

**A MARKET ASSESSMENT OF THE POTENTIAL FOR OSB  
PRODUCTS IN THE NORTH AMERICAN OFFICE FURNITURE  
AND DOOR MANUFACTURING INDUSTRIES**

by

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B.Sc., The University of British Columbia, 1997

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF  
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

Faculty of Forestry

We accept this thesis as conforming  
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

June 2001

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## **Abstract**

A market study was conducted on the potential for OSB products in the North American office furniture and door manufacturing sectors. It is hoped that the information gathered in this study will aid OSB manufacturers in improving their market situation within the industrial sector. This study also provides OSB manufacturers with some recommendations for marketing strategies to help them improve their product's market position within this highly competitive market.

A list of 973 door and 894 office furniture manufacturers across North America were selected using simple random sampling. The adjusted response rate for office furniture and door manufacturers combined gave an outcome of 11.86%. Although this response rate is slightly on the low side, it is sufficient to make inferences onto the population. The two surveys were divided into four main sections: 1) Company Information; 2) Material Used in Doors/Office Furniture; 3) Wood Panels Use in Door/Office Furniture; 4) OSB Use in Door/Office Furniture Manufacturing. Although the focus of this study was to find industrial manufacturers' level of awareness, perception, and use of OSB products, for the sake of comparison, some steps were taken to gather information on competing products, as well.

Results of this study clearly show that office furniture manufacturers have higher consumption rates and knowledge of wood-based panel products compared to door manufacturers. On the other hand, door manufacturers seem to have more acceptance of solid wood products over wood-based panel products. The study showed that OSB's market share within the office furniture and door sector was fairly low. There are two possible explanations for this outcome. The first includes industrial manufacturers' low familiarity with OSB products. More than half of the respondents indicated that they had no familiarity with OSB products and its attributes. For those familiar with OSB products, technical problems (please refer to result section) was the main reason for not using the product. Some recommendations have been made to OSB manufacturers in terms of strategies to use to enhance OSB's market position within the industrial marketplace. These include emphasizing on OSB's strengths and improving its technical problems, stabilizing OSB prices, forming partnership with industrial manufacturers and displaying the final products in trade shows and show rooms.

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## Acknowledgments

I like to thank the following for their support, guidance, and assistance throughout this journey:

- the research sponsor, Ainsworth Lumber Company, Ltd., for their kindness and support;
- office furniture and door manufacturers across North America, who took the time to fill out these surveys;
- to my supervisors, Drs. Robert Kozak & David Cohen, for all their help and guidance.
- to my committee members, and advisors for their guidance.
- to my family for their life long support.
- my friends and colleagues for their support.

This thesis is dedicated to my mother: Atefeh Raouf

# Chapter 1

## Introduction

### *1.1 What is Oriented Strand Board (OSB)?*

OSB is the descendant of waferboard, a nonstructural panel. However, in the case of OSB, great improvements have been made to its structural properties by orienting the strands or core flakes at right angles to the surface layers. This type of orientation gives OSB its strength, stiffness, and dimensional stability. As a result, the strength of OSB is much greater than that of waferboard.

OSB is an engineered structural panel made by processing tree species such as aspen, poplar, and southern yellow pine. One of the inherent advantages in OSB is in the use of low quality tree species such as aspen, which were once burned as weeds. OSB uses 85 – 90% of the harvested log, with very little waste material (G&M Enterprises, LLC, 1998). Although OSB does generate some wood residues in debarking and trimming, this is kept at a minimum in most plants. Another advantage of OSB is its environmental friendliness, since it is bonded with fully waterproof resins such as urea-formaldehyde and phenol-formaldehyde. These adhesives usually emit very little formaldehyde into the atmosphere when fully cured. However, the biggest advantage of OSB products over other competing products is its low price.

Today, the majority of OSB panels produced are used as sheathing material in home construction. However, with the increase in OSB production in North America, new potential markets need to be explored. After an in-depth interview with key marketing personnel at Ainsworth Lumber Company, Ltd., the research sponsor, two large industrial markets were chosen for further study, office furniture and doors

The main objective of this study was to gain a better understanding of North American wooden office furniture and door manufacturers' perceptions, awareness and extent of use of OSB products. It is believed that, this in turn will help OSB manufacturers better position their product to compete with materials like plywood, MDF, particleboard, hardboard, etc.

