Wood-Based Material Use in the
United States Pallet and Container Industry

by

John Carmen Christoforo

Thesis submitted to the Faculty of
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Wood Science and Forest Products

APPROVAL:

Robert J. Bush, Chairman — Date: 2/12/93

Fred M. Lamb — Date: 2/8/93

Marshall S. White — Date: 2/8/93

February 15, 1993
Blacksburg, Virginia

Wood-Based Material Use in the
United States Pallet and Container Industry

by

John Carmen Christoforo

Committee Chairman: Robert J. Bush
Wood Science and Forest Products

(Abstract)

A questionnaire was sent to 2,111 U.S. pallet and container manufacturers to (1) estimate the total volume of hardwood lumber, softwood lumber, and wood-based panels used by the industry in 1991, (2) estimate lumber use by species category within the industry, and (3) predict shifts in the volumes of wood-based materials used by the U.S. pallet and container industry.

Data from 656 pallet and container manufacturers were analyzed and used to estimate total industry use of the wood materials. Total 1991 hardwood lumber and cant use was estimated to be over 3.8 billion board feet and consumption was expected to increase 13% by 1993. Softwood lumber and cant consumption in 1991 was estimated to be over 1.8 billion board feet and an increase of 7% was expected by 1993. Softwood plywood use during 1991 was estimated to account for 271 million square feet (3/4" basis) and consumption was expected to increase by 13% through 1993. Oriented strandboard use for 1991 was estimated to be 36 million square feet (7/16" basis) and use of OSB was predicted to increase 25% by 1993.

Oak was the largest single species group consumed by pallet and container manufacturers in 1991, accounting for over 1.6 billion board feet of lumber, cants, parts and shook . Southern yellow pine consumption was an estimated 541 million board feet in 1991, followed closely by almost 500 million board feet of yellow-poplar, and over 227 million board feet of alder.

Seventy percent of hardwood lumber and cant purchases (by volume) were made direct from the sawmill in 1991. Softwood lumber purchases were made either from a lumber broker (38%) or direct from the sawmill (37%).

Acknowledgements

This thesis is the compilation of the efforts of many individuals beyond myself. The most prominent of these is my major professor, Dr. Robert Bush, who provided the crucial assistance and guidance necessary to bring this entire work to fruition. My gratitude is also due to Vijaya Reddy and John Punches for their help (and patience) in managing the database for the study and also in guiding me through much of the software used in writing this thesis. I wish to express thanks to Dr. Steven Sinclair for his valuable input during my time at Virginia Tech and specifically during the writing of the pallet and container report. My appreciation also belongs to Dr. Sinclair and Dr. Marshall White for serving on my committee. My sincere thanks go to my fellow graduate students for their hours of labor involved in mailing questionnaires and also for their input during the course of my studies and thesis work. I would also like to thank Dr. Fred Lamb for serving on my committee upon such a short notice.

My unwavering appreciation is due to my wife, Rebecca, for her support and exceptional understanding since the day she joined me in Virginia. I am indebted to her for her patience and personal sacrifice, from my first exam to the last revision of this thesis.

Deep appreciation goes to my entire family, for their support and willingness to stand by me in all pursuits. To my mother, whose belief and pride in me has meant more than I can say. Thanks also to my step-father for being there for both myself and my mother. Thanks to my father, brother, and to my wife's parents, for their encouragement and interest in this work.

In conclusion, I give complete thanks to the Lord for his steadfast love and constant provision in my life. I could not have done it without His help!

Preface

This thesis is divided in four distinct sections. The Review of Literature contains a synopsis of relevant data and discussion pertinent to material use by the pallet and container industry. The Methods section describes, in detail, the steps taken to obtain data and estimate industry use of wood-based materials. The next section is a report written for the sponsors of this research and contains the greatest depth and discussion of the results. The last section is an abbreviated version of the forementioned report which was prepared as an article to be submitted for publication. The reader may find some repetition in the last two sections of the thesis which contain, in condensed form, portions of the literature review and methods. The author hopes this does not cause any confusion or inconvenience.

Table of Contents

WOOD-BASED MATERIAL USE IN THE U. S. PALLET AND CONTAINER INDUSTRY: 1991 and 1993

A PROFILE OF THE U. S. PALLET AND CONTAINER INDUSTRY

Table of Tables

Table of Figures

Objectives

The primary objective of this study was to augment and refine existing data on the U.S. pallet and container industry. Specific objectives included:

1. Estimate the total volume of hardwood lumber, softwood lumber, and wood-based panels used by the U. S. pallet and container industry.

2. Estimate lumber use by species category within the U. S. pallet and container industry.

3. Predict shifts in the volumes of wood-based materials used by the U. S. pallet and container industry.

Review of Literature

Introduction

The pallet and container industry purchases tremendous quantities of wood materials and has consumed nearly 40% of total U.S. hardwood lumber production since the 1980's (Spelter and Phelps 1984, Luppold 1989). The industry also provides an important outlet for the large amount of low grade hardwood lumber produced by grade sawmills. However, very little current information is available concerning the types of products used by this industry and trends in the use of wood materials.

Researchers have investigated several aspects of the industry (e.g., McCurdy et al. 1985, 1988, 1991; Luppold 1989; etc.). However, up-to-date information concerning the volumes of wood materials used by the industry is not available in the public domain. Bureau of the Census data on material use, while relatively consistent and widely available, are only available in detail every five years and are generally not published for at least three years after they are gathered. Even then, researchers spend a great amount of time attempting to interpret and validate the results (Luppold 1989).

Anderson (1988) points out in his study of pallet utilization by the grocery industry: *"Although the pallet industry is the largest single user of hardwood raw material, it is made up many small, independent firms. No individual firm has the resources to do market research which can provide the detailed information required to make informed decisions. The National Wooden Pallet and Container Association, with which many of the firms have contact, also has a limited budget and staff and cannot*

provide this type of research". Because of this lack of current information about the pallet and container industry, this study was undertaken.

There has been, however, various studies of wood materials use conducted on specific areas of the pallet industry. Among the earliest were three studies conducted by the Forest Service. Lucas (1969) studied the use of wooden pallets in the brewing industry, Lucas and Wallin (1969) reported on the Department of Defense market for wooden pallets, and Strobel and Wallin (1969) studied the unit-load growth within the food industry. Another study was conducted by Bond and Sendak (1970), who researched the structure of the wood platform industry of the northeast. More recently, there have been two studies at the state level. Fraser et al. (1990) reported a description of Pennsylvania's pallet industry in 1986, and Smith (1991) studied the Washington state wood pallet industry.

Industry Characteristics

The pallet industry[1] is one of the major forest products segments in the United States, and is the largest consumer of domestic hardwood lumber (McCurdy and Phelps 1991). The industry is very fragmented, characterized by many firms with many customers. Dempsey and Luppold (1992) write that the pallet industry's growth as a lumber market has been consistent since records on the industry were kept, and that the

[1] For convenience, the terms "Pallet Industry" and "Container Industry" will be used in this document to refer to the manufacturers producing these products. A stricter definition would consider pallet and container manufacturers as portions of the same industry.

expansion in volume used has occurred despite a steady reduction in the amount of lumber used per pallet and an increase in the use of softwoods in the construction of pallets, skids, and containers.

In 1990, it was estimated that there were 2,180 companies producing pallets in the U. S. (McCurdy and Phelps 1991). The average firm had eighteen employees, had been in business for 19 years, and sold its products within state borders, usually at delivery distances of less than 100 miles from the plant (McCurdy and Phelps 1991). Michigan and Pennsylvania had the largest number of firms in 1990, each with more than 200. Illinois and Ohio had the next largest number of firms with 184 and 197 respectively. By Bureau of the Census regions (Figure 1), more than one-third of the firms are located in the North Central region of the United States.

The amount of wood used in the average pallet in 1990 was found to be 17.3 board feet, down slightly from 17.7 board feet in 1985 (McCurdy and Phelps 1991). The mean production per firm was 211,600 pallets in 1990. However, some firms produced more than 1 million pallets that year and 40% of the firms produce over 140,000 pallets annually. McCurdy and Phelps (1991), estimated that a total of 460 million pallets were manufactured in 1990.

McCurdy and Phelps (1991) determined that 37% of the firms in their study produced containers (with no description as to what kind) in addition to pallets in 1990. The average number of containers produced by these firms was 5,335 units. One-tenth of the firms produced more than 10,000 units of containers.

The container industry has consumed decreasing amounts of wood and wood-based panels since 1948 (Spelter and Phelps 1984, USDA Forest Service 1989). This has resulted from a continued displacement of wooden containers by wood fiber and plastic containers, by metal, plastic, and wood fiber barrels and pails, and by multiwall fiber and plastic bags (USDA Forest Service 1989). The decline of wood container consumption can be attributed to both lower costs of substitute materials and the need to reduce shipping weight.

Wood Materials Used by the Pallet and Container Industry

Hardwood Lumber

As mentioned, the pallet and container industry is the single largest market for hardwood lumber (Cardellichio and Binkley 1984), consuming approximately 40% of all hardwood lumber produced annually in the U. S. The bulk of this lumber is low-grade lumber which is graded as #3A Common or below under the National Hardwood Lumber Association grading rules. Due to the industry's importance to hardwood lumber manufacturers, there is a considerable amount of literature discussing hardwood lumber consumption by pallet and container manufacturers.

Spelter and Phelps (1984) compiled all wood products market surveys since World War II, developed use factors, and compared them to leading economic indicators. The authors determined that the pallet industry consumed 120 million board feet of hardwoods in 1949 (Figure 2). Rapid growth has occurred since that time and it was estimated that

the pallet industry consumed over 2.5 billion board feet of hardwoods in 1981. The authors also reported that the container industry consumed over 1.2 billion board feet of hardwoods in 1949, and that hardwood consumption for declined from 1.44 billion board feet in 1953 to 570 million board feet in 1981.

McKeever and Hatfield (1984) compiled data from previous U.S. Forest Service *Wood Used in Manufacturing* bulletins and reported that the pallet industry consumed 106.5 million board feet of hardwoods in 1948 and that consumption grew to 1.77 billion board feet in 1977 (Figure 3). The authors also report that the container industry (excluding cooperage) consumed 1.08 billion board feet of hardwoods in 1948 and that consumption fell to 246 million board feet in 1977. Figure 4 displays the decline in cooperage manufacture for the years 1906 to 1976.

Hicks (1991) estimated that the pallet and skid industry consumed 5.1 billion board feet of hardwood lumber, logs, and cants during 1990. These data were based on information from the U.S. Department of Commerce (USDC) Annual Survey of Manufacturers or from the Census of Manufacturers. However, these data may underestimate actual use (Luppold 1992). Based on an examination of wages paid within the industry, Luppold contends that the USDC miscalculates the size of the pallet and container industry.

McCurdy and Phelps (1991) conducted a census of pallet manufacturers and estimated that in 1990 hardwoods had a 71% share of the approximately 460 million

pallets produced in 1990. These figures indicate that approximately 5.6 billion board feet of hardwoods were used in pallets during 1990, including residues.

The latest publicly available estimate of hardwood lumber use by pallet and container manufacturers was reported by Dempsey and Luppold (1992). This estimate was based upon data extrapolated from the first nine months of 1991. The authors estimate that approximately 4.6 billion board feet of hardwood lumber were consumed by the industry in 1991. Other groups estimate lumber use by the pallet and container industry, however, these estimates are proprietary and are not publicly available.

Softwood Lumber

Spelter and Phelps (1984) reported that the pallet industry consumed 70 million board feet of softwoods in 1949 and that consumption grew to one billion board feet in 1981. The container industry consumed 2.69 billion board feet of softwoods in 1949 and this consumption declined to 650 million board feet in 1981 (Figure 5).

In 1985, McCurdy et al. (1988) conducted a random sample of pallet manufacturers and reported that 25% of the lumber used in pallet production were softwoods. An estimated 450 million pallets were produced in 1985, containing an average of 13.9 board feet. These figures indicate that approximately 1.56 billion board feet of softwoods were consumed by the industry in 1985, excluding residues. Hicks (1991) reports that the pallet and skid industry consumed 1.7 billion board feet of softwoods in 1990.

Wood-Based Panels

The U. S. Forest Service estimated that the pallet industry consumed one million square feet of wood-based panels[2] in 1948 and that consumption grew to over 500 million square feet in 1986 (USDA Forest Service 1989). The container industry consumed 313 million square feet in 1948 and consumption fell after 1960 (1.125 billion square feet) to 100 million square feet in 1986 (Figure 6).

In a study of structural panel usage within industrial markets conducted by the American Plywood Association (APA), it was estimated that 52% of pallet, crate, and container firms with less than 20 employees and 56% of the firms with 20 or more employees used structural panels in 1986 (Anderson 1987b). The APA reports that more than 407 million square feet of structural panels (3/8-inch basis) were consumed by pallet and container firms in 1986.

The discrepancy between the estimates of the Forest Service and the APA can be attributed to differing data collection methods. The U.S. Forest Service based their estimates on trends in the value of pallet production and wooden container shipments and trends in timber products use per unit of production. The APA's estimates, however, were based on a random telephone sample of structural panel users within each SIC code of interest. Every 16th firm on a list of producers was telephoned until a quota of 25

[2] Wood-based panels refers to both structural and nonstructural panels on a 3/8" basis, unless otherwise specified.

structural panel using firms from each SIC code was reached. These data were then expanded to estimate each SIC's total consumption.

The USDA Forest Service (1982), in a report prior to their current Analysis of the Timber Situation in the United States (USDA Forest Service 1989), estimated that the pallet industry would consume as much as 130 million square feet (1/8" basis) of hardboard by the year 2030. The current Analysis of the Timber Situation in the United States does not predict hardboard usage but simply the use of nonstructural panels.

More recently, however, the APA estimated that 2 billion square feet (3/8" basis) of structural panels were consumed by the materials handling industry in 1991, and that two-thirds of the total structural panel volume in the materials handling industry was consumed by pallet firms and industrial fabricators (Adair 1992). Industrial fabricators are considered to be manufacturers that fabricate products from structural panels, such as agricultural bins, specialty pallets, and sporting goods (ping-pong tables, basketball backboards, etc.).

Lumber Use by Species

Throughout the literature concerning materials consumed by the pallet and container industry, volumes of lumber were traditionally reported simply as "hardwoods" or "softwoods", without indication as to species. While it is understood that just about any species of wood can be (and is) used in constructing a pallet or container, no specific breakdowns are available for species groups other than oak.

McCurdy et al. (1985, 1988, 1991), in their studies of the pallet and container industry, has reported the steady decline in the consumption of oak. McCurdy reports hardwoods as having an 83% share of pallet production in 1980, with 41% of all lumber being oak, and 42% being *other hardwoods*. In 1985, 73% of all lumber used were hardwoods (34% oak and 39% *other hardwoods*). McCurdy's latest study (McCurdy and Phelps 1991) reports that 71% of all lumber used for pallets are hardwoods, and no description is given as to oak's share of total lumber use.

It is not known which species or products are increasing to compensate for this reduction in the use of oak. However, the Southern Pine Marketing Council (SPMC) is reporting increased use of southern pine in the pallet industry, noting the advantage of lower weight per pallet using kiln-dried softwood material (Anon. 1991). Although the SPMC profiles a few manufacturers who are switching to southern pine, no indication is given as to quantities consumed. In order to provide greater insight to species use, this study asked manufacturers to specify species used in their pallets and containers.

Industry Trends

One trend in the industry is clear. Since 1948 the pallet segment of the industry has experienced rapid growth in consumption of wood materials (especially hardwoods), while the container segment of the industry has experienced decline in the consumption of all wood materials. This trend has been projected to continue (McKeever and Dickerhoof 1980, USDA Forest Service 1982, Anderson 1986, 1987a).

As mentioned, a shift is occurring from the traditional use of hardwood lumber to softwoods, especially southern pine. This shift away from oak and other hardwoods has been documented in studies of the pallet industry conducted over the last decade (McCurdy et. al 1985, 1988 and 1991).

Of the many issues that are of concern to the pallet and container industry perhaps the most important is the question of block pallets. A review of the *Wooden Pallet Index* and the newsletter of the National Wooden Pallet and Container Association for the past twelve months indicates considerable concern about the adoption of block pallets.

The Grocery Manufacturer's Association (GMA) has developed a specification list for pallets to be used by their industry, the criteria on their list included: (1) True full four way entry (read as block style pallet), (2) Pallet weight of 50 pounds or less, (3) The availability of materials to meet the demand for pallets, (4) The ability for a pallet to meet the widely varied requirements of various customers, and (5) A reduction in the current levels of product damage (Anon. 1992).

Along with the specification list is concern over misuse of the pallet exchange program, where not every party is buying the same quality pallet and thus some pallets in the system are of higher quality than others. For the past year, the GMA has been investigating the use of a block pallet and a third party to manage the pallets used by the grocery industry.

The GMA recommendation could have far reaching implications. Anderson and Wisdom (1991) estimated that the grocery industry purchased 75 million pallets in 1989,

or about 15% of the estimated 505 million pallets manufactured in the United States during 1989 (NWPCA 1991). On the issue of block pallet construction, the *Wooden Pallet Index* reported that "from a hardwood perspective this is likely to mean a shift toward more softwood pallet construction" (Brindley 1992).

Another trend that is worth noting is the increasing repair of pallets and containers. This increase could have a dampening effect upon the volume of new pallets produced and the volume of hardwood lumber consumed (Dempsey and Luppold 1992). Although the short term impact of the increase in pallet repair would not be very significant, if growth in pallet repair continues and pallet leasing gains wider acceptance, the impact on hardwood lumber use could be very significant (Dempsey and Luppold 1992).

McCurdy and Phelps (1991) estimated that 41% of responding firms recycled pallets in addition to producing new pallets. Firms recycled, on average, 90,000 used pallets annually and one-third of firms recycled over 100,000 used pallets annually.

Literature Cited

Adair, C. 1992. End-Use Marketing Profiles for Structural Panels, E52. American Plywood Association. Tacoma, Washington. 80 pp.

Anderson, R.B. 1986. Future availability of pallet raw material in the South. *Pallet Enterprise* 6(6):44-46.

Anderson, R.B. 1987a. Future availability of pallet raw material in the North. *Pallet Enterprise* 7(3):31-34.

Anderson, R.B. 1988. Regional Utilization of Reusable Pallets by the Grocery and Related Products Industry. Doctoral Dissertation. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 204 pp.

