predisposed to theft (e.g., individuals with substance abuse problems).

In terms of a facility's focus, experts recommend a combination of overt and covert surveillance methods. With respect to the former, electronic devices such as closed-circuit television systems can be helpful, particularly if they are monitored on a regular basis. One type of covert surveillance involves unannounced security audits that focus on shortages or overages of particular products.[37] You should recognize that there is virtually no limit to the sophistication or cost of devices and techniques that can be used to monitor warehousing security. Having said this, the more sophisticated security devices also tend to be more expensive, and organizations need to weigh the trade-off of whether the devices' benefits exceed their costs.

In terms of processes to improve warehousing security, the more times a shipment is handled, the greater the opportunities for loss or damage. Thus, logisticians would do well to reduce the number of times an individual shipment is handled. Table 1 highlights some possible shortcomings in warehousing security.

Cleanliness and Sanitation Issues

At first glance, cleanliness and sanitation might seem like issues that are more relevant to, say, restaurants and hospitals than to warehousing operations. However, warehousing cleanliness and sanitation are of paramount importance in many industries, such as the foodservice industry where clean and sanitary warehouses reduce the likelihood of foodborne illnesses. Moreover, clean and sanitary warehousing facilities can have a positive impact on employee safety, morale, and productivity while also reducing employee turnover.[38]

Fortunately, warehouse cleanliness and sanitation are not predicated on complex theories or costly technology, but rather on common sense and diligence. For example, a leading provider of industrial cleaning equipment suggests that a company develop a schedule to clean its warehouse on a regular basis—and stick to the schedule. In addition, a company can instill a culture that focuses on warehouse cleanliness and that requires employees to clean up upon finishing a particular task. Another suggestion is to create teams of two or three people and assign each team a specific cleaning task. Rather than cleaning an entire warehouse, the teams can be assigned to one of four quadrants in order to make the task seem more manageable.[39]

TABLE 1 Possible Shortcomings in Warehousing Security

Shortcoming	Comment
Making it too easy for dock personnel to work in collusion with truck drivers	Fewer than 5% who commit crimes are prosecuted
Relying on safeguards that simply don't work	Security cameras aren't always turned on
Approach to theft is too reactive	Don't wait until theft reaches an "unacceptable" level
Not weeding out on-the-job substance abusers or dealers	Approximately 90% of drug users either steal or deal to support their habit
Not checking your checkers on a frequent basis	They may become complacent
Not making it easy to report theft and substance abuse	Outsourcing the reporting may be more effective
Hiring high-risk employees	An ounce of prevention is worth a pound of cure

Source: Julia Kuzeljevich, "The Seven Deadly Sins in Warehouse Security," *Canadian Transportation & Logistics,* April 2006, 44.

[37]Maria Hoffman, "Eight Ways to Prevent Cargo Theft," *Food Logistics,* July 2011, 5.
[38]Ned Bauhof, "Keeping It Clean," *Beverage World,* July 2007, 77.
[39]http://www.sweeperland.com/how-to-clean-warehouse.html

Hazardous Materials

Hazardous materials (hazmat) often receive special attention from logistics managers because of the injuries, death, and property damage they can cause. Broadly speaking, **hazardous materials** can negatively impact the health and/or safety of the general public. Examples of hazardous materials include explosives, flammable liquids, and flammable solids.

Government regulations often require that shipping documents indicate the hazardous nature of the materials being transported. Warehouse employees should note these warnings when receiving materials and similarly should include such warnings on outbound shipping documents when materials leave warehouses. Many countries also require organizations to create a safety data sheet (SDS) for each hazardous product to be stored in a facility. The SDS contains information about the physical and health hazards associated with a particular product as well as information about its proper storage.[32]

Hazmat experts generally agree that the applicable regulations should only provide a starting point for proper storage of hazardous materials, in part because for some situations no regulations exist. These experts further suggest that hazmat storage can be managed effectively by answering four questions: *What* material is being stored? *Why* is it being stored? *Where* is it being stored? *How* is it being stored?[33]

A number of design elements must also be considered with the storage of hazardous materials. Buildings that store hazmat often have specially constructed areas so that materials can be contained in the case of an accident. Likewise, these facilities may have walls and doors that can withstand several hours of intense fire. It is also important for a hazmat storage facility to have proper sprinkling systems as well as excellent ventilation.

Warehousing Security

Interest in providing building security for warehouses and other distribution facilities is a primary concern for many organizations because, according to FreightWatch International, a company that specializes in logistics security, "Freight at rest is freight at risk."[34] Potential threats to warehousing security include theft, pilferage, heat and humidity, vandalism, fire, and loss of electricity, among others.[35] These threats can present a number of negative consequences such as lost sales and revenues, additional costs to enhance security, the time and costs to file the appropriate claims, and potential danger to the public.

Some of these consequences were well illustrated in the high-profile theft of nearly $80 million in pharmaceuticals from a Connecticut warehouse in 2010. The pharmaceutical manufacturer instituted an immediate review of its warehouse security processes and procedures and began implementing more stringent (and most costly) security practices. In addition, pharmaceuticals that are sold outside of traditional channels can create potential safety risks (e.g., lack of refrigeration could contaminate some pharmaceuticals) and the revenues from such sales are not realized by the manufacturer. And although the pharmaceuticals stolen from the Connecticut warehouse were eventually recovered, they became evidence in criminal and civil lawsuits and will be destroyed at the conclusion of all relevant legal proceedings—which means no revenues from their sale for the manufacturer.[36]

Warehousing security focuses on two primary issues, namely, protecting products and preventing their theft, and warehousing security can be enhanced by focusing on people, facilities, and processes. In terms of people, one area of focus should be the hiring process for warehousing workers; a starting point might be determining whether an individual facility even has a formal hiring process.

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[32]Maureen Brady, "Safe, Segregated and Secure: Are Your Hazardous Chemicals Properly Constrained?" *Industrial Safety & Hygiene News*, June 2012, 46.

[33]Todd Nighswonger, "Are You Storing Hazardous Materials Safely?" *Occupational Hazards*, June 2000, 45–47.

[34]FreightWatch, *US Cargo Theft: A Five-Year Review*, April 2011.

[35]Linda Pohle, "What to Do with a Warehouse," *SDM: Security Distribution and Management*, September 2008, 64–70.

[36]Diane Ritchey, "The $80 Million Theft," *Security: Solutions for Enterprise Security Leaders*, July 2012, 20–24.

lifting procedures, trying to carry too heavy a load, failing to observe proper hand clearances, and the like. Back and shoulder injuries are the most frequent among warehousing personnel; back support belts and braces are becoming more widely used, but they are only of value if workers also receive adequate training in how to safely lift various loads.

Property. Warehousing facilities generate large volumes of waste materials, such as empty cartons, steel strapping, and broken pallets, as well as wood and nails used for crating and **dunnage** (material that is used to block and brace products inside carrier equipment to prevent the shipment from shifting in transit and becoming damaged). The various waste materials must be properly handled because they pose threats to employee safety and may also be fire hazards.

Moreover, even with the best of practices, some goods that are received, stored, and shipped will be damaged. Special procedures must be established for handling broken or damaged items, if only from the standpoint of employee safety. A broken bottle of household ammonia, for example, results in three hazards: noxious fumes, broken glass, and a slippery floor. Aerosol cans pose hazards that are affected by the product in the cans. For example, cans of shaving cream cause little problem in fires because if they explode, the shaving cream serves to extinguish the fire; that is not the case with aerosol cans containing paints or lacquers, and such cans are often kept in special cages because in a fire they might become burning projectiles.

Indeed, fires are a constant threat in warehousing, in part because many materials used for packaging are highly flammable. In addition, although plastic pallets last longer, are cleaner, and are less likely to splinter than wooden pallets, plastic pallets tend to be a greater fire risk. High-rise facilities are more susceptible to fires because the vertical spaces between stored materials serve as flues and help fires burn. You should recognize that warehouse fires may result in substantial property damage as well as injury or death, as illustrated by the 2015 explosions at the Port of Tianjin (China). The explosions, which started with an initial explosion (and fire) at a warehouse that illegally stored thousands of tons of hazardous products, killed more than 100 people and cost insurance companies approximately $2 billion.[28]

A 2016 report by the National Fire Protection Association indicated that U.S. warehouses averaged approximately 1,200 fires per year between 2009 and 2013. The report indicated that the two most common causes of warehousing fires between 2009 and 2013 were those that were intentionally set and those caused by electrical distribution and lighting equipment. Moreover, the 2016 report indicated that the number of warehousing fires decreased by approximately 75% between the early 1980s and 2013.[29] Many warehousing fires can be prevented by common sense; flammable products, for example, should not be stored near heat sources (such as space heaters).

Motor vehicles. We mentioned earlier that forklift operations and equipment have been a particular focus of governmental safety regulations. Indeed, in the United States approximately 85 employees are killed and there are approximately 35,000 serious injuries each year while operating forklifts; approximately 40% of deaths are caused by an operator being crushed by a forklift tipping over.[30] An annual National Forklift Safety Day began in 2014 as an effort to provide greater awareness of safe forklift practices as well as to encourage safer operator behavior.

There are other vehicle-related safety considerations in warehousing; for example, tractor-trailer drivers who are backing into loading/unloading docks should utilize a lookout person to alert the driver about employees who might be walking behind the vehicle. Moreover, wheel chocks—hard-rubber wedges that are inserted under truck tires—can guard against intentional or unintentional trailer movements.[31]

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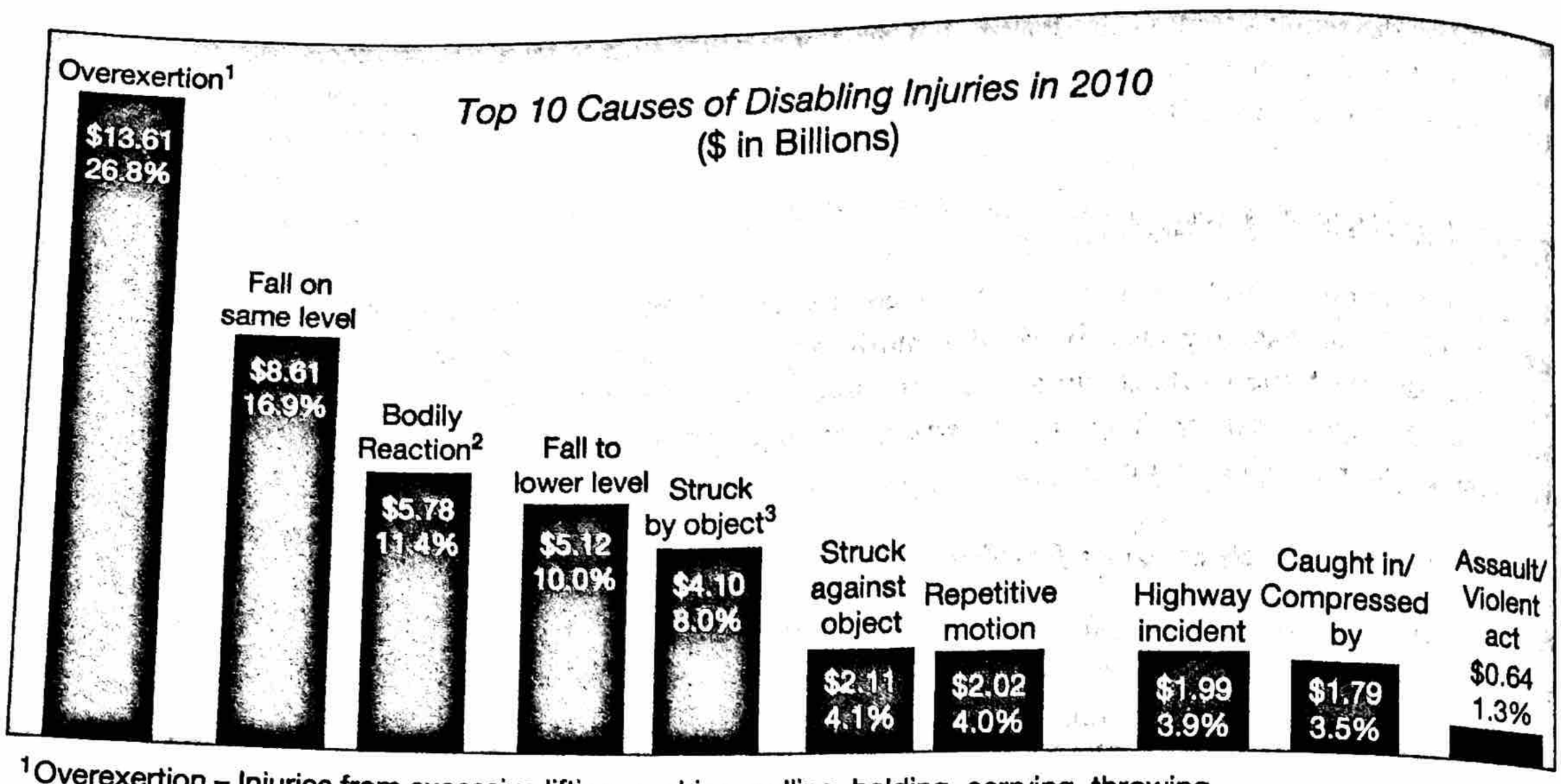
[28]Patrick Burnson, "Resilience Requires Transparency," *Logistics Management*, January 2016, 64.

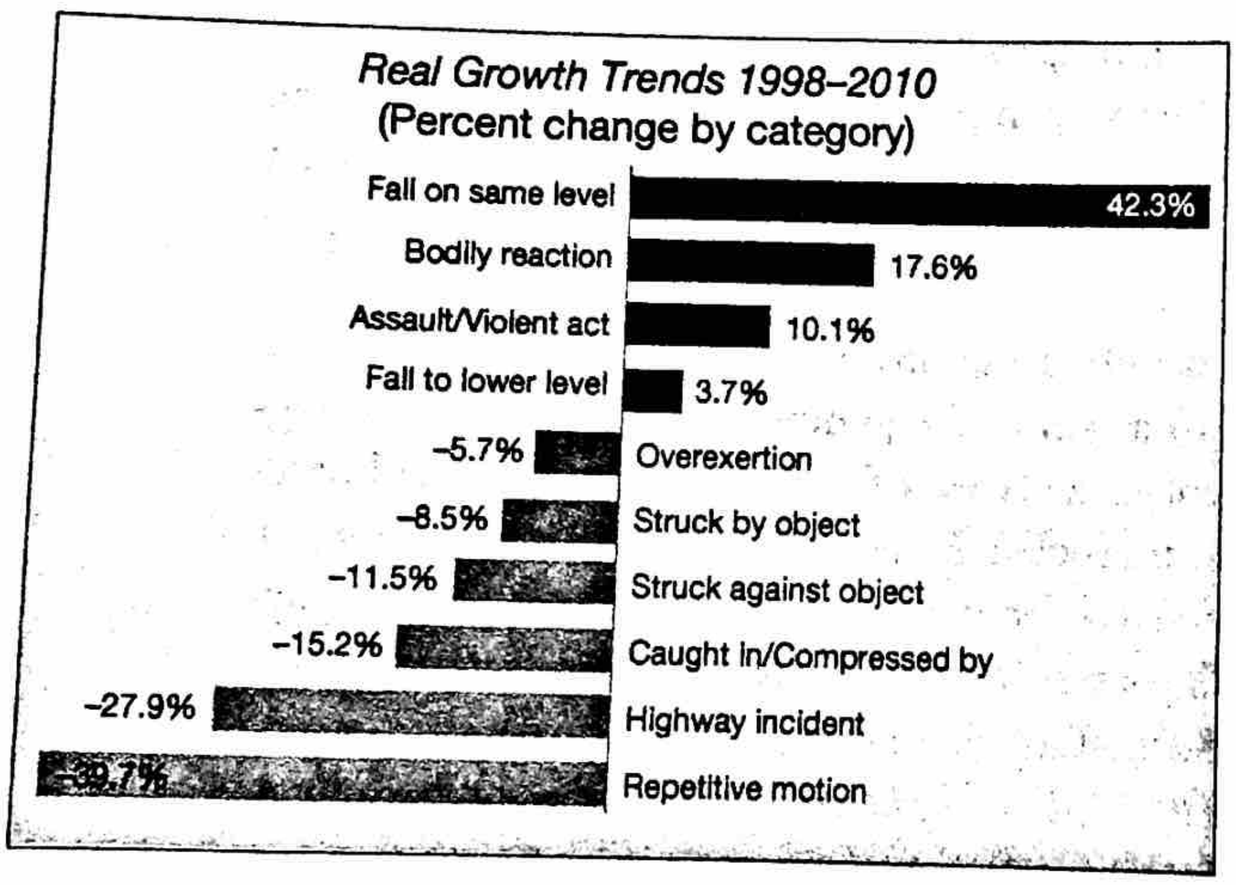
[29]Richard Campbell, *Structure Fires in Warehouse Properties* (Quincy, MA: National Fire Protection Association, January 2016).

[30]http://forkliftsystems.com/national-forklift-safety-day-is-june-10th/

[31]Nowlan, "Safety Doesn't Have to Hurt Your Budget."