## 1.2 Traditional End Uses for OSB – The Housing Market

The perpendicular alignment of strands gives OSB panels excellent mechanical properties (strength and stiffness) and physical properties (dimensional stability) in the direction of alignment (Forintek Canada Corp., 1998). Thus, OSB can substitute plywood in most applications. In North America, OSB has gained extensive market acceptance since the early 1980s, mainly in house sheathing applications. A survey concluded in 1995 by the North American Home Builders Research Center showed that approximately 97% of all the OSB products used in new residential construction was used in sheathing applications, while only 3% was used in millwork (NAHB, 1996). The following describes each of the major applications for OSB products in the sheathing industry:

1. *Roof sheathing*: It is extremely important for roofs to withstand heavy snow and wind loads. OSB used in this application can protect homes for many years against unpredictable environmental conditions (Structural Board Association, 1996).
2. *Wall Sheathing*: In order to ensure a strong wood frame structure, it is essential to have a rigid wall system. OSB's strength provides good support and fire resistance. Additionally, it is a highly workable panel. OSB products are easy to saw, drill, nail, sand, paint, and glue (Structural Board Association, 1996).
3. *Floor Sheathing*: OSB panels are flat and very stiff, which make them ideal for flooring. They have excellent resistance to handling heavy loads and work well as material for subfloors (Structural Board Association, 1996).
4. *Underlayment*: OSB underlayment is a specialty product, which provides a fairly smooth surface and a uniform base to work with. However, there are still some concerns as OSB tends to cause what is known as "telegraphing" (Structural Board Association, 1996). Telegraphing occurs as a result of the irregular expansion and shrinkage of the variably shaped wood chips under the overlay as moisture changes, causing irregularities on the surface (personal communication, Zhaozhen 1999).

Figure 1.1 provides a summary of the proportion (by volume) of OSB products used in various home sheathing applications in the United States. By far, the most common sheathing application was for roofs at 53% (taking into consideration the total amount of OSB used in both single-family detached and multifamily new housing construction). An equal proportion of OSB is used for wall sheathing and floor sheathing, each at 23% of

the total volume. The least common sheathing application for OSB was in underlayment at 1% (NAHB, 1996).

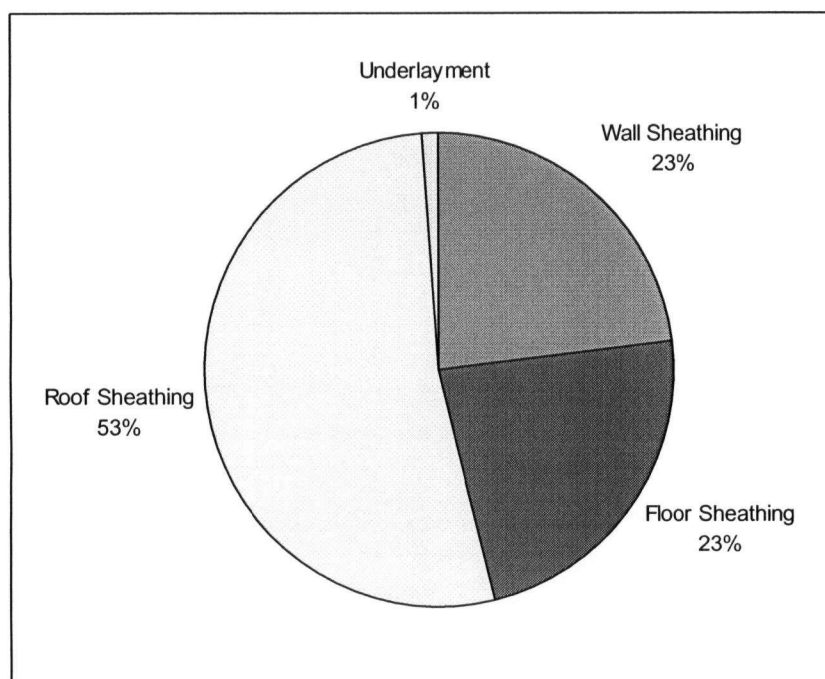


Figure 1.1: The proportion of OSB use in four different types of sheathing applications.  
(Source: NAHB, 1996)