Anderson, R.B. and H.W. Wisdom. 1991. Wood pallet inventory estimation for the grocery distribution system. *Forest Products Journal* 41(4):19-24.

Anderson, R.G. 1987b. Structural Panel Uses in Industrial Markets: 1986. American Plywood Association. Tacoma, Washington. 55 pp.

Anonymous. 1991. Pallet producers picking up on pine. *Wood and Wood Products*, 96(10):49.

Anonymous. 1992. Industry explores pallet of future: grocery pallet debated. *Pallet Talk* 92(19):1-4.

Bond, R.S. and P.E. Sendak. 1970. The Structure of the Wood-Platform Industry of the Northeast. Massachusetts Agricultural Experiment Station, College of Agriculture, University of Massachusetts, Amherst, Massachusetts. Bulletin No. 586. 70 pp.

Brindley, E. 1992. Here come block pallets! *Wooden Pallet Index*, March 6:1-4, 7.

Cardellichio, P.A. and C.S. Binkley. 1984. Hardwood lumber demand in the United States: 1950 to 1980. *Forest Products Journal* 34(2):15-22.

Dempsey, G.P. and Luppold, W.G. 1992. The state of hardwood lumber markets. *The Northern Logger and Timber Processor*. 40(9): 22-23, 30

Fraser, R.F., W.W. Johnson, and P.R. Blankenhorn. A description of the 1986 pallet manufacturing industry in Pennsylvania. *Forest Products Journal* 40(6):43-46.

Hicks, C.M. 1991. U.S. Industrial Outlook: Pallets and Skids. U.S. Dept. of Commerce, Washington, D.C.

Lucas, J.T. 1969. Use of Wooden Pallets in the Brewing Industry. Resource Paper NE-132. USDA Forest Service. Northeastern Forest Experiment Station. Upper Darby, Pennsylvania. 60 pp.

Lucas, J.T. and W.B. Wallin. 1969. The Department of Defense Market for Wooden Pallets. Resource Paper NE-122. USDA Forest Service. Northeastern Forest Experiment Station. Upper Darby, Pennsylvania. 60 pp.

Luppold, W.G. 1989. Shifting Demand for Eastern Hardwood Lumber. Presented at Hardwood Forest Product Opportunities: Creating and Expanding Businesses. Pittsburgh, Pennsylvania. October 17.

Luppold, W.G. 1992. Alternative Estimates of Pallet Production. Unpublished Working Paper. USDA Forest Service. Northeastern Forest Experiment Station. 6 pp.

McCurdy, D.R. and J.T. Ewers. 1985. The U.S. pallet industry. *Pallet Enterprise* 4(6):8-12.

McCurdy, D.R., J.T. Ewers, F.H. Kung, and D.B. McKeever. 1988. A study of lumber use in pallets manufactured in the United States: 1982 and 1985. *Forest Products Journal* 38(2):11-15.

McCurdy, D.R. and J.E. Phelps. 1991. The Pallet Industry in the United States, 1980, 1985, 1990. Department of Forestry, Southern Illinois University, Carbondale, Illinois. 16 pp.

McKeever, D.B. and H.E. Dickerhoof. 1980. Lumber and Panel Consumption for Packaging and Shipping in the United States - Perspective for the 1980's. Resource Bulletin FPL-10. USDA Forest Service. Forest Products Laboratory. Madison, Wisconsin. 5 pp.

McKeever, D.B. and C.A. Hatfield. 1984. Trends in the Production and Consumption of Major Forest Products in the United States. Resource Bulletin FPL-14. USDA Forest Service. Forest Products Laboratory. Madison, Wisconsin. 59 pp.

National Wooden Pallet and Container Association. 1991. Unpublished pallet production data. Washington, D.C.

Smith, P.M. 1991. The Washington state wood pallet industry. *Forest Products Journal* 41(5):39-44.

Spelter H. and R.B. Phelps. 1984. Changes in postwar U.S. lumber consumption patterns. *Forest Products Journal* 34(2):35-41.

Strobel, J.J. and W.B. Wallin. 1969. The Unit-load Explosion in the Food Industry. Resource Paper NE-121. USDA Forest Service. Northeastern Forest Experiment Station. Upper Darby, Pennsylvania. 60 pp.

USDA Forest Service. 1982. An Analysis of the Timber Situation in the United States, 1952-2030. Forest Resource No. 23. Washington, D.C. 499 pp.

USDA Forest Service. 1989. An Analysis of the Timber Situation in the United States, 1989 -2040. Washington, D.C. Draft Report. pp. 47-56.

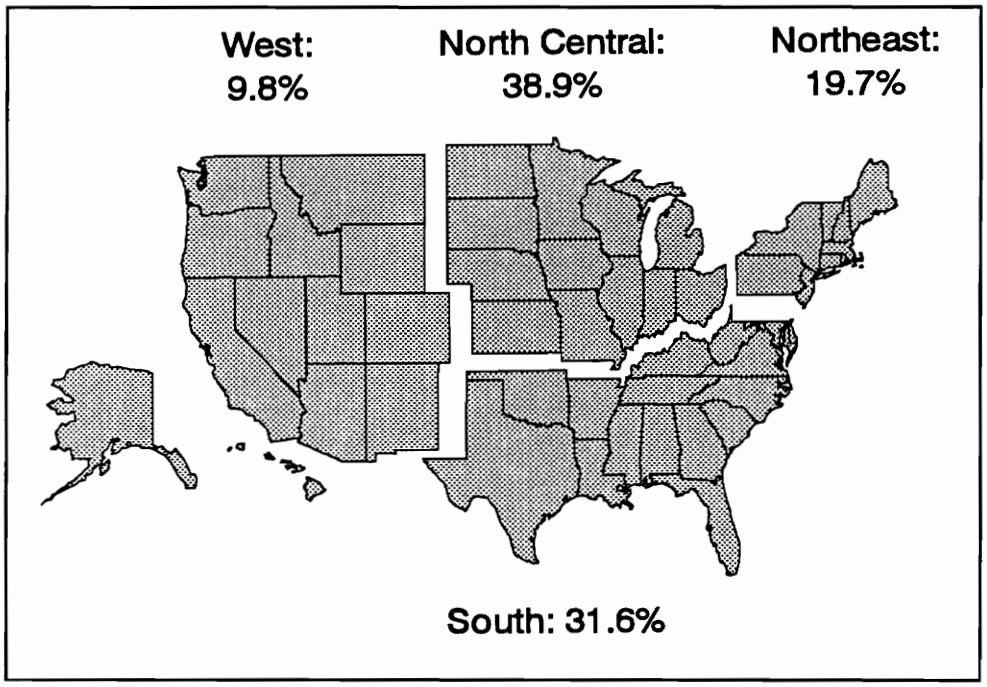


Figure 1. **Estimated Percentage of Pallet Manufacturers by Region (McCurdy and Phelps 1991)**

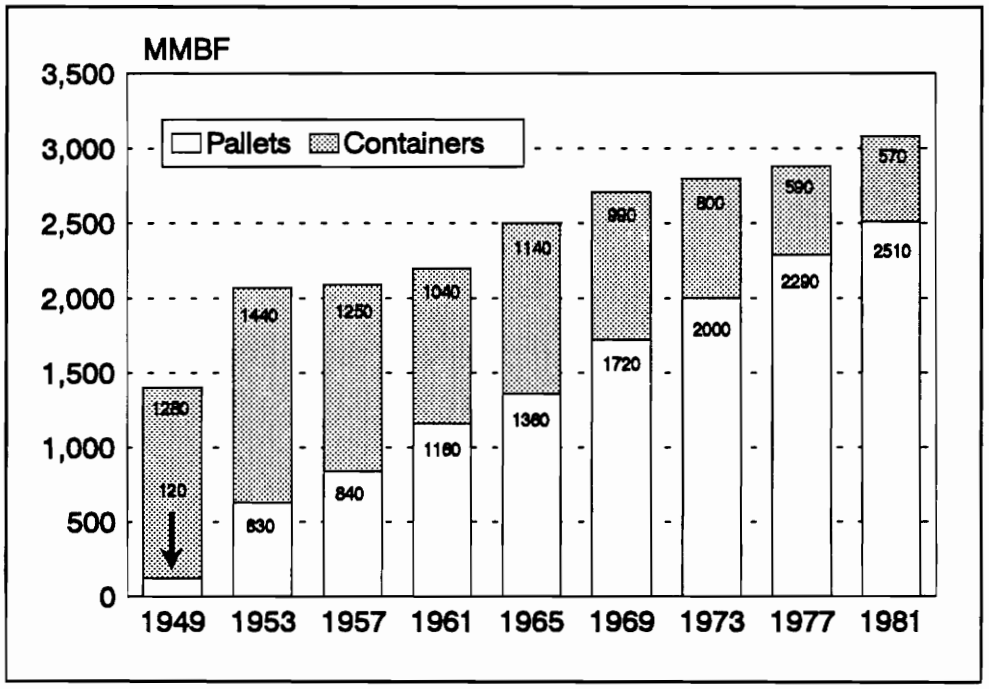


Figure 2. **Hardwood Lumber Consumption by the U.S. Pallet and Container Industry: 1949-1981 (Spelter and Phelps 1984)**

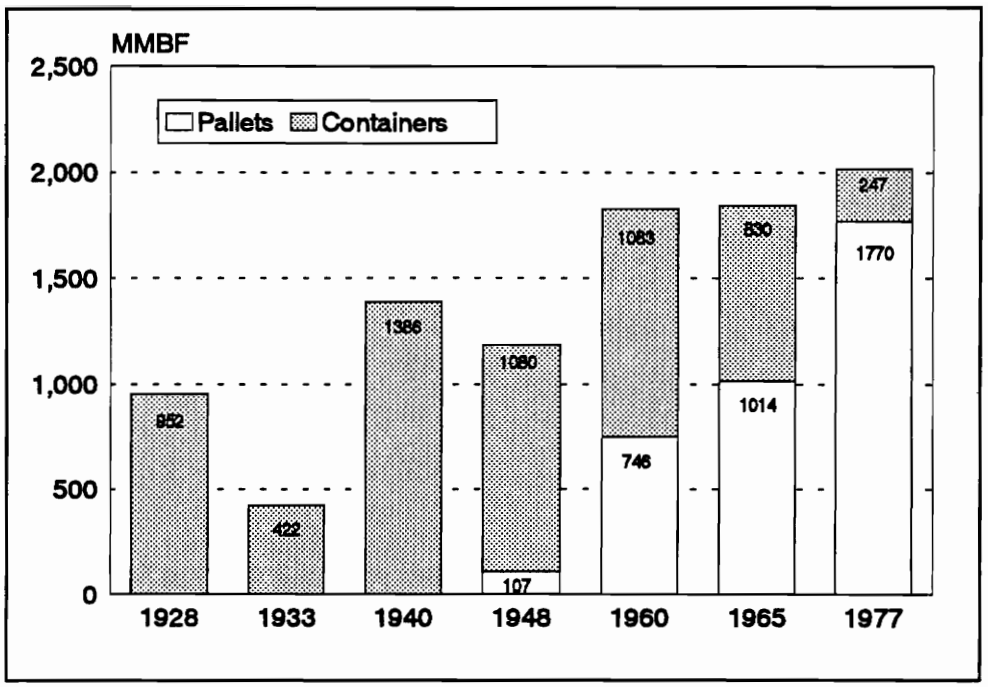


Figure 3. **Hardwood Lumber Consumption by the U.S. Pallet and Container Industry: 1928-1977 (McKeever and Hatfield 1984)**

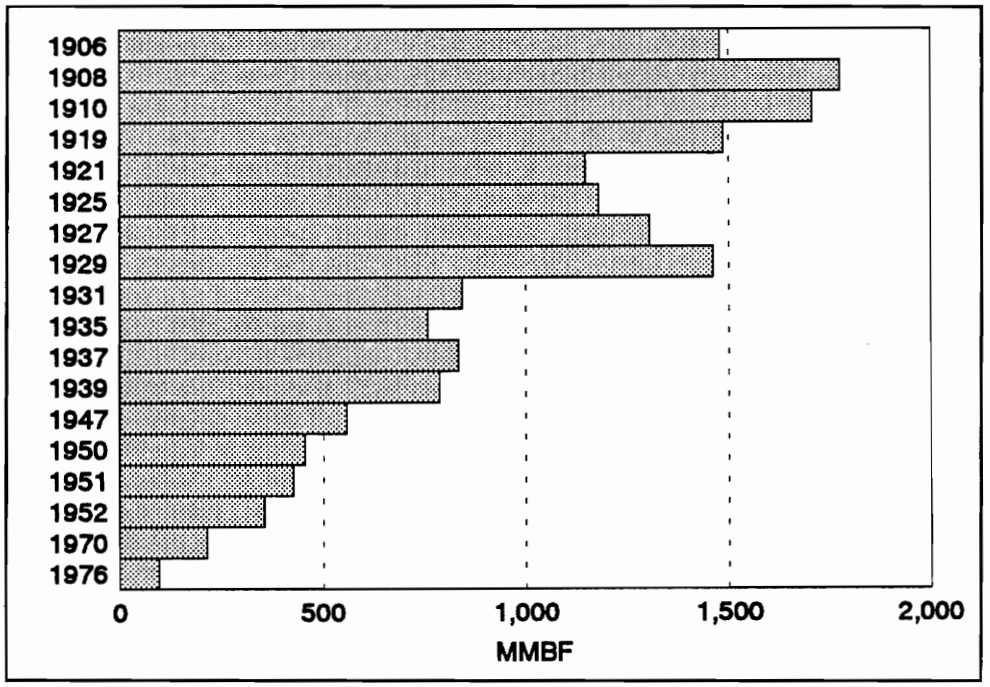


Figure 4. **Cooperage Consumption in the United States: 1906-1976 (McKeever and Hatfield 1984)**

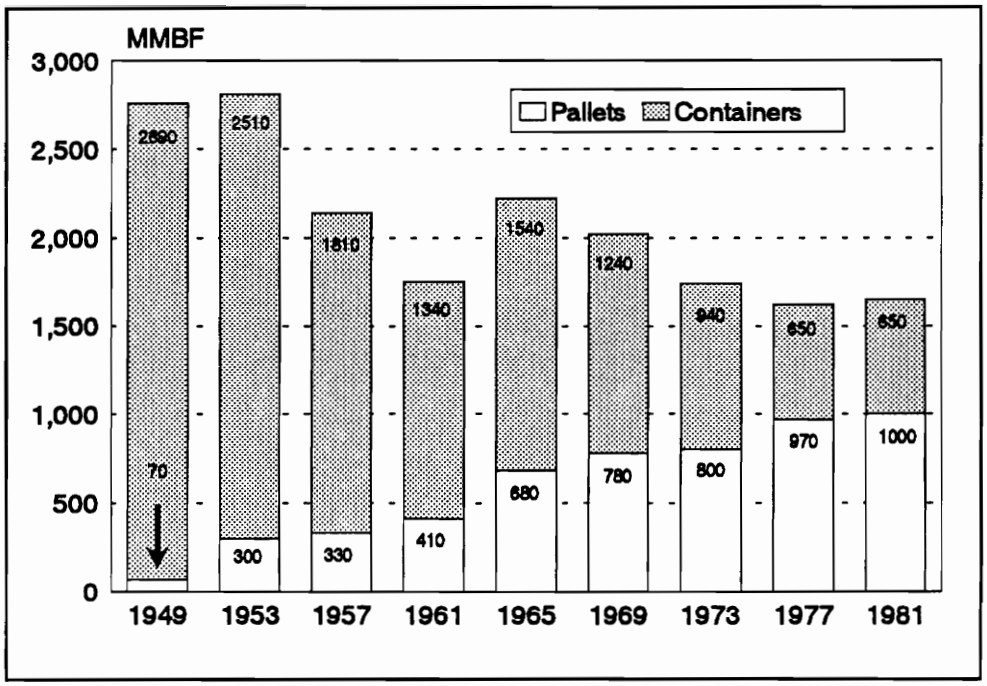


Figure 5. **Softwood Lumber Consumption by the U.S. Pallet and Container Industry: 1949-1981 (Spelter and Phelps 1984)**

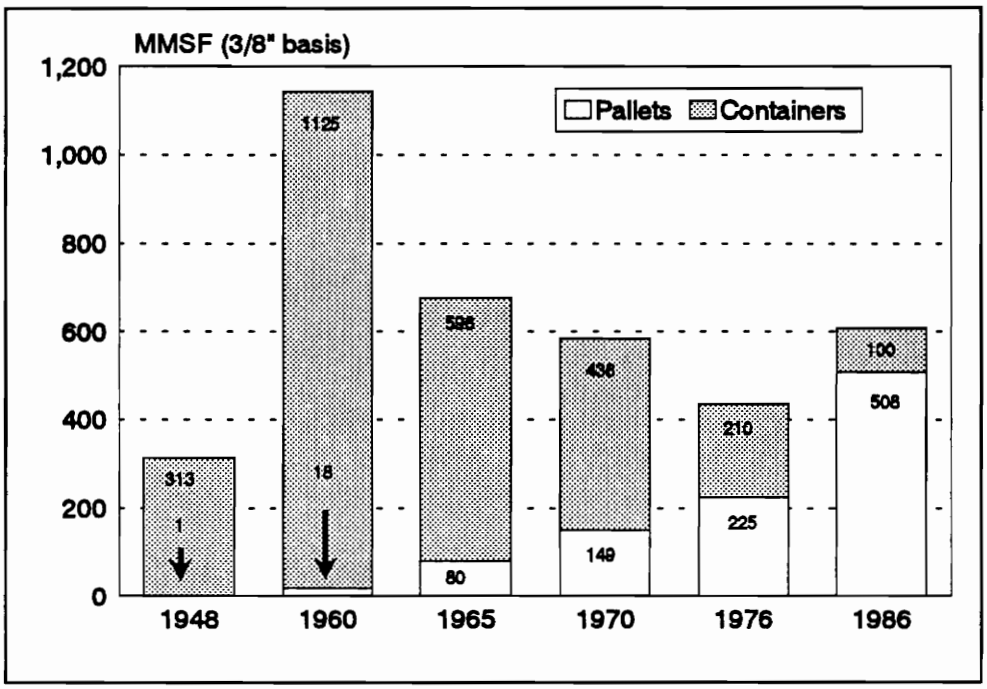


Figure 6. **Wood-Based Panel Consumption by the U.S. Pallet and Container Industry: 1948-1986 (USDA Forest Service 1989)**

Research Methodology

Sample Design

The population of interest in this study consisted of those manufacturers whose primary or secondary Standard Industrial Classification (SIC) code is listed as 2441 (wood boxes), 2448 (wood pallets), or 2449 (wood containers not elsewhere classified). To ensure complete coverage of pallet and container production, it was also necessary to include those firms whose secondary business is pallets and containers. In other words, firms that have a secondary SIC code of 2441, 2448, or 2449 were also included. A description of products manufactured by firms in these categories is displayed in Table 1.