[1]Overexertion – Injuries from excessive lifting, pushing, pulling, holding, carrying, throwing
[2]Bodily reaction – Injuries from bending, climbing, reaching, standing, sitting, slipping or tripping without falling
[3]Struck by object – Such as a tool falling on a worker from above
[4]Struck against object – Such as a worker walking into a door
[5]Repetitive motion – Injuries due to repeated stress or strain



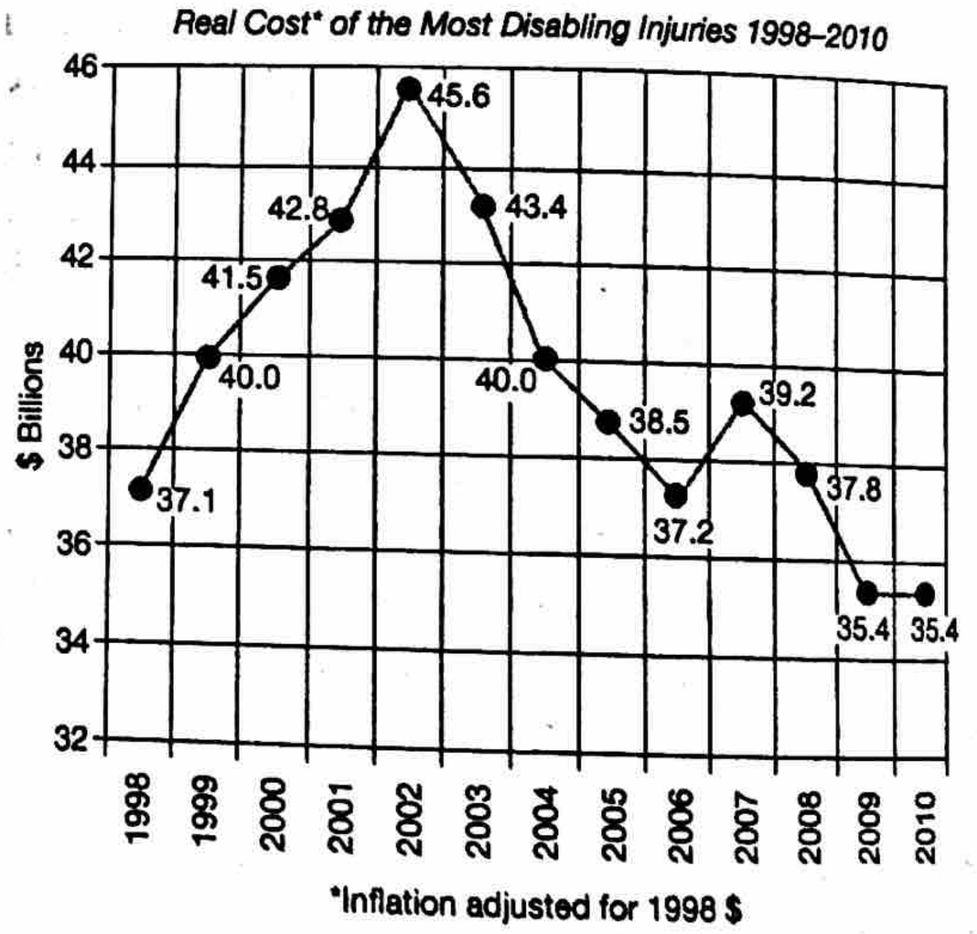


Figure 3 Workplace Safety Issues *Source:* Reprinted with permission of Liberty Research Institute for Safety, August 30, 2012.

Warehousing safety can be influenced by governmental regulations. In the United States, safety standards have been set for warehousing equipment and operations, and OSHA inspectors make frequent visits to industrial workplaces to ensure regulatory compliance. Forklift operations and equipment have received particular attention from OSHA in part because of the number of deaths and injuries associated with them. For example, only trained and certified warehousing employees are permitted to operate a forklift and forklift operators must be recertified every three years.

Warehouse safety considerations fall into three primary categories—employee, property, and motor vehicles[26]—and we will discuss each of these in the paragraphs that follow. With respect to *employee safety*, consider one warehousing professional's advice: "It costs more to recruit, train, and replace a worker than to provide a safe environment."[27] Workers can be injured due to improper

[26]Joe Nowlan, Safety Doesn't Have to Hurt Your Budget," *Industrial Distribution*, January 2008, 25–27.
[27]Don High In, "Getting a Lift from Safety," by Ed Engel," Warehousing Management, January–February 2001, 5.

When designing warehousing facilities, it is also important to keep in mind external space-related needs, which unfortunately are sometimes overlooked. These include areas for vehicles waiting to be loaded and unloaded, space for vehicle maneuvering (e.g., turning, backing up), and employee parking.

WAREHOUSING OPERATIONS

Learning Objective 4

Because operating a warehousing facility has many facets, efficient and effective warehousing management can be an exacting task. Workforce motivation can be difficult because of the somewhat repetitive nature of the work. It can also be strenuous and physically demanding, and on occasion warehousing facilities can be dangerous places. Some of the more significant operational issues are discussed in the following sections.

Warehousing Productivity Analysis

Productivity is a measure of output divided by input, and although a number of different productivity metrics can be used to assess warehousing productivity, not all are relevant to all kinds of facilities. Representative measures of warehousing productivity include cases shipped per person, product lines shipped per person, pallets shipped per person, average warehouse capacity used, and forklift capacity used, among others. These and other productivity metrics can be utilized to provide comparisons within an organization over time.

In addition, external data may be available that can be used for benchmarking purposes depending on the relevant metrics being analyzed. Suppose, for example, that the cases picked and shipped per hour at a particular warehouse increased from 72 to 84 over a two-year period. Although this represents a 16.7 percent ([84 − 72]/72) productivity improvement over the two years, the 84 cases per hour might be viewed much differently when compared to warehousing industry data that shows a median of 100 cases picked and shipped per hour and a best practice metric of more than 250 cases picked and shipped per hour.[22]

It is important to recognize that increases in warehousing productivity do not always require significant investment in technology or mechanized or automated equipment. For example, one suggestion for improving warehousing productivity involves a review of existing procedures and practices to identify the tasks that are creating the largest inefficiencies and then developing methods to reduce or eliminate the inefficiencies without adding to or upgrading present technology or equipment. Organizations can also examine their facility layouts; long horizontal runs and frequent backtracking could be symptoms of layout problems. Something as basic as adding cross aisles could reduce the length of horizontal runs as well as the length of backtracking. Another low cost suggestion for improving warehousing productivity is to play music, if conditions permit; research suggests that worker productivity increases when music is playing.[23]

Safety Considerations

Warehousing facilities can be dangerous places to work. In the United States, for example, forklifts account for *one of every six* workplace deaths.[24] Figure 3 provides a listing of workplace safety issues, and many of these safety issues, such as falls and bodily reaction, are associated with warehousing facilities. You should recognize that many suggestions for dealing with warehousing safety are commonsense—and low cost—in nature. Consider, for example, several of the Occupational Safety and Health Administration's (OSHA) suggestions to improve warehouse safety: "prohibit 'dock jumping' (jumping from dock plate to dock plate) by employees;" "prohibit stunt driving (of forklifts) and horseplay;" "keep floors clean and free of slip and trip hazards."[25]

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[22]Karl B. Manrodt and Kate L. Vitasek, "DC Measures 2012," *WERC Watch*, Spring 2012.

[23]John Tufts, "9 Tips for Improving Warehouse Productivity," *Multichannel Merchant Executive Insight*, March 6, 2012, 1.

[24]Eric Scharski, "Want a Safer Warehouse? Start with Forklift Users," *Food Logistics*, January/February 2015, 36–41.

[25]www.osha.gov/Publications/3220_Warehouse.pdf

conventional aisles.[18] However, it is easier to operate mechanical equipment in wider aisles and wider aisles reduce the chances of accidents and product damage.

Narrower aisles require specialized storage and handling equipment, such as narrow aisle (very narrow aisle) lift trucks, which are capable of simultaneously moving both vertically and horizontally. This specialized equipment is noticeably more expensive than traditional lift trucks, and it is not unusual for specialized lift trucks to cost twice as much as traditional lift trucks. However, specialized lift trucks can be twice as productive as traditional lift trucks.[19]

Degree of Warehouse Automation

The degree of automation is another important consideration in warehousing design. For our purposes **warehouse automation** will refer to utilizing mechanical or electronic devices to substitute for human labor. Examples of warehouse automation include narrow aisle forklifts, automated guided vehicles, automated storage and retrieval systems, radio frequency identification, and robotic picking, among others. Although warehouse automation offers the potential to reduce labor costs and to improve warehouse productivity, it is important for managers to ensure that the automation results in noticeable improvement in warehousing effectiveness and efficiency. To this end, an organization should first assess whether it is ready for automation, because automation can be complex, expensive, and disruptive to day-to-day operations. If an organization is ready for automation, then it's important to evaluate how the automation will support the organization's logistics system.[20]

Other Space Needs

Although many would assume that the primary role of warehousing involves the storage of product, it is not uncommon for a warehousing facility to operate with only *20 percent* of the space being occupied by product.[21] Because every warehousing facility sets aside areas for nonstorage activities, it's important to know about them. These nonstorage activities include, but are not limited to, the following:

1. An area where transport drivers and operators can wait while their equipment is loaded or unloaded
2. Staging, or temporary storage, areas for both incoming and outgoing merchandise
3. Employee washrooms, lunchrooms, and the like
4. Pallet storage and repair facilities (Facilities that receive unpalletized materials but ship on pallets may require a pallet-assembly operation.)
5. Office space, including an area for the necessary computer systems
6. An area designed to store damaged merchandise that is awaiting inspection by claim representatives
7. An area to salvage or repair damaged merchandise
8. An area for repacking, labeling, price marking, and so on
9. An area for accumulating and baling waste and scrap
10. An area for equipment storage and maintenance (For example, battery-powered lift trucks need to be recharged on a regular basis.)
11. Specialized storage for hazardous items, high-value items, warehousing supplies, or items needing other specialized handling (such as a freezer or refrigerated space)
12. A returned or recycled goods processing area

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[18]Mary Aichlmayr, "Narrow-Aisle: Form Follows Lift-Truck Function," *Material Handling Management*, June 2009, 18–20.

[19]Josh Bond, "Avoiding a Tight Spot in Narrow Aisles," *Modern Materials Handling*, September 2015, 12.

[20]Bridget McCrea, "7 Steps to Take before You Install an Automated Warehouse System," *Modern Materials Handling*, September 2015, 8–11.

[21]http://www.ioptimizerealty.com/2012/12/21/measuring-utilization-warehouse/

that slots the most frequently picked items in the most accessible location; velocity slotting generally reduces an order picker's travel distance.[15]

A well-thought-out slotting plan can reduce labor costs, increase pick and replenishment efficiencies, and increase order accuracy.[16] To this end, organizations need to understand the attributes of fixed and variable slot locations for merchandise. With a **fixed slot location,** each SKU has one or more permanent slots assigned to it (think of a parking garage that assigns particular parking spaces to certain individuals). This can provide stability in order picking in the sense that the company should always know where a specific SKU is located. However, this may result in low space utilization, particularly with seasonal products.

Alternatively, a **variable slot location** involves empty storage slots being assigned to incoming products based on space availability. One example of variable slot location is the closest available storage position, with "closest" defined as the shortest travel time to an entrance or exit point. Although variable slot location generally results in more efficient space utilization, from an order picking perspective it requires a near-perfect information system because there must be flawless knowledge of each product's location.

Build Out (Horizontal) versus Build Up (Vertical)

A general rule of thumb is that it's cheaper to build up than build out; building out requires more land, which can be quite expensive, particularly in certain geographic locations. As an illustration, during 2015 a 1.5-acre land parcel in London, England was priced at £25,000,000![17] Alternatively, although building costs decline on a cubic-foot basis as one builds higher, warehousing equipment costs tend to increase.

Order-Picking versus Stock-Replenishing Functions

Organizations must decide whether workers who pick outgoing orders and those who are restocking storage facilities should work at the same time or in the same area. Although the latter scenario may result in fewer managerial personnel being needed, it may also lead to congestion within the facility due to the number of workers. One suggestion to reduce congestion is for order pickers and stock replenishers to use different aisles for their respective activities—again, this requires a very good information system to identify where a given employee is at any time.

Two-Dock versus Single-Dock Layout

A two-dock layout generally has receiving docks on one side of a facility and shipping docks on the other side, with goods moving between them. In a one-dock system, each and every dock can be used for both shipping and receiving, typically receiving product at one time of the day and shipping it at another time. Viewed from overhead, the goods move in a U-shaped rather than a straight configuration. This alternative reduces the space needed for storage docks, but it requires carriers to pick up and deliver at specific times. In addition, this alternative may also result in an occasional mix-up in that received product is sometimes reloaded into the vehicle that delivered it.

Conventional, Narrow, or Very Narrow Aisles

Aisle width might seem like an arcane issue until you realize that as aisle space increases, the storage capacity of a facility decreases. For example, narrow aisles (defined as between 9.5 feet and 12 feet wide) can store 20% to 25% more product than conventional aisles (more than 12 feet wide), while very narrow aisles (defined as less than 8 feet) can store 40% to 50% more product than

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[15]Bryan Jensen, "Racing Past Velocity: Slotting Your Facility to Optimize Order Picking," *HVACR Distribution Business,* December 2012, 26–28.

[16]Paul Hansen and Kelvin Gibson, "Effective Warehouse Slotting," *The National Provisioner,* May 2008, 90–94.

[17]http://www.rightmove.co.uk/property-for-sale/London/land.html

boring, and visually unappealing. He decided to build a more aesthetically pleasing facility and designed a warehouse with black floors, reasoning that black floors would stand out compared to the floors in many other warehouses.

Although the black floor was certainly eye-catching, it was an unmitigated disaster in part because the floor showed more dirt than comparable facilities. Moreover, the black floor was extremely slippery—meaning that forklifts had a harder time stopping (some actually crashed into the walls!), and warehouse workers were more prone to falling. This anecdote provides an excellent example of form triumphing over function or style triumphing over substance. From a commonsense perspective, the primary design consideration should be the facility's function—be it long-term storage or product movement—in the relevant logistics system, with aesthetics a secondary consideration.

One commonsense piece of advice is that prior to designing a warehousing facility, the quantity and character of goods to be handled must be known. Indeed, one of the early challenges of online commerce for bricks-and-mortar organizations was that many of them attempted to fulfill online orders through warehousing facilities largely designed to supply retail store locations. In contrast, the design of fulfillment centers should explicitly incorporate key attributes of online commerce, to include small order sizes, the necessity to store limited quantities of many SKUs, intense peaks in demand (e.g., holidays), and same-day (same-hour) fulfillment, among others.[14]

A second commonsense piece of design advice is that it is important for an organization to know the purpose to be served by a particular facility because the relative emphasis placed on the storage and distribution functions affects space layout. As such, a storage facility with low rates of product turnover should be laid out in a manner that maximizes utilization of the cubic capacity of the storage facility. Alternatively, a facility that emphasizes rapid product movement with limited time in storage should be configured to facilitate the flow of product into and out of it.

Trade-offs

Trade-offs must be made among space, labor, and mechanization with respect to warehousing design. Spaciousness may not always be advantageous because the distances that an individual or machine must travel in the storing and retrieving functions are increased. Moreover, unused space is excess capacity, and we know that excess capacity costs money. Alternatively, cramped conditions can lead to such inefficiencies as the product damage that can be caused by forklift puncture and movement bottlenecks caused by insufficient aisle width, to name but two.

Before layout plans are made, each item that will be handled should be studied in terms of its specific physical handling properties, the volume and regularity of movement, the frequency with which it is picked, and whether it is fast or slow moving compared to other items. Many trade-offs are inevitable when designing the structure as well as the arrangement of the relevant storage and handling equipment. Several of these trade-offs are discussed in this section. These trade-offs are often more complex than they appear because individual trade-offs are not independent of one another. Although there may not be "right" or "wrong" answers with respect to warehousing design, an understanding of the various trade-offs might help managers make more efficient, as opposed to less efficient, decisions.

Fixed versus Variable Slot Locations for Merchandise

You might be aware that order picking and assembly represents the best opportunity to improve the effectiveness and efficiency of the order cycle. One possible way to improve the effectiveness and efficiency of order picking and assembly involves figuring out where to store (slot) product in a warehouse or distribution center. For example, **velocity slotting** is a popular strategy

[14]Kelly Reed, "Five Facility Design Principles for E-commerce Order Fulfillment," *Distribution Center Management*, August 2013, n.p.

Contract Warehousing

Organizations historically had two choices with respect to renting or owning warehousing facilities—public (renting) and private (owning). In the early 1990s contract warehousing (also referred to as *third-party warehousing* or *dedicated warehousing*) emerged as a second option for renting warehousing space. Although **contract warehousing** has been defined in a number of different ways, in this text it refers to "a long term, mutually beneficial arrangement which provides unique and specially tailored warehousing and logistics services exclusively to one client, where the vendor and client share the risks associated with the operation."[11] From a cost perspective, contract warehousing tends to be less costly than private warehousing but more costly than public warehousing.

Contract warehousing is a preferred alternative for many organizations because it simultaneously mitigates the negative aspects and accentuates the positive aspects of public and private warehousing. More specifically, contract warehousing allows a company to focus on its core competencies (what it does best), with warehousing management provided by experts—experts who solely focus on the client's needs and wants.[12] In addition, contract warehousing potentially offers the same degree of control as private warehousing because key specifications can be included in the contract. For example, if a certain product should not be stored on the floor, then this can be explicitly reflected in the particular contract.

With respect to changes in the external environment, contract warehousing is viewed as more flexible than private warehousing but less so than public warehousing. This flexibility depends in part on the length of the contract; as the contract length increases, the flexibility to respond to change decreases. Three- to five-year contracts appear to allow sufficient time for the warehousing provider to learn the client's business while allowing the client some flexibility in case the agreement fails to produce acceptable results.

Multiclient Warehousing

Another warehousing alternative, **multiclient warehousing**, which mixes attributes of contract and public warehousing, has become popular in recent years. For example, where contract warehousing is generally dedicated to just one customer and public warehousing may be used by any number of customers, a limited number of customers (at least two, but generally no more than one dozen) utilize a multiclient facility. In a similar fashion, the services in a multiclient facility are more differentiated than those in a public facility, but less customized than would be found in contract warehousing.

Furthermore, where public warehousing services are purchased on a month-to-month basis, multiclient warehousing services are purchased through contracts that cover at least one year. Multiclient facilities can be attractive to organizations that (1) don't have sufficient volume to build their own storage facilities; (2) don't have sufficient volume to justify using contract warehoushing; (3) have regular, but not continuous, need for specialized equipment or services; (4) can benefit from working with other companies that have similar needs or requirements (e.g., shared transportation to common locations).[13]

DESIGN CONSIDERATIONS IN WAREHOUSING

Learning Objective 3

General Considerations

One of the best pieces of advice with respect to the design of warehousing facilities is to use common sense, as illustrated by the businessperson who was convinced that warehouses were bland,

[11]Warehousing Education and Research Council, *Contract Warehousing: How It Works and How to Make It Work Effectively* (Oak Brook, IL: Author, 1993).