### ***1.3 Emerging End Uses for OSB – Industrial Markets***

OSB is just now being introduced into various industrial markets. Statistics Canada classifies these industries into groups which share similar characteristics, defined by (SIC) Standard Industrial Classification Systems. The five major industrial groups categorized by APA – the engineered wood association are:

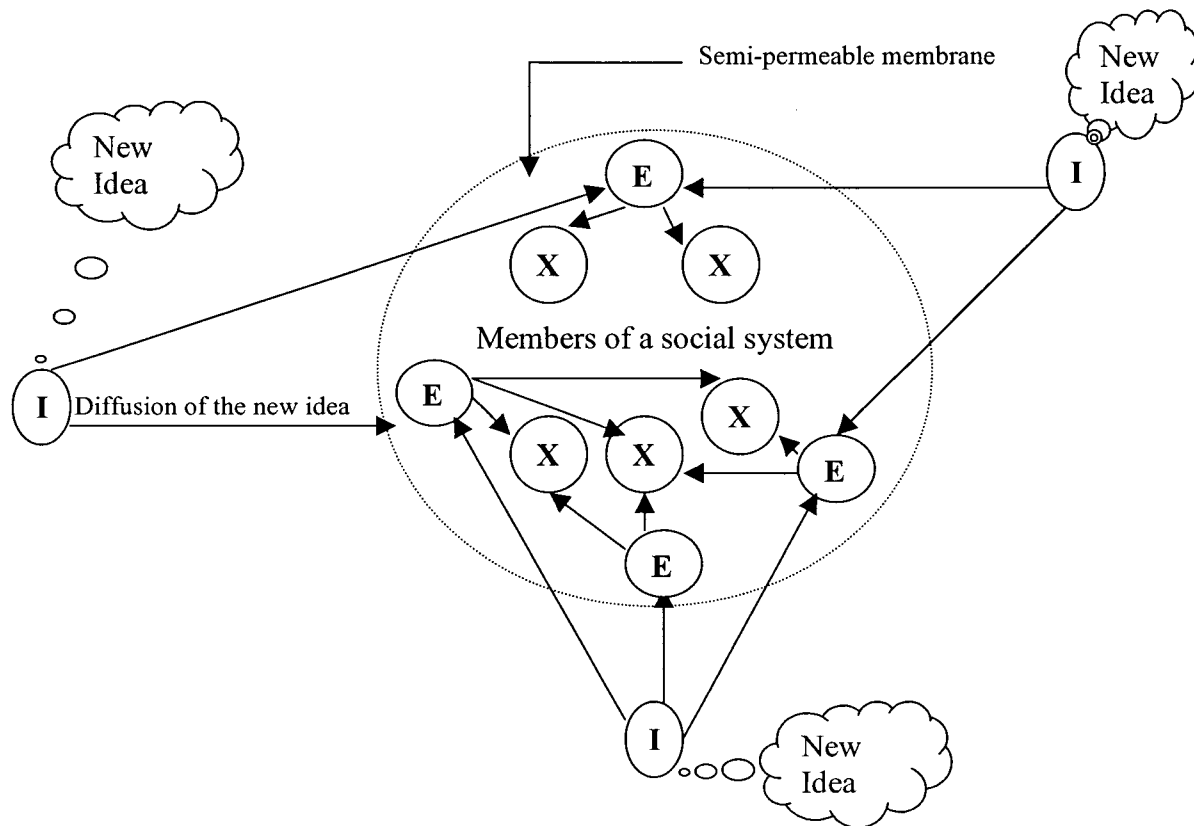
- furniture group
- transportation group
- wood products group
- manufactured materials handling group
- low incidence industries

More research and development is required in this area to improve OSB's market share and initiate its growth phase. Currently, there are few industrial manufacturers using OSB in their product lines. Pacific Frame is one such company which uses OSB in



its bed frames. Global Group is another company that uses OSB in its office furniture line. OSB's strengths (Module Of Elasticity and Module Of Rupture) make it ideally suited for use in applications such as furniture framing, shelving, and cabinet furniture, where load handling is of primary importance. OSB is also suitable for use in various door applications including door cores, door rails and stiles.

