FACTORS INFLUENCING PALLET MATERIAL SUBSTITUTION BY THE U.S. **GROCERY DISTRIBUTION INDUSTRY**

by

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(ABSTRACT)

Persons involved in pallet decisions at U.S. grocery distribution centers were surveyed to investigate the degree of material substitution, assess factors influencing pallet material substitution, and quantify consumer perceptions of wood pallets compared to substitutes. A total of 444 questionnaires were mailed nationwide. Underlying reasons for material substitution were investigated through in-depth interviews with 20 respondents.

Cost per use was considered by grocery distributors to be the most important factor when choosing a pallet to be sent downstream to their customers. Common advantages of solid wood pallets reported by respondents included: availability, low initial cost, durability/stability (the ability of the pallet to be racked and hold the necessary weight with little deflection), industry standard, ability to exchange, ease of repair. Common disadvantages of solid wood pallets reported by respondents included: easily damaged, short life, high repair and replacement costs, heavy, inconsistent construction, and damages product. Advantages of plastic pallets reported by respondents included: light weight, durability, longer life, true four-way entry, and ability to nest.

Plastic pallets were perceived to be superior to wood pallets in terms of overall performance, durability, and recyclability. Although 100 percent of the responding companies use solid wood pallets to ship goods to customers, approximately 20 percent of the companies also use plastic pallets (the dominant substitute pallet material) for this purpose. The common plastic pallet used by respondents was of the twin sheet thermoform type. The primary reason for switching to plastic pallets was perceived overall cost savings resulting from long pallet life.

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PREFACE

The thesis is organized into two separate manuscripts, each designed to focus on a specific aspect of the research effort. Because each article was formatted for publication purposes, a certain amount of duplication was unavoidable. Therefore, the organizational style may be somewhat redundant, and the author hopes this causes no inconvenience.

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1. PROBLEM STATEMENT AND JUSTIFICATION

The pallet and container industry is the largest market for hardwood lumber in the U.S. (Luppold 1988). An estimated 4.7 billion board feet of solid hardwood (lumber cants, parts, and shook) were consumed by this industry in 1992 (Hansen et al. 1993). Furthermore, when consumption of solid softwood (lumber cants, parts, and shook) for 1992 is combined with the hardwood consumption, the pallet industry used an estimated total of 6.9 billion board feet of solid wood in 1992. With an average of 17.3 board feet of lumber per pallet (McCurdy and Phelps 1991a), one can calculate that approximately 400 million solid wood pallets were produced in 1992. With the U.S. population at approximately 252 million people, this amounts to about 1.6 solid wood pallets produced for every man, woman, and child in the U.S. Not only is the pallet industry a major market for hardwood lumber, it is an industry that has been growing since World War II and, according to Hansen et al. (1993), Christoforo (1992), and McCurdy and Phelps (1992), is predicted to grow into the future.

The solid wood pallet is used by a countless number of industries including the grocery industry. The grocery industry is a major and important market for solid wood pallets because of the quantity of pallets it

uses. In 1985, the grocery and related products industry purchased 42 million standard 48 by 40-inch Grocery Manufacturers of America (GMA) solid wood reusable pallets (Anderson 1987a). This constituted 25 percent of the total 1985 reusable pallet production (Anderson 1987a). The grocery industry is also important to the pallet industry because it is a leader in the development of unit load handling (Strobel and Wallin 1969).

Traditional solid wood pallets¹ have dominated the pallet market in the past and continue to do so today. Competing products on the market include plastic, corrugated paperboard, metal, and wood composite pallets; however, their use is quite limited. A major study sponsored by the National Wooden Pallet and Container Association (NWPCA) and Modern Materials Handling Magazine found that 78 percent of the pallets purchased by users included in the study were wood, 10 percent were plastic, and the remaining 12 percent were wood composites, corrugated paperboard or metal (Anonymous 1993c). However, the USDC International Trade Administration (1992) reported that alternative shipping materials, including corrugated paperboard slipsheets, plastic, and metal pallets, have been pressuring sales of traditional wood pallets. They forecasted continued

¹A new or recycled wood pallet not owned by a third party. The most common style is a 48 by 40-inch stringer, non-reversible design GMA pallet.

This trend is also prevalent in today's grocery distribution industry. Current trends suggest that the grocery industry's reliance on wood pallets could be changing in response to high materials handling costs. A recent report concluded that current materials handling systems cost the grocery industry nearly 2 billion dollars annually, and many believe wood pallets contribute to a significant portion of that cost (Table 1.1) (Anonymous 1989). These unacceptably high costs are a signal that the traditional solid wood pallet is falling short of meeting the grocery industry's needs. To satisfy these unmet needs, some grocery distributors are investigating and even switching to alternative materials handling devices (plastic, corrugated paperboard, and wood composite pallets²).

Possible factors driving this trend toward material substitution include: rising lumber costs, advances in substitute material and processing technology, and life cycle cost analysis. In terms of rising lumber costs, Luppold (1993) states that lumber prices will probably not return to the lower prices that existed before 1991 because of reduced timber supplies and increased demand for lower grade lumber. According to Wilder (1991), advances in material and processing technology will increase the variety of plastic resin used in pallets. This could lead to lower production costs and ultimately lower plastic pallet prices. Pallet users today are beginning to

²The molded Inca pallet manufactured by Litco International.

look at life cycle cost analysis, the cost of a pallet from initial purchase to disposal (Auguston et al. 1990). Packaging wastes, including pallets, make up almost one-third of the total municipal solid waste stream; hence, they have been a prime target for restrictive landfill legislation (Figure 1.1). For example, increasing landfill fees and the refusal of some landfills to even take pallets have resulted in pallet disposal costs that are almost as high as the cost of a new pallet (Auguston 1990). The Costs to Operate the Grocery Industry Pallet System (a recent report by the Cleveland Consulting Associates) is another attempt to uncover the life-cycle cost of the traditional pallet in their system which is being used as a benchmark to evaluate substitutes (Anonymous 1989).

Unfortunately, very little information is available concerning reasons for material substitution in the grocery industry or perceptions of the various products. If the hardwood pallet is to remain the dominant force in the increasingly competitive grocery pallet market, producers must be aware of the factors influencing material substitution and make changes to meet the changing needs of pallet consumers. The research discussed in this thesis was conducted to provide this information.

Pallet Cost Impact	Manu- facturer	Public Warehouse	Carrier	Retailer and Wholesale	Total	Percent of Total
Damage	335.0	54.0	-	111.0	500.0	25.8
Carrier rate factor to cover lost or scrapped pallets	-	-	394.7	-	394.7	20.3
Pallet Purchase	185.3	61.1	-	114.2	360.6	18.6
Productivity Loss in Order Selection and Shipment Preparation	60.5	60.5	-	183.4	104.4	15.7
Sorting	61.0	20.1	-	52.1	133.2	6.9
Repair	14.9	4.9	-	86.4	106.2	5.5
Administration	14.3	4.7	29.3	16.1	64.4	3.3
Workers' Compensation	10.7	3.5	24.4	11.4	50.0	2.6
Exchange/Sorting Productivity Loss	11.1	7.4	-	7.9	26.4	1.3
Total Direct Cost	692.8	216.2	448.4	582.5	1,939.9	100.0
Percent of Total	35.7	11.2	23.1	30.0	100.0	

Table 1.1. Dry grocery pallet system costs (millions of dollars)

Source: Anonymous (1989)



Source: Auguston et al. (1990)

Figure 1.1 Composition of the Waste Stream in the United States

2. OBJECTIVES

The overall objective of the study was to identify factors influencing pallet material substitution by the U.S. grocery distribution industry and to predict changes in the use of substitute materials for pallets. This study also quantified consumer perceptions of various pallet materials. The information was designed to help solid wood pallet manufacturers make changes in the traditional hardwood pallet to meet the changing needs of consumers and society. Specific objectives were as follows:

- Determine the factors contributing to grocery distributors' demand for pallets made from substitute materials.
- Determine grocery distributors' perceptions of substitute material pallets including plastic, corrugated paperboard, and wood composite pallets.
- Determine the grocery distributors' trends in substitute material pallet use by region and type of operating organization served.
- Investigate and predict changes in the use of substitute material pallets by grocery distributors.

3. REVIEW OF LITERATURE

PALLET INDUSTRY

Introduction

A pallet is a platform, traditionally made of wood, used for storage and/or movement of packages by a mechanical device, typically a forklift or pallet jack (Eichler 1976).

The pallet industry, using 38 percent of the total U.S. hardwood consumption in 1991(Luppold 1991), is the largest single market for hardwood lumber (Luppold 1988). In terms of markets for all sawn wood, it ranks second behind the construction industry (Martens 1989b). Furthermore, Hansen et al. (1993) reported that the pallet industry has been growing since World War II and continues to grow today.

History

The introduction of mechanical lifts in the 1920's stimulated the use of pallets (Panshin 1962). However, pallets were not used extensively in materials handling systems until World War II (1940s) when there was a major logistics problem of economically moving large quantities of supplies

and materials to the battlefields. It was this enormous problem which promoted the use of pallets and forklifts (Orr 1990). The time and money saved from using pallets and forklifts promoted the use of more than 90 million pallets during the war (Panshin 1962).

Size and Distribution

In 1991, there were approximately 2,180 pallet producing firms in the United States (USDC International Trade Administration 1992). According to McCurdy and Phelps (1991a), the number of pallet producing firms has increased by more than one-third since 1980. The distribution of pallet producing firms varies by region. The East North Central region (as defined by the Bureau of the Census) has the most firms while the Mountain Region has the fewest (McCurdy and Phelps 1991a). According to Brindley (1984), pallet manufacturers tend to locate where there is an ample supply of lumber and unskilled labor, a region called the "Pallet Belt". This region includes Virginia, North Carolina, Kentucky, Tennessee, Missouri, Arkansas, and segments of bordering states.

Pallet Production

Approximately 460 million pallets were produced in 1990, and production increased 67 percent in the 10 years between 1980 and 1990 (McCurdy and Phelps 1991a). Forty-one percent of the pallet producing firms in the industry recycled used pallets in addition to producing new pallets in 1991. These firms, on-the-average, recycled 90,000 used pallets annually (USDC International Trade Administration 1992).

Pallet Characteristics

Raw Material

Approximately 4.7 billion board feet of hardwood and 2.2 billion board feet of softwood lumber, cants, parts, and shook were consumed by the pallet and container industry in 1992 (Hansen et al. 1993). According to McCurdy and Phelps (1991a) an average of 17.3 board feet of lumber is used for each pallet produced. Oak was the largest species group consumed by the pallet industry in 1992. It accounted for 39.6 percent of total hardwood use in 1992, while other major species include yellow poplar and alder (Hansen et al. 1993). Total consumption of hardwood lumber, cants, parts, and shook was expected to increase 6.6 percent through 1994 (Hansen et al. 1993).

In 1992, southern yellow pine accounted for 40 percent of the of total softwood consumption by the pallet and container industry followed by Douglas-fir with 28.8 percent (Hansen et al. 1993). Overall, softwood use was expected to increase by 9.6 percent through 1994 (Hansen et al. 1993).

Size and Type

According to McCurdy and Phelps (1992) there are over 300 different sizes of pallets manufactured in the U.S. and the number of different sizes of pallets has greatly increased during the past 10 years (McCurdy and Phelps 1991a). The most common pallet size is the 48 by 40-inch pallet which accounts for 33 percent of all pallets produced. This pallet is typically used by the grocery industry (McCurdy and Phelps 1992). The most frequently manufactured pallet in 1980, 1985 and 1990 was a flush stringer, double-faced, non-reversible design pallet (McCurdy and Phelps 1992).

Classes

The two classes of pallets are *expendable* and *non-expendable*. Expendable pallets are designed for and discarded after a single use. Nonexpendable (also called multiple-use or reusable) pallets are used repeatedly

for approximately one year and contain approximately fifty percent more wood than expendable pallets (McCurdy and Ewers 1985). The NWPCA defines multiple-use as a pallet with an average minimum life to first repair of 10 trips. In 1982, half of the pallets produced in the U.S. were expendable, and the rest were non-expendable (McCurdy and Ewers 1985). In terms of species for expendable and non-expendable pallets, softwoods were used primarily in expendable pallets while hardwoods were most often used in non-expendable pallets (McCurdy and Ewers 1985).

Markets and Marketing of Wood Pallets

More than 40 percent of the pallet producing firms in 1990 sold pallets to the food, chemical/fluids, paper/fiber, steel/metal, and printing industries (McCurdy and Phelps 1992). Other major markets for pallets include the military, suppliers of military goods, and the automotive industry (Orr 1990). According to Anderson (1987a) over 25 percent of the reusable pallets produced in 1985 were purchased by the grocery and related products industry.

Pallet producing firms typically sell their pallets mill direct, but sometimes a broker/wholesaler is used. Although only 12 percent of the total pallet production was sold using a broker/wholesaler in 1990, the use of this method has been increasing over the past 10 years (McCurdy and

Phelps 1991a). According to McCurdy and Phelps (1991a) pallets were usually sold in the region that they were produced and sold for an average of six dollars.

Changes in Products Produced

A major change within the industry has been in the quantity of raw material used in pallet manufacturing. In the last 20 years, the average volume of lumber contained in a pallet has decreased from 20 board feet to about 13 board feet (Martens 1989a) due in part to a decrease in the thickness of pallet part sizes. This volume appeared to be inconsistent when compared to the 17.3 board feet reported by McCurdy and Phelps (1991a). A major reason for this change was the introduction of engineering methods such as the Pallet Design System (PDS). With PDS, pallets can be designed to meet specific levels of performance with regard to load, deflection, racking resistance, and number of trips until first repair. Major benefits of this system include reduced lumber and fastener costs and reduced manufacturer's potential liability should the pallet fail in service (Sinclair 1992).

Changes in Raw Material

The pallet industry has seen many changes in the form of raw material used since the 1940s. In the late 1940s pallet material was mostly low grade (*#* 2 and *#* 3 common), random-width, random-length hardwood boards obtained from hardwood sawmills producing lumber for the furniture industry (Martens 1989b). In locations where hardwoods are scarce, softwood lumber has been substituted (Martens 1989b). Also during the 1940s, hardwood sawmills began manufacturing lumber in 4-, 6-, and 8-inch widths (pallet grade material) to reduce waste generated from using random-width lumber (Martens 1989b).

During the 1960s, there was a trend toward vertical integration between the pallet and grade mills and the use of 4-, 6-, and 8-inch cants in pallet mills and sawmills (Martens 1989b). Vertical integration allowed mills to produce both high grade and low grade lumber, where the high grade material went to the furniture industry while the low grade went to the pallet industry. The use of 4-, 6-, and 8-inch cants increased production and efficiency in the sawmill because the log spent less time at the headsaw (Martens 1989b).

The 1970s were marked by the concept of going directly from roundwood to pallets parts. As raw material supplies tightened, there was

an increase in the number of bolter and scragg mills that produced pallet parts from pulpwood bolts (Martens 1989b).

During the 1980s, some pallet producers eliminated the log by switching to tree-length material (Martens 1989b). Using tree-length material allowed the stems to be crosscut to length or multiples of the length of pallet parts to be produced. The benefits of using tree length included: eliminating end trim waste, increasing volume yield, and facilitating handling through multiple scragg saws, gang ripsaws, or other multiple sawing operations (Martens 1989b). According to Martens (1989b), the use of tree length material should continue to increase as an economical way of obtaining necessary supplies.

Changes in Price and Availability of Hardwood Pallet Material

Hardwood lumber prices have been increasing according to Luppold (1993) and others (Brindley 1993a, Luppold and West 1992). Increasing prices are due, in part, to increasing demand of the raw material from other markets and to technological advances in grade mill equipment (Luppold and West 1992).

The markets for low grade material include pulp, composite products, and hardwood flooring industries; all of which are experiencing growth (Luppold and West 1992). Technological advancement in grade mill equipment now allows higher quality lumber to be made from lower grade logs. The end result is a decreased supply of lower quality lumber available to the pallet industry (Luppold and West 1992). In terms of environmental legislation, Luppold (1993) stated that it has increased the cost of logging on public and private lands which will ultimately affect the price of sawlogs.

Regarding lumber prices, Luppold (1993 p.26) stated:

"Hardwood demand, supply, and price have always been cyclical however, reduced timber supplies combined with increased demand for lower grade lumber and timber will mean that relative prices of lower grade hardwood lumber probably will not return to the relatively low level that existed prior to 1991."

MATERIAL SUBSTITUTION

Introduction

Wood pallets have traditionally dominated the unit load market because they have provided the best value in terms of performance for the price (Brindley 1993b). A study sponsored by the NWPCA and Modern Materials Handling showed that 78 percent of the 1992 pallets purchased by users included in the study were wood, 10 percent were plastic, and the remaining 12 percent were wood composite, corrugated paperboard or metal (Anonymous 1993c).

Although wood pallets continue to dominate the unit load handling market, recent trends in hardwood lumber prices and the prices of substitute materials suggest that wood's market share will change. According to Brindley (1993b), the price of substitute material pallets (plastic, corrugated paperboard, and metal) could decrease due to increases in production efficiencies. This decreasing price differential between solid wood pallets and substitute material pallets allows more room for substitute materials to enter the market (Brindley 1993b). According to Kotler (1991 p.222), "close substitutes are defined in economic terms as products with high cross elasticity of demand. If the price of one product rises and causes the demand for another product to rise, the two products are close substitutes."

Substitutes (Description, Markets, Advantages, Disadvantages)

Each pallet material is unique in terms of construction, uses, and various advantages and disadvantages (Table 3.1). The next section gives a general overview of the different substitutes along with uses, advantages, and disadvantages.

Plastic Pallets

Plastic resins (polystyrene and polyethylene) may be formed into a pallet by a variety of processing techniques. These techniques include foam molding, injection molding, and thermoforming. The foam molding technique uses a low pressure injection molding process that produces a solid outer layer and a foam center. The advantage of this process is that it provides good design flexibility.

Injection molding uses high pressure to produce a pallet with narrower wall sections than structural foam; the rib design of this pallet provides its strength. One advantage of the pallet produced by this process is its light weight.

Thermoforming uses heat, vacuum, and pressure to shape sheets of resin on a mold (Jacoby 1994). An advantage of this process is that it offers many low-cost lightweight designs (Anonymous 1986). It is also typically less expensive than the injection molding process because thermoforming uses less resin (Jacoby 1994).

 Table 3.1.
 Relative properties and applications of wood and non-wood pallets.

Material	Durability*	Repairable	Environmental Impact	Typical Applications
Wood	Medium	Yes	Material is biodegradable and recyclable	Grocery, Automotive Durable Goods Hardware
Wood composite Fiber	Medium	Yes	Recyclable and can be burned with out leaving fuel residues	Printing, Metal Stampings Plumbing Fixtures Building Materials
Corrugated Fiberboard	Low	No	Biodegradable and recyclable	One-way shipping applications in:Grocery Lightweight-paper products Industrial parts
Plastic	High	No	Material is recyclable	Captive or closed loop systems, FDA and USDA applications, Automotive

* Durability is defined as expected number of trips.

Source: Auguston (1990)

Plastic pallets are predominantly used in the food, pharmaceutical, textile, high-technology, and automotive industries. Examples of plastic pallet brands include Retailer[™], by Cadillac Products, and the Loudon pallet. The Retailer[™] is a twin-sheet thermoformed, high density polyethylene Plastic pallets are predominantly used in the food, pharmaceutical, textile, high-technology, and automotive industries. Examples of plastic pallet brands include Retailer[™], by Cadillac Products, and the Loudon pallet. The Retailer[™] is a twin-sheet thermoformed, high density polyethylene pallet. It is 40 x 48-inches with true four-way entry, weighs 18 lbs, and has a dynamic load capacity of 3,000 pounds (Anonymous 1993d). The Loudon plastic pallet is a structural foam molded, high density polyethylene product. The pallet has true four-way entry and a dynamic load capacity of 4,000 lbs (Anonymous 1994b).

Suggested advantages of some plastic pallets include: long pallet life, reduced load damage, USDA and FDA clearance, reduced worker injury, chemically inert, moisture proof, no harboring for pests, and design advantages (Anonymous 1986). Since plastic pallets usually cost more than their substitutes, maintaining ownership of the pallet after each trip is critical to the economics of the plastic pallet. Therefore, the pallet is most often used in a closed-loop shipping system (Anonymous 1986). Disadvantages of some plastic pallets include: initial cost and deflection under load (White 1988). The price for a solid molded plastic pallet can range from 30 to 80 dollars whereas solid wood pallet prices range from 3.5 to 25 dollars (Anonymous 1993b). Because HDPE (High Density

Polyethylene) has a lower elastic modulus than wood, aluminum or steel, pallets made of this material will experience greater deflection than other materials under similar loads (White 1988).

Corrugated Paperboard Pallets

Corrugated paperboard pallets are another alternative to the solid wood pallet in some uses. This product is marketed to meet a large number of one-way shipping needs (Anonymous 1993a). Some users of corrugated paperboard pallets include manufacturers of foam products, electrical components, and plastics (Anonymous 1986). The automotive and grocery industries are also users of this product.

Corrugated paperboard pallets are manufactured and branded by several companies. One of these companies, the Corrugated Pallet Corporation, claims that one of its corrugated pallets can be racked and transported over most conveyer systems; however, other less expensive corrugated paperboard pallet models are not suitable for current warehouse racking systems.

Corrugated paperboard pallets are perceived to be advantageous because they are 100 percent recyclable, light weight (which saves money on freight, increases productivity, and reduces personal injury), clean, and sanitary (Auguston 1990). The corrugated paperboard pallet is one of the

few alternatives that conform to the lifting requirements recommended by The National Institute for Occupational Safety and Health (Anonymous 1993b). They can be custom manufactured to fit the exact dimensions of the intended load and have a low initial cost that can range from 3 to 8 dollars (Anonymous 1993b). Disadvantages of some corrugated paperboard pallets include a load limitation of 1500 lbs and no weather resistance.