[12]John R. Johnson, "Bigger and Better," *Warehousing Management,* October 2000, 22–25.

[13]John Peters, "Multiclient versus Dedicated Distribution Center: Which Model Better Fits Your Business?" blog.ryder.com, July 10, 2013.

Public warehousing offers more locational flexibility than do company-owned facilities, and this can be important when a company is entering new markets. For example, an organization may want to start off slowly in new markets or may be uncertain how well its products will be received in these markets. Public warehousing can provide storage services in these markets without an overwhelming capital commitment.

Public warehousing may provide a number of specialized services that are not available from other sources. For example, public warehousing is heavily involved in such value-added services as repackaging larger shipments into retail-size quantities and then shrink-wrapping them, assisting in product recalls, and doing price marking, product assembly, and product testing.

Perhaps the biggest drawback to public warehousing is the potential lack of control by the user. For example, sometimes public warehousing does not have the space availability required by a particular user. And even if space is available, users may have little say in where their goods are stored—they may be placed wherever space is available, which may result in part of a user's inventory being stored in one area and the remainder in another. Moreover, some public warehousing is not open 24 hours a day, meaning that prospective users may not be able to access their products as needed or that users may need to tailor their operations to fit those of the public warehouse.

Private Warehousing

Private warehousing is owned by the firm storing goods in the facility. Private warehousing generates high fixed costs and thus should only be considered by companies dealing with large volumes of inventory. In so doing, the high fixed costs can be spread out over more units of inventory, thus reducing the cost per unit of storage. The largest users of private warehousing are retail chain stores; they handle large volumes of merchandise on a regular basis.

In addition to large volumes, private warehousing also tends to be feasible when demand patterns are relatively stable. Fluctuating demand patterns could at times lead to insufficient storage space for product, in which case the company might need to use public warehousing as a supplement, thus increasing total warehousing costs. At other times, by contrast, there could be too much space (excess capacity), which costs money as well.

Assuming both sufficient demand volume and stability of demand, private warehousing offers potential users a great deal of control over their storage needs. For example, the storage facility can be constructed to the user's specifications, which is a particularly attractive feature when a company has unique storage or handling requirements, as is the case with steel beams and gasoline. Moreover, in private warehousing, companies can control product placement with a facility; some products, for example, should not be stored on the floor. Another aspect of control is that private warehousing offers access to products when an organization needs (or wants) them, as opposed to an organization having to tailor its activities to match a public facility's operating hours.

Private warehousing is also characterized by several important drawbacks, including the high fixed cost of private storage and the necessity of having high and steady demand volumes. In addition, a high-fixed-cost alternative such as private warehousing becomes less attractive in times of high interest rates because it is more costly to secure the necessary financing to build or lease the facility (to be fair, interest rates in some nations, such as the United States, have been relatively low in recent years).

Private warehousing may also reduce an organization's flexibility in responding to changes in the external environment. For example, companies that utilize private warehousing are susceptible to changing demand patterns, such as those experienced with the passage of multicountry trade alliances. Likewise, organizational flexibility can be affected by mergers with, or acquisitions of, other companies, as illustrated by the case of a multibillion-dollar company that acquired a competitor's production and private warehousing facilities. Although the production facilities added much-needed manufacturing capacity, the warehousing facilities were largely redundant in nature. Yet the acquiring company had little choice but to continue operating them because of substantial penalties (e.g., labor compensation) that would have been incurred if the facilities were closed.

Contract Warehousing

Organizations historically had two
public (renting) and private (owni
third-party warehousing or *dedicated*
space. Although **contract wareho**
it refers to "a long term, mutually
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Multiclient Warehousing

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DESIGN CONSIDERATION

General Considerations

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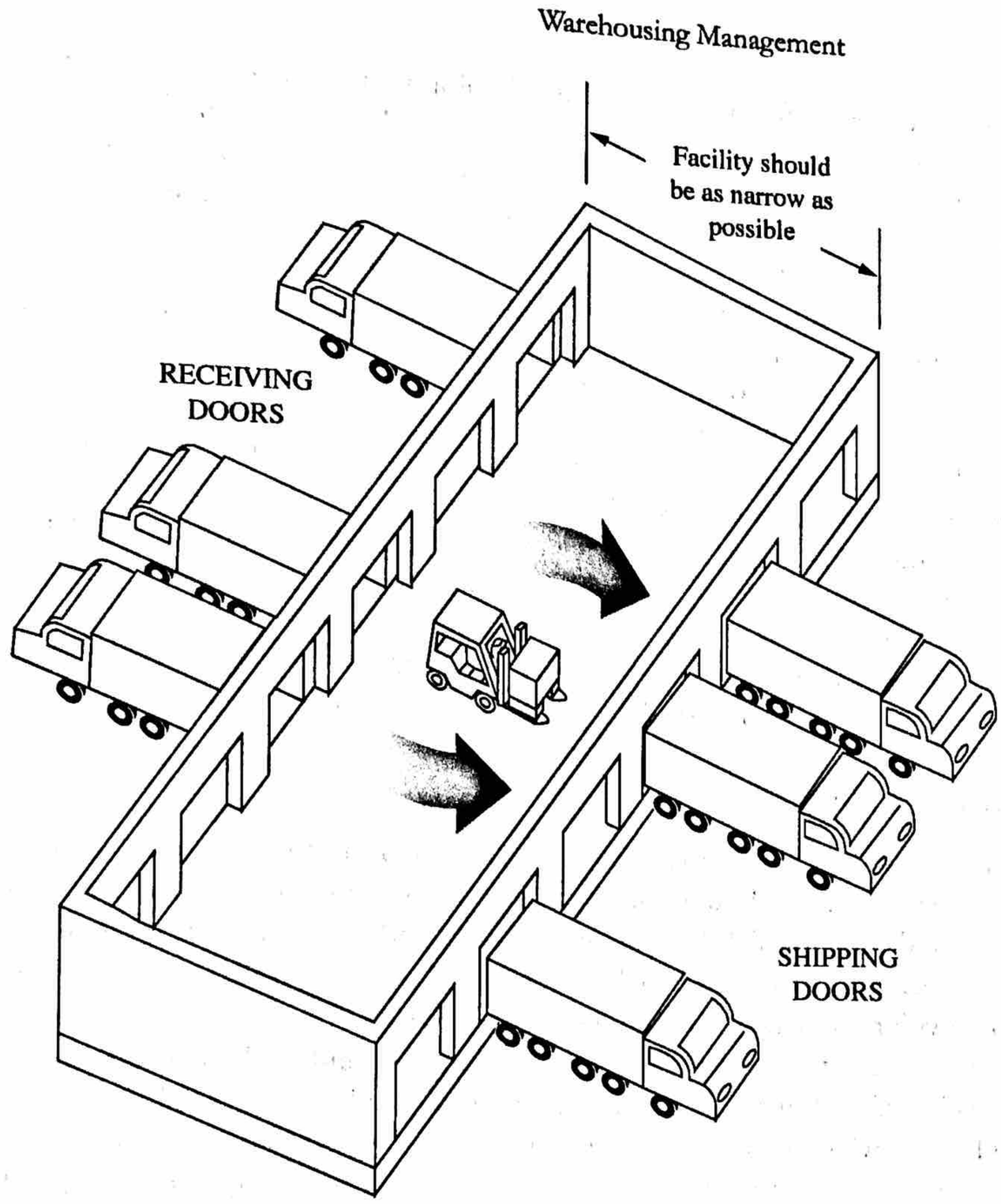

Figure 2 Ideal Facility for Pure Supplier Consolidation (Full Pallet Movement) *Source:* Reprinted by permission of the Warehousing Education and Research Council.

With public warehousing, the user rents space as needed, thus avoiding the costs of unneeded space. A related advantage is that users should have a fairly exact determination of their warehousing costs because public warehousing space tends to be rented on a month-to-month basis.

Public warehousing can also be attractive to prospective users because other parties have the responsibility for personnel decisions and regulatory issues. Warehousing is one of two major sources of labor in logistics (the other is transportation), and warehousing employees can be unionized, thus adding to the managerial challenges. At a minimum, when using public warehousing the recruitment, selection, compensation, motivation, and evaluation of warehousing employees are the responsibility of the warehousing company and not the customer (user).

With respect to regulatory issues, warehousing labor safety practices in the United States are monitored by the **Occupational Safety and Health Administration (OSHA)**. From a managerial perspective, because OSHA standards are complex and lengthy, it can be quite costly and challenging to comply with OSHA regulations. It is worth pointing out that in recent years warehousing in the United States has been subjected to closer OSHA scrutiny because warehousing has been classified as a high-hazard workplace.[10] As was the case with personnel decisions, when using public warehousing, regulatory issues are the responsibility of the warehousing provider and not the warehousing customer.

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[10]No author, "OSHA Announces FY 2010 Inspection Plan to Target Industries with High Injury Rates," *HR Focus*, December 2010, 11.

Warehousing can be provided by warehouses, distribution centers, fulfillment centers, or cross-docking facilities. **Warehouses** emphasize the storage of products, and their primary purpose is to maximize the usage of available storage space. **Distribution centers** emphasize the rapid movement of products through a facility, and thus they attempt to maximize **throughput** (the amount of product entering and leaving a facility in a given time period). **Fulfillment centers** represent a special type of distribution center that is focused on e-commerce orders.

The increased emphasis on time reduction in supply chains has led to the growth of **cross-docking**, which can be defined as "the process of receiving product and shipping it out the same day or overnight without putting it into storage."[4] Indeed, the length of time a product is in a facility is one factor that differentiates distribution centers and cross-docks, with 24 hours (or less) of storage time often being used to differentiate a cross-dock facility from a distribution center. Key benefits to cross-docking include improved service by allowing products to reach their destinations more quickly as well as reduced inventory carrying costs from less safety stock because of faster product delivery.[5]

The experiences of Saks Inc., an upscale retail department store, illustrate some of the potential benefits of cross-docking. For example, it takes just *seven minutes* to move a carton from the inbound dock to an outbound trailer at the Saks cross-dock facility. Moreover, on a daily basis the Saks cross-dock can handle four times as much product, with one-half the labor, of its predecessor facility; in other words, the cross-dock facility is approximately *eight times* as productive as its predecessor.[6]

Because cross-docking is predicated on time reduction, the design of cross-dock facilities is an important consideration. More specifically, cross-docks emphasize extremely rapid product movement, and they should be designed with a minimal amount of storage space and truck doors on two or more sides.[7] Figure 2 shows an "I-shaped" cross-dock design—rectangular, long, and as narrow as possible.[8] Other possible cross-dock designs include "H," "L," "T," "U," and "E," and their applicability depends on the spatial configuration of the land used to build the cross-dock as well as the number of docks to be used.[9]

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PUBLIC, PRIVATE, CONTRACT, AND MULTICLIENT WAREHOUSING

In addition to understanding the distinctions among warehouses, distribution centers, and cross-dock facilities, organizations must decide the proper mix in terms of owning (private warehousing) or renting (public, contract, multiclient warehousing) warehousing space. Because companies have different strategies, goals, and objectives, there is no correct mix of owning or renting. Thus, one organization might use only public warehousing, another organization might use only private warehousing, and a third organization might use a mix of public, private, contract, and multiclient warehousing. Each has distinct characteristics that might be either attractive or unattractive to potential users. These characteristics are discussed in the following sections.

Public Warehousing

Public warehousing serves (is supposed to serve) all legitimate users and has certain responsibilities to those users. Public warehousing requires no capital investment on the user's part, which can certainly be an important consideration when the cost of borrowing money (interest rates) is high.

[4]No author, "2008 Cross-Docking Trends Report," Saddle Creek Corporation, 2008.

[5]Mike DelBoro, "Cross-Docking Rediscovered," *Material Handling & Logistics*, May 2011, 34–37.

[6]Connie Robbins Gentry, "Distribution Utopia," *Chain Store Age*, November 2005, 70–72.

[7]DelBoro, "Cross-Docking Rediscovered," May 2011.

[8]Maida Napolitano, *Making the Move to Cross-Docking* (Oak Brook, IL: Warehousing Education and Research Council, 2000).

[9]Jan Van Boelle, Paul Valckenaers, and Dirk Cattrysse, "Cross-Docking: State of the Art," *Omega*, 40, no. 6 (2012): 827–846.

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[10]No author, "OSHA Ann
2010, 11.

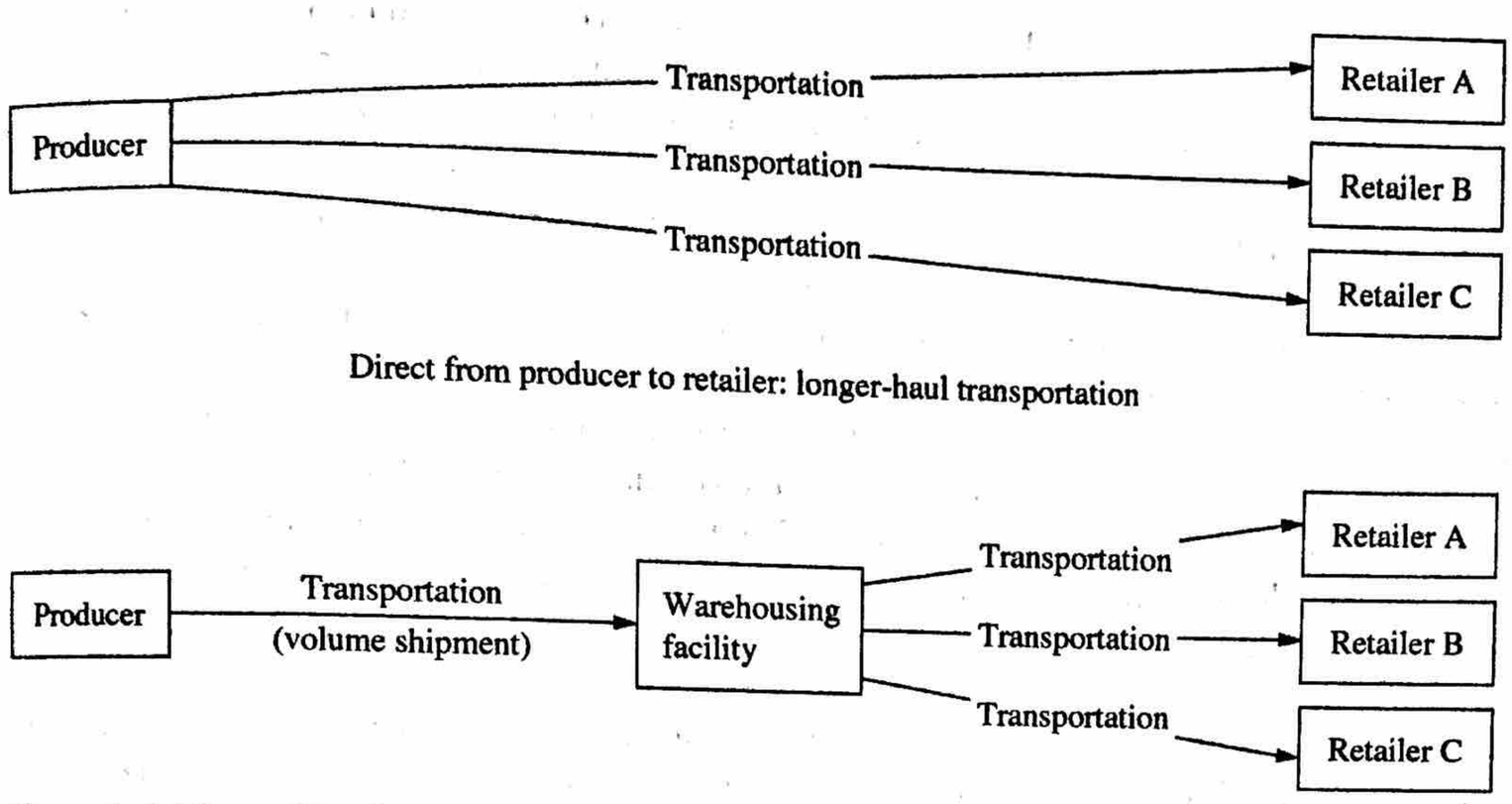

Figure 1 Adding a Warehousing Facility: Shorter-Haul Transportation

If the introduction of warehousing into a supply chain simply shifts business costs across various logistics activities, then why is warehousing desirable? A key reason for warehousing is because patterns of production and consumption do not coincide, and warehousing serves to match different rates or volumes of flow. Canned fruits and vegetables are examples of one extreme in which production occurs during a relatively short period, but sales are spread throughout the year. The other extreme—sales concentrated in a relatively short time period, steady production rates throughout the year—is more likely to be addressed by having the production occur closer to the demand period.

Sometimes, larger quantities of goods are purchased than can be consumed in a short period of time, and warehousing space is needed to store the surplus product. This can occur for several reasons, such as guarding against anticipated scarcity or to benefit from a seller's advantageously priced deal.

Much of the preceding discussion could be viewed as a market-oriented approach to warehousing. However, warehousing management can also be relevant to production and raw materials considerations. For example, an automobile manufacturer might purchase extra amounts of steel in response to anticipated steel shortages.

Moreover, warehousing facilitates the **regrouping function** in a supply chain. This function, which involves rearranging the quantities and assortment of products as they move through the supply chain, can take four forms—accumulating (also referred to as bulk-making), allocating (also referred to as bulk-breaking), assorting, and sorting out. Accumulating and allocating refer to adjustments associated with the *quantity of product,* whereas assorting and sorting out refer to adjustments associated with *product assortment.*

Thus, **accumulating** involves bringing together similar stocks from different sources, as might be done by a department store that buys large quantities of men's suits from several different producers. **Allocating**, by contrast, involves breaking larger quantities into smaller quantities. Continuing with our suit example, whereas the department store might buy 5000 suits in size 42 short, an individual store might only carry 15 or 20 suits in this size.