A sample of the population of interest was obtained from Dun's Marketing Services (1992) and stratified into two groups based on number of employees. The first group consisted of manufacturers having ten or more employees and the second group consisted of manufacturers having less than ten employees. According to Dun's Marketing Service, the population for the two groups is 1,567 for the former and 1,912 for the latter, totalling 3,479 firms over the three SIC codes. A 100% sample was conducted of those manufacturers with ten or more employees (1,567 firms) and a 25% random sample of those manufacturers with less than ten employees (478 firms) for a total of 2,045 manufacturers.

The mailing list for the sample was thoroughly checked for errors such as incomplete names and addresses. In the course of cleaning the list, some firms were

found to be out of business or not producers of pallets and/or containers. After the process of cleaning the list was completed, 2,035 addresses remained.

In order to insure inclusion of all known pallet and container manufacturers, the membership directory of the National Wooden Pallet and Container Association (NWPCA 1992) was consulted. The NWPCA list was compared to the sample list and an additional 76 manufacturers were identified and added to the 2,035 firms previously identified.

Data Collection

Because they are the most efficient and cost effective method of securing data from geographically diverse populations (Dillman 1978), a mail survey served as the primary data collection vehicle.

The survey instrument (questionnaire) used in this study was similar to previous Virginia Tech surveys of materials use in other industries, specifically the cabinet and furniture industries. The questionnaire was reviewed by Virginia Tech faculty members, USDA scientists, and trade association staff both to verify construction of the questions and to verify that language and terms were proper for the target industry. The questionnaire was then pretested with three local pallet manufacturers to verify its effectiveness.

The survey was designed to determine pallet and container manufacturers' wood material use for the previous year (1991) and anticipated material needs for 1993. The

questionnaire was sent to a specific contact person at each firm, usually the president or owner of the firm.

Survey Administration

The final survey instrument was mailed in May 1992. Enclosed with the questionnaire was a personalized cover letter explaining the purpose of the study. To further stimulate response, the return mailing of the survey instrument was post-paid. A follow-up postcard was mailed one week later in order to thank those who returned their questionnaire and encourage a response from those who have not yet done so. A second follow-up letter and replacement survey was mailed three weeks after the first survey to motivate those firms that had not yet responded. A complimentary bookmark was also included. Two weeks after the second survey was mailed, a final follow-up letter was mailed to urge those who have not returned their survey to do so. A replacement survey was not mailed with this letter, though one could be requested. A hand-written signature in blue ink was included on all correspondence. Appendices A and B display, respectively, the survey instrument and correspondence used for the survey.

Calculating the Response Rate

A response rate was calculated for each group in the sample. Adjusted response rates were computed by using the following formula:

$$\textit{Response Rate} = \frac{\textit{Number of Usable Responses Received}}{\textit{Adjusted Number of Surveys Mailed}}$$

Where:

Usable Responses =	Responses that are correctly filled out and represent a manufacturer of wood boxes, wood pallets, and/or wood containers.
Adjusted Number of Surveys =	(all surveys mailed) - (undeliverable surveys) - (surveys representing non-manufacturers of wood boxes, wood pallets, and/or wood containers).

When a response was not given for a certain material for a certain year, it must be determined whether the material was not used (value equal to zero) or the material was used but the question was not answered (a non-response). Question #2 of the survey instrument (Appendix A) accounts for this situation. If a material was marked as used for pallet and container production in 1991 and no volumes were reported for that material in question #3, it was treated as a missing value. Conversely, for any material that was not marked as used for pallet and container production in 1991, consumption was considered to be zero for that material.

Data Analysis

Analysis of primary data began with the inspection of each questionnaire to verify that responses were reasonable. Each questionnaire was entered into the database at the

time of its arrival. After the last correspondence was mailed and questionnaires were received, each entry to the database was checked against each corresponding questionnaire to ensure the accuracy of the coding.

A material use per employee ratio was calculated for all respondents to identify those producers whose material use per employee ratio was large in comparison to all responding producers. These producers were contacted by telephone to confirm that volumes reported were accurate and that an error did not occur in reporting material use volumes. Producers with large material use per employee ratios were consistently found to have highly automated manufacturing facilities.

Material Volume Estimates

Estimation of industry use and predicted future use of wood materials required that the volumes used by responding firms be extrapolated to the entire industry. This was accomplished by dividing each reported volume by the coverage of the total number of employees for each stratum (firms with ten or more employees or firms with less than ten employees) within the pallet and container industry. The denominator in this equation combines (a) the total number of respondents' employees for firms which gave a positive response for that particular material, year, and stratum and, (b) the total number of employees in the pallet and container industry for that particular stratum. This calculation can be expressed by the following formula:

$$\textit{Industry Volume Estimate} = \sum_{x=1}^{2} \sum_{y=1}^{n} \frac{\textit{Volume Reported by Respondent Y}}{\textit{Coverage Ratio}}$$

Where:

Volume Reported = The volume reported by each respondent for a given material.

Coverage Ratio = The total number of employees for firms in that stratum that gave a positive response for that material divided by the total number of employees within that stratum.

n = The total number of item responses for a given material and year.

x = Stratum number.

Number of Employees per Stratum

At this point, the reader is referred to Figure 1 for further illustration. It was first necessary to determine what coverage of the population's employment was achieved by the previously defined sample. In the course of conducting non-response bias checks, it was determined that 87% of all firms on the Dun's Marketing List actually belonged in the sample as manufacturers of pallets and/or containers. All other firms were determined to be out of business, not producers of pallets or containers, or solely involved in pallet recycling. The remaining 87% of Dun's population left 1,363 firms in the "ten or more" stratum and 1,663 firms in the "less than ten" stratum. The number of firms in each stratum was then multiplied by the average number of employees in each

stratum, as determined from respondents, to arrive at an estimate of the population's total employment.

Adjusted Number of Employees per Stratum

Since the sum of the calculated number of employees was greater than the estimate provided by the U.S. Department of Labor (44,000 employees for 1991), it was necessary to tabulate what percentage of the calculated total employment was in each stratum. The row entitled "Revised number of employees per stratum" is the product of the percentage of employees in each stratum and the U.S. Department of Labor (USDL) estimate of 44,000 pallet and container employees for 1991. These estimates (36,575 employees in Stratum 1 and 7,425 employees in Stratum 2) were used in further analysis.

U.S. Department of Labor employment estimates were the most accurate available. This accuracy is supported by independent research (McCurdy and Phelps 1991), which estimate that the pallet industry employed 40,000 people in 1990.

Coverage Ratio of Employees for Each Wood-Based Material

The next step in estimating industry use was to determine how many firms indicated a positive response when asked about their use of a given wood-based material. A positive response is the case where a respondent reported not using a given material or reported a volume greater than zero for a given material. Respondents were separated by stratum, to reflect the stratification of the sample and allow proper manipulation. For

a given material/year/stratum, the total number of employees was calculated for all firms that indicated a positive response. The total number of employees calculated within a given material/year/stratum was then divided by the previously calculated "revised employees per stratum" to obtain a coverage ratio of employees for each material/year/stratum.

Calculating a Population Volume

The last step in this process is to divide a reported material use volume by the coverage ratio of employees for that corresponding material/year/stratum. This calculation results in a population volume based on a single reported volume for a given material/year/stratum. An example is given in Figure 1. This operation is repeated within each material/year/stratum and is then summed within that material category and stratum. At this point it is possible to sum matching material and year categories across strata. This last calculation results in the estimated population material use volume for each material and year.

Up-to-date estimates of the total number of employees in various segments of the pallet and container industry were obtained from Dr. William Luppold of the U.S. Forest Service. Although the Annual Survey of Manufacturers, administered by the U.S. Department of Commerce (USDC), publishes employment estimates; their estimates are often published two to three years after the survey is conducted. Thus this estimate is out

of date for this study's purposes. Also, USDC figures are suspected to underestimate actual employment within the pallet and container industry (Luppold 1992).

The industry employment estimate from the Forest Service was obtained from the U.S. Department of Labor's (USDL) unemployment insurance records. Because the penalties associated with not reporting unemployment insurance information are much greater than noncompliance with USDC surveys, employment data developed from unemployment insurance records is probably more accurate than USDC information (Luppold 1992).

Non-response Bias

In any mail survey where people are not required to respond, the potential exists for bias. That is, respondents may differ from non-respondents, making the data from the responding firms not representative of the total industry.

The hypothesis that responders are like non-responders, and thus represent the population, was evaluated. The respondents were compared to a random sample of 50 non-respondents who were contacted by telephone. Non-respondents were asked key questions (such as hardwood lumber & cant consumption and number of employees) and their responses were compared to those of firms that returned the questionnaire. Independent t-tests were used to compare the average material volumes and average number of employees of respondents and non-respondents. The test used is appropriate for comparing the means of two groups with different sizes (i.e., the 50 non-respondents

and all survey respondents). The t-test used in this analysis pools the variances of the two groups and is expressed as (Howell 1987):

$$t = \frac{(\overline{X_1} - \overline{X_2})}{\sqrt{s_p^2(\frac{1}{N_1} + \frac{1}{N_2})}}$$

Where:

X_i = the mean of the variable being tested (i.e. hardwood lumber use, number of employees, etc.) for group i.

s_p^2 = the pooled variance estimate, expressed as:

$$\frac{(N_1 - 1)\, s_1^2 + (N_2 - 1)\, s_2^2}{N_1 + N_2}$$

N_i = the size of group i.

s_i^2 = the variance of the variable that is measured for group i.

with $(N_1 + N_2) - 2$ degrees of freedom.

No significant differences were found between respondents and non-respondents when tested at the 95% confidence level, suggesting that respondents were representative of the industry. Table 2 provides the details of these tests.

Literature Cited

Dillman, D.A. 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley and Sons, New York.

Dun and Bradstreet. 1988. Standard Industrial Classification Manual: SIC 2 + 2. Dun and Bradstreet Information Resources. New York, New York.

Dun's Marketing Services. 1992. Dun and Bradstreet Corporation. Parsippany, New Jersey.

Howell, D.C. 1987. Statistical Methods for Psychology. Second Edition. PWS-Kent. Boston, Massachusetts.

Luppold, W.G. 1992. Alternative Estimates of Pallet Production. Unpublished Working Paper. USDA Forest Service. Northeastern Forest Experiment Station.

McCurdy, D.R. and J.E. Phelps. 1991. The Pallet Industry in the United States, 1980, 1985, 1990. Department of Forestry, Southern Illinois University, Carbondale, Illinois. 16 pp.

National Wooden Pallet and Container Association. 1992. 1992 - 1993 Membership Directory. Arlington, Virginia.

Office of Management and Budget. 1987. Standard Industrial Classification Manual. Washington, D.C.

Table 1. 8-digit Description of Products in the Sample Frame

SIC 244 Wood Containers

2441 Nailed and Lock Corner Wood Boxes and Shook

Establishments primarily engaged in manufacturing nailed and lock corner wood boxes (lumber or plywood), and shook for nailed and lock corner boxes.

00 00 Nailed and Lock Corner Wood Boxes and Shook

01 00 Boxes, Wood
01 01 Ammunition boxes, wood
01 02 Box cleats, wood
01 03 Box shook, wood
01 04 Cigar boxes, wood and part wood

02 00 Cases, Wood
02 01 Egg cases, wood
02 02 Packing cases, wood: nailed or lock corner
02 03 Shipping cases, wood: nailed or lock corner

03 00 Chests and Trunks, Wood
03 01 Tool chests, wood
03 02 Trunk slats, wood

99 xx Nailed Wood Boxes and Shook, NEC
99 01 Carrier trays, wood
99 02 Flats, wood: greenhouse

2448 Wood Pallets and Skids

Establishments primarily engaged in manufacturing wood or wood and metal combination pallets and skids.

00 00 Wood Pallets and Skids

01 00 Cargo Containers, Wood and Wood with Metal
01 01 Cargo containers, wood
01 02 Cargo containers, wood and metal combination

02 00 Pallets, Wood and Wood with Metal
02 01 Pallets, wood
02 02 Pallets, wood and metal combination

03 00 Skids, Wood and Wood with Metal
03 01 Skids, wood
03 02 Skids, wood and metal combination

2449 Wood Containers, Not Elsewhere Classified

Establishments primarily engaged in manufacturing wood containers, not elsewhere classified, such as cooperage, wirebound boxes and crates, and other veneer and plywood containers. Establishments primarily engaged in manufacturing tobacco hogshead stock are classified in Industry 2421, and those manufacturing cooperage stock are classified in Industry 2429.

00 00 Wood Containers, NEC

01 00 Food Containers, Wood Wirebound
01 01 Berry crates, wood: wirebound
01 02 Butter crates, wood: wirebound
01 03 Fruit crates, wood: wirebound
01 04 Vegetable crates, wood: wirebound

02 00 Barrels, Tubs and Vats: Wood, Coopered
02 01 Barrels, wood: coopered
02 02 Casks, wood: coopered
02 03 Hot tubs, wood
02 04 Pails, buckets, vats: wood, coopered
02 05 Tobacco hogsheads
02 06 Tubs, wood: coopered
02 07 Vats, wood: coopered

03 00 Rectangular Boxes and Crates, Wood
03 01 Boxes, wood: wirebound
03 02 Chicken coops (crates), wood: wirebound
03 03 Planters and window boxes, wood
03 04 Shipping cases, wood: wirebound
03 05 Tanks, wood: coopered

99 xx Wood Containers, NEC, NSK
99 01 Baskets: fruit and vegetable, round stave, till, etc.
99 02 Containers, plywood and veneer wood
99 03 Shipping cases and drums, wood: wirebound and plywood

Source: Dun and Bradstreet 1988, Office of Management and Budget 1987

Table 2. Calculated and Critical Values of t for Non-response Bias Checks

Variable	1991 Hardwood Lumber and Cants (MBF)	1991 Softwood Lumber and Cants (MBF)	1991 Full-time Employees
Non-respondents			
Mean	2,331.76	679.82	32.33
Variance	13,915,778.59	1,199,653.87	4,103.04
Standard Deviation	3,730.39	1,095.29	64.05
Respondents			
Mean	2,824.33	1,371.27	34.49
Variance	15,329,629.42	10,067,561.33	1,541.83
Standard Deviation	3,915.31	3,172.94	39.27
t-test			
s_p^2	15,208,724.20	9,309,223.70	1760.86
Calculated t	-0.85	-1.53	-0.35
Critical t (@ 0.05 alpha)	1.645	1.645	1.645

Allocation of 1991 industry employment estimate according to the USDL (44,000)		
	Stratum 1	**Stratum 2**
Average number of employees per firm	34.44	5.73
Number of D&B firms who belonged in the sample	1,363	1,663
Calculated number of employees per stratum (rounded off)	46,946	9,530
Proportion of calculated total (56,476)	83.1 %	16.9 %
Total employment in the pallet and container industry for 1991 (according to the USDL)	44,000	44,000
Revised number of employees per stratum	36,575	7,425

An example of a population volume calculation.

Assume:	For the year 1991 in stratum 1, the total number of employees in all firms that indicated a positive response was 10,000 for hardwood lumber and cants.
	A respondent reports using 100,000 board feet of hardwood lumber in 1991.
Therefore:	Coverage ratio of employees = 10,000/36,575 = 0.27
	Population volume = 100,000/0.27 = 370,370 board feet

Figure 1. Calculating a Population Volume Based on a Reported Volume

WOOD-BASED MATERIAL USE IN THE

U. S. PALLET AND CONTAINER INDUSTRY: 1991 and 1993

A report submitted to the members of the
Center for Forest Products Marketing
(December 1992)

Executive Summary

This report is the first in a series of annual tracking studies to estimate volumes of wood-based materials used by the U.S. pallet and container industry. Specifically, our goals were to (1) estimate the total volume of hardwood lumber, softwood lumber, and wood-based panels used by the U.S. pallet and container industry, (2) estimate lumber use by species category within the U.S. pallet and container industry, and (3) predict shifts in the volumes of wood-based materials used by the U.S. pallet and container industry. In order to meet these objectives, a large mail survey was conducted in the late spring of 1992. Data are presented on prominent wood-based materials and are broken down by firm size and geographic region. The major findings of the study are as follows:

* Almost 4.6 billion board feet of hardwood lumber, cants, parts and shook were consumed in 1991 and hardwood use was expected to grow 13% by 1993.

* Approximately 2.1 billion board feet of softwood lumber, cants, parts and shook were consumed in 1991 and an increase of 5% in softwood use was predicted for 1993.

* Softwood plywood use by the pallet and container industry was estimated to be 271 million square feet (3/4" basis) in 1991 and was projected to increase 13% by 1993.

* Oriented strandboard use was estimated to be 36 million square feet (7/16" basis) in 1991 and was expected to increase 25% by 1993.

* Over 1.6 billion board feet of oak lumber, cants, parts, and shook were consumed by pallet and container manufacturers in 1991 and oak use was expected to grow 15% by 1993.

* Over 496 million board feet of yellow-poplar and over 227 million board feet of alder were consumed by the industry in 1991 and use was expected to increase by 26% and 31%, respectively, in 1993.

* The use of southern yellow pine lumber, cants, parts, and shook accounted for over 541 million board feet in 1991 and is expected to increase 18% by 1993.

* Almost three-quarters of the hardwood lumber (board feet) purchased by pallet and container manufacturers came directly from the sawmill in 1991.

* Over one third of the softwood lumber purchases by the industry were made through a lumber broker, followed closely by purchases made direct from the sawmill.

Introduction and Background

The pallet and container industry purchases tremendous quantities of wood materials and consumes nearly 40% of total U.S. hardwood lumber production (Cardellichio and Binkley 1984, Luppold 1989). The industry also provides an important outlet for the large volume of low grade hardwood lumber produced. However, very little current information is available concerning the types of products used by this industry and trends in wood material use.