Wood composite pallets

Wood composite pallets, composed of wood fibers and resin, typically are used in the printing, grocery, and building materials industries. Litco International, Inc. manufactures one such pallet which is designed for warehousing and shipping applications. The pallet designed for the grocery industry is a four-way entry, solid deck pallet with nine feet. The recommended use for this pallet is order selecting in the warehouse for a closed-loop operation. Claimed advantages of this pallet are its light weight, ability to nest, recyclability, lack of nails (reducing the potential for product damage), and load capacity of up to 2,500 pounds (Anonymous 1993d).

In general, the advantages of wood composite pallets include relatively low initial cost (\$4.75 to \$6.75), fairly low weight (30 to 42 lbs.),

ability to nest, and full four-way entry. Disadvantages include difficulty of repair, susceptibility to damage from forklift impact, and tendency to absorb moisture (Auguston 1990).

Plastic Pallet Market Trends

Prices of plastic resin have a major impact on the plastic pallet market. The availability of relatively inexpensive resin during the late 1960s sparked the growth of the plastic pallet market. However, the 1973 oil embargo almost brought this growth to a standstill. Plastic pallets experienced a rebirth in the 1980s for several reasons. First, some companies began to look at packaging as a part of direct production cost rather than fixed overhead. Second, there was an increasing use of robots and automatic palletizers which require pallets to be of uniform size and weight. Third, increased awareness and regulation of plant sanitation became an issue (Anonymous 1986).

According to a study conducted by General Electric Plastics, four percent of the estimated 500 million pallets produced in 1990 were made of molded plastic (Wilder 1991). According to a NWPCA and Modern Materials Handling study, ten percent of pallet purchases by respondents were plastic in 1992 (Anonymous 1993c). Also, Dow Chemical states that the market

for injection molded pallets and containers is growing at a rate of seven to eight percent per year (Wilder 1991).

A wide range of industries are reported to be interested in converting to plastic material handling items (Wilder 1991). The reasons for this interest include: reusability, ability to design a material to meet desired characteristics, and the potential for recyclability.

Corrugated Paperboard and Wood Composite Pallet Market Trends

Corrugated paperboard and wood composite pallets have made some inroads into the pallet market, but to a lesser extent than plastic pallets. According to a study sponsored by NWPCA and Modern Materials Handling (Anonymous 1993c), 13 percent of pallet users included in the study used plastic pallets in 1992, six percent used corrugated paperboard pallets and eight percent used wood composite pallets. In another study, pallet buyers indicated that 12 percent of their purchases in 1992 were composite, corrugated paperboard, or metal (Anonymous 1993c).

THE GROCERY INDUSTRY

Introduction

The grocery industry is a major user of wood pallets. In 1985, 42 million reusable pallets were purchased by the grocery and related products industry (Anderson 1987a). This amounted to 25 percent of the total reusable pallet production in 1985 (Anderson 1987a). As stated previously, the grocery industry is also important to the pallet industry because it is a leader in the development of unit load handling (Strobel and Wallin 1969).

The grocery industry is considered to be very competitive: "competition is the constant of the supermarket industry." (Anonymous 1994a). According to a survey of persons involved in the grocery industry, the biggest problem impacting sales is competition (Anonymous 1994a). A portion of the competitive pressure is coming from clubs and mass merchandisers (e.g. Wal-Mart and Kmart) which are growing (Anonymous 1994a). Cutting total supply chain costs for products is one way companies plan to improve their competitiveness and profitability. The Joint Industry Pallet Subcommittee (a group of manufacturers, wholesalers, and retail members representing the Food Marketing Institute, Grocery Manufacturers of America, and National-American Wholesale Grocers' Association) is one example of how serious this industry is about making changes in the current

pallet system to cut costs (Thornton 1993). The purpose of this committee was to study the costs of the current grocery pallet exchange system along with alternatives and to make recommendations (Appendix A).

History of Unit Load Handling in the Grocery Industry

In 1960, the food industry adopted the use of wood pallets and forklifts for unit load handling as a cost cutting measure (Eichler 1976). Cutting costs was vital to this industry because they typically operate on a one-percent profit margin. In 1962, a pallet-exchange program involving manufacturers and distributors was added to the unit load handling system. With the help of the NWPCA' and a study of The European Pallet Exchange Program, several major U.S. food manufacturers and distributors instituted a pallet exchange program among their processing plants, sales warehouses, and customers (Eichler 1976). The program consisted of a 48 by 40-inch, four-way wood pallet along with a fork-lift and specialized rail car and truck trailer equipment (Eichler 1976).

Also in 1962, "push paks" were introduced (Eichler 1976). The equipment for this unit load handling system included a forklift with special attachments and a flat sheet of cardboard called a slipsheet. This unit load handling technique eliminated transporting pallets to the distribution center. Unitized goods were loaded on slip sheets and transferred to distribution
centers. At the distribution center, forklifts with special attachments were able to retrieve the unit load and place it on a pallet that belonged to the distribution center. In 1964, the clamp-truck was introduced. This system also eliminated shipping pallets to the distribution center. This special equipment allowed floor loaded unitized goods to be unloaded from the truck and placed on a pallet in the distribution center.

Structure of Grocery Distribution

Pallets typically travel through three segments of the grocery industry; the manufacturing plant, distribution center, and retail store. The second segment, the distribution center, serves three basic types of operating organizations: corporate chains, voluntary groups, and cooperative groups. A corporate chain is defined as one company that operates more than 11 retail stores (Anonymous 1994a p.8). A voluntary group is "a number of retailers who have voluntarily decided to adhere to a particular wholesaler's supply and service program in order to carry on a useful, integrated food merchandising program." (Anonymous 1994a p.8). A cooperative group is "a number of retailers (generally independents - an operator of fewer than 11 retail stores) who are stockholding members of a cooperative wholesale buying group." (Anonymous 1994a p.8). The distribution center that serves a corporate chain is typically owned by that company. The distribution

center that serves a cooperative or voluntary group is typically owned by a wholesaler.

Of all the types of operating organizations, the corporate chain is the largest in terms of number of stores and sales. Corporate chains serve 17,690 stores that have \$204.3 billion in sales and control 52.9 percent of the total sales volume in 1992. On the other hand, cooperatives and volunteer groups, combined, have 12,710 stores that have \$171.0 billion in sales and control 44.7 percent of the total sales volume in 1992 (Anonymous 1994a).

Pallet Use in Grocery Distribution

The transfer of pallets in the grocery industry can be divided into two parts: the upstream and downstream loops. In industry terms, the transfer of pallets from manufacturer to distribution center is called the upstream, or manufacturer, loop. The second part, the transfer of pallets from the distribution center to the retail store, is called downstream, or store, loop.

The majority of pallets used in the grocery industry (including downstreaming) today consist of the wood stringer design and are managed by a basic exchange system (Shaw 1994a). During the exchange the receiver gives the shipper a quantity of empty pallets equal to the number of full pallets received. Ninety percent of all dry groceries are moved on the traditional 48 by 40-inch GMA reusable pallet (Anonymous 1992). This standard pallet is used for all grocery products except dairy, health and beauty aids, slow-moving items, and automated meat and frozen food storage systems (Anderson 1987a).

There are a variety of ways in which pallets enter the distribution center. They are as follows: direct or indirect purchase from a pallet manufacturer, exchange with grocery vendor, exchange with other distribution centers, or exchange with retail stores served by distribution center. The carrier may deliver products on pallets, slip sheets, or floorloading devices. Regardless of what the product is shipped on, it is stored in the distribution center on pallets. (Anderson 1987a).

Grocery distributors directly purchase new and used pallets from a pallet manufacturer or indirectly purchase them by buying the pallet under a unit load of goods when a carrier delivers it to a distribution center. The number of pallets purchased in each manner varies among distribution centers. The price of directly and indirectly purchased pallets is negotiated with pallet manufacturers (Anderson 1987a).

Pallets are exchanged with grocery vendors and retail stores when the truck unloads palletized goods. The quality of the pallets present in the distribution center is dependent on the quality of the pallets received during an exchange. Typically, the quality of the pallets that the distribution center

possesses decreases with exchanges (Anderson 1987a). In the downstream loop, pallets are exchanged with retail stores when the truck unloads palletized goods. Typically, bread trays, milk trays, and paper bails are loaded into the empty trailer and returned to the distribution center to be sorted (Anderson 1987a).

Pallets are also exchanged when a distribution center picks up a backhaul. A backhaul is an efficient and profitable way for the distribution center to obtain palletized goods. Instead of trailers returning to the distribution center empty after they deliver goods to the retail outlet, the trailer (carrying a sufficient number of empty pallets to exchange with the manufacturer) proceeds from the retail outlet to a nearby manufacturing plant for product pickup. Since the distribution center provides their own transportation, they will typically receive a discount on the price of the goods (Anderson 1987a).

Grocery manufacturers are increasingly using slipsheets. The use of slipsheets eliminates pallet exchange between the manufacturer and distributor because goods arrive at the distribution center on slipsheets instead of pallets. Once the product on the slipsheet arrives at the

distribution center, a forklift with special attachments is able to place the unitized goods including the slipsheet onto one of the distribution center's pallets. The elimination of pallet exchange allows the distribution center to maintain better control over the quality of their pallets (Anderson 1987a).

Pallet Problems in the Grocery Industry

A recent report by Cleveland Consulting Associates (Anonymous 1989) stated that current materials handling systems cost the grocery industry nearly two billion dollars annually in product damage, carrier inefficiency, and pallet purchase, sorting, and maintenance costs (Anonymous 1989) (Table 3.2). Many authors report that wood pallets and the current management system contribute to these high materials handling costs. Some product damage is the result of the uneven design of the traditional wood pallet (Anonymous 1992). When a pallet load of product is stacked upon another, the top pallet applies pressure in certain points to the bottom load. This direct heavy pressure has the potential to break the case of goods and cause product damage.

Key Data Description	Manufacturers	Wholesalers/Retailers
Pallet Life (years)	1.5(1)	1.7(1)
Pallets in System (millions)	44.7	37.4
New Pallet Cost (Dollars)	6.92	6.55
Used Pallet Cost (Dollars)	4.72	4.42
Repair Cost (Doliars)	1.88	2.05
% Requiring Repair/Year	17.8	112.7
Pallet Load Turns/Year	4.4	5.4
Cases/Pallets	61.0	63.0
Pallets/Load	27.9	21.0
Note: ⁽¹⁾ Probably overstated because outside carriers purchase a portion of pallets needed prior to shipment pick-up; manufacturers and wholesalers are not aware of these pallet additions		

Table 3.2Characteristics of pallets in the grocery industry by industry
segment

Source: Anonymous (1989)

According to the article, Review of Costs to Operate the Grocery Industry Pallet System (Anonymous 1989), pallets contribute to carrier inefficiency because carriers waste time trying to find acceptable pallets. This inefficiency increases trucking costs by 18 percent. This article also stated that pallet purchases contribute to these high costs (Anonymous 1989). The grocery industry has 100 million pallets in inventory where the value of new replacements is between \$600 and 700 million. These pallets stated that pallet purchases contribute to these high costs (Anonymous 1989). The grocery industry has 100 million pallets in inventory where the value of new replacements is between \$600 and 700 million. These pallets have an average life of 1-1/2 years and make an average of 5 shipment cycles. According to Shaw (1994a), wood pallets have a short life because they have to be repaired after a few trips.

The current pallet management system is thought to contribute to the high costs of sorting and maintaining pallets. E. Dean Werries, Chairman of Fleming Company and Chairman of Food Marketing Institute, stated "there are no built-in incentives for anyone to contribute good and standard pallets to the system." (Merrefield 1990 p.49). After a pallet exchange between grocery manufacturers and distributors, the distributor may end up with many substandard pallets (Garry 1993).

The grocery industry is also seeing an unacceptable level of costs in injures resulting from cumulative trauma (Garry 1994, Shaw 1994b). Injuries sometimes occur with wood pallets because they are heavy and awkward to handle (Anonymous 1992) Creating ergonomically correct work places is one way the grocery industry is trying to fight these costs (Garry 1994, Shaw 1994b). For example, the grocery industry's GMA pallet design committee states that an ergonomically correct pallet should weigh no more than 50 pounds.

Traditionally, the low initial cost of a wood pallet has been its major selling point, however, this can be misleading (Auguston et al. 1990, Brindley 1993b). In some areas of the country, the cost of wood pallet disposal is almost as much as the initial purchase price (Auguston et al. 1990).

The produce industry is suffering from a slightly different problem due to their usage of disposable softwood pallets (Blackwood 1991). Because these pallets do not resemble the GMA pallet in terms of size and material, they cannot be used in the distribution system and are, therefore, discarded. Many chain store warehouses will not accept these disposable pallets and sometimes require unit loads to be transferred onto GMA pallets before they are received into the warehouse (Mejia 1991). The problem is that disposal costs of softwood pallets have skyrocketed; therefore, the produce industry is interested in using reusable pallets and possibly substitute materials (Blackwood 1991).

Garry (1993) believed these high materials handling system costs are symptoms of a bigger problem, part of which was an inadequate pallet design and management. The Pallet Subcommittee concluded that all pallets on the market today fall short of economically meeting the grocery industry's needs (Garry 1993). Because the traditional wood pallet is falling short of meeting the grocery industry's needs, retailers and wholesalers are

looking at their growing pallet alternatives in both substitute materials and pallet management systems to possibly meet their needs (Garry 1993).

Perceptions and Use of Plastic Pallets

Material substitution has occurred in the downstream sector of the grocery industry, and, according to Garry (1993) and Shaw (1994a), several grocery chains are either currently using or testing plastic pallets for downstream shipments. Users see several advantages in plastic pallets. They are considered to be safer, easier to store, more cost effective, guaranteed to last for a certain number of years, more efficient unit load handling devices, and can be recycled into new pallets (Garry 1993). One warehouse manager believes plastic pallets as compared to wood are safer for employees because they weigh only 20 pounds and do not possess lose boards and nails. Plastic pallets are also considered to be easier to store because they can nest inside one another (Garry 1993). Plastic pallets could be more cost effective because they can a longer life span than wood pallets and lower repair costs (Shaw 1994a). In fact, at least one plastic pallet manufacturer guarantees their pallets for two years (Garry, 1993).

Some grocery distributors believe plastic pallets provide more efficient unit load handling because they have true four-way entry. The true fourway entry allows pallets to be loaded and unloaded with a pallet jack or a

hand jack from either the 40- or 48-inch side (Anonymous 1991). Some claims are made concerning the recyclability of plastic pallets. For example, one person involved with grocery distribution believes that when plastic pallets are unusable they can be recycled to make new pallets, and they can be produced from virtually any type of recycled plastic material (Blackwood 1991).

Disadvantages of some plastic pallets include initial price, risk of losing the pallet, sliding problems, sanitation, and durability. Plastic pallet prices average between 20 and 30 dollars each, which is considerably more expensive than a wood GMA pallet at approximately seven dollars (Garry 1993). Some people involved in grocery distribution believe that the risk of losing a plastic pallet is much greater than a solid wood pallet because of the high initial price of the plastic pallet (Garry 1993); therefore, plastic pallets are most feasible in a closed loop system (Millstein 1993). Others believe that some of the earlier plastic pallets had slick surfaces which caused loads to shift in the truck. Grocery distributors expressed concern over sanitation and durability of the plastic pallets because the cups in some plastic pallets can collect debris and attract bugs.

Perceptions and Use of Other Substitute Pallets

Another potential substitute for the traditional solid wood pallet is a wood composite pallet. Currently, this type of pallet has little market acceptance; however, a wood composite pallet that is currently undergoing testing by some grocery companies weighs 30 pounds, provides six to eight trips, stores and transfers easily, and costs six dollars (Garry 1993).

Yet another alternative material pallet is the corrugated paperboard shipping platform. Like the wood composite pallet, this potential substitute has limited market acceptance. The pallet is a "one-way" platform used for shipping goods from suppliers to wholesalers to retail stores. Although the pallet is not yet widely used, some believe that they will find a niche for unit loads of 1,500 pounds or less, which constitute half of the loads transported by the food industry (Garry 1993).

Potential advantages of the corrugated paperboard shipping platform include light weight (approximately 12 lbs) and potential overall cost savings. They could eliminate the need for pallet repair and pallet management which could result in overall cost savings for grocery distributors (Anonymous 1991).

The corrugated paperboard pallet is not without its disadvantages. First, the initial price of the platform is too high (Garry 1993). Jim Blaser (Executive Vice President, Cleveland Consulting) stated, "If someone could

come up with a disposable pallet in the 3 to 4 dollar range, I think it would have great appeal to the industry" (Alaimo 1990 p.33). The inability to rack the pallet is another major disadvantage of some corrugated paperboard pallets. However, if a support system is installed in a rack, the shipping platforms will have the ability to be racked for loads under 1,500 pounds (Garry 1993). This is a feasible option as some believe that racks should be restructured anyway for safety reasons (Alaimo 1990).

Although the variety of substitute material pallets are growing, some users prefer using one type of pallet that can be racked all the way through the distribution cycle. Sid Portwood (Senior Warehouse Consultant, Safeway Inc.) stated, "We don't want to use two or three different pallets that complicates the issue." (Garry 1993 p.73).

Substitute Management Systems

Third party pallet management systems are one possible solution to part of the pallet management problem. Two of the pallet management companies that provide services to the grocery industry are CHEP (Commonwealth Handling Equipment Pooling) U.S.A. and First National Pallet Rental. CHEP U.S.A. operates by leasing high quality pallets to grocery manufacturers at a daily rate. Once the pallet is transferred to the distribution center, the manufacturer is charged a transfer fee, and the pallet

is used by the distribution center free of charge. The distribution center is only liable for the loss of the pallet.

First National Pallet Rental works in a somewhat similar way. The grocery manufacturer is charged a fixed rental rate plus a refundable deposit. Manufacturers get the deposit back when the pallet is transferred to the distribution center. When the distribution center receives this pallet a refundable deposit is charged. The distribution center is refunded this deposit back when the pallets are returned to a First National Pallet Depot.

A major advantage of third party systems is that all the expense and problems of pallet exchange is eliminated because pallets never get exchanged. According to Shaw (1994a) third party pallet management has been a growing trend for upstream distribution between grocery manufacturers and retailers or wholesalers because it provides high quality pallets to the system. For example, one major grocery store chain urges its suppliers to use third party pallets (Mejia 1992).

LITERATURE CITED

- Alaimo, Dan. 1990. One-way shipping platforms urged. Supermarket News 40(27):33.
- Anderson, Bruce R. 1987a. Pallet use in the grocery industry. Pallet Enterprise 6(6):20-23.
- Anonymous. 1994a. Progressive Grocer's Marketing Guidebook. Trade Dimensions. Stamford, Connecticut.
- Anonymous. 1994b. Loudon Plastics, Inc. Promotional literature. Lantham, New York
- Anonymous. 1993a. A corrugated alternative offered to compliment wood. Pallet Enterprise 13(4):44-47.
- Anonymous. 1993b. Selection guidelines for pallets and slipsheets. Modern Materials Handling 48(13):42-44.
- Anonymous. 1993c. A report on pallet use and applications among buyers of materials handling systems. Research Report. Washington, DC: National Wood Pallet and Container Association in cooperation with Modern Materials Handling Magazine.
- Anonymous. 1993d. Pallets: a process of evolution. Grocery Distribution Magazine 18(5):9-24.
- Anonymous. 1992. Summary of subcommittee findings and recommendations on the grocery industry pallet system. Produce Marketing Association. Newark, Delaware.
- Anonymous. 1991. New lighweight pallet may be near. Supermarket News 41(4):14-15.
- Anonymous. 1989. Review of costs to operate the grocery industry pallet system. Cleveland Consulting Associates.

- Anonymous. 1986. Wiley Encyclopedia of Packaging Technology. John Wiley & Sons, Inc., New York, NY.
- Auguston, Karen A. 1990. Pallet trends: loads of options for the 90s. Modern Materials Handling 45(5):52-56.
- Auguston, Karen, Nancy Staples, and Janine Weston.1990. Packaging in the '90s, the environmental impact. Modern Materials Handling 45(7):52-57.
- Blackwood, Francy. 1991. Disposable pallet cause for concern. Supermarket News 41(23):35.
- Brindley, Ed. 1993a. Lumber in 1993. Pallet Enterprise 12(2):48.
- Brindley, Ed. 1993b. Changes in the wooden pallet industry. Pallet Enterprise 13(10):52
- Brindley, Ed. 1984. Pallet markets in the United States. Pallet Enterprise 3(6):3-5.
- Christoforo, John. 1992. Wood-Based Material Use in the U.S. Pallet and Container Industry:1991 and 1993. Masters thesis. Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Eichler, John R. 1976. Wood pallet manufacturing practices. Eichler Associates. Cape Coral, Florida.
- Garry, Michael. 1994. It's not weird science. Progressive Grocer 73(1):67-74.
- Garry, Michael. 1993. Pallet-able alternatives. Progressive Grocer 72(2):71.
- Hansen, Eric, Robert Bush, and John Punches.1993. Wood materials use in the U.S. pallet and container industry:1992-1994. Center for Forest Products Marketing. Department of Wood Science and Forest Products. Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Kotler, Philip. 1991. Marketing Management. Prentice Hall. Englewood Cliffs, New Jersey.