Assorting refers to building up a variety of different products for resale to particular customers. Our department store example might want to supply individual stores with a number of different suit sizes (e.g., size 36, size 38, size 40, etc.) and styles (e.g., two-button suits, three-button suits, etc.). **Sorting out** refers to "separating products into grades and qualities desired by different target markets."[3] For example, a department store chain may sell $1,000 men's suits only in stores located in high-income areas, whereas $600 men's suits might be the highest priced suit sold in less-affluent areas.

[3]William D. Perreault, Jr., Joseph P. Cannon, and E. Jerome McCarthy, *Basic Marketing,* 16th ed. (New York: McGraw-Hill Higher Education, 2008), Chapter 11.

WAREHOUSING MANAGEMENT

Learning Objectives

1. To discuss the role of warehousing in a logistics system
2. To learn about public, private, contract, and multiclient warehousing
3. To analyze select considerations when designing warehousing facilities
4. To examine some prominent operational issues in warehousing

In the systems approach of logistics, changes to one function affect other functions as well. Indeed, many changes—such as electronic ordering, facility consolidation, and lean inventories—have especially affected warehousing management.

Many well-run companies today view warehousing as a strategic consideration—and thus a potential source of competitive advantage. For example, the continuing growth of e-commerce is causing some companies to shift away from warehousing's traditional cost focus to an emphasis on customer satisfaction in terms of rapid, and correct, order fulfillment.[1]

This text begins with an overview that defines what is meant by warehousing and discusses the role of warehousing in a logistics system. This is followed by analysis of public, private, contract, and multiclient warehousing. Next comes a section devoted to design considerations in warehousing, with particular attention to trade-offs in design considerations. The text concludes with an examination of some key operational issues in warehousing, such as productivity, safety, and security.

THE ROLE OF WAREHOUSING IN A LOGISTICS SYSTEM

rning ective 1

Warehousing, which refers to "that part of a firm's logistics system that stores products (raw materials, parts, goods-in-process, finished goods) at and between points of origin and point of consumption,"[2] and transportation are substitutes for each other, with warehousing having been referred to as "transportation at zero miles per hour." Figure 1, which presents an example of the trade-off between warehousing and transportation, indicates that placing a warehousing facility between the producer and customers adds a new layer of costs (those associated with warehousing) into the system. Moreover, the warehousing facility generates shorter-haul transportation routes (from the producer to the facility; from the facility to the customers); as a general rule, short-haul transportation tends to be more costly per mile than long-haul transportation. However, the increased costs of short-haul transportation may be offset by lower transportation costs per unit of weight associated with volume shipments.

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[1]Mary Shacklett, "The 21st Century Warehouse," *World Trade*, March 2011, 18–25.

[2]Douglas M. Lambert, James R. Stock, and Lisa M. Ellram, *Fundamentals of Logistics Management* (New York: Irwin McGraw-Hill, 1998), Chapter 8.

TABLE 3 Example of a Carrier Performance Scorecard

Attribute	Importance (%)	Evaluation (1–5)	Weighted Evaluation
Improved cost performance	30	4	1.2
On-time delivery performance	25	4.5	1.125
Customer complaints	20	4.25	.85
Loss and damage performance	15	4.75	.7125
Social media presence	10	2.5	.25
Sum			4.1375
Performance score			82.75%

The data are hypothetical and for illustrative purposes only.

The performance scorecard can be used as a diagnostic tool; if an individual carrier's performance is rated as lower than, say, 70, then the carrier might be put on probation for a certain time period. Moreover, if performance does not exhibit satisfactory improvement during the probationary period, then the carrier might be fired.

There are also more "positive" manifestations of transportation service quality. A number of organizations now officially recognize (e.g., a press release, an awards recognition dinner, a plaque) transportation carriers that provide superior service. In addition, several logistics trade publications annually recognize transportation service excellence. For example, *Logistics Management* annually conducts its "Quest for Quality," in which users of transportation services are asked to rate transportation companies on five dimensions: on-time performance, value, customer service, information technology, and equipment and operations. Individual carriers receive a "Quest for Quality" award when their overall rating on the five dimensions exceeds their industry average, and many of these carriers prominently feature this award on their websites.

Summary

This text covered transportation management, which refers to the buying or selling of transportation services by a shipper or consignee. This text analyzes several of a transportation manager's primary responsibilities. Rate considerations are one prominent responsibility, particularly in terms of rate determination. A transportation manager is also responsible for modal and carrier selection, and an emerging selection trend involves a focus on transportation metrics as opposed to transportation mode.

Documentation is another responsibility of a transportation manager, and the text discussed key documents such as the bill of lading, freight bill, and freight claims. Another key area of decision making in transportation management is making and receiving shipments, which includes activities such as shipment consolidation, demurrage, and detention, among others. The text concluded by looking at transportation service quality.

Key Terms

Amodal shipper
Bill of lading
Class rate system
Commodity rate
Concealed loss or damage
Demurrage
Density
Detention
Documentation
Expediting
FOB destination
FOB origin
Freight bill
Freight claims
Rate
Routing
Routing guide
Stowability
Tracking
Transportation management

list of preferred carriers, and a list of which carrier or carriers to use for shipments moving between two points. As an example, Nordstrom's (a high-end retail department store) routing guide contains information that lists which distribution center is to supply a particular retail location. To this end, the Nordstrom's in Spokane, Washington is supplied from the Nordstrom's distribution center in Portland, Oregon. In addition, Nordstrom's routing guide also indicates which carriers are to be used to transport shipments to Nordstrom's distribution centers.

Routing guides are intended to standardize various aspects associated with transporting shipments and can simplify modal/carrier selection (e.g., modes and/or carriers may be explicitly identified), reduce transportation costs (e.g., via volume discounts), and improve supply chain performance (e.g., reduced cycle times). However, the reality is that routing guides aren't always followed, which can lead to higher transportation costs and potentially dissatisfied customers. Suggestions for maximizing the effectiveness of routing guides include making them readily available to the relevant personnel as well as monitoring and enforcing compliance with them.[14]

Tracking and Expediting

Tracking refers to determining a shipment's location during the course of its move, and the ability to track shipments directly affects **expediting**, which involves the need to rapidly move a shipment to its final destination. Today, many transportation carriers have information systems that provide real-time information about shipment status, and this information is widely available to customers through the Internet and smart phones, thus making it fast and easy to trace shipments. Air transportation and motor carriers are the two most prominent modes involved in expediting, and both modes played key roles in alleviating supply chain problems, such as congestion and delays, that arose with U.S. West Coast water port labor issues in late 2014 and early 2015.[15]

TRANSPORTATION SERVICE QUALITY

Learning Objective 5

We will conclude this text with a look at transportation service quality. Macroenvironmental changes, such as globalization and advances in technology, have caused organizations to demand higher levels of service quality, and this is particularly true for transportation services. For example, when one of the authors worked in the trucking industry in the late 1970s and early 1980s, shipment tracking was a laborious manual process that might take multiple days before information was provided to a transportation manager about a particular shipment. Today, by contrast, the combination of real-time information systems and global positioning systems allows for virtually instantaneous tracking of a shipment, and this tracking information is increasingly provided to the transportation manager on mobile devices such as a laptop, tablet, and/or smart phone.

Economic deregulation allowed for both price and service competition among carriers, and this resulted in the need for organizations to measure their carriers' performance. To this end, a number of organizations utilize transportation performance scorecards that contain a list of relevant attributes (perhaps the same attributes used to select carriers) and an evaluation of each carrier on every attribute.

Table 3 illustrates how a carrier performance scorecard might work; in this example, the transportation manager has selected five performance attributes that will be used to evaluate individual carriers. The transportation manager assigns each attribute an importance rating, such as 30% for "improved cost performance." The transportation manager also evaluates each attribute with respect to a particular carrier's performance on that attribute; 4 is the evaluation for "improved cost performance." "Net weighted score" is calculated by multiplying each attribute's importance rating by its evaluation; for example, the 1.2 for "improved cost performance" comes from its 30% importance multiplied by its evaluation of 4. The net weighted scores for all five attributes are summed (4.1375 in Table 3) and divided by the maximum possible gross score (5.00) to yield the "performance score" (82.75%).

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[14]Nico Michas, "Using Routing Guides to Reduce Costs," *Traffic World*, June 30, 2008, 6.

[15]William B. Cassidy, "Expediting Advantage," *The Journal of Commerce*, May 18, 2015, 58–62.

rule, it is easier to keep track of, say, one shipment of 10 units than to keep track of 10 shipments of one unit apiece. However, it could take some time to accumulate 10 units, and the increased time could result in poorer service to the final customer. Moreover, although a 10-unit shipment might yield transportation cost savings, there would be inventory carrying cost considerations in the sense that it is more costly to hold 10 units of product than to hold 1 unit of product.

Potential solutions for consolidating small shipments involve consolidation across time or place.[11] Continuing with the 10-unit example from the previous paragraph, and supposing that 2 units are available for shipment each day, consolidation across time could be accomplished through volume guidelines (e.g., minimum shipment of 8 units, which would mean a shipment on the fourth day) or time guidelines (e.g., ship every third day, in which case the shipment volume would be 6 units). In consolidation across place, the transportation manager looks to build volume with shipments going to a similar destination or similar destinations, and this often involves looking outside one's firm. Transportation specialists such as freight forwarders, shippers' associations, and transportation brokers all can be helpful in achieving consolidation across place.

Demurrage and Detention

Demurrage is a penalty payment made by the shipper or consignee to a railroad for keeping a railcar beyond the time when it should be released back to the carrier. Demurrage is also collected by inland water carriers if their barges are kept by the shipper or consignee for a longer period than allowed. Pipelines are involved with demurrage if oil stored in tanks at destination is not removed within specified time limits. **Detention** is basically the same concept as demurrage, except that it usually refers to the trucking industry. Users of containers owned by the airlines are subject to similar charges. With both demurrage and detention, carriers are concerned that their equipment is idle and unproductive—a less-than-optimal situation for a revenue-generating asset. From the shipper or consignee perspective, idle transportation vehicles such as a rail car or truck trailer can act as temporary (and potentially inexpensive) warehousing.

Both demurrage and detention operate on a "free-time" principle; that is, shippers or consignees are permitted a specified amount of time to load or unload freight before monetary penalties are levied. For example, as of mid-2016, CSX Transportation's penalties for demurrage violations were $105 per day per car, with several exceptions. More specifically, CSX also assesses demurrage charges of $175 per day per hazardous materials cars, $200 per day per car for refrigerated units, and $1,500 per day per car for rail security-sensitive materials such as PIH (poisonous by inhalation) materials and radioactive materials.[12]

Many carriers currently offer averaging agreements, where an accounting system of debits and credits is established, for demurrage and detention. A credit is received every time the shipper or consignee releases a piece of equipment early, and a debit is recorded each time a piece of equipment is surrendered to a carrier late. These averaging agreements are typically one month in duration, and at the end of a month, credits and debits are totaled, and the particular demurrage account is settled. If the total demurrage days exceed the total credit days, then demurrage charges are equal to: (total demurrage days minus total credit days) times the applicable demurrage rate. Alternatively, if the total credit days exceed the total demurrage days, then no demurrage charges are paid. As a general rule, credits are not allowed to be carried over from one month to another.

Routing

Routing can be defined as the "process of determining how a shipment will be moved between origin and destination."[13] One example of routing is a **routing guide,** which is a document that can provide a variety of shipment-related information such as shipment preparation, freight invoicing, a

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[11]Ibid.

[12]Information derived from CSX Transportation's Publication CSXT 8100, Terms and Conditions of Service and Prices for Accessorial Services, effective July 1, 2016.

[13]http://www.cscmp.org/sites/default/files/useruploads/resources/downloads/glossary.pdf

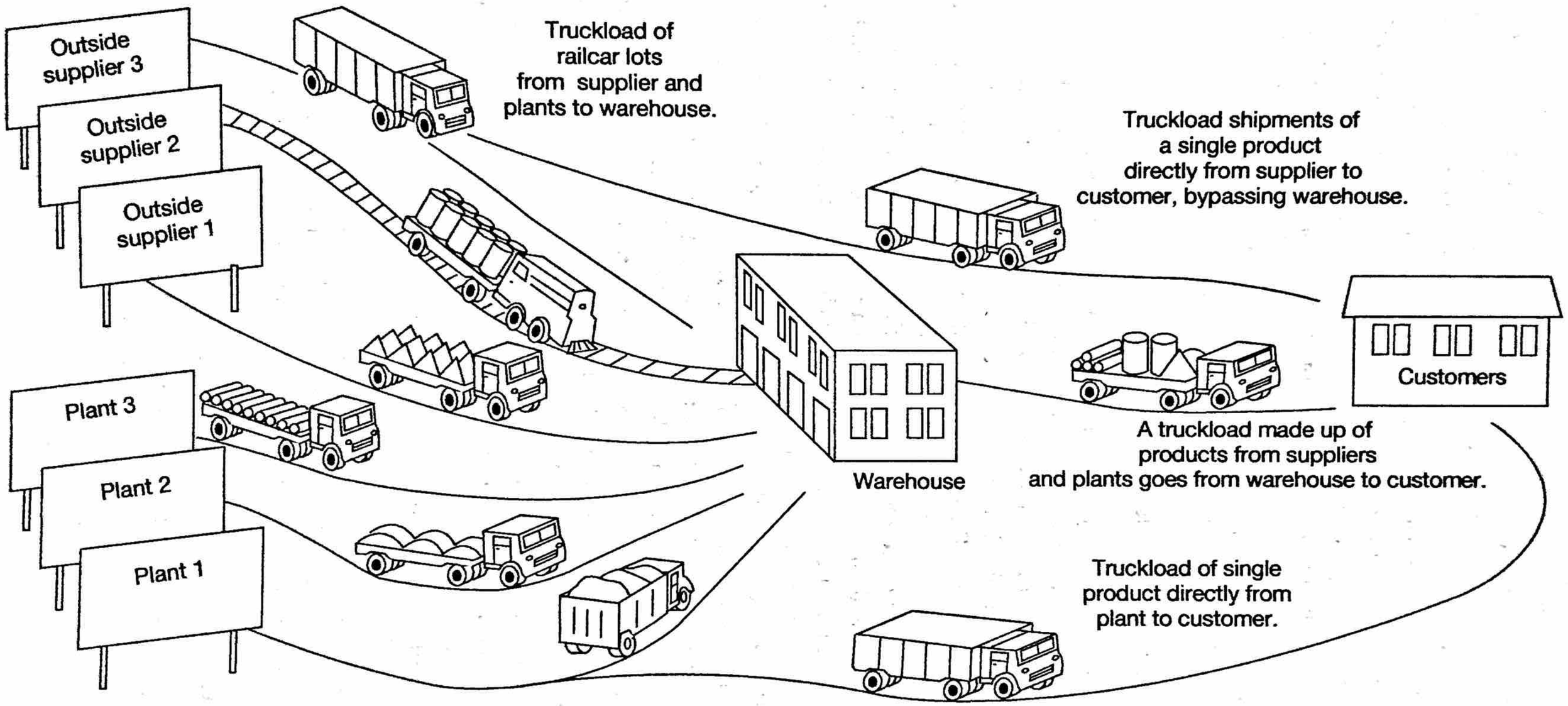

Figure 4 The Transportation Manager Consolidates Shipments Whenever Possible

arrives, it is damaged, and the retailer's customer states that he or she will wait no longer and cancels the order. In this situation, the retailer is entitled to the retail price because the profit would have been earned if the carrier had properly performed its service.

Another difficult area for shippers and carriers alike involves **concealed loss or damage**, which refers to a situation where loss or damage is not apparent until after a shipment has been unpacked and inspected. Carriers may be reluctant to pay concealed loss and damage claims for two reasons. First, if the shipment came through the transportation process with no exterior damage, then there is a strong possibility that the product was improperly protected on the inside. If this is the case, the carrier is exempted from liability because improper packaging is the fault of the shipper. Second, the possibility exists that the consignee's employees damaged or stole the products in question. The potential delicateness of concealed loss or damage claims is the balancing act between a carrier (1) not wanting to pay claims caused by shipper or consignee errors and (2) upsetting a shipper or consignee by seemingly implicating them in the loss or damage.

Transportation experts suggest that receivers/consignees follow five tips for managing concealed loss and damage: (1) inspect the freight as soon as possible; (2) break down the shipment as soon as possible; (3) note issues that look out of the ordinary in the proof of delivery (e.g., broken pallets, punctured packaging); (4) document, document, document; (5) have the shipper take photos when the freight is being shipped out and the receiver take photos when the freight is received.[9]

Since transportation deregulation, the volume of claims activity has dropped because, during the negotiation process, the shipper may agree to hold the carrier less liable for claims in return for lower transportation charges. In addition, the transportation deregulation acts have reduced carrier liability. The Staggers Act of 1980, which lessened railroad economic regulation, and the Motor Carrier Act of 1980, which pertained to trucks, permitted railroads and motor carriers, respectively, to establish released value rates (wherein the shipper agrees that a commodity is worth no more than so many dollars per hundred pounds in case a claim is filed, in return for a lower rate).

4 MAKING AND RECEIVING SHIPMENTS

Another key area of decision making in transportation management involves making and receiving shipments, which refers to tactical planning and control of shipments along with supervision of freight loading and unloading.[10] A number of activities are associated with making and receiving shipments. We will discuss some of them in the paragraphs that follow.

Consolidating Small Shipments

Small shipments, often defined as those that weigh more than 150 pounds and less than 500 pounds, represent one of the most challenging situations faced by the transportation manager. The nature of transportation costs is that it costs less on a per-pound basis to ship a larger quantity because certain costs (fixed, administrative, or terminal) are the same per shipment. When the shipment is larger, such costs can be allocated over a larger weight. The transportation manager faces the decision of whether and when to consolidate large numbers of small shipments into small numbers of large shipments. Some shipment consolidation activities are shown in Figure 4.