Much of the available information concerning material use by the pallet and container industry can be considered out of date, disputed by industry experts or not providing enough detail. Census data on material use are only available in detail every five years and the data are generally not published for at least three years after they are gathered. Even then, researchers spend a great amount of time attempting to interpret and validate the results (Luppold 1989). This study was undertaken to provide current information about the pallet and container industry's wood material use.

Summary of Previous Studies

Hardwood Lumber

Spelter and Phelps (1984) reported on wood use in the pallet and container industry for the years 1949-1981. They determined that the pallet industry consumed 120 million board feet of hardwood lumber in 1949 and that a rapid increase in consumption occurred through 1981, when the industry consumed 2.51 billion board feet of hardwood

lumber. The container industry consumed 1.28 billion board feet of hardwood lumber in 1949, but hardwood lumber consumption declined from 1.44 billion board feet in 1953 to 570 million board feet in 1981.

McKeever and Hatfield (1984) studied wood use in the pallet and container industry during the years 1948 to 1977. The authors reported that the pallet industry consumed 106.5 million board feet of hardwood lumber in 1948 and that consumption grew to 1.77 billion board feet in 1977. The authors also reported that the container industry (excluding cooperage) consumed 1.08 billion board feet of hardwood lumber in 1948 and that consumption fell to 246 million board feet in 1977.

Softwood Lumber

Spelter and Phelps (1984) reported that the pallet industry consumed 70 million board feet of softwood lumber in 1949 and that consumption grew to one billion board feet in 1981. The container industry consumed 2.69 billion board feet of softwood lumber in 1949 and consumption declined to 650 million board feet in 1981.

McCurdy et al. (1988) reported that 25% of the lumber used in pallet production during 1985 was softwood. It was estimated that 450 million pallets were produced in 1985, containing an average of 13.9 board feet of lumber. These figures indicate that approximately 1.56 billion board feet of softwood lumber was consumed by the pallet industry in 1985, excluding residues.

Wood-Based Panels

The U. S. Forest Service estimated that the pallet industry consumed one million square feet of wood-based panels (3/8" basis) in 1948, and that consumption grew to over 500 million square feet in 1986 (USDA Forest Service 1989). The container industry consumed 313 million square feet in 1948 and consumption fell from a peak of 1.125 billion square feet in 1960 to 100 million square feet in 1986 (USDA Forest Service 1989).

The American Plywood Association (APA) estimated that 2 billion square feet (3/8" basis) of structural panels were consumed by the materials handling industry in 1991, and that two-thirds of the total structural panel volume in the materials handling industry was consumed by pallet firms and industrial fabricators (Adair 1992). Industrial fabricators are considered to be manufacturers that fabricate products from structural panels, such as agricultural bins, specialty pallets, and sporting goods (ping-pong tables, basketball backboards, etc.).

Lumber Use by Species

McCurdy et al. (1985, 1988, 1991), in their studies of the pallet and container industry, reported a steady decline in the consumption of oak. In 1980, McCurdy et al. (1985) report hardwood lumber as having an 83% share of pallet production, with 41% of all lumber used being oak, and 42% being "other hardwoods". In 1985 (McCurdy et al. 1988), 73% of all lumber used was hardwood (34% oak and 39% "other hardwoods").

McCurdy's latest study (McCurdy and Phelps 1991) reported that 71% of all lumber used for pallets was hardwood in 1990, and no information was given on oak's share of total lumber use.

Status of the Pallet and Container Industry

Of the many issues that are of concern to the pallet and container industry, perhaps the most important is the question of block pallets. A review of the *Wooden Pallet Index* and the newsletter of the National Wooden Pallet and Container Association for the past twelve months indicates considerable concern about the adoption of block pallets.

The Grocery Manufacturer's Association (GMA) has developed a specification list for pallets to be used by their industry, the criteria on their list included: 1) True full four way entry (read as block style pallet), 2) Pallet weight of 50 pounds or less, 3) The availability of materials to meet the demand for pallets, 4) The ability for a pallet to meet the widely varied requirements of various customers, and 5) A reduction in the current levels of product damage (Anonymous 1992).

Along with the specification list is concern over misuse of the pallet exchange program, where not every party is buying the same quality pallet and thus, some pallets are of higher quality than others. For the past year, the GMA has been investigating the use of a block pallet and a third party to manage the pallets used by the grocery industry.

The GMA recommendation could have far reaching implications. Anderson and Wisdom (1991) estimated that the grocery industry purchased 75 million pallets in 1989,

or about 15% of the estimated 505 million pallets manufactured in the United States during 1989 (NWPCA 1991). On the issue of block pallet construction, the *Wooden Pallet Index* reported that "from a hardwood perspective this is likely to mean a shift toward more softwood pallet construction" (Brindley 1992).

Results

Introduction

As previously stated, the purpose of this study was to estimate volumes of wood-based materials used by the U.S. pallet and container industry. To best address this study's objectives, a survey of pallet and container manufacturers was required. A questionnaire was mailed to more than 2,000 firms and more than 6,500 pieces of mail were handled during the process of data collection. In general, the response to our inquiries was favorable. The adjusted response rates were:

Firms with 10 or more employees	41%
Firms with less than 10 employees	19%
All Firms	36%

Please see the Research Methodology section for more details concerning data collection procedures.

Profile of Respondents

Number of Employees and Sales

Table 1 shows the average number of employees reported by respondents and average sales for 1991. The average number of employees for all respondents was 29. The highest reported sales for a single firm was $32 million and the average was $2,109,206.

Table 1. Average Number of Employees and Average Sales of Respondents by Firm Size: 1991

Firm Size	Average Number of Employees	Average Sales ($)
10 or more employees	32	$2,304,442
Less than 10 employees	6	$486,304
All Respondents	29	$2,109,206

Location of Respondents

Four geographic regions, roughly following those used by the Bureau of the Census, were utilized to allow geographic segmentation of manufacturing facilities. Figure 1 shows that the north central region contained 36% of the respondents. The South accounted for the second largest group of respondents (33%).

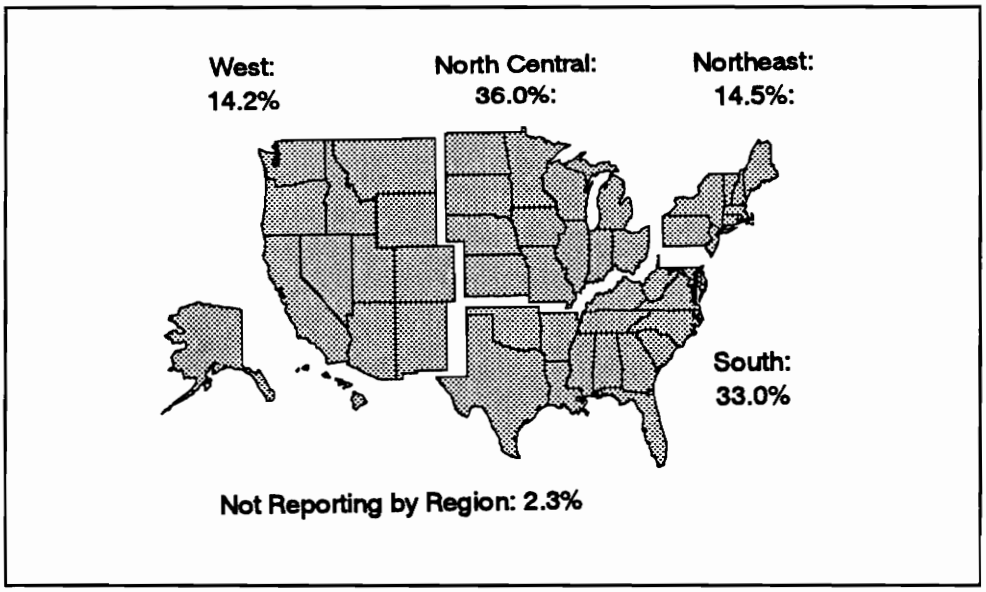


Figure 1. Location of Respondents' Production Facilities by Region

Use of Wood Materials

Respondents were asked to indicate those wood materials their firm used to manufacture pallets and containers during 1991. Hardwood lumber and cants were used by 81% of respondents in 1991, 64% used softwood lumber and cants, and 48% used softwood plywood. Table 2 shows the percentage of respondents using selected wood products.

Table 2. Percentage of Respondents Using Selected Wood Products in 1991

Wood-based Product	Percentage of Respondents*
Hardwood Lumber and/or Cants	81%
Softwood Lumber and/or Cants	64%
Hardwood Parts and/or Shook	35%
Softwood Parts and/or Shook	26%
Oriented Strandboard (OSB)	14%
Hardwood Plywood	9%
Softwood Plywood	48%

* Percentages add to more than 100% due to multiple responses.

Respondent Sales

Respondents were asked to indicate how their 1991 sales, in dollars, were divided among various products. Figure 2 shows the percentage of total 1991 sales by product. Sales of expendable pallets (over $379 million) were slightly greater than sales of non-

expendable pallets (almost $372 million). The product with the next highest sales was boxes, at over $145 million. Table A-1 displays sales of all products by region for responding firms. As has been shown by McCurdy and Phelps (1991), our respondents indicated that the manufacture of expendable pallets continued to outweigh the manufacture of non-expendable pallets in 1991.

Material Use Estimates

Firms were asked to report consumption volumes of seven wood-based materials for 1991 and the volumes that they anticipated consuming in 1993. Reported volumes were then used to estimate the total industry use and predict changes in use. Total

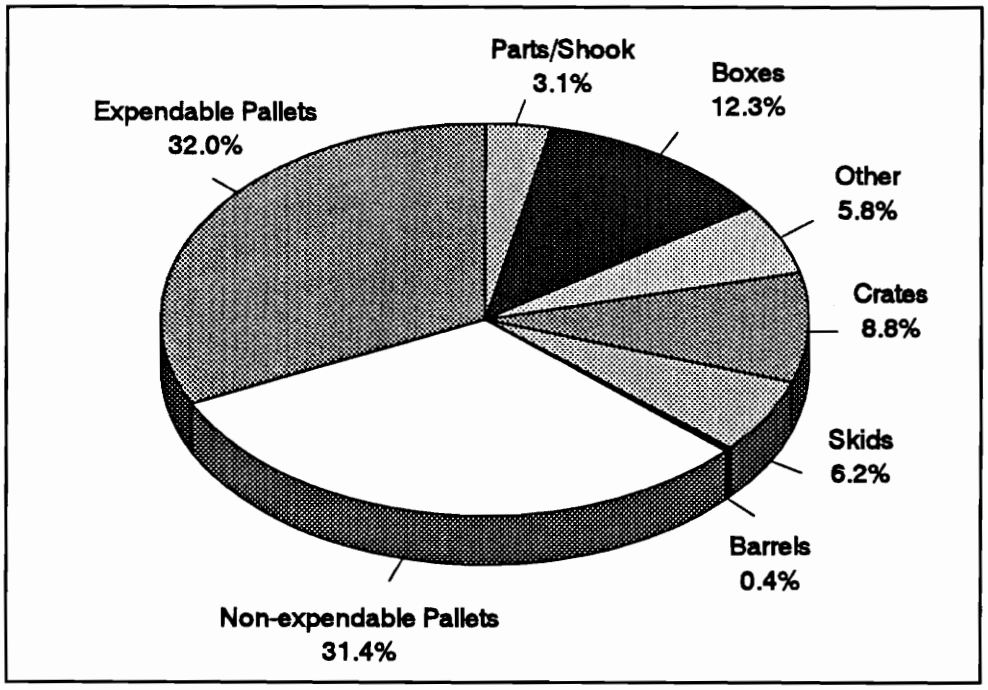


Figure 2. Total 1991 Pallet and Container Sales by Product for Responding Firms

hardwood lumber and cant use in 1991 was estimated to be approximately 3.8 billion board feet. Softwood lumber and cant consumption was estimated to be approximately 1.8 billion board feet. Use of hardwood parts and shook was estimated to be 667 million board feet and softwood parts and shook consumption was estimated at 429 million board feet in 1991.

Among panel products, softwood plywood consumption was estimated to be 271 million square feet (3/4" basis), hardwood plywood use was estimated to be 9 million square feet (3/4" basis) and oriented strandboard consumption was estimated to be 36 million square feet (7/16" basis). A complete description of estimated wood-based materials use for 1991 and 1993 can be found in Table A-2.

Predicted Changes in Wood Material Use

Figure 3 shows the projected changes in the use of both hardwood lumber and cants and hardwood parts and shook between 1991 and 1993. Hardwood lumber and cants were expected to increase in use by 13% within this period, while the use of hardwood parts and shook was predicted to increase by 12%. Figure 3 also shows a projected increase in use of softwood lumber and cants and a predicted decline in the use of softwood parts and shook. Softwood lumber and cant consumption was predicted to increase by 7% in 1993, softwood parts and shook use was expected to decrease by 3%.

As can be seen in Figure 3, oriented strandboard use was expected to increase strongly (25%) between 1991 and 1993. Softwood plywood consumption was expected

to increase by 13% and hardwood plywood use was expected to remain unchanged through 1993.

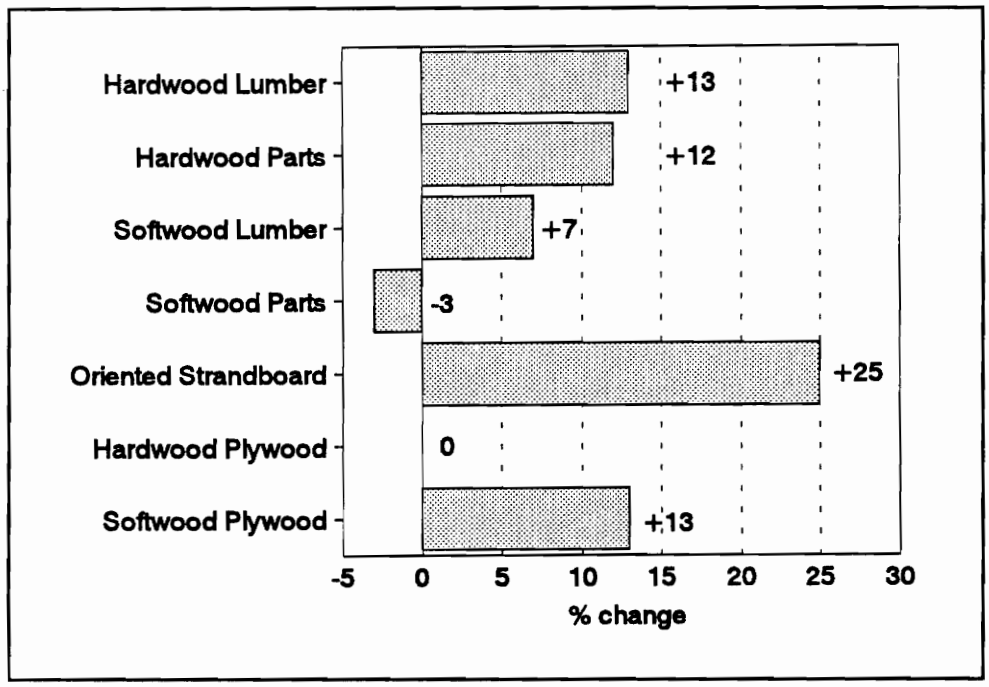


Figure 3. Projected Material Use Changes in the Pallet and Container Industry: 1991 to 1993

Material Use by Region

The south and north central regions, combined, accounted for almost 80% of all hardwood lumber and cants used in the pallet and container industry during 1991. Southern use of hardwood lumber and cants was expected to grow by almost 16% between 1991 and 1993, while consumption in the north central region was expected to increase by 12%. The West consumed over 47% of all softwood lumber and cants used

in the pallet and container industry in 1991 and this region's use was expected to grow by 13% by 1993. Figures 4 and 5 show the projected growth in hardwood and softwood lumber and cant consumption from 1991 to 1993.

The north central (207.6 mmbf), west (206.5 mmbf), and south (189.4 mmbf) regions consumed similar amounts of hardwood parts and shook in 1991 and consumption was expected to increase in each of these regions. The western region consumed the greatest volume of softwood parts and shook at 316.2 million board feet in 1991. However, consumption in the western region was predicted to decline by 6% through 1993.

Southern pallet and container manufacturers consumed the most softwood plywood in 1991 (133.6 million square feet, 3/4" basis) and this region's consumption was expected to remain steady through 1993. The western region consumed 82.9 million square feet (3/4" basis) of softwood plywood in 1991 and consumption was expected to grow by 42% through 1993. The north central region consumed the most oriented strandboard (OSB) in 1991 (25.4 million square feet, 7/16" basis) and this region's use was expected to grow by 11% through 1993. A complete description of estimated wood material use by region for 1991 and 1993 can be found in Table A-3.