- Jacoby, Jim. 1994. Cadillac Products Inc. Troy Michigan. Personal conversation 6/15/94.
- Luppold, William. 1993. Why are hardwood lumber prices so high? Will they remain high? Pallet Enterprise 13(3):24,26.
- Luppold, William and Cynthia West. 1992. Factors influencing price and availability of hardwood pallet material. In: The Lumber Source. 1992, p2-3. Pallet Enterprise 12(6).
- Luppold, William. 1991. Annual Hardwood Symposium. Proceedings: Twenty-First Annual Hardwood Symposium of the Hardwood Research Council. May 24-26 pp 11-24.
- Luppold, William. 1988. Current trends in the price and availability of pallet lumber. Pallet Enterprise 8(5):30-32.
- Martens, David G. 1989a. Changing characteristics of the pallet industry. Pallet Enterprise 9(7):22-24.
- Martens, David G. 1989b. Raw material use in the pallet industry. Pallet Enterprise 9(6):40-42.
- McCurdy, Dwight R. and James T. Ewers. 1985. The U.S. Pallet Industry. Pallet Enterprise 4(6):8-12.
- McCurdy, Dwight R. and John E. Phelps. 1992. Trends in the U.S. pallet industry: 1980, 1985, and 1990. Forest Prod. J. 43(1):1-4.
- McCurdy, Dwight R. and John E. Phelps. 1991a. The pallet industry in the United States 1980, 1985, 1990. Department of Forestry. Southern Illinois University at Carbondale. Carbondale, Illinois.
- Millstein, Marc. 1993. Urgent need is seen to solve pallet problems. Supermarket News 43(19):66.
- Mejia, John. 1992. A & P asks its suppliers to use 3rd-party pallets. Supermarket News 42(32):36.

- Mejia, John. 1991. Throwaway pallets should be tossed. Supermarket News 41(9):38.
- Merrefield, David. 1990. Wood pallets may be on way out. Supermarket News 40(4):49.
- Orr, Thomas E. 1990. Pallet material needs and future markets. Proceedings: Eighteenth Annual Hardwood Symposium of the Hardwood Research Council. May 6-9 pp 35-43.
- Panshin, A.J., E.S. Harrer, J.S. Bethel, and W.J. Baker. 1962. Forest Products Their Sources, Production, and Utilization. McGraw-Hill Book Company New York.
- Shaw, Russell. 1994a. Plastic and other more durable pallet designs are gaining converts. Supermarket News 44(15):1,12-13.
- Shaw, Russell. 1994b. Ergonomics in motion. Supermarket News 44(8):1,12.
- Sinclair, Steven A. 1992. Forest Products Marketing. McGraw-Hill Book Company, New York.
- Strobel, John J. and Walter B. Wallin. 1969. The unit-load explosion in the food industry. Research paper NE-121. U.S. Forest Service, Northeastern Forest Experiment Station, Broomall, PA.
- Thornton, Meg. 1993. Forging new links in the grocery supply chain. Pallet Enterprise 13(2):34-36.
- USDC International Trade Administration. 1992. U.S. industrial outlook '92, Washington, D.C.
- Wilder, Robert V. 1991. Conservation ethic aids cause of plastic pallets. Modern Plastics 68(13):45-47.
- White, Marshall. 1988. The wood pallet vs. the competition. Presentation transcript of National Wood Pallet and Container Association, Regional Roundup Meeting. Detroit, MI, Oct. 28.

4. METHODS

SECONDARY DATA

A thorough review of literature was performed to provide background information on the pallet and grocery industries. Key sources for this review included journal articles, trade magazine articles, promotional literature, and government publications. Computerized databases such as Infotrac and Dialog were also used to extend the literature search. Marketing research and research methodology texts assisted in the development of the methods.

PRIMARY DATA

Research Design

The survey method of descriptive research was used in the first portion of this study. The purposes of the descriptive research were as follows: 1) to estimate the percent of grocery distribution companies (a key retailer or wholesale company operating within a market area) using substitute material pallets (plastic, corrugated paperboard, and wood composite) in 1994 and to predict use for 1997; 2) to quantify consumer (persons involved in their company's pallet decisions) perceptions of solid wood pallets as compared to substitute material pallets on various factors;

3) identify critical factors grocery distributors consider when selecting pallet types to ship goods downstream; and 4) to estimate the percent of grocery distribution companies using third party pallet management programs. Respondents were surveyed using a questionnaire which consisted of openended, fixed-alternative, multichotomous questions, and questions using rating scales.

In the second portion of the study, exploratory research was performed through in-depth interviews to gain insight and understanding of factors influencing material substitution. In-depth interviews are unstructured personal interviews in which the interviewer attempts to get subjects to talk openly and express their true feelings about a particular topic (Malhotra 1993).

The in-depth interviews utilized open-ended questions in order to facilitate the probing process. Specific questions included asking the respondent why they have switched to a substitute or why they are thinking about switching to a substitute, and their opinion of third party pallet management systems. Respondents were also asked what they like and dislike about the wood pallet, and how it can be improved.

Sample Frame and Sampling

The population for this study included all persons in the U.S. grocery distribution industry whose distribution center sends pallets downstream to their customers, and who are involved in their company's pallet decision. The sample frame for the descriptive portion of the study was the Progressive Grocer's Marketing Guidebook (1994). The key distribution personnel listed in this guidebook were the desired respondents. Progressive Grocery's Marketing Guidebook (1994) lists approximately 300 companies operating distribution centers across the U.S. Companies with at least one percent market share in terms of sales or sales of at least \$35 million are listed in the book.

Judgement sampling was used in the descriptive portion of the study. Judgement sampling is a form of convenience sampling in which population elements are selected based on the researcher's judgement (Malhotra 1993). The criteria for inclusion were title and location. An attempt was made to have at least one person from each distribution center listed in the 1994 Progressive Grocer's Marketing Guidebook included in the sample. If an appropriate person was not listed for a distribution center, a phone call was made to obtain the desired person's name and other information. To reach a desired sample size of approximately 450, all persons with the appropriate titles (director of distribution, distribution manager, etc.) were included in the

included in the sample (i.e. a census of the sample frame). In cases where only personnel of very high ranks were listed, a phone call was made to get the name of a person (at a lower level) who would also be involved in their company's pallet decisions and include him/her in the sample. This was done because the researcher believed that lower ranking personnel would also be involved in this industrial buying decision. Because larger companies typically have more employees and more levels of management, it is possible that the sample included more people representing larger companies.

Before the questionnaire was mailed to 444 persons involved in their company's pallet decisions, it was pretested in person with a convenience sample. The convenience sample consisted of five desired respondents who were located in close proximity to the interviewer. The pretest resulted in minor modifications to improve the clarity of the questions.

The sample frame for the exploratory part of the study consisted of survey respondents who had switched to or were considering switching to a substitute pallet material. Due to budget limitations, the selection area for respondents was limited to the south, midwest, and northeast regions of the U.S. Respondents were interviewed in each of the three regions resulting in a total of twenty interviews.

Data Collection, Response Rate, and Data Preparation

Of the 444 questionnaires mailed, 245 returned questionnaires were usable for further analysis. This resulted in a usable response rate of 55 percent. Usable questionnaires were questionnaires answered by decisionmakers in the grocery distribution industry whose company sends pallets downstream to their customers. Unusable questionnaires included questionnaires from respondents whose company does not send pallets downstream to stores and questionnaires that were returned to sender (less than 1 percent of the total). Data preparation included editing, coding, transcribing, and cleaning the data.

Profile of Respondents

In general, the location of the respondents was dispersed between the northeast, south, midwest, and west (Figure 4.1). Furthermore, all types of operating organizations served by distribution centers were represented by respondents (Figure 4.2). Approximately 69 percent of the respondents reported that company annual sales for 1992 were at least one billion dollars while the remaining 31 percent reported annual sales below one billion dollars.

The titles of respondents varied greatly, and the majority of the respondents were managers. Respondents also held the titles of director,

vice president, other, and CEO (Figure 4.3). On a scale of 1 (No influence) to 7 (Final decision-maker), respondents reported a mean response of 5.67 in terms of their ability to influence their company's choice of pallet types, thereby indicating that the desired respondents were reached. The title that had the most influence in their company's choice of pallet types was CEO (mean response of 7.0) followed by vice president (mean response of 6.6), director (mean response of 6.1), manager (mean response of 5.3) and other (mean response of 4.2).

Study Bias

Mail Survey Bias

A non-response bias check was performed to determine if survey respondents differed from non-respondents. To test for non-response bias, a random sample of 36 non-responding grocery distribution decision-makers were contacted by telephone and asked to rate plastic pallets on overall performance. Company size (measured in 1992 company sales) and geographic region (based on Bureau of the Census Regions) for each non-respondent, was obtained from a secondary source. Both the parametric t-test (p = .324) and the non-parametric Mann-Whitney U (p = .212) statistical tests indicated no differences between respondents and non-respondents on overall performance of plastic pallets. Both the parametric t-test (p = .464)

and the non-parametric Mann-Whitney U (p = .242) statistical tests indicated no differences between respondents and non-respondents on company size. The Chi -Square test procedure revealed no association between regions and response (p = .188). Consequently, non-response bias was not considered a problem with the data.

In-Depth Interview Bias

A non-response bias check was performed to determine if the interviewees differed from non-interviewees. To test for bias, company sales and type of operating organization served were collected from a secondary source and compared for each group. Both the parametric t-test (p = .236) and the non-parametric Mann-Whitney U (p = .399) statistical tests indicated no differences between interviewees and non-interviewees on company size. The Chi -Square test procedure revealed no association between type of operating organization served and interview type (p = .244). Consequently, interview bias was not considered a problem with the data.



Figure 4.1 Percent and number of respondents by geographic region (based on Bureau of the Census Regions)



Figure 4.2 Percent of respondents serving each type of operating organization



Figure 4.3 Percent of respondents indicating each title

LITERATURE CITED

Anonymous. 1994a. Progressive Grocer's Marketing Guidebook. Trade Dimensions. Stamford, Connecticut.

Malhotra, Naresh. 1993. Marketing Research. Prentice Hall, Englewood Cliffs, New Jersey.

5. TRENDS IN SUBSTITUTE MATERIAL PALLET USE IN GROCERY DISTRIBUTION

(For potential submission to the Forest Products Journal)

ABSTRACT

Trends in pallet material substitution in the U.S. grocery distribution industry were investigated through 444 mailed questionnaires and 20 interviews with persons involved in pallet decisions at grocery distribution centers. Results indicate all companies (100 percent) are using solid wood pallets for sending goods downstream to their customers, while some companies are also using substitutes (plastic, corrugated paperboard, and wood composite pallets). Plastic is the most common substitute material and is used by approximately 22 percent of the responding companies. The commonly used plastic pallet is the twin-sheet thermoform type. Many respondents claim that their ultimate reason for switching to plastic pallets is cost savings resulting from long pallet life. In the future, the majority of companies plan to continue using solid wood pallets while the rate of plastic pallets use is estimated to double by 1997. Some respondents claim that their company will continue to increase the use of third party pallets in the upstream distribution loop (manufacturer to distributor) and plastic pallets in the downstream (distribution center to retailer) loop as a way to cut total distribution costs.

INTRODUCTION

The pallet and container industry is the largest market for hardwood lumber in the U.S. (Luppold 1988). An estimated 4.7 billion board feet of solid hardwood (lumber cants, parts, and shook) were consumed by the industry in 1992 (Hansen et al. 1993). When consumption of solid softwood (lumber cants, parts, and shook) for 1992 is combined with hardwood consumption, the industry used an estimated total of 6.9 billion board feet of solid wood in 1992. Using an average of 17.3 board feet of lumber per pallet in 1990 (McCurdy and Phelps 1991a), one can calculate that approximately 400 million solid wood pallets were produced in 1992. With the U.S. population at approximately 252 million people, this amounts to about 1.6 solid wood pallets produced for every man, woman, and child in the U.S. Not only is the pallet industry a major market for hardwood lumber but it is an industry that has been growing since World War II and, according to Hansen et al. (1993), Christoforo (1992), and McCurdy and Phelps (1992), is predicted to grow into the future.

Traditional solid wood pallets have dominated the pallet market in the past and continue to do so today. Competing products on the market include plastic, corrugated paperboard, metal, and wood composite pallets; however, their use is limited. A major study sponsored by the National

Wood Pallet and Container Association (NWPCA) and Modern Materials Handling Magazine found that 78 percent of the pallets purchased by users included in the study were wood, 10 percent were plastic, and the remaining 12 percent were wood composites, corrugated paperboard or metal (Anonymous 1993c).

The solid wood pallet is used by a countless number of industries including the grocery industry. The grocery industry is a major and important market for solid wood pallets because of the quantity of pallets it uses. In 1985, the grocery and related products industry purchased 42 million standard 48 by 40-inch GMA solid wood reusable pallets (Anderson 1987a). This amounts to 25 percent of the total reusable pallet production in 1985 (Anderson 1987a). The grocery industry is also important to the pallet industry because it is a leader in the development of unit load handling (Strobel and Wallin 1969).

Current trends suggest that the grocery industry's reliance on wood pallets could be changing in response to high materials handling costs. A recent report concluded that current materials handling systems cost the grocery industry nearly \$ 2 billion annually, and many believe wood pallets contribute to a significant portion of that cost (Anonymous 1989). These unacceptably high costs are a signal that the traditional solid wood pallet is falling short of meeting the grocery industry's needs. To satisfy these

unmet needs, some grocery distributors are investigating and even turning to alternative materials handling devices (plastic, corrugated paperboard, and wood composite pallets). The USDC International Trade Administration (1992) also reported that alternative shipping materials including (corrugated paperboard slipsheets, plastic, and metal pallets, have been pressuring sales of traditional wood pallets, and they forecasted continued pressure over the next five years, assuming continued growth in the U.S. economy.

Unfortunately, very little information is available concerning reasons for material substitution in the grocery industry or perceptions of the various. products. If the hardwood pallet is to remain the dominant force in the increasingly competitive grocery pallet market, producers must be aware of the factors influencing material substitution and make changes to meet the changing needs of pallet consumers. The objectives of this study were to identify substitute material pallet use for shipping goods downstream from grocery distributors to customers, to investigate the reasons for use of substitute materials and products, and to predict trends in substitute material use by the industry.

BACKGROUND

The Grocery Industry

The grocery industry is notorious for being highly competitive and exhibiting low profit margins. "Competition is the constant of the supermarket industry" (Anonymous 1994a p.16). Competitive pressure, in some cases, is coming from the growing number of clubs and mass merchandisers (e.g. Wal-Mart and Kmart) which has had a devastating impact on supermarket sales (Anonymous 1994a). Traditionally, supermarket sales have grown at about six percent a year, but, in 1992, supermarket sales grew only 2.1 percent (Anonymous 1994a). In comparison, the grocery industry had average annual growth of 5.3 percent between 1986 and 1991(Anonymous 1994a).

To improve competitiveness and profitability, some companies are looking for ways to cut costs. For example, the Joint Industry Pallet Subcommittee (a group of manufacturers, wholesalers, and retail members representing the Food Marketing Institute, Grocery Manufacturers of America, and National-American Wholesale Grocers' Association) was recently formed to evaluate the current pallet situation and make recommendations concerning the improvement of the distribution system to ultimately cut costs (Thornton 1993). One area of potential savings is in

materials handling. Specifically, companies are reevaluating their use of wood pallets and considering alternatives with perceived lower costs.

The grocery industry traditionally uses a 48 by 40-inch stringer, nonreversible design GMA pallet in its system. Ninety percent of all dry groceries are moved on this type of reusable pallet (Anonymous 1992). This standard pallet is used for all grocery products except dairy, health and beauty aids, slow-moving items, and automated meat and frozen food storage systems (Anderson 1987a).

Pallets typically travel through three segments of the grocery industry: the manufacturing plant, the distribution center, and the retail store. The second segment, the distribution center, serves three basic types of operating organizations: corporate chains, voluntary groups, and cooperative groups. A corporate chain is defined as one company that operates more than 11 stores (Anonymous 1994a). A voluntary group is "a number of retailers who have voluntarily decided to adhere to a particular wholesaler's supply and service program in order to carry on a useful, integrated food merchandising program" (Anonymous 1994a p.8). A cooperative group is "a number of retailers (generally operating less than 11 retail stores - i.e., independents) who are stockholding members of a cooperative wholesale buying group" (Anonymous 1994a p.8). The distribution centers in each category predominately receive and ship goods on pallets; however, there is

no trading of pallet between distribution centers serving the various groups.

Of the three types of organizations, the corporate chain is the largest in terms of number of stores and total sales volume. Corporate chains serve 17,690 stores in the U.S. which accounted for \$204.3 billion in sales in 1992 and control 52.9 percent of the total sales volume (Anonymous 1994a). Cooperatives and volunteers, combined, have 12,710 stores, had 1992 sales of \$171.0 billion in sales, and control 44.7 percent of the total sales volume (Anonymous 1994a).

To understand the reasons for substitution and the problems with pallets, one must first understand how the grocery distribution industry acquires and uses pallets.

Pallet Movement in the Grocery Industry

Pallets are constantly moving between grocery manufacturers, distributors, and retailers. A trailer typically carrying palletized unit loads typically moves groceries from a grocery manufacturer to a distribution center receiving dock. This segment of the distribution channel is commonly called "upstream". Typically, the goods are FOB (Free On Board) distribution center. In other words, the distribution center does not take title until goods of the desired specifications are delivered to the center. The truck driver is responsible for unloading the palletized goods with the distribution center's materials handling equipment. It is the receiver's duty to make sure that the incoming load of goods meets the specifications of the sale. These specifications usually include noting that the correct product and flavor of product has been received, each palletized load has the correct quantity of cases, the cases are stacked at the correct height, and the pallet is considered "good".

The pallet that enters the distribution center at this point is either an exchange pallet, a third party rental pallet, or a pallet purchased by the distribution center. When pallets enter the distribution center under the pallet exchange management system, the carrier (truck driver) takes back as many pallets as were accepted by the distribution center under load. Sometimes, the busy receiver will spot a bad pallet entering the distribution center and refuse to exchange a good pallet for the bad pallet attempting to be exchanged. When this situation occurs the carrier will receive as many good pallets accepted by the distribution center minus any pallets that were rejected. Typically, the receiver is too busy to police all the inferior pallets entering the distribution center. The pallets obtained by the carrier in an exchange are either owned by the carrier or the manufacturer (from whom they have just obtained palletized groceries). If the pallets are owned by the manufacturer, it is the duty of the carrier to make sure the pallets are returned.
Pallets entering the distribution center as part of a third party rental system are not owned by the manufacturer or distributor. Instead, they are owned by an outside company that is responsible for repair and maintenance. These pallets flow one-way from the manufacturer to the distribution center and occasionally to the retail store. Because of this oneway flow and third party ownership, the carrier is not responsible for transporting pallets back to the manufacturer. Sometimes pallets are purchased by the distribution center from vendors that do not have a pallet exchange system (for example paper supplies).

Once the palletized goods are determined to meet the distribution center's desired specifications, a forklift driver places the palletized loads in a rack storage system. Racks are metal structures typically 23 feet high that have five vertical slots. Order selection occurs on the bottom two slots while the upper slots are used for storage. Typically, unitized pallet loads will be double stacked on the top slots.

The next phase of grocery distribution involves order selection. Typically, workers called "order selectors" ride double pallet electric jacks to a computer to receive a merchandise order print out. The order specifies product, quantity, and the length of time it should take to fill the two pallets. Next, the order selector rides the electric jack to either a pallet dispensing machine or a stack of pallets to put pallets on the electric jack; some

warehouses have this piece of machinery and some do not. A pallet dispensing machine is an approximate \$35,000 piece of equipment that contains stacked pallets which are fed out two at a time onto a pallet jack. One purpose of this machine is to take the manual handling out of placing pallets on the electric jack. In warehouses that do not contain this piece of equipment, order selectors go to stacks of pallets and throw two pallets onto the floor next to each other. Then the order selector drives the pallet jack into the openings of the pallets. In either case the order selector drives to the appropriate slots to collect and stack the cases on the pallets. When the order is completed, each pallet contains an average of 70 cases of various products and is taken to the outbound shipping area.

When pallets in the rack bins are emptied, the pallets are usually inspected and moved to the appropriate storage area in the warehouse. If they are in good condition, they are either placed back in the centrally placed pallet dispensing machine, put in stacks throughout the distribution center to be used again for order selecting, placed on the receiving dock for exchanges, or sold to outside companies. If they are in poor condition, they are sent to be repaired either in house or by an outside contractor. In some cases both outside and inside repair facilities may be used depending on the types of repair needed.

Outbound or downstream shipment of goods usually takes place in the evening, and the majority of products going to retail stores leave on pallets. Today, there are three ways that pallets are typically loaded into the trailer. First, pallets can be loaded exclusively on their 40-inch face which allows 22 palletized unit loads to be floor loaded in the trailer. Second, pallets can be loaded on the 40-inch face alternated with the 48-inch face (pinwheeling) which results in 4 extra pallets on a trailer. Even before the concept of pinwheeling started, it was typical for the distribution center to squeeze one last palletized load of product on the truck on the 48-inch face. Finally, 102-inch wide trailers allow pallets to be loaded exclusively on their 48-inch face which results in a total of 28 palletized unit loads per trailer.

From the distribution center, the palletized loads of product move downstream to the retail store. At the retail store, the palletized goods are unloaded with a hand jack. When the traditional four-way pallets are loaded into the trailer by a forklift on its 48-inch face it presents a major problem at the retail store using a hand jack. The hand jack is unable to enter the 48inch side of the pallet if it is not a true four-way pallet because the openings are not wide enough for the forks. The operator will typically attempt to turn the pallet with the tines of the hand jack to get it around to the 40-inch face to enter it properly.

After the trailer arrives at the retail store, the driver either picks up a salvage trailer (a trailer containing empty pallets, bread trays, and other recyclables) and returns to the distribution center where these items are sorted, returns the trailer empty to the distribution center, or proceeds to a manufacturing plant to pick up palletized goods for transport back to the distribution center.