One of the reasons why OSB has not yet made inroads into the industrial market may be due to industrial manufacturers' low familiarity with OSB. Companies currently using OSB can be characterized as innovative companies interested in experimenting with new products. Research has shown that larger firms with greater access to resources, capital markets and human resources tend to be more prepared for process innovation than smaller firms (West et al., 1992). In order for OSB manufacturers to increase their market share in industrial markets and increase their competitiveness, they may need to rely on the experiences of innovators and early adopters. Figure 1.2 summarizes the diffusion process of a new idea within a community or a social system. This model can be readily transposed to an industrial company considering the use of a new product or component (West et al., 1992).



**Figure 1.2: The process of diffusion of new ideas within communities or a social systems.**

**Note: I = Innovators**

**E = Early Adopters**

**X = Early Majority, Late Majority, Laggards**

### ***1.3.1 Advantages and Disadvantages of OSB Use in Industrial Applications***

In order for OSB to be successful in various industrial applications, it must compete with a number of panel products (structural and non-structural) such as plywood, MDF and particleboard. Both MDF and particleboard are less expensive than OSB, making them more attractive to industrial manufacturers. However, it is predicted that in the near future the price of OSB should drop significantly. Perhaps the main reason being the excess production, which will swamp the market in the near future. However, it is hard to predict how long this trend will continue. One of the main disadvantages of OSB is that, as a commodity product, its price is unstable and varies depending on daily demand. Figure 1.3 shows the average annual price of plywood (southern yellow pine), OSB, MDF and particleboard for the years 1998 and 1999 and also the predictions for years 2000 to 2004 (Wood Markets 2000).

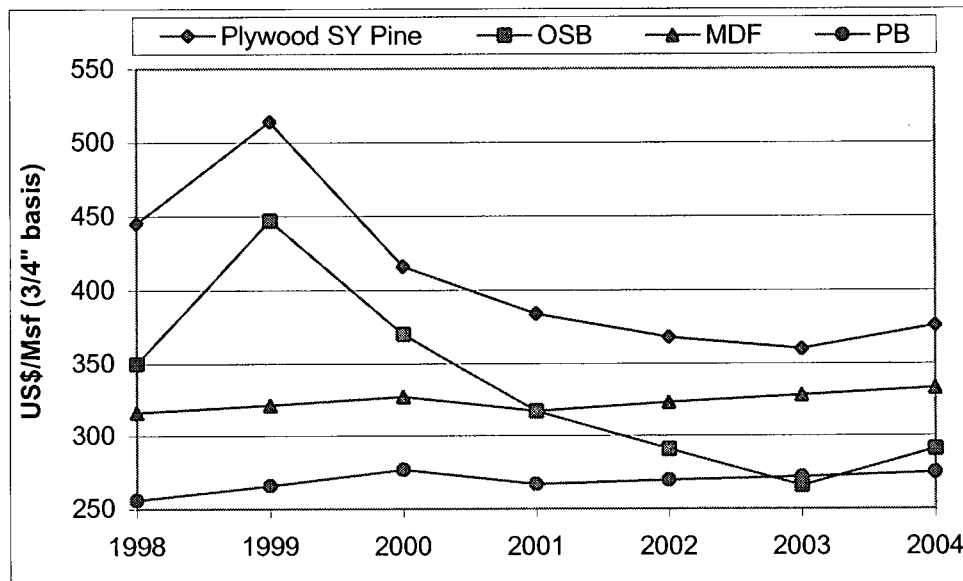


Figure 1.3: Average price for southern yellow pine plywood, OSB, MDF, and PB for 1998 – 2000.  
(Source: Wood Markets 2000)

Another potential drawback to OSB use in industrial markets could be due to manufacturers' perceptions that it does not have a tight edge compared to other panels and therefore can not be intricately machined. Furthermore, some manufacturers may feel that OSB needs improved moisture resistance (it has been shown that OSB edges tend to swell to a greater extent than plywood if not properly protected). Ways of solving this problem include edge-coating the OSB panel with a waterproof sealer to reduce the amount of edge swelling or protecting the edges with edge banding - the process of covering the edges of manufactured panel products with lumber banding, veneer tape, or plastic laminates (Umstattd, 1996).