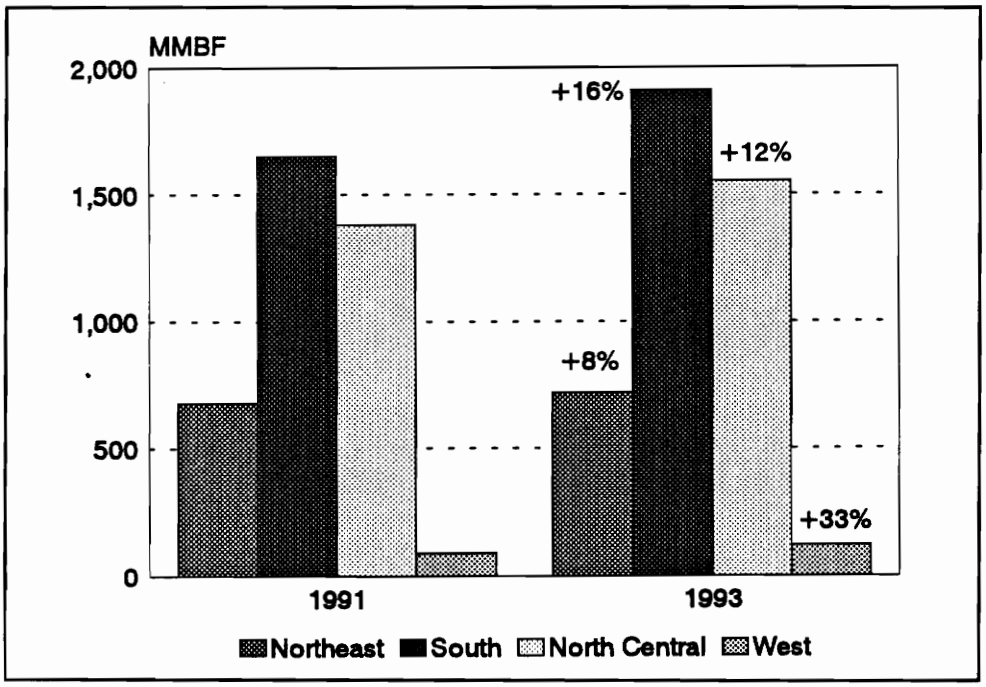


Figure 4. Estimated Hardwood Lumber and Cant Use by Region: 1991 - 1993

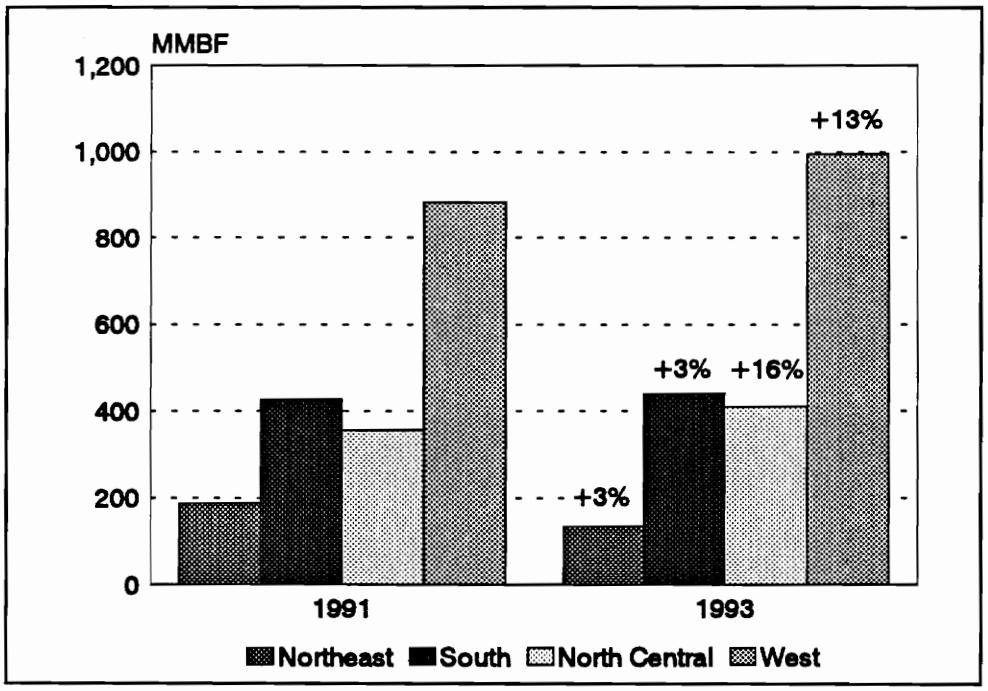


Figure 5. Estimated Softwood Lumber and Cant Use by Region: 1991 - 1993

Lumber, Cant, Part, and Shook Use by Species

In an effort to provide greater insight as to the materials used by the pallet and container industry, firms were asked to indicate their consumption of several specific species. Figure 6 provides the estimated 1991 and projected 1993 lumber, cant, part, and shook use by species. Tables A-4 and A-5 display, respectively, the estimated lumber, cant, part, and shook use by species and region for 1991 and the projected lumber, cant, part, and shook use by species and region for 1993.

It was estimated that 24% of the lumber used by the pallet and container industry during 1991 was oak, and use of this species was expected to grow 15% in 1993. Oak was also the single largest species group consumed by the industry. Yellow-poplar represented 7% of all lumber used by this industry in 1991, and its use was expected to increase by 26% through 1993. Alder represented over 3% of lumber use in 1991 and alder consumption was expected to grow 31% in 1993. Mixed hardwoods, those species purchased in an unidentified manner, represented 45% of all hardwood lumber used during 1991. Other hardwoods (any single hardwood species not previously mentioned) made up over 4% of all hardwood lumber used. Some of the species in the "other hardwoods" group were aspen, basswood, and cottonwood. Overall, the use of hardwoods was expected to increase by 13% through 1993.

Southern yellow pine represented almost 26% of the softwood lumber used by this industry in 1991 and use of this species was expected to grow by 18% through 1993. Other softwoods made up the bulk of softwood species use (over 74%). Species

represented by this group include Douglas-fir, Spruce-pine-fir, and miscellaneous pines. Overall, the use of softwood lumber, cants, parts, and shook was expected to increase by 5% through 1993.

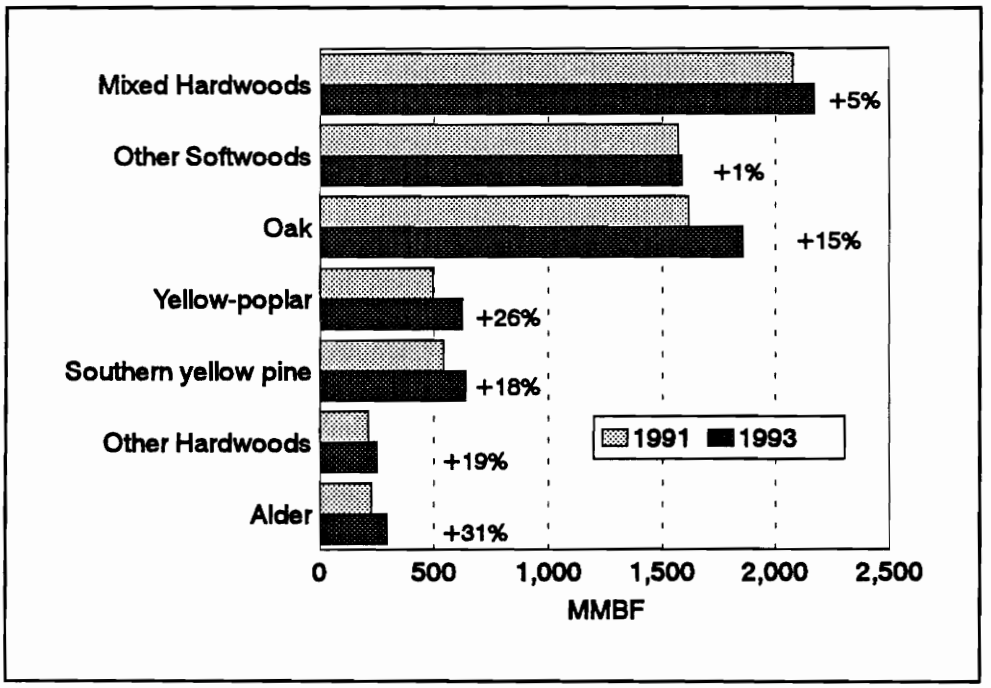


Figure 6. Estimated 1991 and Projected 1993 Lumber, Cant, Part, and Shook Use in the Pallet and Container Industry by Species

Wood Materials Use by Type of Firm

Firms were categorized by the type of production they were engaged in. Two groups were specified: 1) Those firms primarily engaged in pallet production and, 2) Those firms primarily engaged in production of containers and other miscellaneous products. Miscellaneous products included lumber, cut stock, mulch, chips, and appliance

bases. A firm was considered to be primarily engaged in pallet production if 50% or more of its sales (dollars) resulted from sales of pallets. Figures 7 and 8 display the 1991 estimated and 1993 projected wood materials use for firms primarily producing pallets and firms primarily producing containers and other miscellaneous products. Please note that this breakdown allows for a firm primarily in container production to also produce pallets or skids, or vice versa.

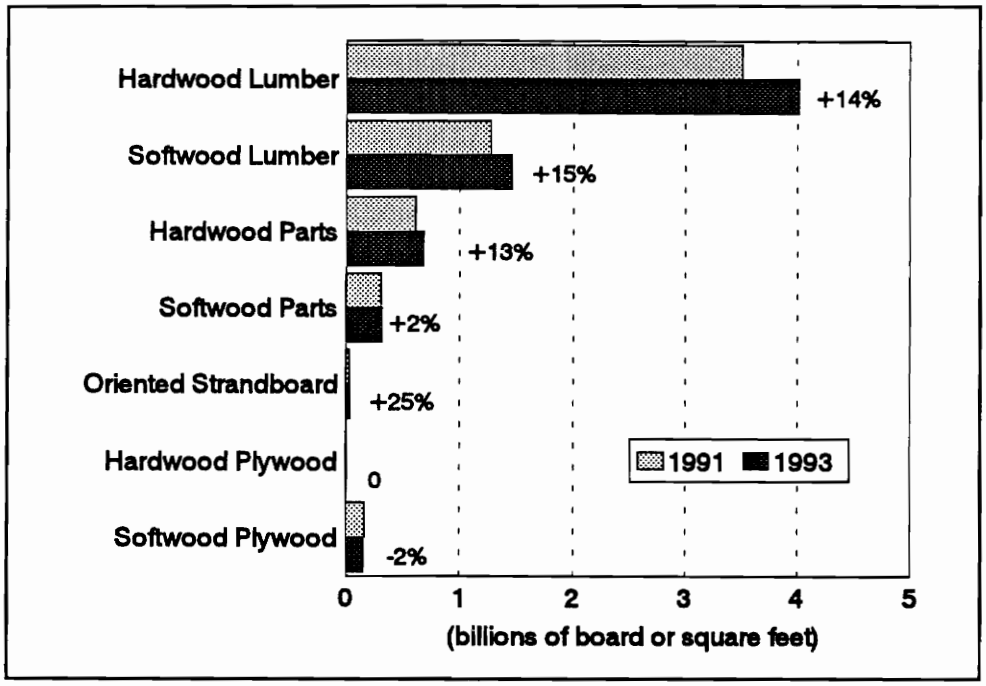


Figure 7. Estimated Wood Materials Use for Firms Primarily Producing Pallets

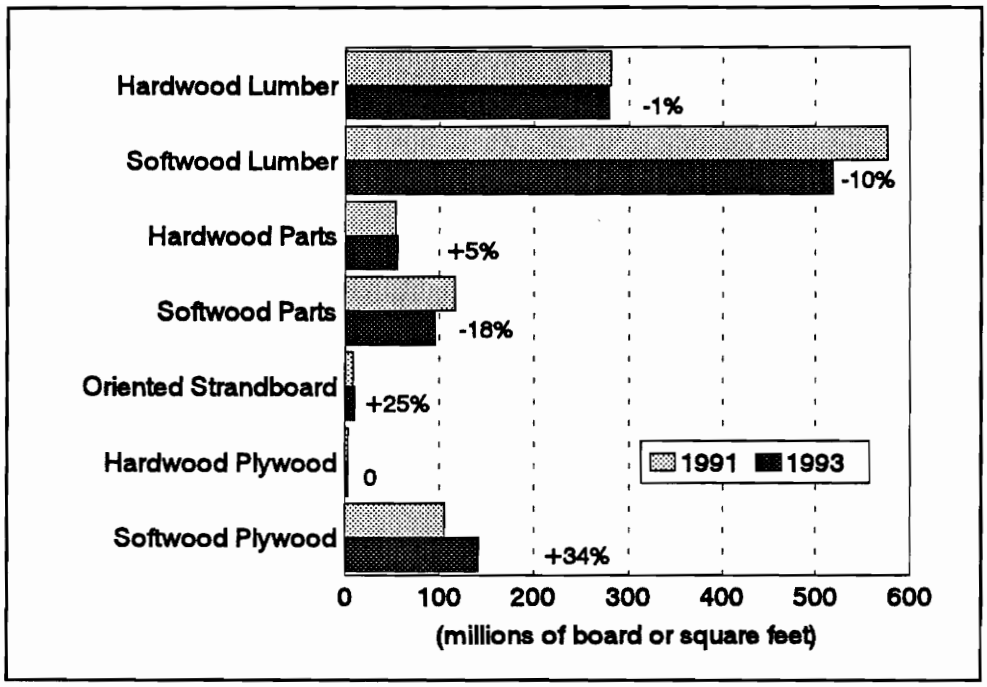


Figure 8. Estimated Wood Materials Use for Firms Primarily Producing Containers and Other Miscellaneous Products

In general, firms primarily involved in the production of pallets consumed the larger amount of all wood-based materials in 1991. Consumption of these materials was expected to increase through 1993. Pallet firms were expected to increase their use of hardwood lumber and cants by 14% in 1993. Similar results were predicted for softwood lumber and cants (15% in 1993). Hardwood part and shook use was expected to grow by 13% in 1993, and OSB consumption was expected to increase by 25% through 1993. Pallet firms were expected to decrease their use of softwood plywood by 2% in 1993, however, consumption of softwood plywood by container firms was expected to grow by 34% through 1993. Table A-6 gives a complete description of 1991 estimations and 1993

projections for wood materials use by firms primarily producing pallets and firms primarily producing containers.

Sources of Materials

Most 1991 hardwood lumber and cant purchases by pallet and container producers were made directly from the sawmill (70%). Most softwood lumber and cant purchases were made from a lumber broker (38%) or directly from the sawmill (37%). Table 3 shows hardwood and softwood lumber and cant purchases by source for 1991.

Table 3. 1991 Hardwood and Softwood Lumber and Cant Purchases by Source

Source	Hardwood Lumber		Softwood Lumber	
	MMBF	Percent	MMBF	Percent
Direct from Sawmill	2,662.1	70	685.6	37
Lumber Wholesaler	114.1	3	352.1	19
Lumber Broker	114.1	3	704.1	38
Within the Company	874.7	23	74.1	4
Other	38.0	1	37.1	2

Pallet and container firms with ten or more employees made their hardwood lumber and cant purchases primarily from the sawmill (72% by volume). Firms with less than ten employees also purchased the majority of their hardwood lumber and cants directly from the sawmill (64%). Firms with ten or more employees purchased softwood

lumber and cants primarily direct from the sawmill (37%), and secondly from lumber brokers (36%). Firms with less than ten employees purchased their softwood lumber and cants from lumber brokers (46%), and secondly direct from the sawmill (34%). Tables A-7 and A-8 give a full description of hardwood and softwood lumber sources by firm size.

A Word of Caution

Caution is always appropriate concerning surveys and estimates derived therefrom. In general, estimates of overall market size and volumes of materials consumed can be made with a higher degree of precision than can estimates of material consumption in individual pallet and container groups or regions. In other words, the more aggregated the data, the more accurate the projected numbers. Conversely, disaggregation of data increases the likelihood that the estimates will differ from actual material use. A few large firms can dramatically alter the results in a small subgroup.

Caution is also appropriate concerning estimates for 1993. These estimates are based on anticipated material use as reported by the study respondents and the volumes reported by our respondents may be optimistic. Overall, the estimates for 1993 are most useful in identifying trends rather than absolute increases.

Furthermore, not long after respondents returned their completed surveys, the cost of hardwood lumber was rising to record highs and increasing "with each passing minute" (Brindley 1993). Pallet manufacturers saw hardwood lumber prices rise $40 to $50 per

thousand board feet from June 1992 to December 1992, while softwood lumber prices remained relatively steady over this same period of time (Brindley 1993). This change could indicate that pallet producers, in response to rising hardwood prices, may look for ways to reduce the amount of lumber in their pallets or substitute softwood lumber in place of hardwood lumber. In short, the effect of rising prices may not have been foreseen by respondents and thus may not be represented in predictions for 1993.

It is possible that the data presented in this report underestimate the market. This is because the employment statistics from the U.S. Department of Labor, while the best available, may underestimate the industry's employment. This would cause our material use estimates to be low.

Summary

Total hardwood lumber and cant use in 1991 by the U. S. pallet and container industry was estimated at 3.803 billion board feet. Use of hardwood lumber and cants from 1991 through 1993 was expected to increase 13%. Total hardwood part and shook consumption by pallet and container manufacturers in 1991 was estimated to be 667 million board feet and the use of hardwood parts and shook was expected to grow by 12% through 1993. Oak was the most common species of hardwood lumber consumed by pallet and container manufacturers (1.614 billion board feet) in 1991, followed by yellow-poplar (511 million board feet) and alder (123 million board feet). Most hardwood lumber and cants (70% by volume) were purchased directly from the sawmill.

Based on the breakdown of firms primarily involved in pallet manufacture, the use of hardwoods for lumber, cants, parts, and shook represents 72% of all solid wood materials used by pallet firms. When compared to previous studies by McCurdy et al. (1991, 1988, 1985), it would appear that the substitution of softwood species for hardwoods in pallet manufacture has leveled off. Table 4 shows the trend in hardwood lumber consumption since 1980.

Table 4. Percentage of Hardwood Lumber Use for Pallet Construction: 1980 - 1991

Study	Year	Percentage of Total Pallet Construction
McCurdy and Ewers (1985)	1980	83
McCurdy et al. (1988)	1985	73
McCurdy and Phelps (1991)	1990	71
Christoforo et al. (1992)	1991	72

Total 1991 softwood lumber and cant use by pallet and container manufacturers was estimated at 1.853 billion board feet and use was expected to grow by 7% from 1991 to 1993. Total softwood part and shook use for 1991 was estimated at 429 million board feet in 1991, however, consumption of softwood parts and shook by pallet and container manufacturers was expected to decline by 3% in 1993. Use of southern yellow pine by pallet and container manufacturers was estimated at 460 million board feet in 1991 and

consumption of this species was expected to grow 18% by 1993. Softwood lumber and cants were most frequently purchased from a lumber broker (38% by volume), followed closely by purchases directly from a sawmill (37% by volume).

Softwood plywood consumption by pallet and container manufacturers was estimated to be 271 million square feet (3/4" basis) in 1991 and use was projected to increase by 13% in 1993. Approximately 36 million square feet (7/16" basis) of oriented strandboard was consumed by pallet and container manufacturers in 1991 and use was expected to grow 25% by 1993. Hardwood plywood use was estimated to be 9 million square feet (3/4" basis) in 1991 and consumption is expected to remain at this level in 1993.

Research Methodology

Sample Design

The population of interest in this study consisted of those manufacturers whose primary or secondary Standard Industrial Classification (SIC) code is listed as 2441 (wood boxes and shook), 2448 (wood pallets and skids), or 2449 (wood containers not elsewhere classified). To ensure complete coverage of pallet and container production, it was necessary to include those firms whose secondary business was pallets and containers, i.e. firms that have a secondary SIC code of 2441, 2448, or 2449.