The process of a trailer proceeding to a manufacturing plant to pick up palletized goods for transport back to the distribution center is typically called a "backhaul." Because the distribution center is picking up a product from a manufacturer located close to the retail store, the distribution center is able to save money in product transportation costs. The distribution center typically receives a discount from the manufacturer on the product because the distribution center is actually transporting the product. A trailer that makes a "backhaul" usually carries enough wood pallets to exchange with the manufacturer upon receipt of palletized goods. If the manufacturer does not participate in a pallet exchange program, the discount that they would receive for providing their own transportation is offset by the cost of the pallets which they had to buy because of an absence of a pallet exchange.

Pallet Problems in the Grocery Industry

Many people involved in the grocery distribution industry consider the traditional pallet, along with its management system, to be a contributing factor to the unacceptably high costs associated with materials handling (Garry 1993). A report by Cleveland Consulting Associates (Anonymous 1989) stated that current materials handling systems cost the grocery industry nearly \$2 billion dollars annually in product damage, carrier inefficiency, pallet purchase costs, and pallet sorting and maintenance costs (Anonymous 1989).

According to a recent report by the Produce Marketing Association (Anonymous 1992), some product damage was the result of the bottom surface of the traditional wood pallet. When loaded pallets are stacked, the bottom surface of the top pallet applies pressure in certain points on the bottom unitized load. This direct heavy pressure has the potential to break the case of goods and cause product damage.

The report by the Cleveland Consulting Associates (Anonymous 1989) stated that pallets contribute to carrier inefficiency because carriers waste valuable time trying to find acceptable pallets. This inefficiency increased trucking costs by 18 percent (Anonymous 1989). This report also stated that pallet purchases contribute to these high costs. The grocery industry has 100 million pallets in inventory, and the value of new replacements is between \$600-700 million (Anonymous 1989). These pallets have an average life of 1-1/2 years or 5 shipment cycles (Table 5.1). According to Shaw (1994a), wood pallets have a short life because they have to be repaired after a few uses.

Table 5.1	Characteristics	of pallets	in the	grocery	industry	by	industry
	segment						

Key Data Description	Manufacturers	Wholesalers/Retailers				
Pallet Life (years)	1.5(1)	1.7(1)				
Pallets in System (millions)	44.7	37.4				
New Pallet Cost (Dollars)	6.92	6.55				
Used Pallet Cost (Dollars)	4.72	4.42				
Repair Cost (Dollars)	1.88	2.05				
% Requiring Repair/Year	17.8	112.7				
Pallet Load Turns/Year	4.4	5.4				
Cases/Pallets	61.0	63.0				
Pallets/Load	27.9	21.0				
Note: (1) Probably overetated because outside carriers purchase a portion of nallets needed prior to shipment						

Note: ⁽¹⁾ Probably overstated because outside carriers purchase a portion of pallets needed prior to shipment pick-up; manufacturers and wholesalers are not aware of these pallet additions

Source: Anonymous (1989)

The current pallet management system may contribute to the high cost of sorting and maintaining pallets. E. Dean Werries, (Chairman of the Fleming Company and Chairman of Food Marketing Institute) stated, "There are no built-in incentives for anyone to contribute good and standard pallets to the system." (Merrefield 1990 p.49). Because there is no incentive for anyone to contribute a good pallet to the system typically the distributor ends up with many inferior and unusable pallets (Garry 1993).

The grocery industry is also seeing an unacceptable number of injures resulting from cumulative trauma (Garry 1994, Shaw 1994b). Injuries sometimes occur with wood pallets because they can be heavy and awkward to handle (Anonymous 1992) Such injuries result in costs to the industry and have prompted the industry to create more ergonomically correct work places (Garry 1994, Shaw 1994b). For example, the grocery industry's GMA pallet design committee states that an ergonomically correct pallet should weigh no more than 50 pounds (Anonymous 1992).

Traditionally, the low initial cost of a wood pallet has been its major selling point (Brindley 1993b). However, more purchasers are beginning to think in terms of life cycle cost. In some areas of the country, the cost of

disposal of a wood pallet is almost as much as the initial cost (Aguston et al. 1990). This has created some dissatisfaction in terms of life cycle cost.

The grocery industry's Pallet Subcommittee concluded that all pallets on the market today fall short of economically meeting the grocery industry's needs. Because the traditional wood pallet is falling short of meeting the grocery industry's needs retailers and wholesalers are looking at their growing pallet alternatives in both substitute materials and pallet management systems to possibly meet their needs (Garry 1993).

METHODS

Research Design

The survey method of descriptive research was used in the first portion of this study. The purposes of the descriptive research were as follows: 1) to estimate the percent of grocery distribution companies (a key retailer or wholesale company operating within a market area) using substitute material pallets (plastic, corrugated paperboard, and wood composite) in 1994 and to predict use for 1997; and 2) to estimate the percent of grocery distribution companies using third party pallet management programs. Respondents were surveyed using a questionnaire which consisted of open-ended, fixed-alternative, multichotomous questions, and questions using rating scales.

In the second portion of the study, exploratory research was performed through in-depth interviews to gain insight and understanding of factors influencing material substitution. In-depth interviews are unstructured personal interviews in which the interviewer attempts to get subjects to talk openly and express their true feelings about a particular topic (Malhotra 1993).

The in-depth interviews utilized open-ended questions in order to facilitate the probing process. Specific questions included asking the

respondent why they have switched to a substitute or why they are thinking about switching to a substitute, and their opinion of third party pallet management systems.

Sample Frame and Sampling

The population for this study included all persons in the U.S. grocery distribution industry whose distribution center sends pallets downstream to their customers, and who are involved in their company's pallet decision. The sample frame for the descriptive portion of the study was the Progressive Grocer's Marketing Guidebook (1994). The key distribution personnel listed in this guidebook were the desired respondents. Progressive Grocer's Marketing Guidebook (1994) lists approximately 300 companies operating distribution centers across the U.S. Companies with at least one percent market share in terms of sales or sales of at least \$35 million are listed in the book.

Judgement sampling was used in the descriptive portion of the study. Judgement sampling is a form of convenience sampling in which population elements are selected based on the researcher's judgement (Malhotra 1993). The criteria for inclusion were title and location. An attempt was made to have at least one person from each distribution center listed in the 1994 Progressive Grocer's Marketing Guidebook included in the sample. If an

an appropriate person was not listed for a distribution center, a phone call was made to obtain the desired person's name and other information. To reach a desired sample size of approximately 450, all persons with the appropriate titles (director of distribution, distribution manager, etc.) were included in the sample (i.e. a census of the sample frame). In cases where only personnel of very high ranks were listed, a phone call was made to get the name of a person (at a lower level) who would also be involved in their company's pallet decisions and include him/her in the sample. This was done because the researcher believed that lower ranking personnel would also be involved in this industrial buying decision. Because larger companies typically have more employees and more levels of management, it is possible that the sample included more people representing larger companies.

Before the questionnaire was mailed to 444 persons involved in their company's pallet decisions, it was pretested in person with a convenience sample. The convenience sample consisted of five desired respondents who were located in close proximity to the interviewer. The pretest resulted in minor modifications to improve the clarity of the questions.

The sample frame for the exploratory part of the study consisted of survey respondents who had switched to or were considering switching to a substitute pallet material. Due to budget limitations, the selection area for respondents was limited to the south, midwest, and northeast regions of the

U.S. Respondents were interviewed in each of the three regions resulting in a total of twenty interviews.

Data Collection, Response Rate, and Data Preparation

Of the 444 questionnaires mailed, 245 returned questionnaires were usable for further analysis. This resulted in a usable response rate of 55 percent. Usable questionnaires were questionnaires answered by decisionmakers in the grocery distribution industry whose company sends pallets downstream to their customers. Unusable questionnaires included questionnaires from respondents whose company does not send pallets downstream to stores and questionnaires that were returned to sender (less than 1 percent of the total). Data preparation included editing, coding, transcribing, and cleaning the data.

Profile of Respondents

In general, the location of the respondents was dispersed between the northeast, south, midwest, and west (Figure 5.1). Furthermore, all types of operating organizations served by distribution centers were represented by respondents (Figure 5.2). Approximately 69 percent of the respondents reported that company annual sales for 1992 were at least one billion dollars

while the remaining 31 percent reported annual sales below one billion dollars.

The titles of respondents varied greatly, and the majority of the respondents were managers. Respondents also held the titles of director, vice president, other, and CEO (Figure 5.3). On a scale of 1 (No influence) to 7 (Final decision-maker), respondents reported a mean response of 5.67 in terms of their ability to influence their company's choice of pallet types, thereby indicating that the desired respondents were reached. The title that had the most influence in their company's choice of pallet types was CEO (mean response of 7.0) followed by vice president (mean response of 6.6), director (mean response of 6.1), manager (mean response of 5.3) and other (mean response of 4.2).

Study Bias

Mail Survey Bias

A non-response bias check was performed to determine if survey respondents differed from non-respondents. To test for non-response bias, a random sample of 36 non-responding grocery distribution decision-makers were contacted by telephone and asked to rate plastic pallets on overall performance. Company size (measured in 1992 company sales) and

geographic region (based on Bureau of the Census Regions) for each nonrespondent, was obtained from a secondary source. Both the parametric ttest (p = .324) and the non-parametric Mann-Whitney U (p = .212) statistical tests indicated no differences between respondents and non-respondents on overall performance of plastic pallets. Both the parametric t-test (p = .464) and the non-parametric Mann-Whitney U (p = .242) statistical tests indicated no differences between respondents and non-respondents on company size. The Chi -Square test procedure revealed no association between regions and response (p = .188). Consequently, non-response bias was not considered a problem with the data.

In-Depth Interview Bias

A non-response bias check was performed to determine if the interviewees differed from non-interviewees. To test for bias, company sales and type of operating organization served were collected from a secondary source and compared for each group. Both the parametric t-test (p = .236) and the non-parametric Mann-Whitney U (p = .399) statistical tests indicated no differences between interviewees and non-interviewees on company size. The Chi -Square test procedure revealed no association between type of operating organization served and interview type (p = .244). Consequently, interview bias was not considered a problem with the data.

RESULTS AND DISCUSSION

Pallet Types Used to Send Goods Downstream to Customers

All (100 percent) of the surveyed grocery distribution companies³ used solid wood pallets to send groceries downstream to their customers. Plastic pallets were the most commonly used substitute pallet. Approximately 22 percent of companies reported using plastic pallets, while 0.5 percent of the companies used wood composite pallets, and 0.5 percent of the companies used corrugated paperboard pallets. An additional 5 percent of the companies reported using "other" types of platforms (metal carts, CHEP (Commonwealth Handling Equipment Pooling), FNPR (First National Pallet Rental), and B grade pallets (a recycled pallet that meets a certain set of standards as defined by the distributor)) (Figure 5.4). Respondents could have placed CHEP, FNPR, and B grade pallets in the "other" category because they perceive a difference between these wood pallets and GMA pallets even though they are all made of wood.

³The sampling unit used in this study (persons involved in their company's pallet decisions) was selected because determining consumer perceptions of pallet types was a major objective of this study. Since this article described trends in pallet material substitution by companies, the sampling scheme was overcome by randomly selecting one respondent from each company (a key retail or wholesale company operating a distribution center within a market area) to be used in this part of the analysis.

Although third party pallet management systems have been in the grocery industry for less than five years, 74.1 percent of responding companies are using them for sending goods downstream to customers. However, the survey question concerning this component of the grocery distribution industry may have been misinterpreted. A more reasonable interpretation of the responses is that 74.1 percent of the companies reported using a third party management or leasing system for inbound and/or outbound shipments. This number may be low when considering that all respondents may not have read the question correctly. For example, some companies may be using a third party system for inbound shipments (manufacturer to distribution center), but the question specifically asked about third party use for outbound (distribution center to retailer) shipments. The in-depth interviews revealed that the majority of grocery distribution companies used a third party system for inbound shipments and a smaller percentage used a third party system for outbound shipments. Typically, a third party pallet was used for outbound shipments only when pallet load and half-pallet load quantities were sent to the retailer.

Because plastic pallets were the dominant substitute pallet used by companies, the remainder of the study focuses on the use of solid wood pallets and plastic pallets.

One major factor that may affect the amount of plastic pallets going downstream is the amount of full and half-pallet load quantities sent to the store. In situations when a retail store orders a large quantity of a particular product, it is more efficient for the order selector to take the wood pallet in the rack with the desired product than to select all the products off the wood pallet onto their typical plastic order selecting pallet. Hence, the distributor will use solid wood pallets for larger orders and plastic pallets for smaller orders.

Two types of plastic pallets used by the grocery industry were the Retailer[™] by Cadillac Products (Troy, Michigan) and the Loudon plastic pallet (Lantham, New York). The Retailer[™] is a twin-sheet thermoformed, high density polyethylene pallet. It measures 40 x 48-inches, has true four-way entry, weighs 18 lbs, and has a dynamic load capacity of 3,000 pounds (Anonymous 1993d).

The Loudon plastic pallet is a structural foam molded, high density polyethylene pallet. The pallet has true four-way entry and a dynamic load capacity of 4,000 lbs (Anonymous 1994b).

From the in-depth interviews, it was observed that the Retailer[™] had gained wide acceptance across the eastern U.S.; while the Loudon plastic pallet was used predominantly in the northeast where the plastic company is based. One respondent stated that they adopted the Loudon plastic pallet

because it did not deflect as much as the Retailer[™] when loaded, and it is locally produced. Those using the Retailer[™] have coped with the deflection problem by either stacking cases on the pallet differently or by using an upgraded stiffer version of the Retailer[™].

Plastic pallet manufacturers usually offer warranties on their plastic pallets to decrease the risk of purchasing a new product. Typically, the plastic pallet manufacturer will offer a two to five year guarantee on the pallet. For example, Cadillac offers a 2 year warranty for the Retailer[™] for failures under normal use excluding abuse or cosmetic damage. They also offer a five year guarantee to buy back destroyed pallets.

Why Plastic Pallets are Being Used

Many respondents reported that their ultimate reason for switching to plastic pallets was cost savings. Many respondents believe the plastic pallet will help solve some of their expensive pallet problems by virtually eliminating pallet repairs, creating a more efficient and economical distribution system, and controlling worker compensation costs.

Respondents believed plastic pallets help to eliminate pallet repairs in several ways. First, many respondents believed plastic pallets should have a longer life than wood pallets. Some believe the plastic pallet will make at least 75 trips (distribution center to store and back) before it needs to be

repaired or scrapped; whereas, wood pallets were perceived to require repair, on average, after five trips. With an average cost of \$3.50 for a used wood pallet and an average number of five trips, solid wood pallets were perceived to average \$.70 per trip; while the plastic pallet were perceived to average \$.31 per trip. The bottom line is that the plastic pallet is perceived to be less expensive on a per use basis.

Some respondents believed that the design of the plastic pallets helps to eliminate pallet repair costs by reducing pallet damage from pallet handling equipment. Many respondents reported that as much as 80 percent of pallet damage occurs in the downstream shipment of goods. Wood pallets are sometimes broken with a double pallet electric jack when they are being loaded into the trailer for downstream shipment, or they can be broken by a hand jack when unloaded at the retail store. It is not uncommon for an electric jack to get hung up on and snap the bottom boards of the non-reversible design of the wood pallet; this adds to pallet repair costs and can damage handling equipment. With the plastic pallet, there are no boards to get stuck on or break; therefore, there are no added repair costs or damage to equipment due to broken boards.

Some respondents are switching to plastic pallets for downstream shipment of goods because they believed plastic pallets offer an economic and efficient compliment to inbound third party pallet leasing programs. One

respondent reported that they are considering switching to a substitute material pallet for outbound shipments to their stores because they believe it would be a good compliment to their increasing use of CHEP pallets for inbound products. Continued use of traditional wood pallets was not considered to be a viable alterative because he had a concern about raw material availability, increasing prices, and decreasing quality.

Another respondent reported that receiving products on CHEP pallets and shipping products on plastic pallet was the best way to control pallet expenses and increase efficiency. He believed that getting out of the "wood business" would result in these advantages because of the time and expense involved in trying to handle the wood pallet through the facility. The "wood business" requires inspection of inbound wood pallets, rejection of unacceptable pallets, confronting vendors that ship bad wood pallets, sorting good wood pallets from bad wood pallets, paying a worker to repair pallets, buying pallet repair materials, and loading scrap pallets. With a third party management system/plastic pallet combination, most of these problems are greatly reduced, partly because plastic pallets are not susceptible to the type of damage that traditional solid wood pallets experience in the outbound loop.

Some respondents believe the plastic pallet increases the efficiency of the distribution system because it offers true four-way entry, meaning a

pallet jack can enter the pallet from either the 40-inch or the 48-inch side. With recent trailer width increases, four extra pallets are able to fit into trailers if they are pinwheeled (a pallet loaded on its 48-inch face is next to a pallet loaded on its 40-inch face); and six extra pallets are able to fit into trailers if they are both loaded on their 48-inch face. The true four-way entry allows hand jacks, commonly used at the retail stores, to efficiently unload the pallets from both the 40-inch and 48-inch face; whereas, in the past, hand jacks were unable to access traditional four-way pallets on their 48-inch face. The traditional four-way pallet, or stringer pallet, created a lost opportunity to increase transportation efficiencies per unit load basis.

Other reasons for switching to plastic pallets included worker compensation insurance costs. One respondent reported that worker compensation costs are a big problem, and that "2 to 3 percent of workers compensation claims are attributed to the pallet, partly due to back injuries from lifting the pallet." Plastic pallets weigh as little as 18 lbs and are easier for employees to lift and handle compared to a 50 to 70 lb wood pallet. Another respondent reported that the ability of plastic pallets to nest reduces the risk of a worker injuring their back by lifting pallets off stacks. He also noted that the lighter weight plastic pallet should increase productivity of the workers due to decreased fatigue of lifting heavy pallets.

Many respondents using plastic pallets have noted various other benefits of plastic pallets. One responded said that the light weight of the plastic pallet is a bonus from an ergonomic standpoint. He also noted that OSHA is taking an active role in reviewing industries and he did not want to "ask for trouble." Another respondent noted that plastic pallets do not have the problem of nails damaging cases of products and splinters injuring workers.

Trends in Types of Pallets Used to Send Goods Downstream to Customers

In the next three years, the percent of surveyed companies planning to use solid wood pallets to ship good downstream is predicted to decrease slightly to 94 percent (Figure 5.4). This means that, in three years almost six percent of the surveyed companies plan to use plastic pallets exclusively for shipping goods downstream to their customers. Based on interviews with respondents, 100 percent material substitution is considered unlikely because of the shipments of pallet load quantities to their customers.

The number of distribution centers that plan to use plastic pallets should almost double in three years. By 1997, 37.2 percent of the responding companies plan to use plastic pallets to send all goods downstream to their customers compared with 22 percent today. There are several possible reasons why more companies plan to use plastic pallets.

First, they could be testing them now, and based on preliminary results, believe they will use them within three years on a permanent basis. Second, they could be working on a budget approval. Finally, they could possibly be waiting to see how they work with other companies before they decide to try them.

Other than the plastic pallet, the use of substitute material pallets appeared to be low. For example, 5.5 percent of the respondents said their company plans to use "other" material pallets during the next three years, a slight increase in the amount they are using today. Nine-tenths of one percent of the companies said they plan to use corrugated paperboard pallets during the next three years for all products, a slight increase to what they are using today (0.5 percent). For wood composite pallets, companies report that their use should increase slightly to 1.8 percent over the next three years.

The use of pallet types was also broken down by product types (dry goods, produce, frozen foods, meat, dairy, and other). Substitute material pallets were used most frequently with dry goods except for wood composite pallets, which were used most frequently for produce. One possible reason for the high use of plastic pallets in the dry goods warehouse is that the dry goods warehouse uses the most pallets; therefore, this could be part of the plastic pallet companies' strategies to target the

biggest warehouses in grocery distribution to make the greatest number of sales. The use of wood composite pallets is higher in produce because the produce industry typically uses new pallets to transport goods and a wood composite pallet has occasionally been used in this application. Other than the large use of plastic pallets in dry goods the use of each material pallet for each product type remained fairly constant across product types (Table 5.2). In terms of what respondents thought their company planned to use during the next 3, years substitute material pallets were to be used more frequently with dry goods than any other product type (Table 5.3). For all pallet types except plastic, this seemed to be quite consistent across product types (excluding "other"). Plastic pallets could be more predominantly used with dry goods than any other product because the environments of other products could present some limitations. For example, one company reported that cases slipped off the plastic pallet during order selection in the frozen foods warehouse. The problem was resolved by placing a sheet of cardboard between the plastic pallet and the cases. Another respondent reported that their company was not using plastic pallets in the produce warehouse due to the possibility of organic debris accumulating in the cups (feet) of the plastic pallet which could create a sanitation problem. One possible reason why few respondents use plastic

pallets for dairy products is because a special dimension pallet is typically used in conjunction with milk crates.

Material Substitution Based on Sales

The average sales of companies using plastic pallets were higher than companies not using plastic pallets (\$8.31 billion and 4.48 billion, respectively). A t-test was employed to determine if this difference is statistically significant. The analysis suggested that average sales of companies using plastic pallets were statistically greater than the average sales of non-users (p = .001). When a non-parametric test, the Mann-Whitney U, was employed, it revealed a significant difference between the distributions of company sales of users and non-users of plastic pallets (P = .002). The analysis suggested, that the mean rank for plastic pallet users (mean rank of 105.46) was statistically greater than that of non-users (mean rank of 78.66) in terms of 1992 company sales. The result of the non-parametric test confirmed the result of the parametric test.

One possible reason why larger companies are more likely to use plastic pallets is that industry leaders are usually the innovators. Also, the larger companies are more likely to have budgets for innovative programs. In addition, plastic pallet manufacturers probably targeted larger companies because they are a larger market and may be looked to as opinion leaders.