Another advantage of MDF, particleboard and softwood plywood over OSB is that each has a much smoother surface. The major problem with OSB is that its surface telegraphs. These rough surface and dimensional instability problems could hamper OSB from being used in industrial applications like furniture and door production. As a result, in order to be used in such industrial applications, OSB must be further processed. Perhaps, this can be accomplished by surface sanding or laminating either wood veneer or other types of laminates to the faces.

Although OSB does have its disadvantages, it also has some important advantages that counterbalance them. Perhaps one of the most important advantages of OSB over other competing panels in the market is its load handling capability. MDF and particleboard both require an extensive amount of bracing to serve as supports in products like furniture

and cabinetry. Virtually no bracing is required for OSB and it has much less “creep” (deformation over a period of time due to the stress of heavy loads) than either nonstructural panel. Lastly, there tends to be a lower reject rate for industrial products made with OSB compared to MDF and particleboard due to its higher strength in load bearing situations (personal communication, Magnuson, 1999).

### ***1.3.2 Some Current Uses of OSB in Industrial Markets***

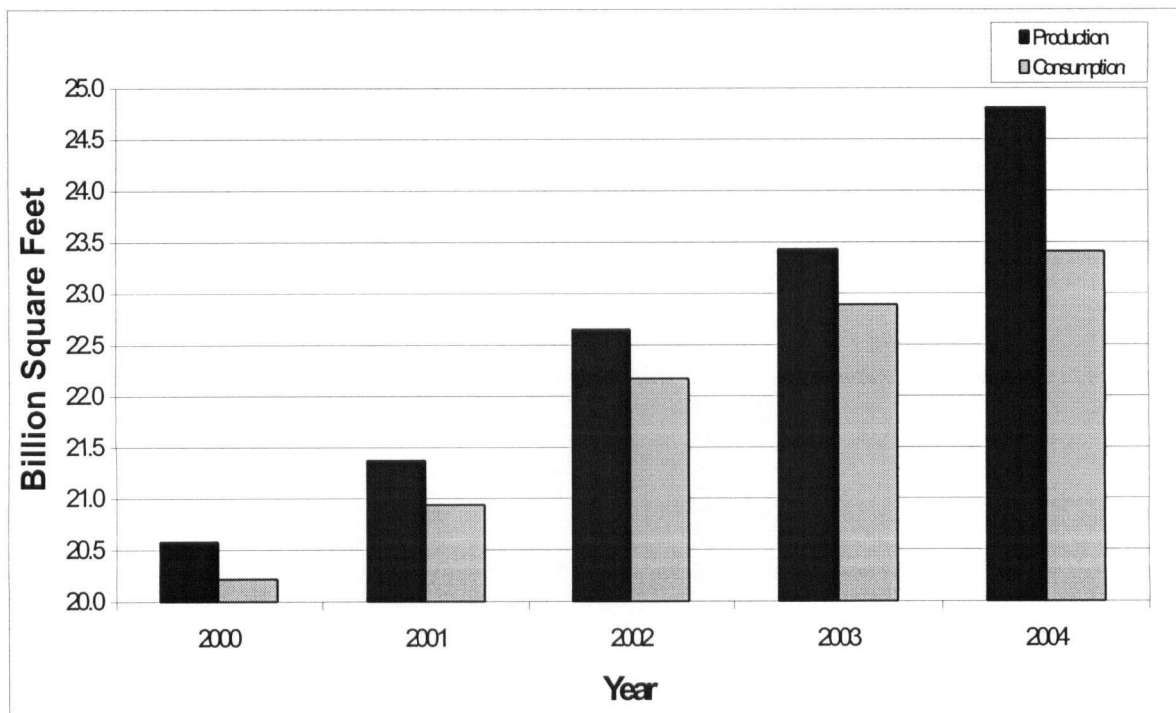
Currently, OSB is being used industrially as substrates for table and desk tops, laminated with plastic sheets or overlays. In order for OSB to make further inroads into industrial markets, the first step might be to improve its surface characteristics and dimensional stability, even if it comes at the cost of lowering some of OSB’s strength properties. Perhaps then, OSB would be more frequently used in applications like cabinetry and furniture, given that a proper surface lamination or treatment is provided (Personal Communication Zhaozhen, 1999). At present, many companies are trying their best to improve the surface characteristics of OSB by extensively sanding the surface to make it as smooth as possible. For example, some companies sell manufacturers well-sanded OSB panels. OSB’s moisture resistance can also be improved by using interior-type resin binders along with small amounts of wax (Structural Board Association, 1996).