Smaller shipments are problematic for several reasons. From a carrier perspective, there may be reluctance to accept small shipments because they tend to require a high degree of manual labor, thus increasing labor costs. In addition, there is a belief by some carriers that they lose money on small shipments because the revenues from them do not sufficiently reflect cost considerations. From a transportation manager's perspective, a large number of small shipments means that there needs to be an information system capable of keeping track of each shipment's status; as a general

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[9]cerasis.com/2015/04/28/concealed-damage-claims/

[10]John E. Tyworth, Joseph L. Cavinato, and C. John Langley, *Traffic Management: Planning, Operations, and Control* (Prospect Heights, IL: Waveland Press, 1991).

and with less chance of error; for example, the shipper can insert the correct classification rather than letting the carrier determine it.

A few shippers are adopting their own bills of lading, which carriers may be reluctant to accept because the carriers may be subject to new liabilities specified in the documents. Carriers are advised to supply drivers with stickers to place on the bills of lading indicating that their signature means only that they have picked up the freight.

Freight Bill

Another basic document that the transportation manager must be familiar with is the **freight bill,** which is an invoice submitted by the carrier requesting to be paid. Often, the transportation manager must approve each freight bill before it is paid, and carriers must be paid within a specific number of working days. In an attempt to meet these time limits, many transportation managers now participate in automated *freight bill-paying services.* Once the transportation manager initiates the program with the payment service, the carriers submit their freight bills directly to the service. The payment service treats the freight bills as checks drawn on the shipper's freight account and then pays the carriers. CT Logistics, Cass Information Services, and Data2Logistics are examples of well-known U.S.-based freight payment companies.

One continuing issue with freight bills involves companies being charged too much (overcharges) for transportation services. To detect current errors that result in overcharges and to correct these errors in the future, shippers conduct *internal audits* (work is performed by employees of the company) of their freight bills. Some shippers also conduct *external audits* (work is performed by an independent third party) of their freight bills.

Freight Claims

Another key documentation issue involves **freight claims,** which refers to a document that notifies a carrier of wrong or defective deliveries, delays, or other delivery shortcomings. Filing claims against carriers is a routine matter, and many carriers post filing information and sample claim forms on their websites. The following are representative of freight claims information that might be found on a carrier website: "Who can file an LTL freight claim? What is the time limit for filing a claim? How do I file an LTL freight claim? What documents do I need to file an LTL freight claim? What should I expect to happen after the freight claim has been filed?[7] You should be aware that there are time limitations—nine months from the date of the bill of lading—within which a freight claim must be filed.

One of the most difficult and challenging aspects of claim work is the determination of the exact dollar amount of the damage. The law states that the common carrier is responsible for the full actual loss sustained by the shipper or consignee. The amount of the "full actual loss" is often determined according to the following common rule of thumb: The basic thought underlying the federal statutes that define the liability and prescribe the measure of damages in cases of this kind is that the owner shall be made whole by receiving the proper money equivalent for what has actually [been] lost; or, in other words to restore [the owner] to the position he or she would have occupied, had the carrier performed its contract.[8]

A key factor in determining the value of the full actual loss is the word *earned.* Assume that a retailer owned the products shipped via a common carrier and that they were damaged beyond repair. The question arises, "Should the retailer recover the wholesale price or the retail price?" If the products destroyed were going into a general inventory replacement stock, the retailer would recover the wholesale price plus freight costs (if they had been paid) because the retail price has not been earned. Assume, instead, that a product is ordered especially for a customer. When the product

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[7] http://works.pittohio.com/mypittohio/ltl/freight-claims.asp

[8] *Atlantic Coast Line Ry. Co. v. Roe,* 118 So. 155.

(Form 18 Regular-Large 8-7-86-150M Sets)

(Uniform Domestic Straight Bill of Lading, adopted by Carriers in Official, Southern, Western and Illinois Classification territories, March 18, 1922, as amended August 1, 1930, and June 18, 1941.)

1

UNIFORM STRAIGHT BILL OF LADING

Shipper's No._____

Agent's No._____

Original — Not Negotiable

The Atchison, Topeka and Santa Fe Railway Company

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

At_____ 19____

From_____

the property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below, which said company (the word company being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its own road or its own water line, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the conditions not prohibited by law, whether printed or written, herein contained, including the conditions on back hereof, which are hereby agreed to by the shipper and accepted for himself and his assigns.

(Mail or street address of consignee—For purposes of notification only.)

Consigned to_____

Destination_____ State of_____ County of_____

Route_____

Delivering Carrier_____ Car Initial_____ Car No._____

No. Packages	DESCRIPTION OF ARTICLES, SPECIAL MARKS, AND EXCEPTIONS	*WEIGHT (Subject to Correction)	Class or Rate	Check Column

Subject to Section 7 of conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:

The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

_____

(Signature of consignor.)

If charges are to be prepaid, write or stamp here, "To be Prepaid."

_____

Received $_____ to apply in prepayment of the charges on the property described hereon.

_____

Agent or Cashier.

Per_____

(The signature here acknowledges only the amount prepaid.)

Charges Advanced:

$_____

*If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's or shipper's weight."

NOTE—Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding_____ per_____

_____ Shipper. _____ Agent.

Per_____ Per_____

Permanent postoffice address of shipper_____

Figure 3 A Long-Form Bill of Lading

difficulty of reading the long-form contract and the printing costs of including the contract on all bills, in 1949 the railroads and motor carriers adopted the short-form bill of lading. The short form has the following statement on its face: "Every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading."

Another kind of bill of lading—which may be long, short, order, or straight—is preprinted. In theory, the bill of lading is prepared and issued by the carrier. In fact, however, most shippers buy their bills of lading and then have them preprinted with a list of the products they regularly ship. Shippers go to the expense of buying and printing their own bills because, in practice, they frequently prepare them prior to calling the carrier. The preprinted bill can be prepared more rapidly

indifferent to the mode(s) and/or carrier(s) used to provide the actual transportation service. Indeed, research indicates that shippers are exhibiting more interest in transportation metrics such as transit time and transit time dependability than in transportation modes. One reason for the growth of amodalism is that non-asset-based third-party logistics companies have the ability to develop multimodal solutions to a client's transportation problems.[6] Amodalism is also aided by companies such as UPS and FedEx that own companies that provide different types of transportation services (e.g., air, expedited, LTL, parcel).

DOCUMENTATION

Learning Objective 3

The definition of logistics refers to the *management of information* and the documents associated with transportation shipments, or **documentation**, are one important source of logistics information. Transportation documentation serves both a practical function (e.g., what, where, and how much is being transported) as well as potentially providing legal recourse if something goes awry with a particular shipment. Our discussion here will focus on the documents associated with domestic shipments.

The transportation department is responsible for completing all the documents needed to transport the firm's products. Today, many carriers provide software or secure websites that enable the shipper to generate all the commonly used documents. Some shippers also have their own order-processing software that is capable of generating transportation documents.

Bill of Lading

The most important single transportation document is the **bill of lading**, which is the basic operating document in the industry. The bill of lading functions as a delivery receipt when products are tendered to carriers. On receipt of the freight, the carrier signs the bill of lading and gives the original to the shipper. The signed original of the bill of lading is the shipper's legal proof that the carrier received the freight. The bill of lading is a binding contract, specifying the duties and obligations of both carrier and shipper. The bill of lading contract for surface carriers is basically standardized by law and greatly simplifies the transportation manager's job because it specifies exactly the duties of the shipper and carrier.

There are two types of bills of lading: the straight bill of lading and the order bill of lading. On a *straight bill of lading*, which is printed on white paper, the name of the consignee is stated in the appropriate place, and the carrier is under a strict legal obligation to deliver the freight to the named consignee and to no one else. Ownership of the goods is neither stated nor implied. On the *order bill of lading*, which is printed on yellow paper, the name of the consignee is not specified. For example, assume that a lumber company in Washington State has loaded a boxcar of plywood that it has not yet sold. It would use an order bill and tender the shipment to the Burlington Northern Railroad, which would start the car moving toward Chicago. Once a buyer for the plywood is found, the shipper would send the original copy of the order bill by mail to a bank near the buyer and would also tell the buyer which bank had possession of the order bill. The buyer would go to the bank and pay for the plywood, and the bank would give the original copy to the buyer. The buyer would take it to the railroad, and the railroad would deliver the carload of plywood. Order bills can also be used when faced with slow-paying customers because the order bill guarantees that the customer must pay for the products prior to receipt.

An additional classification for bills of lading is the specific form: long, short, or preprinted. The *long-form bill of lading*, which may be either an order or straight bill, contains the standard information on the face of the bill (see Figure 3), and on the reverse side it contains the entire contract between carrier and shipper. The reverse side is printed in extremely small print. Because of the

[6] "Transport Buying Shifts from Mode to Metrics," *Transportation and Distribution*, January 2006, 34–35.

- ***FOB destination, freight prepaid:*** The seller pays the freight charges, owns the goods in transit, and files L&D claims, if needed.
- ***FOB destination, freight prepaid and charged back:*** The seller pays the freight charges in advance but bills the buyer for them; the seller owns the goods in transit and files L&D claims, if needed.

The transportation responsibilities associated with FOB origin and FOB destination have important implications for transportation management. For example, an advantage of FOB destination from the seller's perspective is that the seller controls transportation and can assure a more uniform transportation outcome for each buyer. Alternatively, a disadvantage of FOB destination from a seller's perspective is that the seller's organization must have a thorough knowledge of transportation management (e.g., rate and service negotiations, modal and carrier selection, and so on) and this knowledge is not learned in a short period of time.

TRANSPORTATION COST ANALYSIS Another consideration in rate and service negotiation involves transportation cost analysis, which can be especially valuable in the shipment consolidation decision. Because transportation costs tend to be lower per unit of weight for larger shipments, there is a natural motivation to consolidate smaller shipments into larger ones. Having said this, shipment consolidation decisions affect other logistical activities such as warehousing and inventory management.

Transportation cost analysis continues to be facilitated by advances in information technology. Some trucking companies, for example, can examine inbound or outbound deliveries for a representative period of time using data gathered from a customer's paid freight bills. This can allow both the carrier and the customer to determine whether individual shipments or shipment patterns can be improved. Moreover, it is also possible to conduct sensitivity analysis to determine the transportation costs for varying levels of transportation service. Although sensitivity analysis can provide insights about potential transportation cost savings if shifting from one service level to another, the sensitivity analysis does not estimate other relevant costs (e.g., unhappy customers because of slower transportation service).

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ective 2

MODAL AND CARRIER SELECTION

Transportation managers have long been responsible for both modal and carrier selection. Conceptually, modal and carrier selection is a two-step process in which the transportation manager first determines the appropriate mode, or modes, to use and then selects a particular carrier, or carriers, within the chosen mode(s). At a minimum, an understanding of the modal characteristics would be helpful in the modal selection process.

Unfortunately, the carrier selection procedure is more challenging than that for modal selection, in part because there can be tens, hundreds, or even thousands of carriers from which to choose in a particular mode. It might not be realistic to expect a transportation manager to be aware of every possible carrier in a particular mode or to know about each carrier's service and operating characteristics.

Carrier selection is also less straightforward due to a lack of agreement on the number of relevant factors that might be used in carrier selection. For example, the number of carrier selection factors evaluated in academic research studies has ranged from less than 10 to over 150. As was the case with rate and service negotiation, it is not possible to provide a comprehensive list of all possible factors that might be used in the carrier selection decision. Representative carrier selection factors include total transit time, transit time reliability, competitive rates, and loss and damage performance, among others.

Modal and carrier selection has become even murkier in recent years with the rise in what we will call the **amodal shipper**. An amodal shipper refers to a transportation manager who purchases a prespecified level of transportation service (e.g., two-day delivery for a particular price) and is

TABLE 2 Representative Rate and Service Items in the Carrier—Shipper Negotiation Process

Adjustment to Rates	Arbitration	Articles and Commodities Covered
Audit rights	Basis for charges	Billing procedures
Carrier equipment and drivers	Carrier insurance	Carrier notification requirements
Detention time	Duration of agreement	Estimated transportation volume
How loss and damage claims are handled	Lead times	Pallet loading
Proof of delivery	Renegotiation and reopening of contract	Schedule of rates and charges
Termination of agreement	Transportation service level	Waiver of terms

industry. In one case, the shipping organization agreed to pay the railroad a premium for each railcar that was delivered on a precise, previously agreed-upon schedule. In the second case, an organization agreed to ship six million pounds of intermodal freight each year between Houston and Chicago. The shipper agreed to pay the railroad an additional $75 per trailer when at least 90 percent of the trailers completed the rail movement within 96 hours. Although these two examples illustrate situations where monetary premiums were paid for meeting predetermined service standards, the rate and service negotiations can also include *monetary penalties* for failure to achieve predetermined service standards.

It is not possible to present a comprehensive list of all possible rate and service items that might by negotiated by shippers and carriers. However, Table 2 contains a representative list of items that might be used in the negotiation process.

DOMESTIC TERMS OF SALE One consideration in rate and service negotiations involves the terms of sale, or when the freight charges are paid for a particular domestic shipment we will. FOB (free on board) is followed by either "origin" or "destination" and this location specifies the point at which the title and control of a shipment passes from buyer to seller. With **FOB origin,** the buyer assumes title and control of a shipment at the point of pickup, while with **FOB destination** the seller retains title and control of a shipment until it is delivered.

In addition to establishing the point at which title for a shipment passes from buyer to seller, the FOB location term also establishes which party is responsible for arranging transportation for a shipment as well as which party is responsible for filing freight claims (a topic that will be discussed later in this text). FOB origin and FOB destination are typically qualified by modifying terms, the most common of which are *freight collect, freight prepaid,* and *freight prepaid and charged back.* This results in six possible domestic terms of sale, which are described next.[5]

- ***FOB origin, freight collect:*** The buyer pays freight charges, owns the goods in transit, and files loss and damage (L&D) claims, if needed.
- ***FOB origin, freight prepaid:*** The seller pays the freight charges; the buyer owns the goods in transit and files L&D claims, if needed.
- ***FOB origin, freight prepaid and charged back:*** The seller pays the freight charges in advance but bills the buyer for them; the buyer owns the goods in transit and files L&D claims, if needed.
- ***FOB destination, freight collect:*** The buyer pays the freight charges; the seller owns the goods in transit and files L&D claims, if needed.

[5]Derived from http://www.provisionlogistics.com/domestic-terms-sale

SUBJECT 3

Handling Unit Length	Average Density (pcf)	CCSB Minimum Average Density Guideline (pcf)	Class Based on CCSB Guidelines	Class Adjustment Based on Handling and Stowability Considerations
Exceeding 96 inches	13.39	12	85	92.5
Not exceeding 96 inches	20.38	15	70	–

This proposal would cancel item 185653 with reference to a new item for "Rakes or Lutes, hand, consisting of magnesium heads with detached handles of same or other material; or Handles or Parts thereof, NOI," at class 70 when the length does not exceed 96 inches, consistent with the respective density guideline. Handling units exceeding 96 inches in length would be assigned a class 92.5, one class higher than that called for by the respective density guideline.

This proposal is in keeping with CCSB policies and precedent.

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Figure 2 *(Continued)*

SUBJECT 3

When the data is evaluated based on the handling unit's length, the following density ranges and averages emerge.

Handling Unit Length	Density Range (pcf)	Average Density (pcf)
Exceeding 96 inches	9.41 – 16.57	13.39
Not exceeding 96 inches	11.63 – 28.46	20.38

Handling—As shown in the photo on the right, the proponent's magnesium rakes or lutes are shipped in fiberboard boxes secured on lift truck skids or pallets. Individual components (i.e. handles, connector brackets or heads) of magnesium rakes or lutes may be shipped in boxes on the same handling unit. Data furnished by the proponent indicates that handling units can exceed 96 inches in length. Generally, freight that exceeds 96 inches in length will require extra care and attention during handling.

Stowability—The proponent states that the involved products are stackable. However, depending on the shipment configuration, its magnesium rakes or lutes may or may not provide a regular load-bearing surface for top freight. In addition, handling units that exceed 96 inches in length may complicate the carrier's ability to structure a load and maximize vehicle utilization.

Liability—The involved articles are not perishable, hazardous in nature, unusually susceptible to theft, unusually liable to damage and would not appear likely to damage other freight. The proponent provided the list prices for various models of its magnesium rakes or lutes. The list price ranges from $12.58 to $13.48 per pound, with an average price per pound of $13.16. The individual parts range in list price from $12.00 to $19.43 per pound, with an average price per pound of $14.33. The proponent states that no claims have been filed for a one-year period.

Relationship to CCSB Policies and Guidelines

CCSB policy calls for classification provisions to reflect a commodity's known transportation characteristics. The proponent asserts that the provisions of item 185653 for "Rakes, hand, having tines constructed of magnesium" are not reflective of the transportation characteristics of its products. Information provided by the proponent includes 89 density observations ranging from 9.41 to 28.46 pcf, with an average density of 18.73 pcf. An average density of 18.73 pcf is generally associated with a class 70, which under CCSB guidelines calls for a minimum average density of 15 pcf. However, CCSB policies further state that unusual or significant negative handling, stowability or liability characteristics may be contributing factors in the assignment of classes. In this regard, it is noted that some of the involved magnesium rakes or lutes exceed 96 inches in length, which present additional handling and stowability considerations. In such situations, classification precedent has been to assign a class higher than that called for under the CCSB density guidelines. Surfa Slick has proposed classes accordingly, as outlined in the table on the following page.