Material Substitution Based on Type of Operating Organization Served by Companies

Plastic pallet use based on the type of operating organization served by companies was also measured. Approximately 17.2 percent of the companies that serve cooperative groups were using plastic pallets, while 28.6 percent of companies serving the non-specified group, 36.8 percent serving corporate chains, and 9.5 percent serving volunteer groups were using plastic pallets. The chi-square statistic was used to test the association between plastic pallet use and type of operating organization served. The null hypothesis (that there is no association between plastic pallet use and type of operating organization served) was rejected (p < .001), meaning there is an association between type of operating organization served by the company and substitute material use. Cramer's V was used to measure the strength of association. Since the Cramer's V value of .305 is low, it reveals that the association is not very strong; but it is still significant.

One possible reason why plastic pallets have been predominantly adopted by the corporate chain is because they are a closed loop system, meaning the pallet is kept within the company. According to The Wiley Encyclopedia of Package Technology (Anonymous 1986), plastic pallets are

most often used in a closed-loop shipping system because the relatively high price of the pallet makes maintaining possession after each trip critical to the economics of the plastic pallet. While companies that serve co-ops and volunteer groups can control plastic pallets by making their customers accountable for the plastic pallets this method is probably less certain.

Material Substitution Based on Location

Response frequencies were tabulated to examine material substitution based on regional location of companies which was based on Bureau of the Census regional breakdowns. Approximately 22.2 percent of the companies using plastic pallets were located in the northeast, 20.9 percent in the south, 19.4 percent in the midwest, and 28.2 percent in the west. When regional variations were analyzing using the Chi-Square test procedure, the null hypothesis (there is no association between variables) could not be rejected (p = .756), revealing that there was insufficient evidence to conclude that regional differences in frequencies existed. Possible reasons include distribution centers serving corporate chains having substituted nationally. Although corporate chain distribution centers in each market area operate autonomously, they do share ideas.

Future Trends in Substitute Use

The substitution of plastic pallets for solid wood pallets for downstream shipments of goods should continue into the future. Many respondents who were using plastic pallets for outbound shipment believed plastic pallets compliment the third party pallet system for inbound product. Some respondents hoped that, in the future, they can move to 100 percent third party management inbound and a relatively high percentage of plastic pallets outbound (not 100 percent due to pallet load quantities). They believe that the net result is getting out of the "wood business" and significantly reduced pallet costs.

Table 5.2Reported pallet material use by grocery product type for
shipping goods downstream

Pallet Material	Product Type					
	Dry	Produce	Frozen	Meat	Dairy	Other
	Goods		Foods			
	Percent of Companies Using					
Solid Wood	99.1	85.3	91.3	94.0	91.7	22.5
Plastic	22.0	8.7	9.2	9.2	7.8	2.8
Corrugated paperboard	0.5	0.0	0.0	0.0	0.0	0.0
Wood composite	0.0	0.5	0.0	0.0	0.0	0.0
Other	4.1	1.4	1.8	0.9	2.3	0.9

Note: Percentages do not add to 100% due to multiple response

Table 5.3Predicted pallet material use by product type during the next 3
years for shipping goods downstream

Pallet Material	Product Type					
	Dry	Produce	Frozen	Meat	Dairy	Other
	Goods		Foods			
	Percent of Companies Using					
Solid Wood	90.8	79.3	84.8	88.0	84.8	19.4
Plastic	35.9	24.9	27.2	25.3	24.9	6.5
Corrugated paperboard	0.9	0.0	0.0	0.0	0.0	0.0
Wood composite	1.4	0.9	0.9	0.9	0.9	0.0
Other	4.6	2.3	2.8	1.8	4.1	0.9

Note: Percentages do not add to 100% due to multiple response



Figure 5.1 Percent and number of respondents by geographic region (based on Bureau of the Census Regions)



Figure 5.2 Percent of respondents serving each type of operating organization



Figure 5.3 Percent of respondents indicating each title



Figure 5.4 Reported 1994 and estimated 1997 rates of use for selected pallet types by grocery distribution companies

LITERATURE CITED

- Anderson, Bruce R. 1987a. Pallet use in the grocery industry. Pallet Enterprise 6(6):20-23.
- Anonymous. 1994a. Progressive Grocer's Marketing Guidebook. Trade Dimensions. Stamford, Connecticut.
- Anonymous. 1994b. Loudon Plastics, Inc. Promotional literature. Lantham, New York
- Anonymous. 1993c. A report on pallet use and applications among buyers of materials handling systems. Research Report. National Wood Pallet and Container Association in cooperation with Modern Materials Handling Magazine. Washington, DC.
- Anonymous. 1993d. Pallets: a process of evolution. Grocery Distribution Magazine 18(5):9-24.
- Anonymous. 1992. Summary of subcommittee findings and recommendations on the grocery industry pallet system. Produce Marketing Association. Newark, Delaware.
- Anonymous. 1989. Review of costs to operate the grocery industry pallet system. Cleveland Consulting Associates.
- Anonymous. 1986. Wiley Encyclopedia of Packaging Technology. John Wiley & Sons, Inc., New York, NY.
- Christoforo, John. 1992. Wood-Based Material Use in the U.S. Pallet and Container Industry:1991 and 1993. Masters thesis. Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Garry, Michael. 1994. It's not weird science. Progressive Grocer 73(1):67-74.
- Garry, Michael. 1993. Pallet-able alternatives. Progressive Grocer 72(2):71.

- Hansen et al. 1993. Wood materials use in the U.S. pallet and container industry:1992-1994. Center for Forest Products Marketing.
 Department of Wood Science and Forest Products. Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Luppold, William. 1988. Current trends in the price and availability of pallet lumber. Pallet Enterprise 8(5):30-32.
- Malhotra, Naresh. 1993. Market Research. Prentice Hall, Englewood Cliffs, New Jersey.
- McCurdy, Dwight R. and John E. Phelps. 1992. Trends in the U.S. pallet industry: 1980, 1985, and 1990. Forest Prod. J. 43(1):1-4.
- McCurdy, Dwight R. and John E. Phelps. 1991a. The pallet industry in the United States 1980, 1985, 1990. Department of Forestry. Souther Illinois University at Carbondale. Carbondale, Illinois.
- Merrefield, David. 1990. Wood pallets may be on way out. Supermarket News 40(4):49.
- Shaw, Russell. 1994a. Plastic and other more durable pallet designs are gaining converts. Supermarket News 44(15):1,12-13.
- Shaw, Russell. 1994b. Ergonomics in motion. Supermarket News 44(8):1,12.
- Strobel, John J. and Walter B. Wallin. 1969. The unit-load explosion in the food industry. Research paper NE-121. U.S. Forest Service, Northeastern Forest Experiment Station: Broomall, PA.
- Thornton, Meg. 1993. Forging new links in the grocery supply chain. Pallet Enterprise 13(2):34-36.
- USDC International Trade Administration. 1992. U.S. industrial outlook '92, International Trade Admin. Washington, D.C.
6. CONSUMER PERCEPTIONS OF SOLID WOOD AND SUBSTITUTE MATERIAL PALLETS

(For potential submission to the Forest Products Journal)

ABSTRACT

Persons involved in pallet decisions at grocery distribution companies were surveyed to reveal consumer perceptions of wood pallets as compared to substitutes (plastic, corrugated paperboard, and wood composite pallets). Cost per use was noted by respondents to be the most important factor they consider when choosing a pallet to send goods downstream to their customers. Respondents perceived plastic pallets to be superior to solid wood pallets in terms of overall performance, durability, cost per use, and employee handling safety. Common advantages of solid wood pallets reported by respondents included: availability, low initial cost, durability/stability (the ability of the pallet to be racked and hold the necessary weight with little deflection), industry standard, ability to exchange, and ease of repair. Common disadvantages of solid wood pallets reported by respondents included: easily damaged, short life, high repair and replacement costs, heavy, inconsistent construction, and damages product. Advantages of plastic pallets reported by respondents included: light weight, durability, longer life, true four-way entry, and the ability to nest.

INTRODUCTION

The grocery industry is a major market for wood pallets, using approximately 20 percent of the pallets produced in the U.S. However, a recent study suggests that this reliance on wood pallets could be changing. Some grocery distributors claim that the traditional solid wood pallet is falling short of meeting their needs; therefore, they are investigating and even turning to alternative materials handling devices (plastic, corrugated paperboard, and wood composite pallets).

To gain a better understanding of the reasons for this material substitution, it is important to uncover the factors that may lead a grocery distributor to choose a substitute material pallet. According to Berkman and Gilson (1986), an individual's decision-making behavior can be influenced by a personal set of perceptions, motives, experiences, and expectations. The Sheth organizational buying behavior model suggests that there are four factors that may influence buyer expectations (Berkman and Gilson 1986). These included: the personal background of the buyer; information sources (advertising, trade shows, personal sales calls, word of mouth); buyer's perceptions of brands and suppliers; and past experience with brands and suppliers. This study focuses on the buyer's perceptions portion of the Sheth model.

Unfortunately, very little quantitative information is available concerning perceptions of the various pallet material types. Insight into grocery distributors' perceptions of various pallet types could assist solid wood pallet producers in better understanding their customers' needs. Therefore, the objectives of this study were to determine factors that are important to grocery distributors when choosing a pallet to be sent downstream to their customers and to reveal consumer perceptions of wood pallets as compared to substitutes.

METHODS

Research Design

The survey method of descriptive research was used in the first portion of this study. The objectives of the descriptive research were as follows: 1) identify critical factors grocery distributors consider when selecting pallet types to ship goods downstream, and 2) to reveal consumer (persons involved in their company's pallet decisions) perceptions of solid wood pallets as compared to substitute material pallets on various factors. Respondents were surveyed using a questionnaire which consisted of openended, fixed-alternative, multichotomous questions, and questions using rating scales.

In the second portion of the study, exploratory research was performed through in-depth interviews to gain insight and understanding of perceptions of wood pallets as compared to substitutes. In-depth interviews are unstructured personal interviews in which the interviewer attempts to get subjects to talk openly and express their true feelings about a particular topic (Malhotra 1993).

The in-depth interviews utilized open-ended questions in order to facilitate the probing process. Specific questions included asking the respondent why they have switched to a substitute or why they are thinking

about switching to a substitute, and what they like and dislike about the wood pallet, and how it can be improved.

Sample Frame and Sampling

The population for this study included all persons in the U.S. grocery distribution industry whose distribution center sends pallets downstream to their customers, and who are involved in their company's pallet decision. The sample frame for the descriptive portion of the study was the Progressive Grocer's Marketing Guidebook (1994). The key distribution personnel listed in this guidebook were the desired respondents. According to the Progressive Grocer's Marketing Guidebook (1994), there are approximately 300 companies operating distribution centers across the U.S. Companies with at least one percent market share in terms of sales or sales of at least \$35 million are listed in the book.

Judgement sampling was used in the descriptive portion of the study. Judgement sampling is a form of convenience sampling in which population elements are selected based on the researcher's judgement (Malhotra 1993). The criteria for inclusion were title and location. An attempt was made to have at least one person from each distribution center listed in the 1994 Progressive Grocer's Marketing Guidebook included in the sample. If an appropriate person was not listed for a distribution center, a phone call was

was made to obtain the desired person's name and other information. To reach a desired sample size of approximately 450, all persons with the appropriate titles (director of distribution, distribution manager, etc.) were included in the sample (i.e. a census of the sample frame. In cases where only personnel of very high ranks were listed, a phone call was made to get the name of a person (at a lower level) who would also be involved in their company's pallet decisions and include him/her in the sample. This was done because the researcher believed that lower ranking personnel would also be involved in this industrial buying decision. Because larger companies typically have more employees and more levels of management, it is possible that the sample included more people representing larger companies.

Before the questionnaire was mailed to 444 persons involved in their company's pallet decisions, it was pretested with a convenience sample. The convenience sample consisted of five desired respondents who were located in close proximity to the interviewer. The pretest resulted in minor modifications to improve the clarity of the questions.

The sample frame for the exploratory part of the study consisted of survey respondents who had switched to or were considering switching to a substitute pallet material. Due to budget limitations, the selection area for respondents was limited to the south, midwest, and northeast regions of the U.S. Respondents were interviewed in each of the three regions resulting in a total of twenty interviews.

Data Collection, Response Rate, and Data Preparation

Of the 444 questionnaires mailed, 245 returned questionnaires were usable for further analysis. This resulted in a usable response rate of 55 percent. Usable questionnaires were questionnaires answered by decisionmakers in the grocery distribution industry whose company sends pallets downstream to their customers. Unusable questionnaires included questionnaires from respondents whose company does not send pallets downstream and questionnaires that were returned to sender (less than 1 percent of the total). Data preparation included editing, coding, transcribing, and cleaning the data.

Profile of Respondents

In general, the location of the respondents was dispersed between the northeast, south, midwest, and west (Figure 6.1). Furthermore, all types of operating organizations served by distribution centers were represented by respondents (Figure 6.2). Approximately 69 percent of the respondents

reported that company annual sales for 1992 were at least one billion dollars while the remaining 31 percent reported annual sales below one billion dollars.

The titles of respondents varied greatly, and the majority of the respondents were managers. Respondents also held the titles of director, vice president, "other", and CEO (Figure 6.3). On a scale of 1 (No influence) to 7 (Final decision-maker), respondents reported a mean response of 5.67 in terms of their ability to influence their company's choice of pallet types, thereby indicating that the desired respondents were reached. The title that had the most influence in their company's choice of pallet types was CEO (mean response of 7.0) followed by vice president (mean response of 6.6), director (mean response of 6.1), manager (mean response of 5.3) and "other" (mean response of 4.2).

Study Bias

Mail Survey Bias

A non-response bias check was performed to determine if survey respondents differed from non-respondents. To test for non-response bias, a random sample of 36 non-responding grocery distribution decision-makers were contacted by telephone and asked to rate plastic pallets on overall performance. Company size (measured in 1992 company sales) and

geographic region (based on Bureau of the Census Regions) for each nonrespondent, was obtained from a secondary source. Both the t-test (p = .324) and the Mann-Whitney U (p = .212) statistical tests indicated no differences between respondents and non-respondents on overall performance of plastic pallets. Both the t-test (p = .464) and the Mann-Whitney U (p = .242) statistical tests indicated no differences between respondents and non-respondents on company size. The Chi -Square test procedure revealed no association between regions and response (p = .188). Consequently, non-response bias was not considered a problem with the data.

In-Depth Interview Bias

A non-response bias check was performed to determine if the interviewees differed from non-interviewees. To test for bias, company sales and type of operating organization served were collected from a secondary source and compared for each group. Both the parametric t-test (p = .236) and the non-parametric Mann-Whitney U (p = .399) statistical tests indicated no differences between interviewees and non-interviewees on company size. The Chi -Square test procedure revealed no association between type of operating organization served and interview type (p = .244). Consequently, interview bias was not considered a problem with the data.

RESULTS AND DISCUSSION

Important Factors When Choosing A Pallet Type

Respondents assessed the relative importance of specific factors when choosing a pallet to ship goods downstream to their customers by rating them on a scale from 1(low importance) to 7(high importance). Mean scores were calculated for each factor across all respondents (Table 6.1). The most critical factors reported by respondents included: cost per use, durability, employee handling safety, and quality. Cost per use was perceived by respondents to be the most important factor (mean score of 6.45) when sending goods downstream to customers.

Cost per use was typically described by respondents as being the purchase price of the pallet divided by the number of trips (pallet traveling from the distribution center to the retail store and back to the distribution center) the pallet makes before being repaired. Cost per trip was very important to respondents because it revealed the true cost of the pallet. Since companies are usually profit maximizers, they are constantly seeking ways in which they can reduce their costs. Hence, once the true cost of the pallet is known, a profit maximizing company will choose the product that can help reduce their overall costs, if they have the available capital. Ultimately the true cost per trip might include pallet purchase price pallet repair costs, the cost of worker injuries resulting from the pallet, and disposal cost, all divided by the number of trips the pallet makes in its life. The problem with this line of thinking is that the majority of the grocery distributors only have pallet purchase and repair costs as a tangible number on their records. While many grocery distributors are aware that these other costs exist, they are difficult to measure and, therefore, may not be included in cost calculations.

Durability followed cost per trip closely in importance (mean score of 6.44) while employee handling safety and quality tied right behind durability in terms of importance (mean score of 6.42). Durability is important because it relates back to reducing costs. Obviously, if a pallet can last many trips without needing repair, the cost per trip is reduced.

Employee handling safety was very important to respondents because unsafe pallets can cause injuries and result in additional cost. Traditionally, workers compensation insurance claims are associated with a direct injury. However today, workers compensation claims from Cumulative Trauma Disorders (CTD's) are increasing (Garry 1994). A cumulative trauma disorder is a disorder resulting from performing repetitive motions day after day (Garry 1994). The process of order selection in grocery distribution is

very labor intensive and repetitive. Consequently, order selection has the potential for CTD's.

According to Roberts (1994) employee handling safety can become an even bigger issue in the future if the new Occupational Safety and Health Administration (OSHA) rules bill passes congress in 1994. The new bill could increase workers compensation costs by proposing increases in financial liability for employers. The prospect of this legislation is one factor prompting grocery distributor interest in lighter, safer pallets.

Quality, which was also a very important factor, was generally reported by respondents to relate to the durability and consistency of the pallet. More specifically, durability was generally defined by respondents as the ability of the pallet to resist breakage; whereas, consistency was generally defined by respondents as small variations in pallet dimensions. Pallet quality is important to respondents because a high quality pallet could help to reduce costs resulting from product damage and pallet damage. For example, poor quality pallets with inconsistent dimensions make it difficult for equipment to enter and exit the pallet easily which can result in damage directly to the pallet.

The least critical factors noted by respondents included: ability to nest, ability to sanitize, weather resistance and fire resistance. Ability to nest or the ability of the pallet to sit down inside another pallet was

considered by respondents to be a factor of only average importance (mean score of 4.63). In general, respondents reported that the ability of the pallet to nest was an advantage rather than a determining factor in selecting a pallet type. Pallets that nest require less storage space hence, virtually eliminating outside storage of pallets and the chance of pallet theft.

Ability to sanitize, which also rated average in importance (mean score of 4.52), can be defined as the ability to clean the pallet in the event that something is spilled on it. Sanitation problems are typically not a major issue in grocery distribution because food items do not sit directly on the pallet. In the event that something gets spilled on the pallet the contaminated pallet is often discarded immediately.

Weather resistance (mean score of 4.51) and fire resistance (mean score of 4.14) were not considered very critical factors when choosing a pallet to ship goods downstream. For one interviewee this was not the case for fire resistance. He was unable to switch to plastic pallets for downstream shipments of goods because plastic pallets present a fire hazard in the distribution center that could not be controlled by the existing sprinkler system.

One word of caution in analyzing the importance of factors grocery distributors consider when choosing a pallet to ship goods downstream. According to Berkman and Gilson (1986) some research concludes that

consumers base their decisions on a limited number of product attributes. This could mean that, although respondents reported the majority of factors to be at least of average importance in the study, they may consider only a subset of these factors when making a decision. This limited number of product attributes are called determinant attributes according to Runyon (1987). Determinant attributes are typically pricing, quality, complexity, durability, visibility, and multiplicity of purposes for most consumers (Berkman and Gilson 1986). The results of this study tend to agree with these authors because price, quality, and durability appeared in the top six important factors when choosing a pallet to ship goods downstream.

Perceptions of Pallet Types on Overall Performance

Respondents assessed the overall performance of the various pallet types by rating them on a scale from 1 (very poor performance) to 7 (excellent performance). Mean scores were collected for each pallet type by averaging performance scores across respondents. "Other" pallets⁴ (CHEP (Commonwealth Handling Equipment Pooling) and metal carts) were perceived to have the best overall performance (mean score of 5.73)

⁴The superior rating received by the "other" pallet category was not further explored because this study focused on solid wood, plastic, corrugated paperboard, and wood composite pallets. The author believes that this is a definite area in need of future research.

followed by plastic pallets, solid wood pallets, wood composite pallets and corrugated paperboard pallets (mean scores of 5.41, 4.66, 2.06, and 1.83, respectively) (Figure 6.4). Differences in overall performance scores for each pallet type were examined using parametric analysis of variance. The null hypothesis of no difference between means was rejected (p<.001), revealing that the mean scores for pallet types were statistically different from each other. Furthermore, the non-parametric Kruskal-Wallis one-way analysis technique rejected the null hypothesis of all population distributions being equal (p<.001), suggesting that the population distributions of the material types were statistically different from each other statistically different from each other statistically different the population distributions of the material types were statistically different from each other and confirming the parametric results.

The Duncan's multiple comparison technique was employed to determine which pallet types were perceived to be different in overall performance. The technique revealed, with 95 percent confidence, that the mean score for overall performance of "other" pallet types was statistically different from solid wood, corrugated paperboard, and wood composite pallets; while the mean score of overall performance of plastic pallets was statistically different from the mean score of solid wood, corrugated paperboard, and wood composite pallets. The technique also revealed that the mean score of solid wood pallets was statistically different from the mean score of corrugated paperboard and wood composite pallets. The

results reveal that respondents perceived the performance of "other " pallets to exceed the performance of solid wood, corrugated paperboard, and wood composite pallets; while respondents perceived the performance of plastic pallets to exceed the performance of solid wood, corrugated paperboard, and wood composite pallets. Also, respondents perceived the performance of solid wood pallets to exceed the performance of corrugated paperboard and wood composite pallets.

A significant difference was observed for mean performance scores for plastic pallets between users (mean 6.05) and non-users (mean 4.91) when a t-test was used (p < .001). The analysis suggested that plastic pallet users perceived the performance of the plastic pallet to be better than that of solid wood pallets. When a non-parametric test, the Mann-Whitney U, was employed, it revealed a significant difference between the distributions of the users and non-users of plastic pallets (p < .001) on overall performance. The analysis suggested that the mean rank of plastic pallets by users (mean rank of 76.85) was statistically greater than the mean rank for non-users (mean rank of 50.38) in terms of overall performance when sending goods downstream to customers. In general, interviewees who are using plastic pallets were satisfied with their performance and were planning to increase the percentage of plastic pallets for downstream shipments.