A sample of the population of interest was obtained and stratified into two groups based on number of employees. The first group consisted of manufacturers having ten or more employees. The second group consisted of manufacturers having less than ten employees. According to Dun's Marketing Services, the population for the two groups was 1,567 for the former and 1,912 for the latter, totalling 3,479 firms over the three SIC codes. A 100% sample of those manufacturers with ten or more employees (1,567 firms) and a 25% random sample of those manufacturers with less than ten employees (478 firms) was conducted, resulting in a total of 2,045 manufacturers.

The mailing list for our sample was checked for errors such as incomplete or incorrect names and addresses. In the course of revising the list, some firms were found to be out of business or not producers. These entries were deleted, resulting in a sample consisting of 2,035 addresses.

In order to ensure inclusion of all known pallet and container manufacturers, the membership directory of the National Wooden Pallet and Container Association (NWPCA 1992) was consulted. The NWPCA list was compared to our sample list and an additional 76 manufacturers were identified and added to the 2,035 firms previously identified.

Data Collection

A mail survey served as the primary data collection vehicle. Mail surveys have been proven to be an efficient and cost effective method of securing data from a geographically diverse population such as U.S. pallet and container manufacturers (Dillman 1978).

The survey instrument (questionnaire) used in this study was similar to previous Virginia Tech questionnaires designed to measure materials use in other industries, specifically the cabinet and furniture industries. The questionnaire was reviewed by Virginia Tech faculty members, USDA scientists and trade association staff, both to validate the questions' content and to verify that language and terms were appropriate for the target industry. It was then pretested with three local pallet manufacturers to verify its effectiveness.

The questionnaire was designed to determine pallet and container manufacturers' wood material use for 1991 and their anticipated material needs for 1993. The

questionnaire was sent to a specific contact person at each firm, usually the president or owner of the firm.

Survey Administration

The final survey instrument was mailed in May, 1992. Enclosed with the questionnaire was a personalized cover letter. To further stimulate response, the questionnaire's return mail postage was prepaid. A follow-up postcard was mailed one week later to thank those who returned their questionnaire and encourage a response from those who had not yet done so. A second follow-up letter and replacement survey was mailed three weeks after the first survey to motivate those firms that had not yet responded. A complimentary bookmark was also included. Two weeks after the second survey was mailed, a final follow-up letter was mailed.

Calculating the Response Rate

A response rate was calculated for each group in our sample. Adjusted response rates were computed using the following formula:

$$\textit{Response Rate} = \frac{\textit{Number of Usable Responses Received}}{\textit{Adjusted Number of Surveys Mailed}}$$

Where:

Usable Responses = Responses that are correctly filled out and represent a manufacturer of wood boxes, wood pallets, and/or wood containers.

Adjusted Number of Surveys = (all surveys mailed) - (undeliverable surveys) - (surveys representing non-manufacturers of wood boxes, wood pallets, and/or wood containers).

Data Analysis

Analysis of primary data began with the inspection of each questionnaire to verify that responses were reasonable. Each questionnaire was entered into the database at the time of its arrival. After the last correspondence was mailed and questionnaires were received, each entry in the database was checked against its corresponding questionnaire to ensure accurate coding.

A material use per employee ratio was calculated for all respondents to identify those producers whose material use per employee ratio was large in comparison to all responding producers. These producers were contacted by telephone to confirm that volumes reported were accurate and that an error had not occurred in reporting material use volumes. Producers with large material use per employee ratios were consistently found to have highly automated manufacturing facilities.

Material Volume Estimates

Estimation of total industry use and predicted future use of wood materials required that the material use by responding firms be extrapolated to the entire industry. This was accomplished by dividing each reported volume by the coverage ratio of the

total number of employees for each stratum (firms with ten or more employees or firms with less than ten employees) within the pallet and container industry for 1991. The denominator in this equation combines (a) the total number of respondent's employees for firms which gave a positive response for that particular material, year, and stratum and, (b) the total number of employees in the pallet and container industry in 1991 for that particular stratum. This calculation can be expressed by the following formula:

$$\textit{Industry Volume Estimate} = \sum_{x=1}^{n} \frac{\textit{Volume Reported by Respondent X}}{\textit{Coverage Ratio}}$$

Where:

Volume Reported= The volume reported by each respondent for a given material/year.

Coverage Ratio= The total number of employees for firms in that stratum that gave a positive response for that material/year divided by the total number of employees within the pallet and container industry for that stratum.

n= The total number of item responses for a given material and year.

Up-to-date estimates of the total number of employees in various segments of the pallet and container industry were obtained through the U.S. Forest Service from the U.S. Department of Labor's (USDL) unemployment insurance records. Because the penalties associated with not reporting unemployment insurance information are much greater than noncompliance with the U.S. Department of Commerce (USDC) surveys, employment

data developed from unemployment insurance records are probably more accurate than USDC information (Luppold 1992). However, even this data is likely to underestimate the total industry employment.

Non-response Bias Checks

In any mail survey where people are not required to respond, the potential exists for non-response bias. That is, respondents may differ from non-respondents, making the data from the responding firms not representative of the total industry.

The hypothesis that responders are like non-responders, and thus represent the population, was evaluated. Our sample of respondents was compared to a random sample of 50 non-respondents contacted by telephone. Non-respondents were asked key questions (such as hardwood lumber & cant consumption and number of employees) and their responses were compared to those of firms that returned the questionnaire. Independent t-tests were used to compare the average material use volumes and average number of employees of respondents and non-respondents. No significant differences were found between respondents and non-respondents when tested at the 95% confidence level, suggesting that respondents were representative of the industry.

Appendix

1991 Sales By Product and Region

Material Use Tables

Sources of Hardwood and Softwood Lumber

Table A-1. 1991 Pallet and Container Sales by Product and Region for Responding Firms

Product	Total ($000)	Region			
		Northeast ($000)	South ($000)	North Central ($000)	West ($000)
Expendable Pallets	379,279	49,748	142,276	137,928	48,827
Non-expendable Pallets	371,753	41,525	145,355	105,033	79,839
Skids	73,100	11,438	22,739	24,510	14,413
Barrels	4,355	200	1,500	2,155	500
Crates	104,823	3,850	39,004	33,556	28,413
Boxes	145,189	13,285	55,664	25,397	50,843
Pallet Parts and/or Shook	37,065	2,061	12,122	8,470	14,412
Other	69,003	3,656	22,471	18,600	24,276
Total	1,184,566	125,764	441,131	356,147	261,524

Table A-2. Estimated Total Wood Material Use for Pallets and Containers: 1991 and 1993

Wood Material	Units of Measure	Estimated Use in 1991	Predicted Use in 1993	% Change
Hardwood Lumber and Cants	MMBF	3,803	4,299	+ 13
Softwood Lumber and Cants [a]	MMBF	1,853	1,982	+ 7
Oriented Strandboard	MMSF 7/16" [b]	36	45	+ 25
Hardwood Plywood	MMSF 3/4" [b]	9	9	0
Softwood Plywood	MMSF 3/4" [b]	271	305	+ 13
Hardwood Parts and Shook	MMBF [c]	667	747	+ 12
Softwood Parts and Shook [a]	MMBF [c]	429	416	- 3

[a] Some soft hardwoods such as aspen, cottonwood, and yellow-poplar may have been included in these categories.

[b] The fraction represents the base thickness to which reported values were converted.

[c] These volumes are estimated on a nominal basis.

Table A-3. Estimated Wood Material Use by Region: 1991 and 1993

Material	Estimated Use in 1991		Predicted Use in 1993	
Hardwood Lumber and Cants (MMBF)	%	Volume	%	Volume
Northeast	17.8	677.6	16.7	718.0
South	43.5	1653.4	44.4	1910.3
North Central	36.3	1381.8	36.1	1550.3
West	2.4	90.2	2.8	120.4
Softwood Lumber and Cants (MMBF)				
Northeast	10.2	188.4	6.8	134.8
South	23.0	426.9	22.2	441.5
North Central	19.2	355.2	20.7	410.6
West	47.6	882.5	50.3	995.1
Oriented Strandboard (MMSF, 7/16" basis)				
Northeast	2.9	1.1	4.7	2.1
South	20.6	7.4	27.8	12.5
North Central	70.6	25.4	62.8	28.3
West	5.9	2.1	4.7	2.1
Hardwood Plywood (MMSF, 3/4" basis)				
Northeast	0	0	0	0
South	42.9	3.9	33.3	3.0
North Central	14.2	1.2	16.7	1.5
West	42.9	3.9	50.0	4.5
Softwood Plywood (MMSF, 3/4" basis)				
Northeast	5.4	14.6	4.1	12.6
South	49.3	133.6	43.8	133.6
North Central	14.7	39.9	13.1	40.0
West	30.6	82.9	39.0	118.8
Hardwood Parts and Shook (MMBF)				
Northeast	9.5	63.5	5.2	38.3
South	28.4	189.4	31.5	235.6
North Central	31.1	207.6	30.7	229.5
West	31.0	206.5	32.6	243.6

Table A-3. (Continued)

Softwood Parts and Shook (MMBF)	Estimated Use in 1991		Predicted Use in 1993	
Northeast	8.2	35.2	6.7	28.0
South	8.0	34.3	10.6	44.0
North Central	10.1	43.3	11.5	48.0
West	73.7	316.2	71.2	296.0

Table A-4. Estimated 1991 Lumber, Cant, Part, and Shook Use for Pallets and Containers by Species and Region

Species	Total Volume (MMBF)	Volume by Region (MMBF)			
		Northeast	South	North Central	West
Oak	1,619.3	205.1	777.1	574.7	62.4
Yellow-poplar	496.5	53.5	288.3	154.7	0.0
Alder	227.7	0.2	0.0	0.3	227.2
Mixed Hardwoods	2,080.4	491.4	783.7	802.7	2.6
Other Hardwoods	214.1	36.1	37.3	140.6	0.1
Southern yellow Pine	541.2	32.9	383.2	114.5	10.6
Other Softwoods	1,573.0	186.4	20.5	162.0	1204.1
Totals	6752.2	1005.6	2290.1	1949.5	1507.0

Table A-5. Predicted 1993 Lumber, Cant, Part, and Shook Use for Pallets and Containers by Species and Region

Species	Total Volume (MMBF)	Volume by Region (MMBF)			
		Northeast	South	North Central	West
Oak	1,861.1	227.8	935.8	604.8	92.7
Yellow-poplar	625.8	62.3	373.8	189.7	0.0
Alder	297.2	0.2	0.0	1.8	295.2
Mixed Hardwoods	2,175.5	402.8	905.1	864.1	3.5
Other Hardwoods	255.8	5.4	46.7	203.7	0.0
Southern yellow pine	638.5	26.0	471.3	134.3	6.9
Other Softwoods	1,589.6	113.6	26.1	166.4	1,283.5
Totals	7443.5	838.1	2758.9	2164.7	1681.8

Table A-6. Estimated Total Wood Materials Use for Firms Primarily Producing Pallets (SIC 2448) and Firms Primarily Producing Containers and Other Miscellaneous Products (SICs 2441 and 2449): 1991 and 1993

Material	1991		1993	
	Pallet Firms	Container & misc. Firms	Pallet Firms	Container & misc. Firms
Hardwood Lumber and Cants (MMBF)	3,521.6	281.4	4,019.6	279.4
Softwood Lumber and Cants (MMBF)	1,276.7	576.3	1,462.0	519.0
Hardwood Parts and Shook (MMBF)	613.6	53.4	691.0	56.0
Softwood Parts and Shook (MMBF)	311.9	117.1	319.1	96.9
Oriented Strandboard (MMSF, 7/16" basis)	28.0	8.0	35.0	10.0
Hardwood Plywood (MMSF, 3/4" basis)	6.0	3.0	6.0	3.0
Softwood Plywood (MMSF, 3/4" basis)	165.3	105.7	163.2	141.8

Table A-7. 1991 Hardwood Lumber and Cant Purchases by Source and Firm Size

Source	Size of Pallet and Container Firm	
	10 or more Employees (by volume)	Less than 10 Employees (by volume)
Direct from Sawmill	72%	64%
Lumber Wholesaler	3%	4%
Lumber Broker	3%	2%
Within the Company	21%	29%
Other	1%	1%

Table A-8. 1991 Softwood Lumber and Cant Purchases by Source and Firm Size

Source	Size of Pallet and Container Firm	
	10 or more Employees (by volume)	Less than 10 Employees (by volume)
Direct from Sawmill	37%	34%
Lumber Wholesaler	20%	15%
Lumber Broker	36%	46%
Within the Company	4%	1%
Other	2%	5%

Literature Cited

Adair, C. 1992. End-Use Marketing Profiles for Structural Panels, E52. American Plywood Association. Tacoma, Washington.

Anderson, R.B. and H.W. Wisdom. 1991. Wood pallet inventory estimation for the grocery distribution system. *Forest Products Journal* 41(4):19-24.

Anonymous. 1992. Industry explores pallet of future: grocery pallet debated. *Pallet talk* 92(19):1-4.

Brindley, E.C. 1992. Here come block pallets! *Wooden Pallet Index*, March 6:1-4,7.

Brindley, E.C. 1993. Lumber trends - where are they headed? *Pallet Profile Weekly*, January 8:1-4.

Cardellichio, P.A. and C.S. Binkley. 1984. Hardwood lumber demand in the United States: 1950 to 1980. *Forest Products Journal* 34(2):15-22.

Dillman, D.A. 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley and Sons, New York.

Luppold, W.G. 1992. Alternative Estimates of Pallet Production. Unpublished Working Paper. USDA Forest Service. Northeastern Forest Experiment Station. 6 pp.

Luppold, W.G. 1989. Shifting Demand for Eastern Hardwood Lumber. Presented at Hardwood Forest Product Opportunities: Creating and Expanding Businesses. Pittsburgh, Pennsylvania. October 17.

McCurdy, D.R. and J.T. Ewers. 1985. The U.S. pallet industry. *Pallet Enterprise* 4(6):8-12.

McCurdy, D.R., J.T.Ewers, F.H. Kung, and D.B. McKeever. 1988. A study of lumber use in pallets manufactured in the United States: 1982 and 1985. *Forest Products Journal* 38(2):11-15.

McCurdy, D.R. and J.E. Phelps. 1991. The Pallet Industry in the United States, 1980, 1985, 1990. Department of Forestry, Southern Illinois University, Carbondale, Illinois. 16 pp.

McKeever, D.B. and C.A. Hatfield. 1984. Trends in the Production and Consumption of Major Forest Products in the United States. Resource Bulletin FPL-14. USDA Forest Service. Forest Products Laboratory. Madison, Wisconsin. 59 pp.

National Wooden Pallet and Container Association. 1991. Unpublished pallet production data. Washington, D.C.

National Wooden Pallet and Container Association. 1992. 1992 - 1993 Membership Directory. Arlington, Virginia.

Spelter H. and R.B. Phelps. 1984. Changes in postwar U.S. lumber consumption patterns. *Forest Products Journal* 34(2):35-41.

USDA Forest Service. 1989. An Analysis of the Timber Situation in the United States, 1989 - 2040. Washington, D.C. Draft Report. pp. 47-56.

A PROFILE OF THE

U. S. PALLET AND CONTAINER INDUSTRY

An article prepared for submission to the
Forest Products Journal

Abstract

Data from pallet and container manufacturers in the U.S. were gathered via a mail survey to determine volumes of wood-based material use by the industry. In 1991, pallet manufacturers used an average of 2.79 million board feet of hardwood lumber and cants, 1.1 million board feet of softwood lumber and cants, 578 thousand board feet of hardwood parts and shook and 276 thousand board feet of softwood parts and shook. The use of panel products by pallet manufacturers included an average of approximately 100 thousand square feet of softwood plywood (3/4" basis) and 20 thousand square feet of oriented strandboard (7/16" basis) per company. Container manufacturers consumed an average of approximately 936 thousand board feet of hardwood lumber and cants, 1.64 million board feet of softwood lumber and cants, 225 thousand board feet of hardwood parts and shook and 390 thousand board feet of softwood parts and shook. In addition, container manufacturers consumed on average, 423 thousand square feet of softwood plywood (3/4" basis) and 15 thousand square feet of oriented strandboard (7/16" basis) per company. Estimated total industry use of hardwood lumber and cants was approximately 3.80 billion board feet and use of softwood lumber and cants was 1.85 billion board feet. Total hardwood part and shook use was 667 million board feet and total softwood part and shook use was 429 million board feet. Total industry softwood plywood consumption was estimated to be 271 million square feet (3/4" basis) and oriented strandboard use accounted for 36 million square feet (7/16" basis).

Introduction

The U.S. pallet and container industry purchases tremendous quantities of wood materials and has consumed about 40% of total hardwood lumber production since the 1980's (Spelter and Phelps 1984, Luppold 1989, Dempsey and Luppold 1992). The industry also provides an outlet for the large amount of low grade hardwood lumber produced by grade sawmills. However, very little current information is available concerning the types of products used by this industry and trends in wood material use.

Previous research has concentrated on the use of lumber by the pallet and container industry (Anderson 1986, 1987a; Cardellichio and Binkley 1984; Spelter and Phelps 1984; McKeever et al. 1980, 1984; Dempsey and Luppold 1992, McCurdy and Phelps 1992) and on wood-based panel use (Adair 1992; Anderson 1987b; USDA Forest Service 1982, 1989). However, there are indications that the species mix used in the production of pallets and containers is changing (McCurdy et al. 1985, 1988, 1991). In addition, there are indications that the use of panel products, softwood lumber, and non-wood substitutes is increasing.

This study sought to augment the available literature in three areas: (1) By providing current data on various types of wood-based materials use by pallet and container manufacturers (lumber, cants, parts, shook, softwood plywood, etc.), (2) Provide additional information as to species use within the pallet and container industry and, (3) Report predicted shifts (if any) in wood-based material use within the pallet and container industry.

Methods

Sample Design

The population of interest in this study consisted of those manufacturers whose primary or secondary Standard Industrial Classification (SIC) is 2441 (wood boxes and shook), 2448 (wood pallets and skids), or 2449 (wood containers not elsewhere classified).

A sample of the population of interest was obtained from Dun's Marketing Services (1992) and stratified into two groups based on number of employees. The first group consisted of manufacturers having ten or more employees. The second group consisted of manufacturers having less than ten employees. The population of the two groups was 1,567 for the former and 1,912 for the latter, totalling 3,479 firms over the three SIC codes. A 100% sample of those manufacturers with ten or more employees (1,567 firms) and a 25% random sample of those manufacturers with less than ten employees (478 firms) was used, resulting in a total sample of 2,045 manufacturers.