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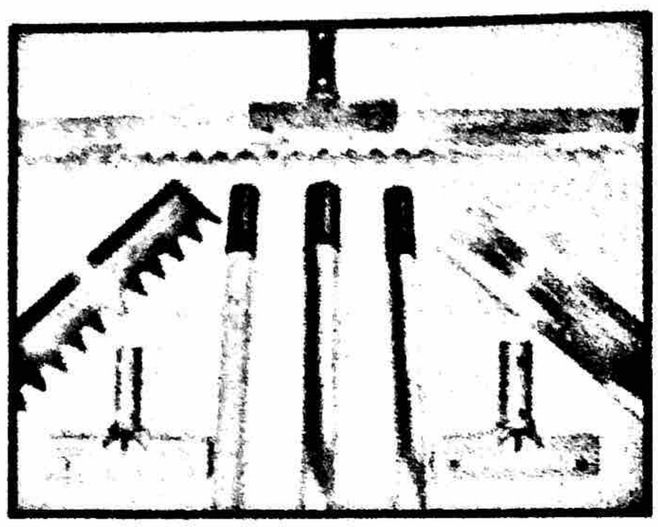
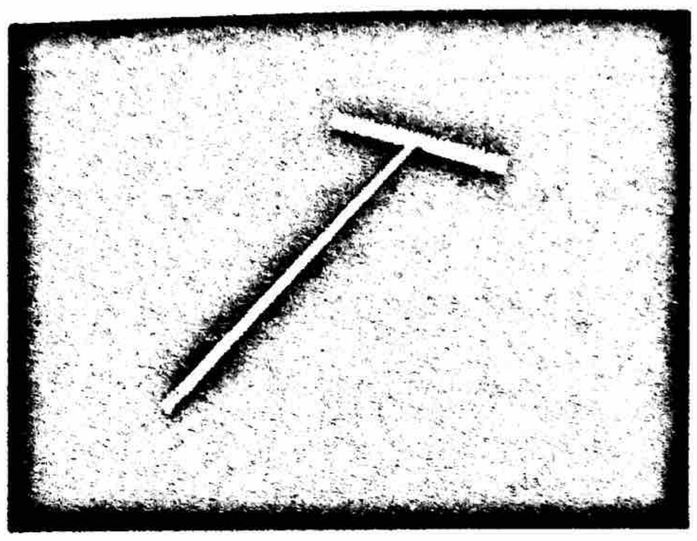
Figure 2 ***(Continued)***

SUBJECT 3

About Magnesium Rakes or Lutes

Magnesium rakes or lutes are tools primarily used in the spreading and leveling of asphalt or concrete. They may also be used to level dirt, rock, gravel or snow. The proponent's products consist of a fiberglass or magnesium handle, metal connector bracket and a magnesium rake or lute head. Some handles will exceed eight feet in length. Examples of the involved parts and assembled product are shown in the photos below.





Transportation Characteristics

Density—The proponent submitted a total of 89 density observations, including data on all of its models of magnesium rakes or lutes and the individual parts. The densities range from 9.41 to 28.46 pcf, with an average density of 18.73 pcf. A frequency distribution is shown below.

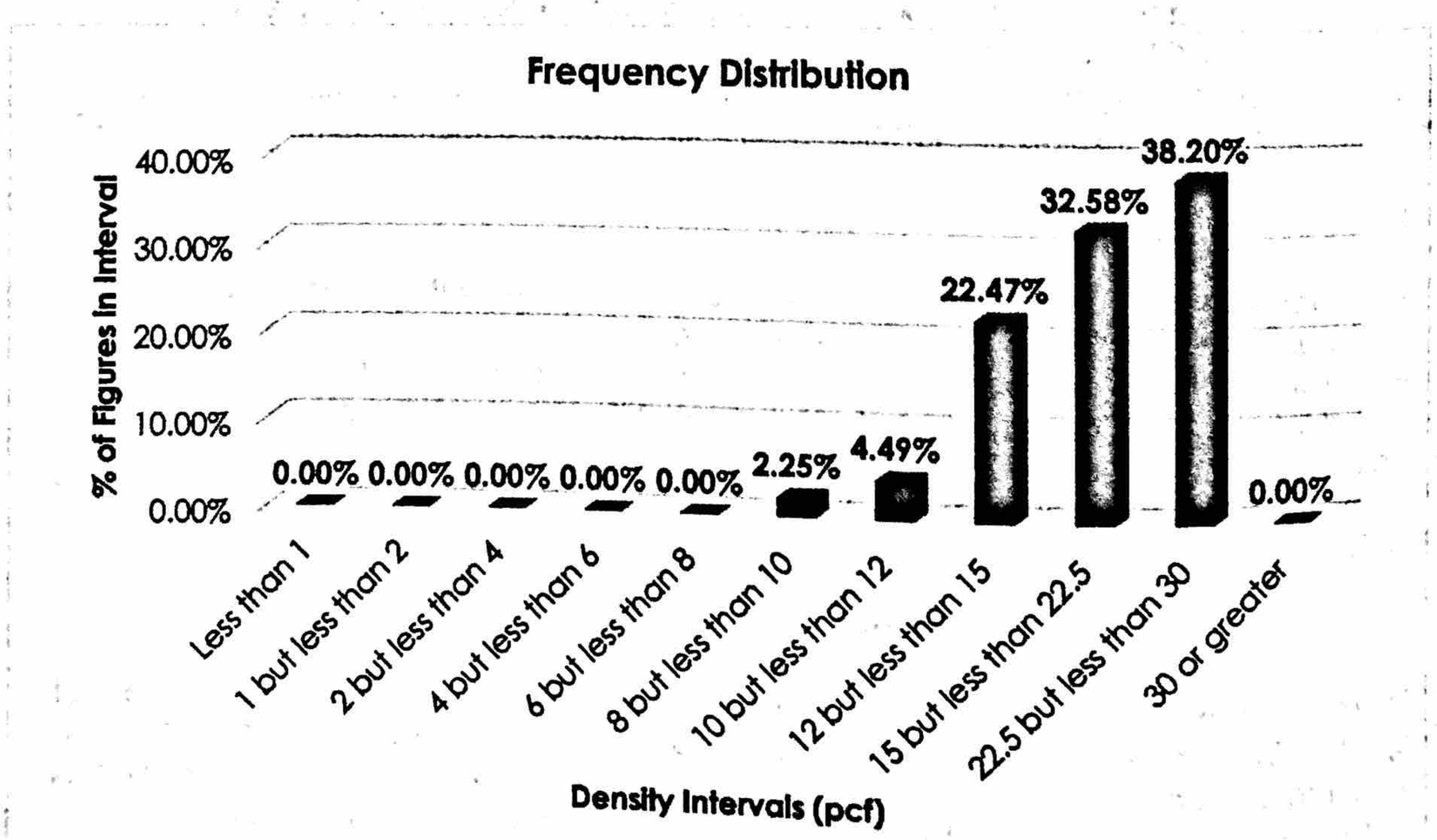


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Figure 2 *(Continued)*

CCSB DOCKET 2015-1 SECTION I

SUBJECT 3

Re: Rakes or Lutes, magnesium

CCSB Contact: George M. Beck Telephone — (703) 838-1813 beck@nmfta.org
Allison L. Austin (703) 838-8864 austin@nmfta.org

Proponent: Surfa Slick, LLC, Riverside, California

Present Classification Provisions

Item	Description	Class
	TOOLS, OR PARTS NAMED: subject to item 183550	
	Rakes, hand, having tines constructed of: subject to item 185645	
185653	Magnesium, in boxes	100

Proposed Classification Provisions

Item	Description	Class
	TOOLS, OR PARTS NAMED: subject to item 183550	
	Rakes, hand, having tines constructed of: subject to item 185645	
185653	Magnesium, etc.	⇉Cancel; see item NEW
⇉NEW	**Rakes or Lutes,** hand, consisting of magnesium heads with detached handles of same or other material; **or Handles or Parts thereof,** NOI; in boxes:	
Sub 1	Exceeding 96 inches in length	92.5
Sub 2	Not exceeding 96 inches in length	70

Analysis

This proposal was submitted by Surfa Slick, LLC to add a new item under the Tools, or Parts Named generic heading for magnesium rakes or lutes, or handles or parts thereof. The proponent's rakes or lutes are currently classified under the provisions of item 185653, naming "Rakes, hand, having tines constructed of magnesium." The proponent states, however, that these particular commodities exhibit transportation characteristics not reflected in the current class 100. The proposal seeks to establish provisions for magnesium rakes or lutes, based on the length of the handling unit.

History of Provisions

Provisions for magnesium rakes were established as a result of action taken on Docket 932, Subject 18 (March 1993). That proposal sought to establish classes for rakes based on the material construction of the tines. Information on that record showed a density of 9.47 pcf for magnesium rakes. When shipped in boxes, no unusual or significant handling, stowability or liability problems were indicated. The proposal was approved as modified, and the provisions first appeared in Supplement 2 to NMF 100-T, effective July 10, 1993. The provisions have remained substantially unchanged to the present.

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Figure 2 Motor Carrier Classification Docket Proposal for Changing the Classification of Soft Contact Lenses *Source:* Permission to reproduce this material has been granted by the National Motor Freight Traffic Association, Inc., 2011.

TABLE 1 Example of the Class Rate System

Shipment	Commodity Classification	Weight (pounds)	Distance (Using ZIP Codes)	Transportation Charges[a]
1	Class 100	500	44023 to 32169	$666.52
2	Class 200	500	44023 to 32169	$1,245.87
3	Class 100	1,500	44023 to 32169	$1,533.26
4	Class 100	500	44023 to 90210	$829.96

[a] Transportation charges are representative as of early 2016.
Data derived from a sample rate calculator for Old Dominion Freight Lines http://www.odfl.com/LTLrate/LTLRateResult.

Shipment 1 (approximately 1,000 miles). Not surprisingly, Table 1 indicates that Shipment 4 is more expensive ($829.96) than Shipment 1 ($666.52).

The transportation charges in Table 1 point out some important considerations with respect to class rates. First, a commodity's classification (e.g., Class 100 versus Class 200) can noticeably impact transportation expenses and one can see why shippers should be cognizant of a particular commodity's classification. Second, heavier shipments of a particular commodity generate higher transportation expenses than do lighter shipments. Having said this, shippers can reduce their transportation expenses by utilizing fewer, heavier shipments (e.g., transportation expense for Shipment 3 at 1,500 pounds is $1,533.26) rather than multiple, lighter shipments (e.g., transportation expense for three 500-pound shipments is $1,999.56 [$666.52 times 3]).

Third, while longer distance shipments (Shipment 4) are more expensive than shorter distance shipments (Shipment 1), the difference in cost—Shipment 4 is approximately 1.25 more expensive than Shipment 1—is not proportional to the increase in distance—Shipment 4 travels more than twice the distance of Shipment 1. As such, transportation managers should try to avoid purchasing transportation in short distance movements.

A commodity's freight classification is developed and maintained by the Commodity Classification Standards Board, which consists of at least three, but no more than seven, full-time employees of the National Motor Freight Traffic Association. There is often a natural tension between shippers and carriers with respect to a product's classification; shippers tend to prefer a lower classification number (which translates into a lower rate), whereas carriers tend to prefer a higher classification number. Transportation managers can appeal a commodity's classification, and Figure 2 shows a proposal for a reclassification of magnesium rakes.

Referring to Figure 2, the proposal begins with the present classification provisions, followed by the proposed classification provisions. Figure 2 indicates that the proposal seeks to lower the classification of magnesium rakes according to the length of the handling unit. The majority of the content presented in Figure 2 provides the proponent's rationale for the proposed classification. Note that the "Transportation Characteristics" section in Figure 2 focuses on the four-product attributes—density, stowability, handling, and liability—that were discussed earlier in this text.

Rate and Service Negotiations

As pointed out earlier in this text, the contemporary transportation manager is much less constrained by rate and service regulations and thus has the opportunity to assume a proactive role in rate and service negotiations. Today's transportation manager can craft rate and service packages that best meet an organization's logistical needs, and these rate and service packages can conceivably vary from product to product, location to location, or customer to customer.

This rate and service flexibility allows transportation managers to take advantage of trade-offs between price and service, and these price and service trade-offs are limited only by the transportation manager's creativity and ingenuity. Consider the following two examples from the railroad

NATIONAL MOTOR FREIGHT CLASSIFICATION 100-AM

ITEM	ARTICLE	CLASS
	GLASS: subject to item 86500	
86560	**Automobile or Boat Glass,** including **Windshield Glass,** cut to shape, see Note, Item 86566, in Packages 772, 2146, 2147, 2223, 2261 or 2483:	
Sub 1	Not bent, in boxes or crates:	
Sub 2	120 united inches or less	70
Sub 3	Exceeding 120 united inches	85
Sub 4	Bent, other than tempered:	
Sub 5	Nested, in boxes, crates or Packages 304, 305, 315, 2347 or 2348	85
Sub 6	Not nested, in boxes or Packages 1180, 1247 or 2034	125
Sub 7	Bent, tempered, in boxes, crates or Packages 304, 305, 315, 774, 2347 or 2348, or when not nested, in Packages 1180 or 2034	85
86566	NOTE—Applies only on glass in specific sizes or shapes for installation in automobile bodies or in or on boats.	
86580	**Building Slabs,** opaque glass, NOI, with or without backing, in boxes or crates:	
Sub 1	$^{5}/_{16}$ inch thick or less	85
Sub 2	Over $^{5}/_{16}$ inch thick,	65
86600	**Cullet (Broken Glass),** in boxes or drums	50
86650	**Glass,** crushed, ground or powdered, not including enamel or frit, in bags, boxes, drums or Package 2453	55
86660	**Glass,** faceted, in panels, see Note, Item 86662, in boxes or crates	85
86662	NOTE—Applies on glass, plain or colored, set in cement, concrete or plastic resins to form designs, patterns or pictures.	
86670	**Glass,** flashed or ruby, not framed nor leaded, in boxes	85
86700	**Glass,** flat, NOI, see Note, Item 86701:	
Sub 1	Bent, in boxes or crates:	
Sub 2	220 united inches or less	85
Sub 3	Exceeding 220 united inches but not exceeding 15 feet in length nor 9 feet in width	100
Sub 4	Exceeding 15 feet in length or 9 feet in width	250
Sub 5	Not bent, see Note, Item 86702, in boxes, crates or Packages 195, 198, 235, 785, 2008, 2025, 2147, 2149, 2160, 2239, 2245, 2281 or 2497:	
Sub 6	220 united inches or less	65
Sub 7	Exceeding 220 united inches but not exceeding 15 feet in length nor 9 feet in width	100
Sub 8	Exceeding 15 feet in length or 9 feet in width	200
86701	NOTE—The term 'flat' applies to glass known as sheet, plate, polished prism, rolled, window or float glass, whether or not polished, laminated, colored, opalescent, opaque, chipped, decorated, wired, etched, figured, acid dipped, ground, sandblasted, metalized (sprayed with atomized metal while glass is hot) or tempered, but not when silvered for mirrors, nor flashed, nor framed or leaded (set in or framed by lead or other metal).	
86702	NOTE—Flat glass, not bent, may also be cut to size, edges beveled or ground, or holes cut or drilled.	
86750	**Glass,** leaded, see Note, Item 86752, in boxes:	
Sub 1	With landscape, pictorial or religious designs,	200
Sub 2	With curved, angled or straight line patterns, or with designs other than landscape, pictorial or religious	100
86752	NOTE—The term 'leaded glass' means glass either colored or clear, set in lead or in other metal.	
86770	**Glass,** microscope slide or slide cover, see Note, Item 86771, in boxes	70
86771	NOTE—Does not apply on microscope slides or slide cover glasses. Applies only on the glass from which these articles are manufactured. For provisions applicable to microscope slides or slide cover glasses, see Item 88535.	
86830	**Glass,** rolled, overlaid with aluminum strips with metal terminals attached, in boxes or crates	77.5
86840	**Glass,** rolled, overlaid with aluminum strips, NOI, in boxes or crates	70
86900	**Glass,** silvered for mirrors, not framed, nor backed nor equipped with hangers or fastening devices:	
Sub 1	Shock (window glass, silvered), in boxes, see Note, Item 86902	85
Sub 2	Other than shock glass, in packages shown:	
Sub 3	Bent, in boxes:	
Sub 4	Not exceeding 15 feet in length nor 9 feet in breadth	100
Sub 5	Exceeding 15 feet in length or 9 feet in breadth	250
Sub 6	Not bent, see Package 785:	
Sub 7	120 united inches or less, in boxes, crates or Packages 198 or 235	70
Sub 8	Exceeding 120 united inches but not exceeding 15 feet in length nor 9 feet in breadth, in boxes or crates	100
Sub 9	Exceeding 15 feet in length or 9 feet in breadth, in boxes or crates	200
86902	NOTE—Glass, silvered for mirrors, which has been framed or backed, or equipped with hangers or fastening devices, is subject to the classes for mirrors, NOI.	
86940	**Glass,** window, other than plate, with metal edging other than sash or frames, in boxes	77.5
86960	**Glazing Units,** glass, not in sash, see Note, Item 86966, in boxes, crates or Packages 2149 or 2281	70
86966	NOTE—Applies on units consisting of sheets of glass separated by air or vacuum, sealed at all edges with same or other materials.	
87100	**Glass Factory Flattening Stones, Floats, Gathering Rings or Pot Rings or Glasshouse Pots,** clay, in boxes, crates or drums or on skids	85
87500	**GLASSWARE GROUP:** Articles consist of Glassware or Glass Articles, see Note, Item 87512, as described in items subject to this grouping.	
87512	NOTE—All articles of glassware which are plated, mounted or trimmed with gold or silver will be subject to the provisions provided for glassware, gold or silver deposit, gold or silver mounted or gold or silver trimmed.	100
87520	**Ampoules (Ampuls),** in boxes or Package 2362	85
87540	**Aquariums or Terrariums,** capacity over $^{1}/_{2}$ gallon, see Note, Item 87552, in boxes or crates:	
Sub 1	Each in individual fiber box, two or more smaller sizes nested within one larger	150
Sub 2	NOI	

Only participants in the NMFC at the time the transportation occurs may use the provisions herein.
For explanation of abbreviations and reference marks, see last page of this Classification. ©NMFTA 2013 403

Figure 1 Page from National Motor Freight Classification *Source:* Reprinted from the National Motor Freight Classification © ATA 2013.