Consumer Perceptions of Wood Pallets As Compared To Substitutes on Various Factors

Respondents rated various pallet types on 9 factors (initial cost, durability, recyclability, ability to sanitize, environmental friendliness, cost per use, disposal cost, quality, and employee handling safety). Differences in agreement scores for each pallet type (solid wood, plastic, corrugated paperboard and wood composite pallets) were examined using parametric analysis of variance on the nine factors (Table 6.2). In all nine cases, the null hypothesis of no difference between means was rejected (p < .001), revealing that the mean scores for the pallet material types were statistically different from each other. Along with employing the parametric one-way analysis of variance technique, a non-parametric counterpart, the Kruskal-Wallis one-way analysis technique, was performed. This test concluded that the null hypothesis of all population distributions being equal was rejected (p < .001), suggesting that the population distributions of the material types were statistically different from each other and confirming the parametric results.

Initial Cost

Initial cost, the purchase price of the pallet, was fairly important to companies for two reasons. First, it is a simple method for comparing pallet

type costs. And, second, companies typically only have a limited amount of capital to spend on the initial pallet investment. Even if the alternative pallet has a low cost per trip, the initial investment can hinder the adoption of the alterative.

The Duncan's multiple comparison technique was employed to determine which pallet types were perceived to be different in initial costs. The technique revealed, with 95 percent confidence, that the mean score for initial cost of plastic pallets (mean 1.82) was statistically different from the mean score of solid wood pallets (mean 4.45), corrugated paperboard pallets (mean 4.91), and wood composite pallets (mean 4.42); while the mean score for initial cost of solid wood pallets (4.45) was statistically different from the mean score of corrugated paperboard pallets (4.91). These results show that respondents perceived plastic pallets to be more expensive than solid wood, corrugated paperboard, and wood composite pallets, while the initial cost of solid wood pallets was perceived to be more expensive than corrugated paperboard pallets.

These results are in agreement with an article in Modern Materials Handling Magazine which reported that the price of a wood pallet ranges from \$3.50-25.00, while the price of a solid molded plastic pallet ranges from \$30-80. The price range for corrugated paperboard pallets and wood composite pallets are \$3.00-8.00 and \$4.75-6.65, respectively (Anonymous

1993a). The prices that grocery distributors pay for wood pallets usually fall into the lower end of this scale because they typically purchase used wood pallets. In terms of plastic pallets, grocery distributors typically paid \$25 dollars for the popular twin-sheet thermoform pallet.

One respondent noted that plastic pallets have been around for a long time but not until recently have the prices come down enough to even consider this product. Plastic pallet manufacturers have found a way to overcome this problem of high initial cost by offering a pallet financing plan. In terms of the corrugated paperboard pallet, respondents generally agreed that it was too expensive on a cost-per-use basis in spite of its low initial cost.

Durability

In general, durability was described by respondents as being how long the pallet holds up before it needs to be repaired. The Duncan's multiple comparison technique suggested, with 95 percent confidence, that the mean score of plastic pallets (5.99) was statistically different from wood pallets (mean 3.96), corrugated paperboard pallets (mean 1.75), and wood composite pallets (mean 2.46). This reveals that respondents perceived the durability of plastic pallets to exceed the durability of wood, corrugated paperboard, and wood composite pallets.

Some respondents perceived that durability was a problem for the solid wood pallet because they believed it typically averages less than ten trips before it needs to be repaired. On the other hand, some respondents perceived plastic pallets to be more durable because they can get at least 10 times the number of trips before they need to be repaired. Respondents also perceived solid wood pallets to have a shorter life than plastic pallets because solid wood pallets tend to get damaged easily.

Damage was frequently noted by respondents to be the result of pallet design and inconsistent construction. Respondents frequently stated that the bottom boards of a stringer style solid wood pallet are easily damaged by the wheels of the pallet jacks. Breakage generally occurs when the operator does not precisely line up the wheel cavity with the space in between the bottom boards. Respondents perceived that inconsistent construction of the solid wood pallet also contributes to pallet damage. When deck boards are thin and warped, and stringers are not at the correct height, pallet jack tines can get stuck inside the pallet and result in pallet and product damage.

Respondents perceived molded plastic pallet to be more durable than the traditional solid wood pallet because they have consistent dimensions and no bottom boards.

The mean score for durability of solid wood pallets (3.96) was statistically different from corrugated paperboard pallets (mean 1.75) and wood composite pallets (mean 2.46), while the mean score for durability of wood composite pallets (2.46) was statistically different from corrugated paperboard pallets (mean 1.75). This result suggests that respondents perceived solid wood pallets to be more durable than corrugated paperboard and wood composite pallets. In general, respondents perceived corrugated paperboard and wood composite pallets to have low durability, and they did not believe they have the strength to hold the required weight. Respondents also believed that corrugated paperboard pallets would not maintain their strength in wet or humid environments. Although the study results indicate that respondents perceive wood composite pallet to be more durable than corrugated paperboard pallets, respondents do not perceive either pallet type to possess the strength necessary to perform in the grocery environment.

Recyclability

Recyclability, which was generally defined by respondents as the ability to keep something out of the landfill, did not rate as high as other factors in terms of importance (mean score of 4.74). While not critically important to grocery distributors, recyclability can affect the total cost of a pallet. With the rising cost of landfill tipping fees, recycling of materials is

becoming an increasingly important factor in total product cost. According to Aguston et al. (1990) some landfills are charging fees and even refusing to accept pallets. The rise in the number of wood pallet repair companies reveals the importance of recycling, especially as lumber prices increase. Perhaps recyclability did not rate very high in terms of importance because of the growing number of companies that are providing recycling services, therefore pallet disposal is not a major issue.

Employing Duncan's multiple comparison technique, at the 95 percent significance level, respondents perceived plastic pallets (mean 5.55) to be significantly more recyclable than solid wood pallets (mean 4.31) and wood composite pallets (mean 4.12), while corrugated paperboard pallets (mean 5.55) were perceived to be significantly more recyclable than wood composite pallets (mean 4.12) and solid wood pallets (mean 4.31). Some respondents perceived plastic pallets to be more recyclable than solid wood pallets because they believed plastic pallet could be made into pallets again whereas solid wood pallets could be repaired or recycled to some extent but the broken pieces were basically thrown out.

Corrugated paperboard pallets were perceived to be more recyclable than solid wood and wood composite pallets possibly because many grocery distributors are already have a cardboard recycling system in place. Grocery distributors may perceive plastic pallets to be more recyclable than solid

wood pallets because plastic pallet manufacturers typically offer a buy back program for destroyed pallets which they claim will ultimately be recycled.

The perception of poor wood pallet recyclability may change with a pilot pallet buy-back program sponsored by NAPAR (National Association of Perishable Agricultural Receivers) and NWPCA for SPEQ-M (Specified Pallets Engineered for Quality-Multiple use) pallets. The pilot program guarantees that produce receivers will recoup a specific sum of money for used SPEQ-M pallets regardless of condition (Thompson 1993).

Ability to Sanitize

A Duncan's multiple comparison technique, at the 95 percent significance level, revealed that respondents perceived plastic pallets (mean score of 5.57) to be significantly easier to sanitize than solid wood pallets (mean score of 2.73), wood composite pallets (mean score of 2.23) and corrugated paperboard pallets (mean score of 1.63). It also revealed that solid wood pallets (mean score of 2.73) were perceived to be significantly easier to sanitize than corrugated paperboard pallets (mean score of 1.63) and wood composite pallets (mean score of 2.23), while wood composite pallets (mean score of 2.23) were perceived to be significantly easier to sanitize than corrugated paperboard pallets (mean score of 1.63) and wood composite pallets (mean score of 2.23), while wood composite pallets (mean score of 2.23) were perceived to be significantly easier to sanitize than corrugated paperboard pallets (mean score of 1.63). One respondent noted during an interview that plastic pallets were easier to sanitize than solid wood pallets because they could be washed down if contaminated with a chemical such as bleach. However, wood pallets absorb liquids due to their porous nature and, hence, are difficult to clean. On the other hand, plastic pallets can also present a sanitation concern if they have pockets that retain spilled liquids. Several respondents noted that the nine legs of some plastic pallets were essentially cups that could accumulate debris and cause a sanitation problem. This was especially a concern for the produce warehouse because produce is typically packaged with air vents to preserve freshness. These vents provide an avenue for organic material to escape the packaging and fall into the cups. To prevent this problem, many of these respondents noted that a system to steam clean plastic pallets will be needed in the future.

Solid wood pallets were perceived to be easier to sanitize than corrugated paperboard and wood composite pallets possibly because they can be rinsed off without the possibility of losing their strength. Wood composite pallets could also be perceived to be easier to sanitize than corrugated paperboard pallets for the same reason.

Environmental Friendliness

Environmental friendliness was generally defined as the ability of a material to be recycled and not harm the environment. Although it was not of critical importance, there is a growing national trend towards environmental awareness. The Duncan's multiple comparison technique, at the 95 percent significance level, was used to investigate differences in mean scores for each pallet type in terms of environmental friendliness. Plastic pallets (mean score of 4.77), corrugated paperboard pallets (mean score of 4.96) and wood composite pallets (mean score of 4.32) were considered by respondents to be significantly more environmentally friendly than solid wood pallets (mean score of 3.90); while plastic (mean score of 4.77) and corrugated paperboard pallets (mean score of 4.96) were perceived to be significantly more environmentally friendly than wood composite pallets (mean score of 4.96) were

Respondents rated plastic pallets to be significantly more recyclable than solid wood pallets. Many respondents also associated environmental friendliness with recyclability. Therefore, many respondents believed that plastic pallets were more environmentally friendly than solid wood pallets. Some respondents also perceived plastic pallets to be more environmentally friendly than solid wood pallets because they believed that cutting trees had a negative effect on the environment. Corrugated paperboard pallets could be perceived as more environmentally friendly than and solid wood pallets because grocery distributors typically have a system to recycle cardboard. Wood composite pallets were perceived by respondents to be more environmentally friendly than solid wood pallets. A possible reason for this is that wood chips used to make wood composite pallet could come from broken pallet parts diverted from the landfill.

Cost Per Trip

The Duncan's multiple comparison technique, at the 95 percent significance level, revealed that plastic pallets (mean score of 5.35) were perceived to have a significantly lower cost per use than solid wood pallets (mean score of 3.75), corrugated paperboard pallets (mean score of 3.27), and wood composite pallets (mean score of 3.20); while solid wood pallets (mean score of 3.75) were perceived to have a significantly lower cost per use than corrugated paperboard (mean score of 3.27) and wood composite pallets (mean score of 3.20).

The majority of the interviewees perceived plastic pallets to have a lower cost per use than solid wood pallets because they believed that the plastic pallet made more trips before needing to be repaired. Corrugated paperboard and wood composite pallets could be perceived by respondents to have a higher cost per trip than solid wood pallets because many respondents believe that they are not suitable for use in the grocery distribution environment. The decision to use a particular type of pallet has traditionally been based on initial price. However, today some grocery distributors are stating that pallet costs are too high, primarily because of repair costs. Therefore, some grocery distributors are investigating cost per use as an attempt to uncover the true cost of the pallet type and employ cost per use as a base for pallet purchase decisions.

Disposal Cost

Disposal cost, which is logically the cost to dispose of a pallet, was not considered by respondents to be very important, possibly because a growing number of pallet suppliers are providing disposal services to their customers. Duncan's multiple comparison technique, at the 95 percent significance level, suggested that corrugated paperboard pallets (mean score of 5.02) were perceived by respondents to have a significantly lower disposal cost than solid wood (mean score of 3.99), plastic (mean score of 4.17), and wood composite (mean score of 4.00) pallets. The perceived lower disposal cost of corrugated paperboard pallets versus the other types could be due to existing cardboard recycling systems employed by many grocery distributors. One company that does their own pallet repair said that increased land fill tipping fees prompted them to consider buying a

grinder to reduce the volume of wood debris going to the landfill. The complexity of the disposal issue prompted them to look at plastic pallets and manufacturer operated recycling programs. Some respondents, however, are able sell repairable and give scrap pallets to pallet repair facilities who deal with the pallet disposal issue.

Quality

The Duncan's multiple comparison technique, at the 95 percent significance level, revealed the differences in mean scores for each pallet type in terms of quality. Respondents perceived plastic pallets (mean score of 5.56) to be of significantly higher quality than solid wood (mean score of 4.12), corrugated paperboard (mean score of 2.47), and wood composite pallets (mean score of 2.85); while they perceived solid wood pallets to be of significantly higher quality than corrugated paperboard and wood composite pallets.

In general, interviewees perceived the quality of plastic pallets to be higher than that of solid wood pallets because plastic pallets were perceived to have a longer life and consistently meet dimensional requirements. Many respondents believed that the quality of solid wood pallets has been a problem because pallet quality specifications are not enforced. However, this problem could be eliminated by a new program sponsored by the

NWPCA which is designed to ensure pallet quality through a third party monitoring system (Thompson 1993b). Perhaps solid wood pallets were rated better than corrugated paperboard and wood composite pallets in terms of quality because many respondents fear that these two pallet types cannot support typical loads.

Employee Handling Safety

The Duncan's multiple comparison technique, at the 95 percent significance level, indicated significant differences between pallet types in terms of employee handling safety. The test revealed that plastic pallets (mean score of 5.77) were perceived to be significantly safer for employees to use than solid wood (mean score of 3.46), corrugated paperboard (score of 4.63), and wood composite (score of 3.72) pallets. The test also revealed that corrugated paperboard pallets were perceived to be significantly safer to use than solid wood pallets and wood composite pallets.

Respondents generally perceived plastic pallets to be significantly safer for employees to handle than solid wood pallets because they are light weight and do not have any fasteners or loose boards that can injure an employee. Pallet weight, protruding nails, and broken boards, all of which can contribute to employee injuries, were reported by respondents to be

major disadvantages of the wood pallet. One respondent reported that order selectors can sustain back, arm, and foot injuries when lifting a wood pallet off a stack. Another respondent reported that their company has a lot of injuries from picking up heavy items, and two to three percent of their workers compensation claims are attributed to pallets. Corrugated paperboard pallets could be perceived to be safer than solid wood pallets because corrugated paperboard pallets are typically light weight and do not have fasteners or loose boards. Corrugated paperboard pallets could also be perceived to be safer than wood composite pallets due to the possibility of splinters with the wood composite pallets.

Reported Advantages and Disadvantages of Pallet Types

Solid Wood

Advantages of solid wood pallets commonly reported by respondents included: low initial cost, durability/stability (the ability of the pallet to be racked and hold the necessary weight with little deflection), industry standard, availability, ability to exchange, and ease of repair.

Many respondents reported durability/stability to be an advantage of solid wood pallets. Durability was described by respondents as the ability of the pallet to hold the necessary weight with little deflection and the ability

to be racked. However, durability was classified as a disadvantage of solid wood pallets when it was defined as the ability to resist damage.

Respondents claimed that solid wood pallets have the strength to be stored in racks while the typical plastic pallet (twin-sheet thermoform type) used by grocery distributors does not match this strength when racked. Solid wood pallets were also considered by respondents to be very stable. For example, when order selectors are gathering cases of products and stacking them on two pallets sitting on double pallet jacks, solid wood pallets typically maintain their shape and do not deflect; whereas, plastic pallets have a tendency to flex and allow product to fall off the sides. Some plastic pallet users have corrected this problem by modifying their stacking technique through interlocking product and redistributing cases.

Many respondents report that solid wood pallets had an advantage over substitutes because they are an industry standard. As an industry standard, solid wood pallets are typically readily available and can be exchanged with grocery manufacturers or vendors, distributors, and retail stores. Grocery pallet distributors typically feel secure about the availability of solid wood pallets because there is a flow of them back and forth through the system, and there is usually a wood pallet company located nearby if they need to purchase additional pallets. Exchange of solid wood pallets was also noted as a major advantage because pallet exchange keeps a

balance in the flow of pallets in and out of each segment in the grocery distribution chain; whereas, plastic pallets are not exchangeable with vendors.

Respondents also reported that the ability to repair the solid wood pallet was a major advantage. Repair of molded plastic pallets, if possible, must be done by the manufacturer.

Common disadvantages of solid wood pallets reported by respondents included: short life, high repair and replacement costs, heaviness, inconsistent construction, damages easily, and damages product. Respondents perceived solid wood pallets to be expensive to repair because they break easily, are in constant need of repair, and the cost of wood is rising.

In terms of pallet damage, many respondents believed that 80 percent of pallet damage occurs in the downstream shipment of goods where the pallet frequently comes in contact with materials handling equipment (electric pallet jacks and hand jacks). The electric pallet jack is typically used for preparing unitized loads for shipments to the stores, while the hand pallet jack is frequently used at the store to retrieve unitized loads off the trailer. Respondents reported that pallet damage can occur during the unloading of a common wood stringer pallet on the 48-inch face because the hand jack cannot enter that side. To deal with this problem, the hand jack

operator will typically attempt to turn the pallet with the hand jack tines which can damage the pallet. Distribution centers will sometimes load pallets on the trailer in this fashion because they are able to get more pallets into the trailer which ultimately decreases their unit load transportation cost.

Respondents reported that product damage was also a major disadvantage of solid wood pallets. Many respondents reported broken pallet boards can lead to protruding nails which damage products. One respondent reported that a protruding nail can cause damage when an order selector is selecting cases and slides the case of goods over a nail which causes a tear. Respondents reported that the design of the traditional solid wood non-reversible design pallet also contributes to product damage. They explained that when two unitized loads on the non-reversible design pallet are stacked on top of each other, the top pallet exerts a large force over a small area of the case directly below it. This direct force can ultimately wear a hole into the bottom case.

Plastic Pallets

The commonly noted advantages of plastic pallets by respondents included: light weight, durability, ability to nest, longer life, and true fourway entry. One respondent noted during an interview that the true fourway entry of the plastic pallet allowed a jack to enter the pallet on all sides.

Therefore, pallets could be loaded and unloaded on the 48-inch face with a jack to maximize loading efficiency. Other common advantages of plastic pallets noted by respondents included: low repair and maintenance, reduced product damage, reduced injures, and ability to clean the plastic pallet. One respondent noted during an interview that, because the twin-sheet thermoform plastic pallet does not have any boards, they do not experience damage by the jacks as do wood pallets.

Commonly reported disadvantages of plastic pallets included: high purchase cost, deflection under heavy loads, inability to rack the pallet, and tracking and control problems. One respondent noted in the questionnaire that the price of the plastic pallet (approximately \$25) makes them prohibitively expensive. Because of the high purchase price of the plastic pallet, tracking and controlling the pallet is indispensable to the economics of this pallet. This has the potential to be more of a problem for wholesale distributors who do not own the retail stores. Another major problem with the plastic pallet noted by respondents is deflection under heavy loads. One respondent noted that, when a loaded pallet is lifted with an electric pallet jack, the edges of the plastic pallet have a tendency to bow, which could potentially cause product to fall off the pallet. He also noted that bowing creates a problem during order selecting. The bowing causes the case of

goods to deviate from a vertical stack which creates a problem for fitting 22-26 pallets on the floor of the trailer.

Other disadvantages of plastic pallets included a slick surface, the inability to exchange with vendors, and the possibility of a fire hazard. Some respondents reported that the initially slick surface of the plastic pallet created problems during order selecting because products would slip off the pallet. According to several respondents, this problem was corrected by either a ridged-top design of the plastic pallet or by placing a sheet of cardboard on the top of the plastic pallet to provide adhesion.

Corrugated Paperboard and Wood Composite Pallets

Several advantages of corrugated paperboard pallets noted by respondents included: light weight, low initial cost, one-way trip pallet, and recyclability. A one-way trip pallet was considered to be an advantage for some respondents because they believed that one-way pallets eliminated the hassle of pallet exchange. Commonly reported disadvantages included: lack of strength, inability to support typical loads, easily damaged in wet and humid environments, and inability to rack. Advantages reported by respondents for wood composite pallets included: low initial cost and light weight; while commonly reported disadvantages included: inability to support typical loads, easily damaged by equipment, and weight.

Possible Improvements for the Solid Wood Pallet

One common complaint of wood pallets by respondents was thin deck boards which deflect under heavy loads. This deflection causes the pallet jack tines to get stuck under the load. Using thicker deck boards and stringers allows for easy entry and exit of the pallet jack tines, which can help prevent damage and improve worker productivity. Some respondents recommended combining plastic and wood. One possibility is to coat the lead board with plastic which would make the lead board less easily damaged by material handling equipment. Another possibility is to use a combination of plastic legs and solid wood deck boards or solid wood blocks and deck boards. These combinations will decrease the weight of the pallet and reduce board breakage by the double pallet electric jack. One respondent stated "you can't improve it without adding weight to it, so you don't want to improve it." Although this is a very strong statement, I believe it contains a very important message. The traditional solid wood pallet can be made stronger by adding thicker boards; however, when
thicker boards are added you can create an employee handling problem which is becoming a major issue in the grocery industry.