In the course of checking the sample, some firms were found to be out of business or not producers. These entries were deleted, resulting in a sample consisting of 2,035 manufacturers. In order to ensure inclusion of all known pallet and container manufacturers, the membership directory of the National Wooden Pallet and Container Association (NWPCA 1992) was consulted. The NWPCA list was compared to the sample list and an additional 76 manufacturers were identified and added to the 2,035 firms previously identified.

Data Collection

A mail survey served as the primary data collection method. The questionnaire used in the survey was designed to determine pallet and container manufacturers' wood material use in 1991 and their anticipated material use in 1993. Specifically, seven wood-based materials were addressed in this study: hardwood lumber and cants, softwood lumber and cants, hardwood parts and shook, softwood parts and shook, oriented strandboard, hardwood plywood and softwood plywood. There are other materials such as veneers and various fiber-based boards used by the pallet and container industry. However, questionnaire length considerations limited questions to the major materials previously mentioned. The questionnaire was sent to a specific contact person, usually the president or owner of the firm. Table 1 summarizes the sampling scheme and response rates to the study.

A material use per employee ratio was calculated for all respondents to identify those producers whose material use was large in comparison to all responding producers. These producers were contacted by telephone to confirm that volumes reported were accurate and that an error had not occurred in reporting or coding the figures.

Non-Response Bias

In any mail survey where people are not required to respond, the potential exists for non-response bias. That is, respondents may differ from non-respondents, making the data from the responding firms not representative of the total industry.

The hypothesis that responders were like non-responders, and thus representative of the population, was evaluated. A random sample of 50 non-respondents was contacted by telephone. Non-respondents were asked key questions (such as hardwood lumber and cant consumption and number of employees) and their responses were compared to those of firms that returned the questionnaire. Independent t-tests were used to compare the average material use volumes and average number of employees of respondents and non-respondents. No significant differences were found between respondents and non-respondents at the 95% confidence level, suggesting that non-response bias was not a problem in this study.

Material Volume Estimates

In order to provide a profile of pallet and container firms, averages of material use by firm type were calculated. However, simple averages were not appropriate due to the different treatments given to each stratum. Rather, averages were calculated on a weighted basis to reflect the stratified sampling scheme.

Material use averages were weighted based on industry employment estimates from the U.S. Department of Labor (USDL). Up-to-date estimates of the total number of employees in various segments of the pallet and container industry were obtained from USDL unemployment insurance records through the U.S. Forest Service, Princeton, West Virginia. Employment figures from the USDL are consistent and available on a monthly basis.

Estimation of the number of employees per stratum was arrived at by first multiplying the number of firms in each stratum, as determined by Dun's Marketing Services, by the average number of employees in each stratum, as determined by our respondents, to arrive at an estimate of the population's total employment. To adjust the calculated number of employees to the estimate from the USDL (44,000), it was necessary to tabulate what percentage of the calculated total employment was in each stratum. The proportion of employment in each stratum was then multiplied by the USDL estimate of 44,000 to arrive at an adjusted employment estimate per stratum. These estimates (36,575 employees in Stratum 1 and 7,425 employees in Stratum 2) were used for further analysis.

Estimation of total industry use and predicted future use of wood materials required that material use by responding firms be extrapolated to the entire industry. This was accomplished by dividing each reported volume by a coverage ratio (weighing factor). The denominator in this calculation combines (a) the total number of respondents' employees for firms which gave a positive response for that particular material, year, and stratum and, (b) the total number of employees for that particular stratum. This calculation can be expressed by the following formula:

$$\textit{Industry Volume Estimate} = \sum_{x=1}^{2} \sum_{y=1}^{n} \frac{\textit{Volume Reported by Respondent Y}}{\textit{Coverage Ratio}}$$

Where:

Volume Reported = The volume reported by each respondent for a given material.

Coverage Ratio = The total number of employees for firms in that stratum that gave a positive response for that material divided by the total number of employees within that stratum.

n = The total number of item responses for a given material.

x = Stratum number.

Results and Discussion

Average Use of Wood Materials

Those firms primarily involved in the manufacture of pallets and skids (SIC 2448) consumed, on average, 2.79 million board feet of hardwood lumber and cants and 1.11 million board feet of softwood lumber and cants per company during 1991 (Table 2). Average hardwood part and shook use per pallet firm was 578 thousand board feet for 1991, while average softwood part and shook use was 276 thousand board feet. Pallet firms used an average of 100 thousand square feet (3/4" basis) of softwood plywood, 5.6 thousand square feet of hardwood plywood (3/4" basis), and 20 thousand square feet of oriented strandboard (7/16" basis). These averages are across all regions and average use of some materials will vary by region.

Hardwood lumber and cant use was well below average in the west, and above average in the south and northeast regions. Use of softwood lumber and cants was far

above the average for Western pallet firms and below average for all other regions. Oriented strandboard use was above average in the north central region, yet below average for the northeast region. Softwood plywood use was above average for the southern and western regions and well below average for the north central region.

Firms primarily involved in container and shook manufacture (SIC 2441 and SIC 2449), on average, used less solid hardwood products in 1991 than did firms producing pallets and skids. Average hardwood lumber and cant use was 936 thousand board feet in 1991 and average hardwood part and shook consumption was 225 thousand board feet per company (Table 2). Also, less oriented strandboard was used by container firms (15 thousand square feet per firm, 7/16" basis) in 1991.

However, average consumption of softwood products and hardwood plywood was greater for container firms than for firms producing pallets. Softwood lumber and cant use was 1.64 million board feet per container firm in 1991, average softwood part and shook use was 390 thousand board feet, and average softwood plywood consumption per container firm was 423 thousand square feet (3/4" basis). Also, hardwood plywood use was higher on average for container firms (13 thousand square feet, 7/16" basis).

Material use averages varied by region for container and shook firms. Hardwood lumber and cant use was well above average for Southern firms and well below average for Western firms. However, softwood lumber and cant use was above average for firms in the West, but below average for Northeast firms. Oriented strandboard use was well above average for firms in the north central region, yet average use of OSB in the western

and northeast regions was minimal. Average use of softwood plywood was more than double the national average for Western firms, but well below average for Northeast and North Central firms.

Lumber Use by Species

Respondents were asked to report the species or species groups they used in the production of pallets and containers during 1991 and to predict what species will be used in 1993. Only lumber, cants, parts, and shook were included in this question.

Mixed hardwoods, those species purchased in an unidentified manner, were the most heavily utilized species group in 1991 (Figure 1) at 30.8% of total volume. Pallet and container manufacturers used 24% oak, followed closely by 23.3% other softwoods (any softwood other than southern yellow pine). Yellow-poplar accounted for 7.4%, alder at 3.4%, southern yellow pine at 8%, and other hardwoods (any single hardwood species not previously mentioned) represented 3.2%.

Pallet and container manufacturers in the northeast region of the U.S. consumed above average amounts of mixed hardwoods at 48.9%, yet lower amounts of oak at 20.4%. Southern firms consumed higher volumes of oak (33.9%) and southern yellow pine (16.7%), while other hardwoods made up only 0.9%. Manufacturers in the north central region used greater amounts of mixed hardwoods at 41.2% but lower than average amounts of other softwoods at 8.3%. Overall, softwood use in the north central region

counted for 14.2%. Western firms, used 79.9% other softwoods and 15.1% alder, while oak use was 4.1%.

Based on the breakdown of firms primarily involved in pallet manufacture, the use of hardwoods for lumber, cants, parts, and shook represents 72% of all solid wood materials used by pallet firms (Christoforo et al. 1992). When compared to previous studies by McCurdy et al. (1985, 1988, 1991b), it would appear that the substitution of softwood species for hardwoods in pallet manufacture has leveled off. McCurdy et al. report that for 1980, hardwoods accounted for 83% of pallet construction. This proportion dropped to 73% in 1985, and in 1990 hardwood use accounted for 71% (McCurdy et al. 1985, 1988, 1991).

Sources of Lumber and Cants

Firms were asked to indicate the sources of their lumber and cants. Approximately 70% (by volume) of hardwood lumber and cant purchases by pallet and container producers were made directly from the sawmill (Figure 2). Softwood lumber and cant purchases (Figure 3) were made from a lumber broker (38%) or directly from the sawmill (37%).

Types of Products Produced

Respondents were asked to indicate how their 1991 sales, in dollars, were divided among various products. Figure 4 shows the percentage of total 1991 sales by product

for all respondents (SIC 2441, 2448, and 2449). Production of expendable pallets (32% of sales) was almost equal to that of non-expendable pallets (31.4%). The next largest segment was in the production of boxes at 12.3%. Similar results were found by McCurdy and Phelps (1991). In their sample the proportion of expendable pallets (54%) was similar to the proportion of non-expendable pallets (46%).

Total Industry Wood-Based Material Use

Firms were asked to report consumption volumes of seven wood-based materials for 1991 and the volumes that they anticipated consuming in 1993. Reported volumes were then used to estimate the total industry use and predict changes in use. Total industry hardwood lumber and cant use in 1991 was estimated to be approximately 3.8 billion board feet. Softwood lumber and cant consumption was estimated to be approximately 1.8 billion board feet. Use of hardwood parts and shook was estimated to be 667 million board feet and softwood parts and shook consumption was estimated at 429 million board feet in 1991.

Among panel products, softwood plywood consumption was estimated to be 271 million square feet (3/4" basis), hardwood plywood use was estimated to be 9 million square feet (3/4" basis) and oriented strandboard consumption was estimated to be 36 million square feet (7/16" basis). A complete description of estimated wood-based materials use for 1991 can be found in Table 3.

Industry use of hardwood lumber and cants is expected to increase by 13% between 1991 and 1993, while the use of hardwood parts and shook is predicted to increase by 12%. Softwood lumber and cant consumption is predicted to increase by 7% through 1993, while softwood part and shook use is expected to decrease by 3%.

Industry use of oriented strandboard use is expected to increase strongly (25%) between 1991 and 1993. Softwood plywood consumption is expected to increase by 13% and hardwood plywood use was expected to remain unchanged through 1993.

In general, firms primarily involved in the production of pallets consumed the larger amount of all wood-based materials in 1991 (Table 3). Consumption of these materials, except softwood plywood, is expected to increase for pallet firms through 1993. Pallet firms are expected to increase their use of hardwood lumber and cants by 14% through 1993. Similar results are predicted for softwood lumber and cants (15% in 1993). Hardwood part and shook use is expected to grow by 13% through 1993, and OSB consumption is expected to increase by 25% through 1993. However, pallet firms are expected to decrease their use of softwood plywood by 2% through 1993.

Container firms are expected to decrease their use of hardwood lumber and cants by 1% through 1993, decrease use of softwood lumber and cants by 10%, and reduce softwood part and shook use by 18% through 1993. However, container firms expect to increase use of hardwood parts and shook by 5% through 1993, OSB use is expected to increase 25% between 1991 and 1993, and the use of softwood plywood is expected to increase by 34% through 1993.

Literature Cited

Adair, C. 1992. End-Use Marketing Profiles for Structural Panels, E52. American Plywood Association. Tacoma, Washington.

Anderson, R.B. 1986. Future availability of pallet raw material in the South. *Pallet Enterprise* 6(6):44-46.

Anderson, R.B. 1987a. Future availability of pallet raw material in the North. *Pallet Enterprise* 7(3):31-34.

Anderson, R.G. 1987b. Structural Panel Uses in Industrial Markets: 1986. American Plywood Association. Tacoma, Washington. 55 pp.

Cardellichio, P.A. and C.S. Binkley. 1984. Hardwood lumber demand in the United States: 1950 to 1980. *Forest Products Journal* 34(2):15-22.

Christoforo, J.C., V.S. Reddy, J.W. Punches, and R.J. Bush. 1992. Wood-Based Material Use in the U.S. Pallet and Container Industry: 1991 and 1993. Unpublished Report. Center for Forest Products Marketing. Virginia Tech. Blacksburg, Virginia. 31 pp.

Dempsey, G.P. and Luppold, W.G. 1992. The state of hardwood lumber markets. *The Northern Logger and Timber Processor.* 40(9): 22-23, 30

Dun's Marketing Services. 1992. Dun and Bradstreet Corporation. Parsippany, New Jersey.

Luppold, W.G. 1989. Shifting Demand for Eastern Hardwood Lumber. Presented at Hardwood Forest Product Opportunities: Creating and Expanding Businesses. Pittsburgh, Pennsylvania. October 17.

McCurdy, D.R. and J.T. Ewers. 1985. The U.S. pallet industry. *Pallet Enterprise* 4(6):8-12.

McCurdy, D.R., J.T. Ewers, F.H. Kung, and D.B. McKeever. 1988. A study of lumber use in pallets manufactured in the United States: 1982 and 1985. *Forest Products Journal* 38(2):11-15.

McCurdy, D.R. and J.E. Phelps. 1992. The Pallet Industry in the United States, 1980, 1985, 1990. *Forest Products Journal* 42(1):1-4.

McCurdy, D.R. and J.E. Phelps. 1991. The Pallet Industry in the United States, 1980, 1985, 1990. Department of Forestry, Southern Illinois University, Carbondale, Illinois. 16 pp.

McKeever, D.B. and H.E. Dickerhoof. 1980. Lumber and Panel Consumption for Packaging and Shipping in the United States - Perspective for the 1980's. Resource Bulletin FPL-10. USDA Forest Service. Forest Products Laboratory. Madison, Wisconsin. 5 pp.

McKeever, D.B. and C.A. Hatfield. 1984. Trends in the Production and Consumption of Major Forest Products in the United States. Resource Bulletin FPL-14. USDA Forest Service. Forest Products Laboratory. Madison, Wisconsin. 59 pp.

National Wooden Pallet and Container Association. 1992. 1992 - 1993 Membership Directory. Arlington, Virginia.

Spelter H. and R.B. Phelps. 1984. Changes in postwar U.S. lumber consumption patterns. *Forest Products Journal* 34(2):35-41.

USDA Forest Service. 1982. An Analysis of the Timber Situation in the United States, 1952-2030. Forest Resource No. 23. Washington, D.C. 499 pp.

USDA Forest Service. 1989. An Analysis of the Timber Situation in the United States, 1989 -2040. Washington, D.C. Draft Report. pp. 47-56.

Table 1. Stratification and Response Rates

Strata	Firm Size	Number of Firms in Sample	Response Rate
1	Ten or more employees	1,638	41%
2	Less than ten employees	473	19%
Overall		2,111	36%

Table 2. Average Wood-Based Material Use by Firm Type: 1991

Wood-Based Material	Average Use Per Firm	
	Pallets and Skids (SIC 2448)	Containers and Shook (SIC 2441 and 2449)
Hardwood Lumber and Cants (MBF)	2794.7	936.4
Softwood Lumber and Cants (MBF)	1109.6	1637.3
Hardwood Parts and Shook (MBF)[1]	578.1	225.6
Softwood Parts and Shook (MBF)[1]	276.1	390.3
Oriented Strandboard (MSF, 7/16" basis)	20.0	15.1
Hardwood Plywood (MSF, 3/4" basis)	5.6	13.1
Softwood Plywood (MSF, 3/4" basis)	100.4	423.0

[1] These volumes are estimated on a nominal basis.

Table 3. Estimated Total Wood-Based Material Use Within the Pallet and Container Industry: 1991

Wood-Based Material	Estimated Use in 1991	Estimated Use by Firm Type	
		Pallets and Skids (SIC 2448)	Containers and Shook (SIC 2441 and 2448)
Hardwood Lumber and Cants (MMBF)	3,803	3,521.6	281.4
Softwood Lumber and Cants (MMBF)	1,853	1,276.7	576.3
Hardwood Parts and Shook (MMBF [b])	667	613.6	53.4
Softwood Parts and Shook (MMBF [b])	429	311.9	117.1
Oriented Strandboard (MMSF, 7/16" [a])	36	28.0	8.0
Hardwood Plywood (MMSF, 3/4" [a])	9	6.0	3.0
Softwood Plywood (MMSF, 3/4" [a])	271	165.3	105.7

[a] The fraction represents the base thickness to which reported values were converted.

[b] These volumes are estimated on a nominal basis.