With respect to the class rate system and weight, Shipment 1 weighs 500 pounds versus 1,500 pounds for Shipment 3. Table 1 indicates that Shipment 3 is more expensive ($1,533.26) than Shipment 1 ($666.52), but not three times more expensive (as might be expected by a linear relationship between weight differences and freight charges). Finally, Shipments 1 and 4 differ in terms of the destination zip code and Shipment 4 is traveling much further (approximately 2,100 miles) than

One approach to rate making is to determine one specific rate for every possible combination of product, weight, and distance—in other words, a **commodity rate.** Although a commodity rate is very good for dealing with demand-specific situations, the number of commodity rates quickly becomes overwhelming (and potentially counterproductive) when you consider how many different products, weights, and distances exist. For example, because there are over 30,000 "important" shipping and receiving points in the United States, in the commodity rate system there would need to be separate rates for all possible combinations of shipping and receiving points—a number that is in the trillions of trillions![2]

When you consider that the transportation rate structure dates to the time of economic regulation in the late 1800s—a time when "office automation" might have meant a *manual typewriter*—it becomes clear that the transportation community needed a way to simplify rate determination. This was accomplished through the **class rate system,** which simplified each of the three primary rate factors—product, weight, and distance. One widely used system for simplifying the number of products is the National Motor Freight Classification (NMFC), which has 18 separate ratings, or classes, from 50 to 500;[3] the higher the rating, the greater the relative charge for transporting the commodity. Classification numbers are very important because they are code words that describe cargo in a manner that carriers and shippers understand, and classification descriptions also specify the packaging that must be used and that carriers require. Figure 1 shows a page of the National Motor Freight Classification; note the detail. *NOI* stands for "not otherwise indexed by number" (i.e., one cannot find a definition that fits more closely). Packages are referred to by number; they are described in great detail in the classification document.

Four factors are used to determine a product's freight classification, namely, *density, stowability, ease of handling,* and *liability to damage and theft.* **Density,** which refers to how heavy a product is in relation to its size, is viewed as the primary factor for setting a product's classification, in part because of the opportunity costs associated with it. That is, a product with low density (i.e., low weight per cubic foot), such as foam rubber, can easily fill a vehicle's usable capacity (cubing out) before reaching the maximum weight (weighing out). As a result, low-density products are assigned a higher classification; for example, products with densities of less than one pound per cubic foot are assigned to Class 400, while densities of one pound but less than two pounds per cubic foot are assigned to Class 300.[4]

Stowability refers to how easy the commodity is to pack into a load, and possible considerations involve the commodity's ability to be loaded with hazardous materials and ability to load freight on top of the commodity. *Ease or difficulty of handling* refers to challenges to handling that might be presented by a commodity's size, weight, and so on. Finally, the *liability for loss and damage* considers, among others, a commodity's propensity to damage other freight, its perishability, and its value.

Just as the freight classification is used to simplify the number of commodities, shipment weight is simplified through weight groups (e.g., less than 500 pounds; 500–999 pounds; 1,000–1,999 pounds, etc.). The rate for shipments weighing less than 500 pounds will be higher than that for shipments between 500–999 pounds, and so on. Distances are simplified in a similar fashion and, historically, distances were classified according to a rate basis number; the higher the rate basis number, the greater the distance between origin and destination. Increasingly, rate basis numbers are being replaced by the zip codes of a particular shipment's origin and destination.

An example of transportation charges using the class rate system is presented in Table 1. Shipment 1 in Table 1 will serve as our reference point for looking at transportation charges based on commodity classification, weight, and distance. As shown in Table 1, the commodity classification is the only difference between Shipment 1 (class 100) and Shipment 2 (class 200). Because a higher class rating takes a higher rate, Shipment 2's transportation charges ($1,245.87) are noticeably higher than Shipment 1's transportation charges ($666.52).

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[2]Ibid.

[3]http://www.nmfta.org/Pages/Nmfc.aspx

[4]www.freightquote.com/howtoship/nmfc-freight-density.aspx

domestic product. Moreover, we havetransportation is the most costly logistics activity for many organizations, and transportation is pivotal to the successful operation of any supply chain.

The discussion in this text will be approached from the perspective of the transportation manager in the United States. Keep in mind that a particular country's transportation system, the degree of government involvement in transportation, and a country's technological development will influence the nature of transportation management in that country. For example, in some countries there may be only one government-run transportation company in a particular mode; thus, the transportation manager would not need to be concerned with carrier selection considerations for that particular mode.

Although the majority of this text will focus on several of the transportation manager's key responsibilities, it should be pointed out that transportation managers are also involved with many other operations of the firm. They can assist marketing by quoting freight rates for salespeople, suggesting quantity discounts that can be based on transportation savings, and selecting carriers and routes for reliable delivery of products. Transportation managers can help manufacturing by advising on packaging and materials handling and making certain that an adequate supply of transportation is available when it is needed. Transportation managers can aid the outbound shipping process by providing simplified shipping or routing guides, drawing up transportation documents, and encouraging shipment consolidations. Finally, they can help purchasing by advising about methods to control the costs and quality of inbound deliveries and by tracing and expediting lost or delayed shipments of important inputs.

The remainder of this text will focus on some of a transportation manager's primary responsibilities. We first analyze rate (pricing) considerations, with a particular emphasis on rate determination. Next, text we discuss modal and carrier selection, followed by a discussion of documentation considerations. Text we also look at making and receiving shipments. The text concludes with an examination of transportation service quality.

RATE (PRICING) CONSIDERATIONS

Learning Objective 1

Rate Determination

we have Logistics has discipline-specific terminology. To this end, one key responsibility of transportation managers involves rate considerations, with **rate** being the logistics term that signifies the price charged for freight transportation ("fare" refers to the prices charged for passenger transportation). Rate determination is essential to calculating the appropriate transportation cost, according to the following formula:

Weight × rate = transportation charge.

Moreover, transportation rates are based on three primary factors—product, weight, and distance—which will be discussed next:

- Relationships between *different products* in terms of their handling characteristics, for example, the difference between carrying 2,000 pounds of ballpoint pens and 2,000 pounds of live chickens
- Relationships between shipments of *different weights,* for example, shipments of 10 pounds each versus shipments of 1,000 pounds each versus shipments of 10,000 pounds each
- Relationships between *different distances* the products are carried, for example, from Boston, Massachusetts, to Albany, New York, versus from Atlanta, Georgia, to Spokane, Washington

Rate determination has to define all three relations in numeric form and then has to devise methods of tying those numbers into a rate for a specific shipment. The three relationships just mentioned are of continual importance to the transportation manager because if they are altered, the total transportation charges will be altered.

TRANSPORTATION MANAGEMENT

Learning Objectives

1. To discuss how rates are determined
2. To learn about modal and carrier selection
3. To distinguish among various transportation documents
4. To illustrate select activities associated with making and receiving shipments
5. To learn about transportation service quality

The transportation manager's job is much different today than when the first edition of this text was published in the 1970s, in part because of globalization, changes in regulation, and advances in technology. With respect to globalization, consider that in the 1970s, the People's Republic of China (China) was in the midst of the Cultural Revolution, a movement that severely restricted the country's economic development as well as trade with other countries. Today, by contrast, China has the second-largest economy in the world (based on gross domestic product) and is a key source of manufactured products for many countries. The transportation requirements associated with a shipment of, say, toys, from Shanghai, China, to Des Moines, Iowa, are noticeably different than those for a shipment of toys from Cleveland, Ohio, to Des Moines.

As for changes in regulation, a reduction of economic regulation in the United States began in the late 1970s, and with it came greater options in terms of both pricing and service. These pricing and service options meant that transportation managers have morphed from a reactive to a proactive focus; rather than simply accepting the available pricing and service packages that were established by economic regulation (reactive), today's transportation manager can play an active role (proactive) in blending the appropriate pricing and service packages for an organization.

Advances in technology, and their impact on logistics management, have been a recurring theme. Rate determination (to be more fully discussed in the next section) provides one example of how advances in technology have impacted transportation management. As recently as the 1980s, all rates were published in tariffs (a phonebook-like manual that contained rate information), and it was not uncommon for a transportation manager to refer to multiple tariffs to determine the applicable rate—a process that led to numerous incorrect rate determinations. Today, by contrast, many carriers provide rating information online and a transportation manager may need to enter little more than origin and destination zip codes and the relevant shipment weight to receive an estimated rate.

For our purposes, **transportation management** will refer to the buying and controlling of transportation services by either a shipper or consignee.[1] Today more than ever before, organizations are concerned about transportation management because transportation represents a major expense item. In general terms, freight transportation accounts for approximately 6 percent of U.S. gross

[1]John J. Coyle, Edward J. Bardi, and Robert A. Novack, *Transportation*, 6th ed. (Mason, OH: Thomson South-Western, 2006).

Summary

Transportation, the actual, physical movement of goods and people between two points, is pivotal to the success of any logistics or supply chain operation. The text began by comparing transportation infrastructures in several different countries and found distinct infrastructural differences across the countries.

The text then discussed the five modes of transportation in terms of each mode's capability, capacity, cost, flexibility, reliability, and speed. This mode-by-mode discussion was followed by a look at intermodal transportation, with a particular focus on containerization. The roles that can be played by transportation specialists such as freight forwarders and brokers were also examined.

The text discussed environmental regulation, safety regulation, and economic regulation as they apply to transportation. We learned that a number of U.S. federal agencies are responsible for transportation and also that the levels and types of regulation may not be consistent across modes. The text concluded with a look at the four legal classifications of carriers—common, contract, exempt, and private.

Key Terms

Accessorial service
Barge
Brokers
Common carrier
Consignees
Contract carrier
Department of Transportation (DOT)
Exempt carriers
Freight forwarders
Intermodal transportation
Land bridge services
Less-than-truckload (LTL)
Line-haul
Lock
Parcel carriers
Piggyback transportation
Private carriers
Rail gauge
Shippers' associations
Slurry systems
Surface Transportation Board
Twenty-foot equivalent unit (TEU)
Terminals
Ton miles
Transportation
Truckload (TL)
Unit load devices (ULDs)

Questions for Discussion and Review

1 Why is transportation important to a firm's supply chain operations?
2 Why is it important to know about the characteristics of a country's transportation infrastructure?
3 Discuss the speed of airfreight transportation in terms of the line-haul and accessorial service.
4 Why is the reliability of airfreight transportation somewhat problematic?
5 How do truckload operations differ from less-than-truckload operations?
6 How do speed limits and hours-of-service rules potentially affect motor carrier service?
7 What are advantages and disadvantages to a pipeline's lack of vehicles?
8 What are pipeline slurry systems? How do they function?
9 Discuss the drawbacks to rail transportation.
10 How do weather conditions influence the reliability of inland water carriers?
11 Discuss the positive attributes of inland water transportation.
12 How do containers help facilitate intermodal transportation?
13 What are freight forwarders? How do they function? What services do they perform?
14 What is a shippers' association?
15 Discuss the various options that are available to parcel shippers.
16 List several environmental regulations and describe their impact on transportation.
17 Pick three modes of transportation, name the federal agency responsible for safety regulation for each of the modes you've picked, and provide a safety-related role or responsibility for each mode.
18 Define what is meant by economic regulation. Why is transportation economic deregulation important?
19 How does a common carrier differ from a contract carrier?
20 Discuss advantages and disadvantages to private transportation.

rates so low that carriers are unable or unwilling to carry freight, and it guards against rates so high that users are unwilling or unable to tender freight to carriers. The obligation to avoid discrimination in pricing and service suggests that similarly situated customers (e.g., customers that ship the same product, customers that ship to the same origin and destination point) should receive identical treatment. One of the key provisions of the ICC Termination Act of 1995 was the elimination of the reasonable rate obligation (hence, also, the obligation to avoid discrimination in pricing and service) for many types of motor carriers.

A **contract carrier** offers a specialized service to customers on a contractual basis. The contract specifies the compensation to be received, the services to be provided, and the type of equipment to be used, among other details. Unlike the common carrier, the contract carrier is under no obligation to render services to the general public and only has to serve customers with whom it has contracts. Moreover, the contract carrier is under no obligation to treat its customers on an equal basis. Because each contract can be tailored to the specifications of individual customers, contract carriage is viewed as offering many of the advantages of private transportation (such as control over service) while avoiding many of the disadvantages of private transportation (e.g., the hiring of drivers, owning equipment).

Exempt carriers are for-hire carriers that have been exempted from economic regulation through provisions in various pieces of legislation; the appropriate rates and services must be negotiated directly between the carrier and user. For example, the Transportation Act of 1940, which brought domestic water carriers under economic regulation, exempted liquid-bulk commodities from economic regulation, as well as dry-bulk commodities, so long as no more than three dry-bulk commodities were moved in a particular tow.[24] In a similar fashion, the Motor Carrier Act of 1935, which brought motor carriers under economic regulation, exempted unprocessed agricultural commodities from economic regulation; the Motor Carrier Act of 1980, which lessened economic regulation for motor carriers, exempted agricultural seeds and plants from regulation.[25]

Private carriers, which are exempt from any economic regulation, are companies whose primary business is other than transportation. They provide their own transportation service by operating trucks, railcars, barges, ships, or airplanes. Private transportation is most prevalent in the trucking industry, accounting for over 50 percent of the U.S. highway mileage for trucks.[26] Prominent private truckers in the United States include Coca-Cola Company, Sysco Corporation, US Foods, and Walmart, among others.

One advantage to private transportation is that the equipment can serve as a rolling billboard that allows an organization to promote itself. Operational control is another advantage to private transportation, in part because shipments can move at a time convenient for the company, as opposed to a time that might be convenient for a for-hire carrier. Private transportation can also provide important competitive advantages to an organization. For example, private truck fleets allow organizations to better serve key customers relative to the performance of for-hire carriers.[27]

Although private transportation can be a cost-effective form of transportation, a key disadvantage is that it can be quite costly, in part because of the capital expenditures that are necessary to own or lease the relevant vehicles as well as regular expenditures to maintain the vehicles. Moreover, managerial costs are often ignored or underestimated; many private fleets require at least one full-time employee to manage the various responsibilities such as vehicle selection, vehicle maintenance, staffing, labor relations, regulatory compliance, and so on.

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[24]Harper, *Transportation in America.*

[25]Ibid.

[26]http://www.nptc.org/index.php?option=com_content&view=article&id=39&Itemid=457

[27]David Cullen, "Private Fleets: Measuring Up," *Fleet Owner*, October 2010, 30–32, 36.

economically regulated, and his experiences offer insight into the challenges presented by economic regulation. For example, under economic regulation, price competition among LTL carriers was limited and carriers could set their prices through collective ratemaking (i.e., sharing cost and price information with one another) without fear of legal prosecution. This meant that all LTL carriers charged the exact same prices for transporting shipments between any two points and when companies can't compete on price, they must compete on service. As such, one reason that the author's employer chose the name "AAA Trucking Corporation" was because it would be the first listing in a telephone book.

Beginning in the late 1970s, various sectors of the transportation industry experienced a reduction in economic regulation (also referred to as deregulation), and in 1985 the CAB went out of existence. The Interstate Commerce Commission was legislated out of existence in 1995, and its remaining economic regulatory functions were transferred to a new agency, the **Surface Transportation Board** (STB), which is affiliated with the Department of Transportation. Although the STB has primary responsibility for resolving railroad rate and service disputes and reviewing potential rail mergers, it continues to have some jurisdiction over motor carriers, domestic water transportation, and the rates and services of pipelines that are not regulated by the Federal Energy Regulatory Commission.[22]

From a logistics perspective, the economic deregulation of transportation is important because it has allowed transportation companies much greater freedom with respect to pricing and service options—two attributes that are at the heart of the tailored logistics concept. In addition, the economic deregulation that occurred in the United States spurred economic deregulation (sometimes called "liberalization") in many other countries. This movement has been particularly noticeable with respect to air transportation.

LEGAL CLASSIFICATION OF CARRIERS

Learning Objective 6

Although there has been a dramatic reduction in U.S. economic regulation since the late 1970s, the legal classification of carriers continues to be relevant. More specifically, transportation carriers are classified as either for hire or private, and for-hire carriers can be further subdivided into common, contract, and exempt carriers. The legal classification of carriers is important because of the varying levels of economic regulation that are applicable to the different carriers (for example, common carriers have more extensive economic regulation than contract carriers). However, all carriers, regardless of their legal classification, must comply with the relevant environmental and safety regulations.

The key factor that separates a **common carrier** from other forms of transportation is that the common carrier has agreed to serve the general public. To ensure that the general public is adequately serviced, common carriers assumed four specific obligations: to serve, to deliver, to charge reasonable rates, and to avoid discrimination in pricing and service. The service obligation means that common carriers are supposed to serve all customers who request service, so long as the commodity and origin/destination are within a carrier's scope of service. For example, a motor carrier that specializes in dry van, general freight service would not be expected to transport a shipment of liquid chemicals. Even though a company might not want to carry certain types of freight, its undesirability is not a legitimate reason to avoid the obligation to serve. To this end, in recent years the major U.S. freight railroads have tried to convince the Surface Transportation Board to waive their common carrier obligations associated with the transportation of hazardous chemicals such as chlorine.[23]

The obligation to deliver requires that a carrier provide timely pickup and delivery as well as ensuring that the delivered shipment is in the same condition as the picked-up shipment (i.e., the avoidance of lost or damaged freight). The obligation to charge reasonable rates has long been viewed as offering protection for both carriers and users; the idea of reasonable rates guards against

[22]http://www.stb.dot.gov/stb/about/overview.html

[23]John D. Boyd, "A Toxic Rate Battle," *The Journal of Commerce*, June 22, 2009, 62.

become important issues for many transportation companies. For example, United Airlines has improved its aircraft fuel efficiency by over 33% since 1994 and in 2016 began a three-year trial of sustainable aviation biofuel at Los Angeles International Airport.[15]

Safety Regulation

The **Department of Transportation (DOT)** is the U.S. federal government body with primary responsibility for transportation safety regulation. Although the DOT's safety responsibilities encompass all five modes of transportation, safety regulation of inland water carriers is primarily the responsibility of the U.S. Coast Guard, which is now part of the U.S. Department of Homeland Security. The key federal government safety agency for each mode, along with an example of its roles or responsibilities, will be discussed in the following paragraphs.