Table 6.1.Mean importance ratings of factors involved in the selection
of a pallet type to ship goods downstream to customers

Factor	Mean rating	Standard Deviation	Factor	Mean rating	Standard Deviation
Cost per use	6.45	0.93	Disposal cost	4.74	1.77
Durability	6.44	0.83	Recyclability	4.74	1.63
Employee handling safety	6.42	0.90	Environmental friendliness	4.72	1.49
Quality	6.42	0.84	Ability to nest	4.63	2.00
Four-way entry	6.26	1.20	Ability to sanitize	4.52	1.72
Initial cost	6.05	1.20	Weather resistance	4.51	1.83
Ability to rack	6.00	1.58	Fire resistance	4.14	1.85
Weight	5.99	1.18			

Note: Scale 1 (Low Importance) to 7 (High Importance)

Attribute Pallet Type Plastic^B Solid^A Corrugated^c Wood^D Wood Paperboard Composite Low initial cost 4.45 1.82 4.91 4.42 $(C)^{1}$ (acd) 3.96 5.99 1.75 2.46 Highly durable (cd)(acd) (c) 4.31 5.55 5.55 4.12 Highly recyclable (ad) (ad) Easy to sanitize 2.73 5.57 1.63 2.23 (cd) (acd) (c) 4.32 3.90 4.77 4.96 Environmentally friendly (ad) (ad) (a) 5.35 Low cost per use 3.75 3.27 3.20 (cd)(acd) Low disposal cost 3.99 4.17 5.02 4.00 (abd) High quality 2.47 4.12 5.56 2.85 (cd) (acd) Safe for employees to 3.46 5.77 4.63 3.72 (acd) (ad) use

 Table 6.2.
 Average perception scores and statistical relationships for major pallet types on selected attributes

Note: Scale 1 (Strongly Disagree) to 7 (Strongly Agree) Note¹: Letters in parentheses indicate statistical differences between indicated columns on that variable (alpha = .05.)



Figure 6.1 Percent and number of respondents by geographic region (based on Bureau of the Census Regions)



Figure 6.2 Percent of respondents serving each type of operating organization



Figure 6.3 Percent of respondents indicating each title



Figure 6.4 Perceptions of pallet types on overall performance for downstream shipment of groceries.

LITERATURE CITED

- Anonymous. 1994a. Progressive Grocer's Marketing Guidebook. Trade Dimensions. Stamford, Connecticut.
- Anonymous. 1993a. Selection guidelines for pallets and slipsheets. Modern Materials Handling 48(13):42-44.
- Anonymous. 1993c. A report on pallet use and applications among buyers of materials handling systems. Research Report. National Wood Pallet and Container Association in cooperation with Modern Materials Handling Magazine. Washington, D.C.
- Anonymous. 1992. Summary of Subcommittee Findings and Recommendations On The Grocery Industry Pallet System. Produce Marketing Association. Newark, Delaware.
- Auguston, Karen, Nancy Staples, and Janine Weston.1990. Packaging in the '90s, the environmental impact. Modern Materials Handling 45(7):52-57.
- Berkman, Harold. and Christopher Gilson. (1986). Consumer Behavior. PWS-Kent Publishing company. Boston, Massachusetts.
- Garry, Michael. 1994. It's not weird science. Progressive Grocer 73(1):67-74.
- Malhotra, Naresh. 1993. Marketing Research. Prentice Hall, Englewood Cliffs, New Jersey.
- Roberts, Gail. 1994. OSHA bill spurs fears of much higher costs. Supermarket News 44(4):14.
- Runyon, Kenneth and David Stewart. 1987. Consumer Behavior. Merrill Publishing Company. Columbus, OH.

Thompson, Tad. 1993. SPEQ-M pallet. The Receiver 1(5):5-6.

7. CONCLUSIONS

Factors contributing to grocery distributors' demand for pallets made from substitute materials were obtained from in-depth interviews. The results follow. 1) Respondents currently using plastic pallets stated that their primary reason for switching is perceived overall cost savings resulting from long pallet life. Other major reasons included reduced pallet repair and sorting costs, increased distribution efficiency, and reduced worker compensation costs. 2) There is a need to modify the design of the traditional grocery pallet (a stringer, non-reversible design) for the downstream shipment of goods because the traditional design is prone to damage by materials handling equipment. One possible design change is the elimination of bottom deck boards by using a solid wood deck with nine wood block feet. 3) Changes in grocery distribution will affect the use of substitute materials. For example, many grocery distributors are considering changing their racking system for safety reasons and high insurance costs. Modified racks with more support could allow pallets with less strength and stiffness to be used. Also, some grocery distributors are looking into shipping only pallet load quantities outbound. This would eliminate the need for an "order selecting" pallet.

Grocery distributors' perceptions of substitute material pallets including plastic, corrugated paperboard, and wood composite pallets were obtained from the mail survey and in-depth interviews. The results follow. 1) The four most important factors considered by grocery distributors when choosing a pallet to be sent to their customers were: cost per use, durability, employee handling safety, and quality. 2) Respondents perceived plastic pallets to be superior to solid wood pallets in terms of overall performance, durability, cost per use, and employee handling safety. 3) Common advantages of solid wood pallets reported by respondents included: availability, low initial cost, durability/stability (the ability of the pallet to be racked and hold the necessary weight with little deflection), industry standard, ability to exchange, and ease of repair. 4) Common disadvantages of solid wood pallets reported by respondents included: easily damaged, short life, high repair and replacement costs, heavy, inconsistent construction, and frequent product damage. 5). Advantages of plastic pallets reported by respondents included: light weight, durability, longer life, true four-way entry, and ability to nest.

Grocery distributors' trends in substitute material pallet use by region and type of operating organization were obtained from the mail survey and data contained in the 1994 Progressive Grocer's Marketing Guidebook. The results follow. 1) There was no statistical association between material substitution and regional location of companies which was based on Bureau of the Census regional breakdowns. 2) Plastic pallets were predominantly used by corporate chains.

Substitute material pallet use and trends by grocery distributors was investigated by the mail survey and in-depth interviews. The results follow. 1) Although 100 percent of responding companies are using solid wood pallets to ship goods downstream to their customers, the use of plastic pallets is predicted to increase. 2) The common plastic pallet used in the grocery industry is of the twin-sheet thermoform type. 3) Plastic pallets were typically used with dry goods, and there is a trend toward increasing use in other product areas. 4) There should be an increasing trend toward third party pallets inbound and plastic pallets outbound combination because some respondents perceive this combination to be the best way to reduce overall distribution costs.

8. RECOMMENDATIONS FOR FUTURE RESEARCH

There are several areas in which opportunities exist for future research. First, a study to investigate consumer perceptions of third party pallet leasing programs is strongly needed. Study results indicated that the use of this system has gained wide spread acceptance in the grocery distribution industry in a short period of time. This system has been available to grocery distributors in the U.S. for approximately five years, and, already, an estimated 75 percent of respondents reported using the system. A study that would uncover reasons for this wide spread acceptance and consumer perceptions of advantages and disadvantages of these systems would assist wood pallet manufacturers in developing alternative pallet management programs to better meet the needs of their consumers.

Second, with a variety of substitute pallets which could potentially enter the market, the need exists for a follow up study (in approximately three years) to monitor changes in this rapidly changing market environment.

Finally, while this study focused on the outbound shipment of goods through the distribution center, there is an opportunity for a future study to investigate material substitution on inbound shipments of goods.

APPENDIX A

Grocery Industry Pallet Performance Specifications

Grocery Industry Pallet Performance Specifications

- Exact 48-inch x 40-inch dimensions. Square in each direction.
- True four-way entry
- Minimum-width pallet jack openings of 12 inches and minimum height of 3-3/4 inch clearance when under load.
- * Smooth, non-skid, top-bearing surface with at least 85% coverage.
- Bottom-bearing surface of no less than 60% coverage with properly placed cut-outs (12-inches square) for pallet jack wheels from four sides.
- * All bottom entry edges chamfered to 1/4 inch for easy entry and exit.
- * Overall height of platform should not exceed six inches.
- * Rackable from both the 48-inch and 40-inch dimensions. Allowable deflection in drive-in and drive-through racks no more than 1/2 inch.
- * Compatible with pallet conveyors, pallet dispensers, skate-wheel pallet flow racks, and automatic storage and retrieval systems.
- No protruding fasteners.
- Must be made of material that does not contaminate the product it carries.
- Must meet or exceed current pallet resistance to fire.
- Must be recyclable. Preferably made from recycled material.
- Desired weight under 50 pounds.
- Load capacities of 2,800 pounds, capable of bearing 2,800 pound loads safely in stacks five loads high.
- * Repairs should be economically feasible.
- Weather resistant.
- Moisture resistant.
- Capable of safely moving product, damage free, through entire distribution channel with multiple cycles.

Source: Anonymous. 1992. Summary of subcommittee findings and recommendations on the grocery industry pallet system. Produce Marketing Association. Newark, Delaware.

APPENDIX B

Grocery Industry Hardwood Pallet Specifications



RECOMMENDED HARDWOOD PALLET SPECIFICATIONS FOR THE GROCERY INDUSTRY

June, 1975

I. SIZE AND TYPE OF PALLET

Pallet shall be 48" x 40"; flush, non-reversible, four-way modified. (See accompanying drawing for details.)

II. TYPE AND QUALITY OF LUMBER

A. Allowable Species

Lumber shall be sound, square edge, free of mold, decay, and noxious odors. The following hardwood species may be used for stringers:

Beech Birch Eucalyptus Hackberry Hard Maple Hickory Oak (except Swamp Oak) Pecan

Rock Elm White Ash

In addition to the above list, the following hardwood species shall be used for deckboards:

Ash Butternut Magnolia Red Alder Soft Elm Soft Maple Sweet Gum Sycamore

Tupelo Walnut Yellow Poplar

B. Moisture Content

Any degree of seasoning acceptable.

C. Permissible Defects and Characteristics

Knots:

The diameter of sound knots shall be no greater than one-third the width of the piece in which they occur; there shall be no more than two such maximum diameter knots in any one piece. Loose or hollow knots shall not exceed one-half the diameter of sound knots.

No knots over 1/2" shall be allowed in the stringer immediately over the notched areas.

Splits, Shakes, and Checks:

Length of crack or grain separation must be no longer than twothirds the width of the piece in end deckboards and no longer than twice the width of the piece in stringers and inside boards. Splits running through full thickness of the piece (not to be confused with nail splits) are permitted in any number, but when appearing in endboards must be straddled by nails. Shakes are permitted in any piece if contained by nailing.

Season checks and splits that do not affect structural strength of pallet are permissible defects.

Wane:

Deckboards: 1/4 width -- 2/3 thickness -- unlimited in length. Stringers: 1/3 width of nailing faces -- 1/2 width of other faces -unlimited in length.

Wane within limits is permitted on any piece provided it is not on exposed edge of end deckboards. Wane may appear on surface or edge of other pieces but in no cases are nails to be driven into or through wane. No more than one-half of the pieces in an individual pallet may contain wane.

Warp:

No individual piece on any one pallet shall have deviation due to warp which is greater than the following percent of its measured dimension:

> Bow - 2% Crook - 2% Cup - 3%

Other Defects:

Pin-worm and grub worm holes in pallet parts are permissible defects, providing that they do not affect the structural strength of the pallet. Infestation of lyctus powder-post beetles, termites and other wood-destroying insects are not permitted in pallet parts.

NO COMBINATION OF DEFECTS WHICH WILL MATERIALLY WEAKEN ANY PIECE OR PALLET SHALL BE ALLOWED.

III. LUMBER PREPARATION

Stringers and deckboards shall be smooth sawn or surfaced to square edge, uniform dimensions.

No bearded ends are permitted; all ends and edges shall be clean and square.

Preservatives not permitted.

IV. TYPE AND QUALITY OF FASTENER

2-1/4 x 0.110" hardened steel screw nail (or tempered), to bend not more than 28 degrees on the MIBANT Nail Tester or equal. Wire diameter 0.110", threaded O.D. body diameter 0.138", flat head nail diameter 9/32", or snag free head average diameter 21/64". Point shall be diamond (not longer than 5/32") or chisel provided that the width does not exceed wire diameter. Helically threaded with four flutes; helical angle of thread at the pitch diameter shall be 60 degrees plus or minus 5 degrees with a plane perpendicular to the axis.

V. DIMENSIONS, SPACING, AND ARRANGEMENT

A. Deckboards

Thickness: 13/16" to 15/16" range Length: 39-7/8" to 40-1/8" range

Top Deckboards

Extreme top end deckboards will be 5-5/8" minimum. All intermediate top deckboards may be random widths, and will be minimum 3-5/8". Maximum 3" spacing will be maintained. Deckboards must provide a minimum actual cumulative surface of 30".

Bottom Deckboards

Bottom end deckboards shall be 5-5/8" to 6" range. Two outside boards in the center cluster shall be minimum 3-5/8". The center board shall be minimum 5-5/8". Spacing of center cluster of bottom deckboards shall not exceed 2-1/2" and the outer edges of the cluster shall be flush with the inside of the notches. Bottom deckboards shall not protrude over any notch opening; ends of all deckboards shall be flush with outside of stringers. The center cluster of deckboards shall provide a minimum actual cumulative surface of 13".

Chamfer inner and outer edges of bottom deck edge boards and wheel space edges of center cluster boards to within 1/2" of bottom face, plus 0, minus 1/8". All chamfers to be cut at 45 degrees angle and to extend within 2" but not closer than 1" of stringers at each end of chamfer.

B. Stringer Dimensions and Placement

Stringer dimensions shall be width: 1-3/4", plus 1/4", minus 0; length: 48", plus or minus 1/8"; height: 3-3/4", plus 1/4", minus 0.

Notch openings shall be 9" wide, plus 1/4", minus 0. Notch openings shall not be closer than 6" from the ends of the stringers, plus 1/4", minus 0. Stringer notches shall have a depth of 1-1/2" and shall have round corners with a radius of 3/4"; the top of the notch shall be flat cut between the corner radii.

Center stringers shall be parallel to and equidistant between outside stringers.

VI. ASSEMBLY

A. Predrilling

Predrilling of deckboards shall be required when nails are hand driven. When predrilling is required, the outer ends of the deckboards shall be predrilled approximately 1/32" larger than the nail shank. When pallets are assembled by nailing machines, predrilling of deckboards is not required.

B. Nailing

The number of nails which shall be employed at all bearing points for the various widths of deckboards is as follows:

Width of Deckboard	Number of Nails
3-5/8" to 5-1/2" width	2 nails
5-5/8" to 7-1/2" width	3 nails
7-1/2" to 8" width	4 nails

Nails shall be staggered. Flat head nails shall be counter sunk at least 1/16" deep. Oval concave "snag free" head nails shall be driven flush with the deckboards.

VII. WORKMANSHIP

- A. Protruding nail heads or points are not permitted. Bent over nails must be driven below surface of deckboards.
- B. Deviation in dimension of assembled pallets shall be limited to 3/8" out-of-square (3/4" difference in diagonals), plus or minus 3/16" in overall pallet length or width.
- C. No combination of defects in workmanship, including nail splits, which will adversely affect the strength of the pallet to a material extent will be permitted.

VIII. IDENTIFICATION OF PALLETS

Each pallet shall be marked on the exterior surface of one outside stringer, with the GPC logo in accordance with the GPC Marking Specifications to clearly show that the pallet meets GPC Standards.

Eichler, John R. 1976. Wood pallet manufacturing practices. Eichler Associates. Cape Coral, Florida. PP.130-134.

APPENDIX C

Summarized Survey Results

1. Does Your Company Send Any Pallets Downstream to Your Customers?

Response	Percent (Frequency)
No	5%(13)
Yes	95%(245)

2. Reported 1994 Rates of Use of Pallet Types by Product Types.

		Product Type					
Pallet Material	Dry	Produce	Frozen	Meat	Dairy	Other	
	Goods		Foods				
	Perce	nt of respo	ndents (Fi	requency	of respon	dents)	
Solid Wood	99.1	85.3	91.3	94.0	91.7	22.5	
	(216)	(186)	(199)	(205)	(200)	(49)	
Plastic	22	8.7	9.2	9.2	7.8	2.8	
	(48)	(19)	(20)	(20)	(17)	(6)	
Corrugated	.5	0	0	0	0	0	
	(1)	(O)	(0)	(O)	(0)	(0)	
Pressed Wood	0	.5	0	0	0	0	
	(0)	(1).	(0)	(0)	(0)	(0)	
Other	4.1	1.4	1.8	.9	2.3	.9	
	(9)	(3)	(4)	(2)	(5)	(2)	

	Product Type						
Pallet Material	Dry	Produce	Frozen	Meat	Dairy	Other	
	Goods		Foods				
	Percei	nt of respo	ndents (Fr	requency	of respon	dents)	
Solid Wood	90.8	79.3	84.8	88.0	84.8	19.4	
	(197)	(172)	(184)	(191)	(184)	(42)	
Plastic	35.9	24.9	27.2	25.3	24.9	6.5	
	(78)	(54)	(59)	(55)	(54)	(14)	
Corrugated	.9	0	0	0	0	0	
	(2)	(0)	(0)	(0)	(O)	(0)	
Pressed Wood	1.4	.9	.9	.9	.9	0	
	(3)	(2)	(2)	(2)	(2)	(0)	
Other	4.6	2.3	2.8	1.8	4.1	.9	
	(10)	(5)	(6)	(4)	(9)	(2)	

3. Estimated 1997 Rates of Use of Pallet Types by Product Types.

4. How would you rate the overall performance of the following types of pallets for shipping dry goods downstream to customers? Scale (Frequency)

	Very Poor Performance			Average Performance			Excellent Performance	Don't Know	Average
Solid wood	1(1)	2(7)	3(21)	4(96)	5(63)	6(32)	7(25)	8(0)	4.66
Plastic	1(3)	2(4)	3(11)	4(10)	5(19)	6(45)	7(31)	8(82)	5.41
Corrugated	1(33)	2(17)	3(6)	4(3)	5(1)	6(2)	7(0)	8(113)	1.83
Pressed wood	1(30)	2(14)	3(16)	4(3)	5(1)	6(1)	7(1)	8(110)	2.06
Other:	1(1)	2(0) -	3(0)	4(2)	5(1)	6(5)	7(6)	8(0)	5.73

5. Please indicate your opinion of the following statements. Scale (Frequency)

2	Strongly Disagree		N	leutral			Strongly Agree	Don't Know	Average
Initial Cost:									
Solid wood pallets have a low initial cost	1(16)	2(16)	3(25)	4(62)	5(56)	6(48)	7(21)	8(0)	4.45
Plastic pallets have a low initial cost	1(116)	2(52)	3(10)	4(7)	5(1)	6(1)	7(10)	8(46)	1.82
Corrugated pallets have a low initial cost	1(6)	2(3)	3(3)	4(24)	5(13)	6(25)	7(15)	8(143)	4.91
Pressed wood pallets have a low initial cost	1(2)	2(5)	3(6)	4(29)	5(16)	6(11)	7(5)	8(157)	4.42
Durability:									
Solid wood pallets are highly durable	1(21)	2(35)	3(43)	4(38)	5(60)	6(35)	7(12)	8(0)	3.96
Plastic pallets are highly durable	1(0)	2(4)	3(9)	4(9)	5(20)	6(71)	7(79)	8(50)	5.99
Corrugated pallets are highly durable	1(53)	2(30)	3(9)	4(8)	5(1)	6(0)	7(0)	8(128)	1.75
Pressed wood pallets are highly durable	1(26)	2(24)	3(23)	4(13)	5(5)	6(1)	7(0)	8(139)	2.46
Recyclability:									
Solid wood pallets are highly recyclable	1(22)	⁻ 2(23)	3(34)	4(38)	5(52)	6(45)	7(26)	8(2)	4.31
Plastic pallets are highly recyclable	1(6)	2(7)	3(4)	4(15)	5(25)	6(61)	7(50)	8(72)	5.55
Corrugated pallets are highly recyclable	1(5)	2(3)	3(3)	4(15)	5(14)	6(35)	7(39)	8(114)	5.55
Pressed wood pallets are highly recyclable	1(7)	2(14)	3(5)	4(23)	5(13)	6(12)	7(9)	8(145)	4.12
Ability to Sanitize:									
Solid wood pallets are easy to sanitize	1(62)	2(58)	3(48)	4(35)	5(17)	6(10)	7(5)	8(8)	2.73
Plastic pallets are easy to sanitize	1(6)	2(7)	3(4)	4(17)	5(34)	6(77)	7(54)	8(42)	5.58
Corrugated pallets are easy to sanitize	1(65)	2(29)	3(9)	4(6)	5(0)	6(1)	7(0)	8(120)	1.64
Pressed wood pallets are easy to sanitize	1(33)	2(32)	3(22)	4(10)	5(2)	6(1)	7(1)	8(130)	2.24
Environmentally Eriondly.									
Solid wood pallets are environmentally friendly	1(34)	2(26)	3(27)	4(51)	5/30)	6(27)	7(25)	8(2)	2 00
Plastic nallets are environmentally friendly	1(16)	2(20)	3(17)	4(30)	5(38)	6(46)	7(33)	8(51)	A 77
Corrugated pallets are environmentally friendly	1(5)	2(5)	3(8)	4(27)	5(22)	6(22)	7(21)	8(108)	4.17
Pressed wood pallets are environmentally friendly	1(3)	2(3)	3(15)	4(30)	5(18)	6(12)	7(21)	8(106)	4.37
resource panels are environmentally mendly	1(4)	2(10)	5(15)	+(30)	2(10)	0(10)	(9)	0(120)	4.33