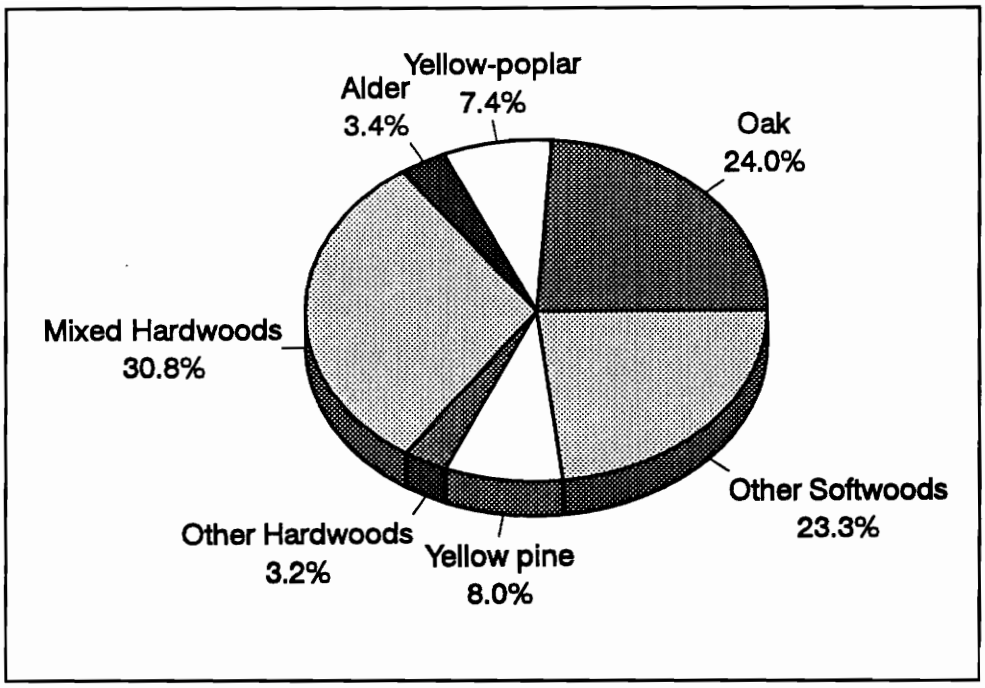


Figure 1. Species Mix for Pallet and Container Firms: 1991

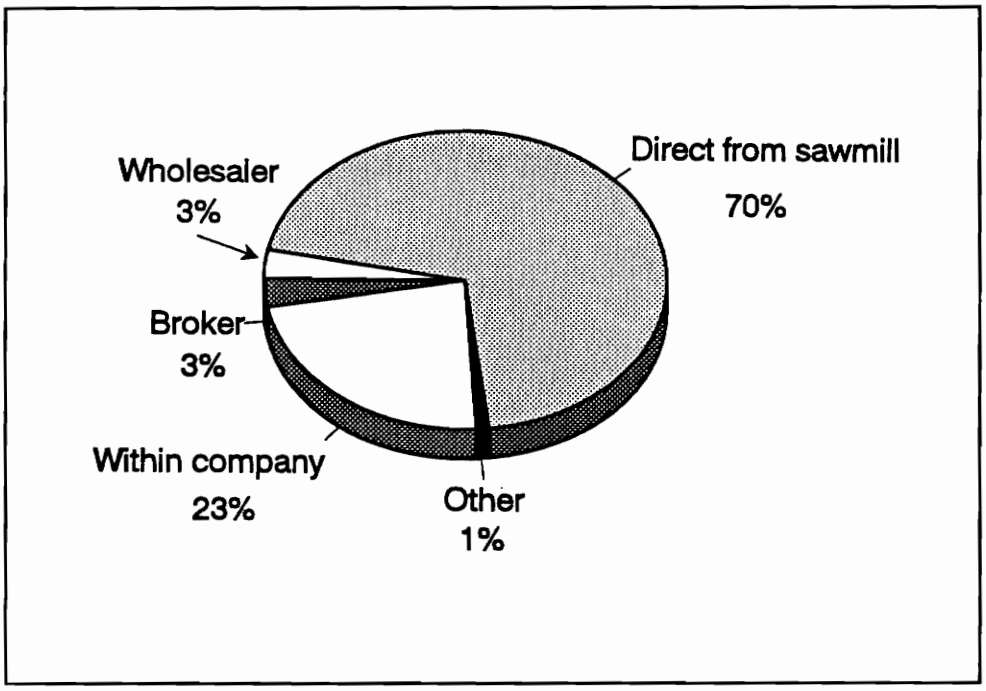


Figure 2. Sources of Hardwood Lumber and Cants: 1991

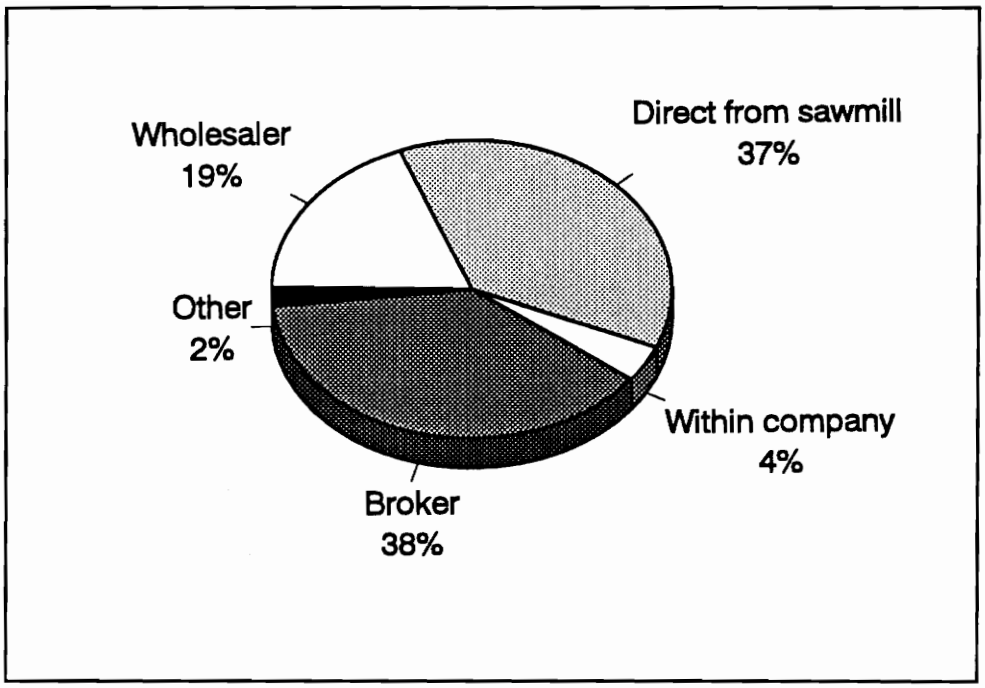


Figure 3. Sources of Softwood Lumber and Cants: 1991

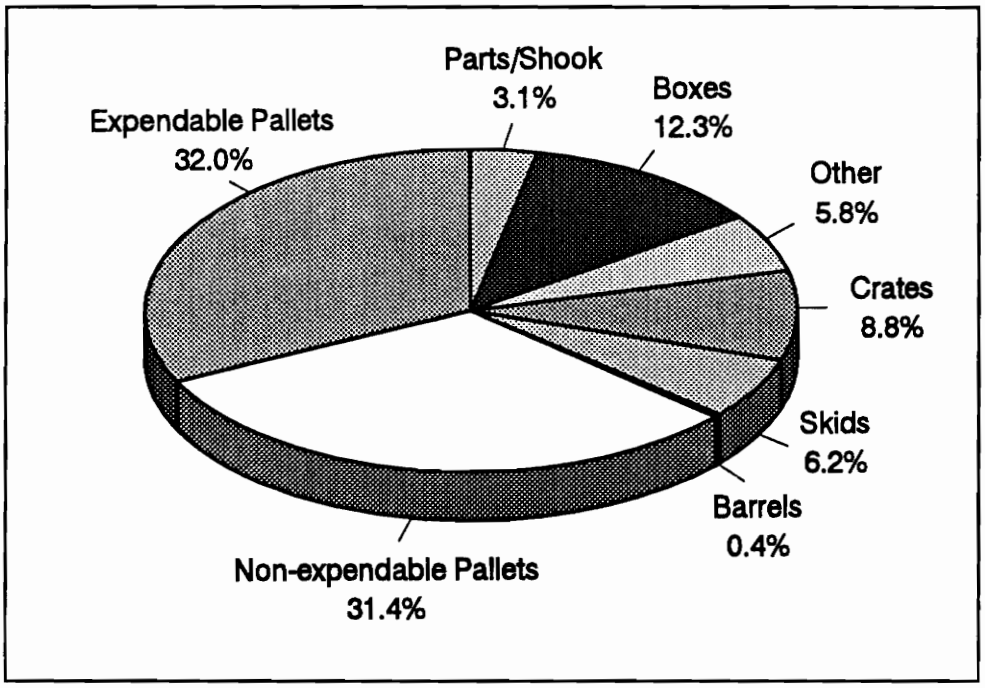


Figure 4. Types of Products Produced as a Percentage of Sales: 1991

APPENDIX A

Survey Instrument

Pallet and Container Industry Study

Center for Forest Products Marketing

Virginia Polytechnic Institute and State University
Department of Wood Science and Forest Products
Blacksburg, VA 24061-0503

Questions? Contact John Christoforo
703/231-5876

Fax: 703/231-8868

VIRGINIA TECH

Pallet and Container Industry Study

This questionnaire asks about your company's use of wood materials. It is designed to help suppliers better understand and serve your wood material needs, and to illustrate the importance of the pallet and container industry to local economies. Please answer for your firm as a whole, not just for your location. If you are not responsible for ordering, purchasing, or tracking WOOD MATERIALS please give this questionnaire to the appropriate person at your firm.

Thank you for your help!

1. **Does your company produce wood pallets, skids, containers, boxes, barrels, or crates?** (Please check one box.)

☐ No ⇨ Please return this questionnaire even if your company does not produce any of the listed products. Just check "No", fold and staple. Postage is prepaid. **Thank you!**

☐ Yes

The following questions use the term "pallets and containers." By this we mean wood pallets, skids, containers, boxes, barrels and crates. Please include all of these products in your answers.

2. **Which of the following wood materials did your firm use in the production of pallets and containers during 1991?** (Please check all that apply.)

☐ Hardwood Lumber or Cants
☐ Softwood Lumber or Cants
☐ Hardwood Parts or Shook
☐ Softwood Parts or Shook
☐ Oriented Strandboard (OSB)
☐ Hardwood Plywood
☐ Softwood Plywood

3. **Please estimate the volume of the following wood materials used by your firm to manufacture pallets and containers during 1991, and predict the volume to be used in 1993.**

(If your company purchases logs or bolts, please report the amount used in pallets or containers under the appropriate lumber or parts category.)

Wood Material	Units of Measure	Used in 1991	Predicted Use in 1993
Hardwood Lumber and Cants	MBF (1000 board feet)	_____	_____
Softwood Lumber and Cants	MBF	_____	_____
Oriented Strandboard (OSB)	MSF (1000 square feet) 7/16" basis*	_____	_____
Hardwood Plywood	MSF 3/4" basis*	_____	_____
Softwood Plywood	MSF 3/4" basis*	_____	_____
Hardwood Parts and Shook	MBF	_____	_____
Softwood Parts and Shook	MBF	_____	_____
Other Wood Material:			
_____	_____	_____	_____

* Basis refers to the thickness of the material. *If the material you purchase does not match the basis shown, please indicate the basis you are using.*

4. **What species of LUMBER, CANTS, SHOOK and PARTS did your company use in the production of pallets and containers during 1991. What species do you expect to use in 1993?**
(Please indicate the percent of total volume (bd ft) for each species.)

Used in 1991		Expect to Use in 1993	
_____%	Oak	_____%	Oak
_____%	Yellow-poplar	_____%	Yellow-poplar
_____%	Alder	_____%	Alder
_____%	Mixed Hardwoods	_____%	Mixed Hardwoods
_____%	Other Hardwoods *Please specify:* _____	_____%	Other Hardwoods *Please specify:* _____
_____%	Southern Yellow Pine	_____%	Southern Yellow Pine
_____%	Other Softwoods *Please specify:* _____	_____%	Other Softwoods *Please specify:* _____
Total = 100%		Total = 100%	

5. **Where did your company obtain the HARDWOOD LUMBER it used in the manufacture of pallets and containers during 1991?**
(Please indicate the percent of total volume (bd ft) from each source. If your company does not use hardwood lumber, please skip this question.)

_____% Purchased directly from a Sawmill

_____% Purchased from a Lumber Wholesaler

_____% Purchased through a Lumber Broker

_____% Produced within the Company

_____% Other: _____

Total = 100%

6. **Where did your company obtain the SOFTWOOD LUMBER it used in the manufacture of pallets and containers during 1991?**
(Please indicate the percent of total volume (bd ft) from each source. If your company does not use softwood lumber, please skip this question.)

_____% Purchased directly from a Sawmill

_____% Purchased from a Lumber Wholesaler

_____% Purchased through a Lumber Broker

_____% Purchased from a Lumber Distributor

_____% Produced within the Company

_____% Other: _____

Total = 100%

7. **What was the total number of full time employees in your firm's pallet and container operations during 1991?**
(Please include yourself and all full-time production, maintenance, management, and sales employees: but exclude part-time employees.)

_____ Full-Time Employees

8. **How was your company's total 1991 sales (dollars) divided among the following products?**
(Please indicate the percentage in each category.)

_____% Expendable pallets

_____% Non-expendable pallets

_____% Skids

_____% Barrels

_____% Crates

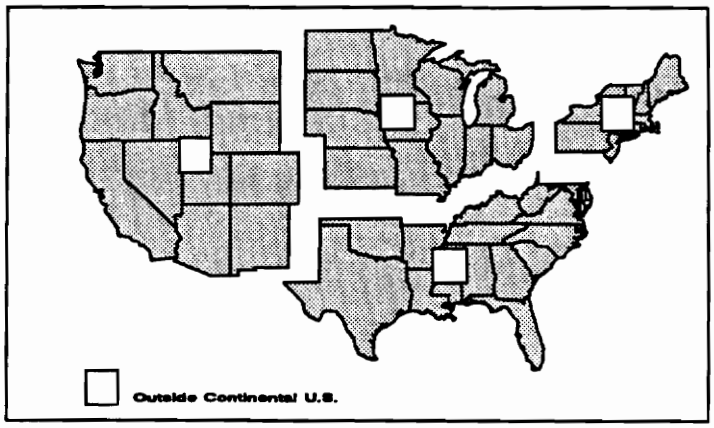
_____% Boxes

_____% Pallet Parts or Shook

_____% Other:_____

Total = 100%

9. **Where are the majority of your firm's pallet and container production facilities located?** (Please check only one region.)



10. **What was your company's total sales of pallets and containers in 1991?**

$_____

Thank you for your help.

Please fold (with the address on the back page showing), staple, and return. The postage is prepaid.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS MAIL PERMIT NO. 10 BLACKSBURG, VA

POSTAGE WILL BE PAID BY ADDRESSEE

VIRGINIA TECH
THOMAS M. BROOKS FOREST PRODUCTS CENTER
ATTN: JOHN CHRISTOFORO
PO BOX 850
BLACKSBURG VA 24063-9959

Fold Along Line

To return this questionnaire, just fold at the line and tape, with the return address showing. **Postage is prepaid.**

THANK YOU!

APPENDIX B

Cover Letter, Reminder, and Follow-up Letters

Cover Letter for First Survey Mailing

May 18, 1992

Contact Person
(Position Title)
Company Name
Street Address
City/Town, State Zip Code

Dear (Contact Person):

As a pallet and/or container producer, your company plays an important role in supporting your local economy. Unfortunately, few people recognize the importance of the pallet and container industry. Even U.S. government statistics underestimate the volumes of materials utilized and the number of persons employed within the industry.

The Center for Forest Products Marketing at Virginia Tech is working to remedy this situation. The enclosed questionnaire is part of a study that will demonstrate the importance of pallet and container producers in local and national economies. Our goal is to ensure that the pallet and container industry receives the consideration it deserves. In addition, improved understanding of the industry's material requirements will enable suppliers to better serve your needs.

We are asking for you to help by completing and returning the enclosed questionnaire. *As we can contact only a limited number of companies, your response is very important to the success of this study.* When answering, please include all your company's manufacturing locations.

Let me assure you that the information you provide will be held in strict confidence. The number on the questionnaire is for administrative purposes only and will allow us to remove your company from the mailing list upon receipt of your response. The published report will contain only group averages and totals. No information will be released about individual companies.

Thank you very much for your help. If you have any questions, please contact me at (703) 231-5876. If you like, we will provide you with a summary of the results. To request a copy, please write your name and address on the back cover of the survey, or request it under separate cover. Results should be available in the latter part of 1992.

Sincerely,

John Christoforo
Graduate Student
Center for Forest Products Marketing

First Follow-up Reminder (Postcard)

May 25, 1992

Dear Manufacturer:

We recently mailed you a questionnaire that asked about your company's use of wood materials. I would like to take this opportunity to encourage you to complete and return the survey. Your response is very important to our goal of showing suppliers how to better serve your industry and illustrating the importance of the pallet and container industry to local economies.

If you have already returned the questionnaire, please accept my sincere thanks. If you did not receive a survey, or have any questions, please contact me at (703) 231-7678 or FAX (703) 231-8868.

Thank you for your help,

John Christoforo
Graduate Student
Center for Forest Products Marketing

Cover Letter for Second Survey Mailing

June 8, 1992

Contact Person
(Position Title)
Company Name
Street Address
City/Town, State Zip Code

Dear (Contact Person):

Recently I mailed you a questionnaire that sought your help in demonstrating the importance of the pallet and container industry. The questionnaire is a part of a study that will aid the industry, allow suppliers to better serve your needs, and also allow me to finish my degree.

If you have completed the questionnaire, please accept my thanks. If not, I would like to encourage you to complete and return it as soon as is convenient. We can contact only a limited number of companies so your response is very important. Of course, all information is strictly confidential and we will only report group averages. Return postage is prepaid.

Several companies have asked how recycled pallet material should be reported. Please report any recycled material under the "other" category in question three. Some companies have also been concerned about their small size. Responses from small companies are greatly needed since they make up a significant part of the industry. If your company does not produce pallets, containers, skids, boxes, or crates, please check "no" for question one and return the questionnaire in order for us to identify misclassifications in our records.

If you would like a summary of the study results, please write your name on the last page of the survey or send it separately. Results should be available in the latter part of 1992.

I would be happy to answer any questions you might have about the study. Please contact me at (703) 231-5876 or FAX at (703) 231-5876. Thank you again for your help.

Sincerely,

John Christoforo
Graduate Student
Center for Forest Products Marketing

P.S. Please accept the enclosed bookmark as a small token of our appreciation for your time and effort.

Final Follow-up Letter

June 22, 1992

Contact Person
(Position Title)
Company Name
Street Address
City/Town, State Zip Code

Dear (Contact Person):

Please Help!

I am writing to you about our survey concerning wood materials use in the pallet and container industry. As of today, we have not received your completed questionnaire. I cannot express how important your response is to the accuracy of the results and also, as a graduate student, to fulfilling my degree requirements. Your help would be greatly appreciated!

I would also like to re-emphasize that your answers will be held in strict confidence and will be used only in combination with surveys from many other firms. If your company does not produce any of the products listed on the first page of the survey, please check "No" for question #1 and return the questionnaire so that we may correct this misclassification.

If you would like to receive a copy of the survey results, just write your name and address on the blank page at the end of the survey, or request it under separate cover. Results should be available in the latter part of 1992.

Thank you in advance for your contribution to the success of this study. If you have any questions or need a replacement survey, please contact me at (703) 231-5876 or FAX (703) 231-8868.

Sincerely,

John Christoforo
Graduate Student
Center for Forest Products Marketing

P. S. Please report your usage of recycled materials, if any, under the "Other" categories.

Vita

John C. Christoforo, son of John R. Christoforo and Jean R. Kenney, was born on July 5, 1967 in Boston, Massachusetts. In 1985, he graduated from Medford Vocational Technical High School, having studied electrical theory and practice. In May of 1990, he graduated from the University of Massachusetts at Amherst with a Bachelor of Science in Wood Science and Technology, with concentration in Building Materials Technology and Management. In the fall of 1991, Mr. Christoforo enrolled at Virginia Polytechnic Institute and State University to pursue a Master of Science degree in the department of Wood Science and Forest Products, specializing in Forest Products Marketing. Mr. Christoforo will receive a Master of Science degree in May of 1993.