The Federal Aviation Administration (FAA) has primary responsibility for air transportation safety and strives to improve the safety and efficiency of aviation. One of the FAA's primary roles involves airspace and air traffic management and to this end the FAA operates airport towers and air traffic control centers.[16] The Federal Motor Carrier Safety Administration (FMCSA), a relatively new government agency, started operations in January 2000. It is focused on reducing crashes, injuries, and fatalities involving large trucks and buses. As such, the FMCSA focuses on strong enforcement of safety regulations; targeting high-risk carriers and commercial motor vehicle drivers; and improving safety information systems and commercial motor vehicle technologies.[17]

The Office of Pipeline Safety (OPS), which is part of the Pipeline and Hazardous Materials Safety Administration, is responsible for safety considerations for natural gas and liquid pipelines. The OPS has responsibility for establishing and enforcing regulations with respect to pipeline design, construction, and operation.[18] Among its myriad responsibilities, the Federal Railroad Administration (FRA) also has primary responsibility for safety in the U.S. railroad industry. The FRA employs approximately 400 safety inspectors who investigate five distinct disciplines, namely, hazardous materials; motive power and equipment; operating practices, including drug and alcohol issue; track structures; and signal and train control issues.[19] Finally, the U.S. Coast Guard (USCG) has three broad roles associated with marine (water) transportation, namely, safety, security, and stewardship. Prominent USCG safety roles include promoting safe boating practices, accident investigation, and licensing mariners.[20]

Economic Regulation

Economic regulation in transportation refers to control over business practices and activities such as entry and exit, pricing, service, accounting and financial issues, and mergers and acquisitions. Federal economic regulation of transportation in the United States, which began in the 1870s, was justified because of transportation's economic and social importance as well as a belief that transportation companies would not act in the public's best interest without government regulation.[21] Economic regulation resulted in the creation of two key economic regulatory bodies, the Interstate Commerce Commission (ICC), with authority over rail, motor, inland water, and oil pipelines, and the Civil Aeronautics Board (CAB), with authority over air transportation.

Although a comprehensive discussion of the economic regulation of transportation is beyond the scope of this text, one of the authors worked for an LTL company while the LTL industry was

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[15] www.united.com/web/en-US/content/company/globalcitizenship/environment.aspx

[16] http://www.faa.gov/about/safety_efficiency/

[17] http://www.fmcsa.dot.gov/mission/about-us

[18] http://www.phmsa.dot.gov/pipeline/about

[19] http://www.fra.dot.gov/us/content/3

[20] http://www.gocoastguard.com/about-the-coast-guard/discover-our-roles-missions/marine-safety

[21] Donald V. Harper, *Transportation in America,* 2nd ed. (Englewood Cliffs, NJ: Prentice Hall, 1982), Chapter 19.

or truck, and second-day service involving air or truck, among others. The size and weight limitations for packages shipped by UPS and FedEx are similar, with both carriers limiting package sizes to a maximum of 108 inches in length and 165 inches in girth. And while the maximum package weight for UPS and FedEx is 150 pounds, both carriers mandate special guidelines and procedures when shipping packages that weigh more than 70 pounds (UPS) or 75 pounds (FedEx).

Package services are also available from Greyhound Lines (called Greyhound Package Express), which is the primary intercity bus company in the United States. As is the case with UPS and FedEx, several service options are available for package delivery, such as direct drive (which uses dedicated vehicles) and standard service (where the packages travel in special compartments on the bus). Packages that are sent via Greyhound Package Express are limited to a maximum weight of 100 pounds.[13]

TRANSPORTATION REGULATION

Learning Objective 5

The five modes of transportation have been influenced, and continue to be influenced, by various types of regulation by federal, state, and local governments. You may not be aware, for example, that until 2007 commercial airline pilots in the United States faced mandatory retirement upon reaching 60 years of age (65 is now the mandatory retirement age for commercial pilots). Likewise, you might not be aware that there are very specific guidelines for the placement of lighting on truck trailers. The existence of these and other regulations have implications not only for transportation companies, but also for users of transportation companies because regulations can affect the effectiveness and efficiency of a user's logistics system. Indeed, regulation costs money—regulations need to be codified, and government agencies (regulatory bodies) exist to enforce the regulations.

Our discussion in this section will focus on federal regulation of transportation in the United States. We will look at environmental, safety, and economic regulation. However, before proceeding with this discussion, readers should recognize that the level and degree of transportation regulation varies from country to country. For example, many of the world's more industrialized economies have instituted fairly stringent regulations with respect to vehicle emissions (air pollution) from transportation equipment. In lesser economically developed countries, emissions regulations are much less stringent—if they exist at all. We are not here to judge the appropriateness or inappropriateness of transportation regulation in individual countries; rather, logisticians need to understand the relevant transportation regulations of the countries in which they conduct business as well as the cost and service implications of these regulations.

Environmental Regulation

The Environmental Protection Agency (EPA), a U.S. federal regulatory agency that was established to protect human health and the environment, influences transportation in a number of different ways. A major transportation-related concern of the EPA involves various types of pollution such as noise and air pollution. With respect to noise, the EPA is responsible for enforcing noise emissions from transportation equipment such as rail locomotives and truck tractors. In terms of air pollution, the EPA has mandated that rail locomotives and truck tractors must meet stringent emissions standards. With respect to locomotives, for example, EPA Tier 4 emission standards, which went into effect in 2015, required new locomotive engines to lower nitrous oxides emissions by approximately 75% compared to locomotive engines that went into service in 2005.[14]

The EPA is also quite concerned with resource conservation, and this is particularly germane in that transportation accounts for approximately two-thirds of the petroleum consumption in the United States. As such, improved fuel efficiency and reduced consumption of petroleum have

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[13]http://www.shipgreyhound.com/e/Pages/Faq.aspx#Ship_Q14

[14]Jessica Hardcastle, "GE's Tier 4 Locomotive Cuts Emissions More Than 70% without Aftertreatment," *Environmental Leader,* September 30, 2013, n.p.

include arranging for transportation, customs clearance, documentation, quarantine facilities, lab services, and custom-made animal containers, among others.

Shippers' associations perform basically the same function as surface and air freight forwarders, except that they do not operate as profit-making organizations. Shippers' associations are membership cooperatives where membership can be based on different considerations, such as shipping a particular commodity or commodities, belonging to a particular industry, or being located in a particular area. Although shippers' associations tend to be thought of as providing a large number of transportation-related services for their members (full-service associations), some shippers' associations are primarily focused on achieving the lowest rates for their members ("rate negotiator" associations). One example of a shippers' association is NASA (North American Shippers Association), which specializes in the transportation of beverages across the globe.[11] NASA, like many other shippers' associations, focuses on transportation cost savings for its members.

Brokers are another type of transportation specialist; they are companies that look to match a shipper's freight with a carrier to transport it. Brokers look to secure the best transportation rate and service package available for shippers, while attempting to ensure that carriers operate as close as possible to maximum capacity. Brokers can handle both LTL and TL shipments; those handling LTL shipments consolidate them and then turn them over to motor carriers, freight forwarders, or shippers' associations. With respect to TL shipments, brokers will retain a particular carrier and receive a portion of the transportation charges as compensation.

In some cases, third-party logistics (3PL) companies are involved in arranging transportation services. They try to find clients with complementary transportation needs so that equipment utilization can be increased, which should reduce transportation costs to the respective clients. As an example, one prominent 3PL was able to persuade Chrysler and Ford to share space on trucks that were delivering repair parts to both Chrysler and Ford dealerships in a particular geographic area. The 3PL was able to show both Chrysler and Ford that dedicated equipment (that is, equipment carrying only Chrysler or only Ford parts) led to additional equipment, additional shipments, and excess capacity for each party—thus increasing the costs of distributing the repair parts.

Much of the discussion up to this point has assumed that we are dealing with shipments that weigh at least several hundred pounds. We'll conclude our discussion of transportation specialists by looking at **parcel carriers**, companies that specialize in transporting parcels, which are often referred to as packages that weigh up to 150 pounds. Parcel shippers have a variety of potential options available to them, one of which is Retail Ground, a service of the U.S. Postal Service. Retail Ground has size (130 inches in combined length and girth) and weight (70 pounds) limitations, with transportation charges based on weight, distance, and shape.[12] In most cases, a parcel must be transported to the post office by the shipper, but it will be delivered to the receiver's actual mailing address.

Another option for parcel shippers is United Parcel Service (UPS), which financially dwarfs any other transportation company in the United States (2015 revenues of approximately $49 billion from package operations). UPS was able to attract customers in its early years because it offered certain services, such as automatic daily pickups, multiple delivery attempts, and the return of undeliverable packages, that were not available from competitors such as the U.S. Postal Service—and UPS was able to offer this service at rates that were competitive with the U.S. Postal Service. Unlike the U.S. Postal Service, UPS rates include both pickup and delivery, and today UPS offers a range of parcel services via several modes of transport, to include truck, rail, and air.

Whereas UPS started as a package delivery company that emphasized line-haul movement by truck and in the 1980s expanded into air transportation, Federal Express (now FedEx Express) started as a package delivery company that emphasized service by air transportation and later expanded into line-haul movement by truck. Both UPS and FedEx now offer package shippers service options that include same-day service involving air transportation, next-day service involving air

20-foot containers. Water ports, for example, are often ranked in terms of the number of TEUs that are handled in a particular period of time. Likewise, containerships are measured by the number of TEUs that can be carried, and containership capacity continues to increase over time. Consider that in the year 2000—a time when many of today's college undergraduates were younger than five years of age—the largest capacity containership was approximately 8,000 TEUs. By contrast, Mediterranean Shipping Company, a major ocean transportation company, began operating three *19,224 TEU* vessels during 2015.

Not only did the container revolutionize freight handling, it also spurred cooperation between various modes to develop more effective and efficient transport offerings, such as **land bridge services**. Rather than all water service between two ports, land bridge services involve the use of surface transportation—usually rail transportation—between the origin and destination port. Consider, for example, a shipment of pineapples from Hawaii to Europe. Rather than the shipment going by water from Hawaii through the Panama Canal and then on to Europe, under land bridge service, the pineapples would move by containership from Hawaii to a U.S. West Coast water port. From this port, the containers of pineapple would be placed on railcars and shipped across the United States to an East Coast port, where the containers would be loaded onto a vessel for continuation of the shipment to Europe. Although the land bridge adds to total transportation costs, the primary advantage to land bridge service is the reduction in total transit time from the origin to destination port.

TRANSPORTATION SPECIALISTS

Learning Objective 4

In addition to the five basic modes and intermodal transportation, a number of different transportation specialists can provide value-added services to prospective customers. We will discuss several transportation specialists in the paragraphs that follow. **Freight forwarders** are not modes, but from the shipper's viewpoint, they are analogous to other carriers. There are two types of domestic freight forwarders—surface and air—and they can best be thought of as consolidators of freight.

Surface carriers give volume discounts to customers shipping large quantities of freight at one time. For example, the LTL rate from city A to city B might be $5 per 100 pounds for shipments less than 20,000 pounds, whereas the TL rate might be $2 per 100 pounds when shipments of 20,000 pounds or more are tendered. Truckload rates are lower than LTL rates for three reasons: (1) the shipper loads the goods, and the consignee unloads the trailer; (2) the load goes directly from shipper to consignee without passing through terminals; and (3) paperwork, billing, and other administrative costs are little more for a 25,000-pound shipment than they would be for a 250-pound shipment.

The freight forwarder exists by offering a service to shippers that use LTL rates because they do not generate enough volume to use TL rates. Without the freight forwarder, the shipper has to use the $5 LTL rate. The freight forwarder, however, offers the same transportation service for a rate between the LTL and TL rate—say, $4 per 100 pounds. This is possible because the freight forwarder consolidates enough small shipments to reach a volume of at least 20,000 pounds and thus qualifies for the $2 per 100 pound TL rate. The freight forwarder typically offers pickup and delivery service but does not perform the line-haul service, which is done by motor carriers or railroads (in terms of intermodal service).

The air forwarding industry works with the air carriers and air forwarders to consolidate shipments and tender them in containers that are ready for aircraft loading. This results in significant ground-handling savings for the airlines. Therefore, airlines encourage forwarder traffic because it results in an agreeable division of labor: The forwarders provide the retailing function and deal with each individual shipper and consignee, and the airline concentrates on wholesaling, moving the forwarders' loaded containers among major cities.

Some forwarders specialize in certain cargoes. A common example is in the garment industry, in which many small garment firms send large numbers of a few garments each to retail shops in most large cities. The garment forwarders use special containers in which the garments are on hangers and thus ready for display on arrival. Some forwarders specialize in animals, and their services

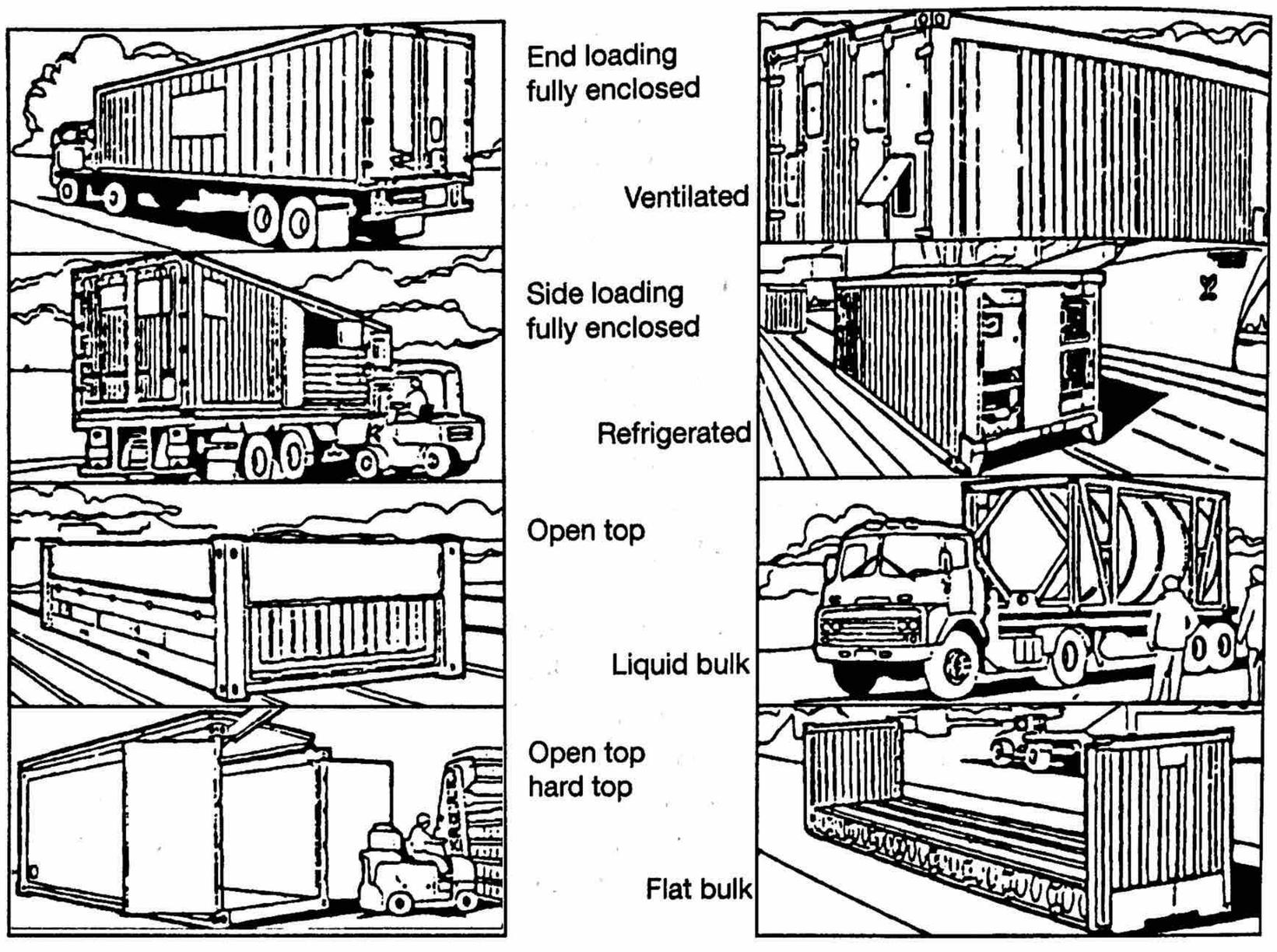

Figure 1 Various Types of Intermodal Surface Containers *Source: Ports of the World,* 14th edition, CIGNA Property & Casualty Companies.

mode without the contents being reloaded or disturbed.[10] With intermodal transportation, two or more modes work closely together in an attempt to utilize the advantages of each mode while at the same time minimizing their disadvantages. For example, a company might use **piggyback transportation,** that is, either truck trailer-on-flatcar or container-on-flatcar, to take advantage of rail's low transportation costs on the line-haul along with truck's ability to provide door-to-door service.

As evident in our defintion, the container is an important type of equipment in intermodal transportation. Containers are moved by mechanical devices such as container cranes, and companies need only handle a container and not the freight inside it—thus providing a dramatic reduction in freight handling costs. Because the container is interchangeable among rail, truck, and water carriers, containers can be used in intermodal applications and provide the advantages offered by each of several modes. Both ocean carriers and railroads have developed methods of handling multiple containers at one time, thereby reducing the number of individual lifting and storage moves.

Containers are generally 8 feet wide, 8 feet high, and between 10 and 53 feet long. Most containers are dry-cargo boxes, although some are insulated and come with temperature-controlling devices. Specialized intermodal containers are also available that carry tanks for holding liquids or gases as well as containers that hold insulated or refrigerated cargo. Figure 1 shows several different types of containers.

Air freight containers, often referred to as **unit load devices (ULDs),** are constructed of lightweight metals and come in different sizes. Unlike the containers in Figure 1, air freight ULDs have somewhat irregular shapes, dictated by the contours of the fuselage into which they must fit.

Although intermodal containers can range between 10 and 53 feet in length, a commonly used metric is **twenty-foot equivalent unit (TEU),** which stands for 20-foot equivalent unit. Volumes of intermodal traffic are commonly expressed as so many TEUs, meaning they would fill that many

[10]This definition comes from Barton Jennings and Mary C. Holcomb, "Beyond Containerization: The Broader Concept of Intermodalism," *Transportation Journal* 35, no. 3 (1995): 5–13.