	Strongly						Strongly	Don't	
	Disagree		N	eutral			Agree	Know	Average
Cost Per Use:									
Solid wood pallets have a low cost per use	1(28)	2(30)	3(35)	4(69)	5(44)	6(25)	7(9)	8(3)	3.76
Plastic pallets have a low cost per use	1(4)	2(10)	3(10)	4(20)	5(28)	6(61)	7(44)	8(64)	5.36
Corrugated pallets have a low cost per use	1(16)	2(15)	3(21)	4(16)	5(9)	6(7)	7(4)	8(142)	3.27
Pressed wood pallets have a low cost per use	1(15)	2(13)	3(16)	4(23)	5(10)	6(3)	7(2)	8(149)	3.21
Disposal Cost:									
Solid wood pallets have a low disposal cost	1(31)	2(40)	3(29)	4(36)	5(32)	6(36)	7(32)	8(4)	3.99
Plastic pallets have a low disposal cost	1(16)	2(16)	3(21)	4(26)	5(23)	6(25)	7(18)	8(94)	4.18
Corrugated pallets have a low disposal cost	1(6)	2(5)	3(8)	4(13)	5(18)	6(20)	7(25)	8(130)	5.02
Pressed wood pallets have a low disposal cost	1(6)	2(9)	3(12)	4(22)	5(14)	6(8)	7(6)	8(149)	4.00
Quality:									
Solid wood pallets are high quality	1(13)	2(27)	3(40)	4(59)	5(56)	6(36)	7(12)	8(1)	4.13
Plastic pallets are high quality	1(0)	2(2)	3(9)	4(32)	5(28)	6(73)	7(45)	8(52)	5.57
Corrugated pallets are high quality	1(27)	2(27)	3(21)	4(16)	5(4)	6(2)	7(0)	8(133)	2.47
Pressed wood pallets are high quality	1(15)	2(25)	3(19)	4(19)	5(5)	6(3)	7(1)	8(143)	2.85
Employee Handling Safety:									
Solid wood pallets are safe for employees to use	1(27)	2(43)	3(50)	4(65)	5(33)	6(21)	7(4)	8(1)	3.47
Plastic pallets are safe for employees to use	1(1)	2(2)	3(3)	4(25)	5(30)	6(74)	7(59)	8(48)	5.78
Corrugated pallets are safe for employees to use	1(10)	2(3)	3(9)	4(23)	5(17)	6(32)	7(10)	8(127)	4.63
Pressed wood pallets are safe for employees to u	ise 1(8)	2(10)	3(21)	4(27)	5(19)	6(7)	7(2)	8(138)	3.72

	Low Importance	•	I	Average mportance			High Importance	Don't Kaow	Mean
Recyclability	1(10)	2(16)	3(12)	4(79)	5(35)	6(44)	7(43)	8(1)	4.74
Four-way entry	1(2)	2(3)	3(3)	4(18)	5(19)	6(48)	7(150)	8(0)	6.26
Initial cost	1(0)	2(3)	3(5)	4(28)	5(24)	6(64)	7(118)	8(0)	6.05
Durability	1(0)	2(0)	3(1)	4(9)	5(21)	6(63)	7(149)	8(0)	6.44
Fire resistance	1(27)	2(24)	3(23)	4(83)	5(23)	6(22)	7(40)	8(1)	4.14
Ability to sanitize	1(18)	2(15)	3(21)	4(71)	5(38)	6(41)	7(37)	8(2)	4.52
Ability to rack	1(6)	2(11)	3(6)	4(16)	5(17)	6(46)	7(141)	8(0)	6.00
Environmental friendliness	1(8)	2(14)	3(13)	4(76)	5(53)	6(46)	7(31)	8(2)	4.72
Weight	1(0)	2(3)	3(4)	4(28)	5(31)	6(68)	7(109)	8(0)	5.99
Weather resistance	1(18)	2(24)	3(20)	4(64)	5(36)	6(33)	7(48)	8(0)	4.51
Disposal cost	1(16)	2(14)	3(23)	4(56)	5(36)	6(50)	7(47)	8(1)	4.74
Quality	1(0)	2(1)	3(1)	4(6)	5(21)	6(71)	7(142)	8(0)	6.42
Cost per use	1(0)	2(0)	3(3)	4(16)	5(9)	6(55)	7(160)	8(0)	6.45
Employee handling safety	1(0)	2(0)	3(1)	4(15)	5(18)	6(55)	7(154)	8(0)	6.42
Ability to nest (i.e., fit inside one another)	1(28)	2(16)	3(14)	4(48)	5(30)	6(42)	7(54)	8(10)	4.63

6. How important are the following factors when choosing a pallet to ship goods downstream? Scale (Frequency)

 Summary of Companies Using any Type of Third Party Pallet Rental or Leasing Program for Downstream Shipment to Their Customers. (e.g., CHEP U.S.A., First National Pallet Rental, National Pallet Leasing System, etc.) Percent (Frequency)

74.1%(183) Yes

25.9%(60) No

8. At what level are final decisions on pallet material types made in your company? Percent (Frequency)

29.8%(73)		Corporate level
10.2%(25)		Company level
16.3%(40)	•	Division level
52.2%(128)		Distribution center level
1.2% (3)		Other:
		(please specify)

9. At what level of operations are you located? Percent (Frequency)

20.6%(50)	Corporate level	
6.6% (16)	Company level	
11.9%(29)	Division level	
72.4%(176)	Distribution center level	
0% (0)	Other:	
	(please specify)	

10. Summary of Respondents Titles. Percent (frequency)

.8(2)	CEO
18.8(46)	Vice President
26.1(64)	Director
42.4(104)	Manager
11.8(29)	Other

11. How much influence do you have in your company's choice of pallet types? (plastic vs. wood vs. corrugated vs. pressed wood). Scale (Frequency)

No influence						Final decision- maker	Mean
1(4)	2(10)	3(2)	4(25)	5(40)	6(83)	7(78)	5.67

12. Please complete the following statement.

"In 1993 I provided input into the decision to purchase ______ pallets."

(please write in the number)

Respondents answers ranged between 0 and 518,000. Caution is necessary in interpreting this answer because the researcher suspects that there was variation in the interpretation of this question.

APPENDIX D

Research Instruments:

In-depth Interview Forms

Questionnaire Cover Letters

Questionnaire

Three forms were used due to questionnaire improvements made following the first two interview trips.

1. Why did you switch (or are going to switch) to a substitute material pallet for shipping goods downstream?

Is there any product type that you wouldn't ship downstream on a plastic pallet? Why? Is dairy, milk, and ice cream, distribution different?

2. What do the following factors mean to you?

durability

recyclability

quality

cost per use

ability to sanitize

employee handling safety

environmentally friendly

3. Why is cost per use more important than initial cost?(where applicable)

- 4. Could you explain the decision process of switching to substitute material pallets? Please start from the title and level of the person who initiated (or who would initiate) the change to the title and level of person or persons who make (or who would make) the final decision.
- 5. Please clarify your answers on the original questionnaire concerning the advantages and disadvantages of the various materials.

Plastic	advantages		
	disadvantages		
Wood	advantages		
	disadvantages		

- 6. How do you control pallets you send downstream? Traditional wood vs CHEP vs plastic.
- 7. What percent of pallets sent downstream are Substitute materials/CHEP? Do you expect this number to increase or decrease over the next 3 years?
- 8. How many pallets do you purchase directly and indirectly?
- 9. Who pays the cost of product damage?
- 10. How many distribution centers does (or would) this decision affect?
- 11. How did you interpret ques. 13 on input into the decision to purchase _ # of pallets?

Misc

In-depth Interview Form #2.

- 1. What types of pallets are you using to send goods downstream?
- 2. Why did you switch (or are going to switch) to a substitute material pallet for shipping goods downstream?
- 3. What do you like and dislike about CHEP? How does it work? What percent of pallets in your system (distribution center and store) are CHEP? Will you use CHEP in the future? What percent? Are you sending CHEP downstream? What percent? What percent would you like to see in 3 years? Are you familiar with other third party pallet systems?
- 4. What do the following factors mean to you?

Durability- How does a wood pallet rate in terms of durability compared to a plastic pallet? How can a wood pallet be improved if durability is a problem?

Recyclability- How does a wood pallet rate in terms of recyclability compared to plastic pallets? How can a wood pallet be improved if recyclability is a problem?

Quality- How does a wood pallet rate in terms of quality compared to plastic pallets? How can a wood pallet be improved if quality is a problem?

Cost per use - How does a wood pallet rate in terms of cost per use compared to plastic pallets? How can a wood pallet be improved if cost per use is a problem?

Ability to sanitize- How does a wood pallet rate in terms of ability to sanitize compared to plastic pallets? How can a wood pallet be improved if ability to sanitize is a problem?

Employee handling safety - How does a wood pallet rate in terms of employee handling safety compared to plastic pallets? How can a wood pallet be improved if employee handling safety is a problem?

Environmentally friendly-How does a wood pallet rate in terms of environmental friendliness compared to plastic pallets? How can a wood pallet be improved if environmental friendliness is a problem?

5. Please clarify your answers on the original questionnaire concerning the advantages and disadvantages of the various materials.

Plastic advantages disadvantages-

Wood advantages disadvantages -.

Can you think of a way the wood pallet can be improved?

- 6. How many pallets do you have in your system at one time? (distribution center and stores) How many distribution centers does this number include? What percent of wood, plastic, are sent downstream? How many plastic pallets do you have in all your systems?
- 7. How did you interpret ques. 13 on input into the decision to purchase _ # of pallets?
- 8. How would you define a 4 way pallet?
- 9. Could you explain the decision process of switching to substitute material pallets? Please start from the title and level of the person who initiated (or who would initiate) the change to the title and level of person or persons who make (or who would make) the final decision.

Misc.

In-depth Interview Form #3.

- 1. What types of pallets are you using to send goods downstream?
- 2. Why did you switch (or are going to switch) to a substitute material pallet for shipping goods downstream?
- 3. What do you like and dislike about CHEP? How does it work? What percent of pallets in your system (distribution center and store) are CHEP? will you use CHEP in the future? What percent? Are you sending CHEP downstream? What percent? What percent would you like to see in 3 years? Are you familiar with other third party pallet systems?
- 4. Please clarify your answers on the original questionnaire concerning the advantages and disadvantages of the various materials.

Plastic advantages disadvantages-Wood advantagesdisadvantages -

How can the wood pallet be improved to meet your needs?

- 5. How many pallets do you have in your system at one time? (distribution center and stores) How many distribution centers does this number include? What percent of wood, plastic, are sent downstream? How many plastic pallets do you have in all your systems?
- 6. How did you interpret ques. 13 on input into the decision to purchase _ # of pallets?
- 7. How would you define a 4 way pallet?

Misc.



1650 Ramble Rd., Blacksburg, Virginia 24061-0503 Phone: (703) 321-5876 Fax: (703) 231-8868

January 3, 1994

1- 2?-3?-4?-5?-6?-7-, 8- 9-

Dear 12~:

A recent report by Cleveland Consulting Associates stated that current materials handling systems cost the grocery industry nearly two billion dollars annually. From this report, the pallet subcommittee (a group of grocery manufacturers, wholesalers, and retailers) concluded that all pallets on the market today fall short of meeting the grocery industry's needs. To gain a better understanding of this problem, I am contacting you regarding your opinions of various pallet materials. The information I am gathering will be used to assist pallet producers to better understand and meet your needs.

Your company was chosen from *The Progressive Grocers Marketing Guidebook*. I am seeking opinions from those persons who provide input into the pallet material decision. Your response is very important to the success of this study. Please complete the questionnaire and return it as soon as possible.

Complete confidentiality is assured to you and your company. The questionnaire has an identification number for mailing purposes only. The number will be used to remove your name from our mailing list when your questionnaire is received. The published report will contain only overall results. Individual respondents will not be identified and no information will be released about you or your company.

I would be pleased to provide you with a summary of the study results. To receive a copy, simply write your name and address on the last page of the questionnaire.

If you have any questions please call me at (703) 231-5876 or fax a note to me at (703) 231-8868.

Thank you for your help.

Sincerely,

Cathy Engle Graduate Student

Enc.

A Land-Grant University - The Commonwealth Is Our Campus An Equal Opportunity / Affirmative Action Institution


1650 Ramble Rd., Blacksburg, Virginia 24061-0503 Phone: (703) 321-5876 Fax: (703) 231-8868

February 1, 1994

1~ 2?-3?-4?-5?-6?-7-, 8- 9-

Dear 12~:

Please Help!

I recently sent you a questionnaire which asked for your opinions of various pallet materials. The questionnaire is part of a study that will allow me to better understand the factors you consider in your pallet material decisions. The information will allow pallet producers to better understand and serve your needs.

Your response is very important to the accuracy of this study. It is also important to me, as it will help in fulfilling my degree requirements. Your help would be greatly appreciated. If you have already returned a copy of the questionnaire, please accept my thanks. If you have not yet had the time to complete and return the questionnaire, please do so as soon as possible.

Complete confidentiality is assured to you and your company. The questionnaire has an identification number that will be used to remove your name from our mailing list when it is received. However, the published report will contain only overall results. Individual respondents will not be identified and no information will be released about you or your company.

I would be pleased to provide you with a summary of the study results. To receive a copy, simply write your name and address on the last page of the questionnaire or attach a business card.

If you have any questions please call me at (703) 231-5876 or fax a note to me at (703) 231-8868.

Thank you for your help.

Sincerely,

Cathy Engle Graduate Student

Enc.

A Land-Grant University - The Commonwealth Is Our Campus An Equal Opportunity / Affirmative Action Institution

Pallet Material Study



Virginia Polytechnic Institute and State University Blacksburg, VA 24061-0503

Questions? Please call: Cathy Engle

Phone:703/231-5876 Fax:703/231-8868

This questionnaire asks about factors you consider when deciding on pallet materials or types (i.e., wood, plastic, corrugated paper, and pressed wood) and will help pallet producers better understand and serve the needs of the grocery industry. If you are NOT involved in pallet purchasing decisions, please give this questionnaire to the appropriate person. All responses are strictly confidential. Thank you!

1. Does your company send any pallets downstream to your customers? (Please check one box.)



Please return this questionnaire if your company does not send any pallets downstream to your customers. Just check "No", fold and tape. Postage is prepaid. Thank you!

2. What type(s) of pallets does your company use to ship the following products downstream to your customers? (Please check all that apply.)

	Dry goods	Produce	Frozen foods	Meat	Dairy	Other: (please specify)
Solid wood						
Plastic						
Corrugated						
Pressed wood ²						
Other: (please specify)						

¹Corrugated pallets are made from corrugated paperboard (cardboard).

² Pressed wood pallets are made from pieces of wood pressed and glued together.

	Dry goods	Produce	Frozen foods	Meat	Dairy	Other:
Solid wood						
Plastic						
Corrugated						
Pressed wood						
Other: (please specify)						

3. What type(s) of pallets does your company <u>plan to use during the next 3 years</u> to ship the following products downstream to customers? (Please check all that apply.)

4. How would you rate the overall performance of the following types of pallets for shipping <u>dry</u> goods downstream to customers. (Please circle the appropriate number.)

	Very Poor Performance			Average Performance			Excellent Performance	Don't know
Solid wood	1	2	3	4	5	6	7	
Plastic	1	2	3	4	5	6	7	
Corrugated	1	2	3	4	5	6	7	
Pressed wood	1	2	3	4	5	6	7	
Other:	1	2	3	4	5	6	7	

(please specify)

.

5. What are the major advantages and disadvantages of the following types of pallets for shipping goods downstream? (Please let us know your opinion even if your company does not use the pallet type.)

Solid	wood

Advantage:	 	 	
Disadvantage:		 	
Don't know			

Plastic

Advantage:	 	 	
Disadvantage:	 	 	
Don't know			
Corrugated			
Advantage:	 	 	
Disadvantage:			

Don't know

Pressed wood

Advantage:		 	
Disadvantage:_		 	
Don't know			

6. Please indicate your opinion of the following statements.

	Strongly Disagree			Neutral			Strongly Agree	Don't Know
Initial Cost:	-							_
Solid wood pallets have a low initial cost	1	2	3	4	5	6	7	
Plastic pallets have a low initial cost	1	2	3	4	5	6	7	
Corrugated pallets have a low initial cost	1	2	3	4	5	6	7	
Pressed wood pallets have a low initial cost	1	2	3	4	5	6	7	
Durability:								_
Solid wood pallets are highly durable	1	2	3	4	5	6	7	
Plastic pallets are highly durable	1	2	3	4	5	6	7	
Corrugated pallets are highly durable	1	2	3	4	5	6	7	
Pressed wood pallets are highly durable	1	2	3	4	5	6	7	
Recyclability:								
Solid wood pallets are highly recyclable	1	2	3	4	5	6	7	
Plastic pallets are highly recyclable	1	2	3	4	5	6	7	
Corrugated pallets are highly recyclable	1	2	3	4	5	6	7	
Pressed wood pallets are highly recyclable	1	2	3	4	5	6	7	
Ability to Sanitize:								
Solid wood pallets are easy to sanitize	1	2	3	4	5	6	7	
Plastic pallets are easy to sanitize	1	2	3	4	5	6	7	
Corrugated pallets are easy to sanitize	1	2	3	4	5	6	7	
Pressed wood pallets are easy to sanitize	1	2	3	4	5	6	7	
Environmentally Friendly:								
Solid wood pallets are environmentally friendly	1	2	3	4	5	6	7	П.
Plastic pallets are environmentally friendly	1	2	3	4	5	6	7	
Corrugated pallets are environmentally friendly	1	2	3	4	5	6	7	
Pressed wood pallets are environmentally friendly	y 1	2	3	4	5	6	7	

	Strongly Disagree		N	eutral			Strongly Agree	Don't Know
Cost Per Use:	U						0	
Solid wood pallets have a low cost per use	1	2	3	4	5	6	7	
Plastic pallets have a low cost per use	1	2	3	4	5	6	7	
Corrugated pallets have a low cost per use	1	2	3	4	5	6	7	
Pressed wood pailets have a low cost per use	1	2	3	4	5	6	7	
Disposal Cost:								
Solid wood pallets have a low disposal cost	1	2	3	4	5	6	7	
Plastic pallets have a low disposal cost	1	2	3	4	5	6	7	
Corrugated pallets have a low disposal cost	1	2	3	4	5	6	7	
Pressed wood pallets have a low disposal cost	1	2	3	4	5	6	7	
Quality:								
Solid wood pallets are high quality	1	2	3	4	5	6	7	
Plastic pallets are high quality	1	2	3	4	5	6	7	
Corrugated pallets are high quality	1	2	3	4	5	6	7	
Pressed wood pallets are high quality	1	2	3	4	5	6	7	
Employee Handling Safety:								
Solid wood pallets are safe for employees to use	1	2	3	4	5	6	7	
Plastic pallets are safe for employees to use	1	2	3	4	5	6	7	
Corrugated pallets are safe for employees to use	1	2	3	4	5	6	7	
Pressed wood pailets are safe for employees to us	se 1	2	3	4	5	6	7	

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	Low Importance		I	Average mportanc	e		High Importance	Don't Know
Recyclability	1	2	3	4	5	6	7	
Four-way entry	1	2	3	4	5	6	7	
Initial cost	1	2	3	4	5	6	7	
Durability	1	2	3	4	5	6	7	
Fire resistance	1	2	3	4	5	6	7	
Ability to sanitize	1	2	3	4	5	6	7	
Ability to rack	1	2	3	4	5	6	7	
Environmental friendliness	1	2	3	4	5	6	7	
Weight	1	2	3	4	5	6	7	
Weather resistance	1	2	3	4	5	6	7	
Disposal cost	1	2	3	4	5	6	7	
Quality	1	2	3	4	5	б	7	
Cost per use	1	2	3	4	5	6	7	
Employee handling safety	1	2	3	4	5	6	7	
Ability to nest (i.e., fit inside one another)	1	2	3	4	5	6	7	

7. How important are the following factors when choosing a pallet to ship goods downstream?

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8.

Is your company using any type of third party pallet rental or leasing program for downstream shipment to your customers? (e.g., CHEP U.S.A., First National Pallet Rental, National Pallet Leasing System, etc.)

Yes

No

9. At what level are <u>final</u> decisions on pallet material types made in your company?

	Corporate level
	Company level
	Division level
	Distribution center level
\Box	Other:
	(please specify)

10. At what level of operations are you located?

Corporate headquarters
Company office
Division office
Distribution center/warehouse
Other:
(please specify)

11. Please indicate your title. (This information will be used for grouping purposes only.)

12.	How muc corrugated	th influence of vs. pressed	lo you have in y wood) (please cir	our company's role the appropri	s choice of palle iate number.)	t types? (plas	tic vs. wood
int	No fluence						Final decision maker
	1	2	3	4	5	6	7
13.	Please col	mplete the fo	llowing stateme	nt.			
	"In 1993 l	provided inp	out into the decisi	ion to purchase	(please wri	te in the numb	er)
	"In 1993 l	provided ing	out into the decisi	ion to purchase	(please wri	te in the numb	er)
	"In 1993 l	provided inp	nut into the decisi	ion to purchase	(please wri	te in the numb	pallets er)
Please	"In 1993 l e fill in your	name and a	nut into the decisi ddress if you wi	ion to purchase	(please wri	te in the numb	er)
Please	"In 1993] e fill in your	provided ing	nut into the decisi ddress if you wi	sh to receive a	(please wri	te in the numb	er)
Please	"In 1993 l e fill in your Name:	name and a	nut into the decisi	sh to receive a	(please wri	te in the numb	pauers
Please	"In 1993 l e fill in your Name: Address:	name and a	nut into the decisi	sh to receive a	(please wri	te in the numb	pauers
Please	"In 1993] e fill in your Name: Address:	name and a 	ddress if you wi	sh to receive a	(please wri	te in the numb	pallets
Please	"In 1993] e fill in your Name: Address:	name and a	ddress if you wi	sh to receive a	(please wri	te in the numb	pauers
Please	"In 1993 e fill in your Name: Address:	name and a 	ddress if you wi	sh to receive a	(please wri	te in the numb	pallets
Please	"In 1993 l e fill in your Name: Address:	name and a	ddress if you wi	sh to receive a	(please wri	te in the numb	pauers

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VIRGINIA TECH THOMAS M. BROOKS CENTER ATTN: CATHY ENGLE PO BOX 850 BLACKSBURG VA 24063-9985

Fold Along Line

Please return this questionnaire, by folding once and taping so that the return address is showing. Postage is prepaid.

THANK YOU!

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VITA

Catherine A. Engle was born in Coronado, California on February 20, 1970, to Robert and Carolyn Engle. In 1988, she graduated from Robinson High School in Fairfax, Virginia. She then moved on to higher education at Virginia Polytechnic Institute and State University where she earned a B.S. degree in Forest Products in 1992 and a M.S. degree in Forest Products in 1994. She has been employed as a research scientist by the U.S. Forest Service since 1992.