Board suppliers brought OSB into the office furniture sector in the late 1980’s as a means of providing additional strength to the work surfaces used in offices. One such firm, the Haworth Company, no longer uses OSB in their furniture products for two major reasons: 1) OSB is expensive compared to other panels such as MDF and particleboard; and 2) larger wafers have the tendency to telegraph through some of the laminates. As a result, additional manufacturing processes, such as surface sanding or applying high pressure laminates (HPLs), is essential. In response to the problems that they were experiencing with OSB, the Haworth Company co-developed a new material, Novospan, which is a hybrid of OSB and particleboard (personal communication, Dutmers, 1999).

## ***1.4 Markets for Structural Panels***

According to data gathered in 1999, there was an even split in the quantity of OSB and plywood manufactured in North America annually (Wood Markets 2000). However, as illustrated in Figure 1.3, it is projected that OSB production will increase from its current

20.4 BSF to 24.8 BSF by 2004. Plywood production is projected to decrease from 20.3 BSF to 17.5 BSF in the same period of time. There are 10 new OSB mills expected to be built between 2000 to 2003, four of which will be in the US South, another two in Eastern Canada and the remaining four in Western Canada. This will result in an estimated increased production of 1.5 BSF per year for the next three years. The excess capacity of OSB in North America will force production capacity rates down from 97% in 1999 to as low as 85% within the next few years (Wood Markets 2000). Production capacity refers to the total volume of a product that a company is capable of manufacturing if operating at 100% of its capacity.



**Figure 1.4: North American production versus consumption from 2000 to 2004.**  
Source: Wood Markets 2000

According to Table 1.1, currently, more than 65% of the total volume of OSB produced in North America is used in home construction. In the case of softwood plywood, only 35% of the total volumes manufactured is used in home construction.

	<b>OSB</b>	<b>SOFTWOOD PLYWOOD</b>
<b>Residential</b>	65%	35%
<b>Remodeling</b>	19%	28%
<b>Non-residential</b>	10%	10%
<b>Industrial</b>	4%	19%
<b>Export</b>	2%	8%
<b>Total</b>	100%	100%

**Table 1.1: End uses of structural panels**  
**Source: Wood markets 2000**

In the future, any slow down in growth of housing starts could prove to be detrimental to OSB manufacturers who rely heavily on this market alone. To ensure future successes, OSB manufacturers need to view their products as more than just a commodity building material. To survive in this extremely competitive market, they need to carefully consider other potential opportunities and strategies. This may include exploring overseas markets like Europe and Asia where OSB is still not widely used. Another option would be to rely less on commodity markets and focus more on industrial or specialty markets. This is one logical option that has been explored to some degree by plywood manufacturers, but not to the same degree by OSB producers. Many researchers today argue that plywood has already passed its maturity stage and is now in the decline stage of its life cycle (Wood Markets 2000). If one looks closely at the sheathing industry, OSB has taken away much of the plywood residential sheathing market share due largely to lower costs. However, in the industrial market, plywood specialty producers have been much more successful than OSB manufacturers.

Currently, only 4% of the OSB manufactured in North America is being consumed within the industrial market compared to 19% for softwood plywood products (Wood Markets 2000). According to the latest survey results gathered by APA – The Engineered Wood Association in 1998, the total volume of structural panels used within the United States industrial market was 6.2 BSF – 3/8” basis, with softwood plywood making up 94% of the total and OSB the remaining 6% (1999). In order to ensure future successes within industrial markets, OSB manufacturers should consider competing directly in these markets with plywood as well as with non-structural panels like MDF and particleboard.

## Chapter 2

### Market Trends In The Industrial Sector

Today, there is a growing demand for high quality wood products in industrial markets. However, as access to old growth timber decreases, manufacturers are relying more heavily on wood-based panels as substitutes for solid wood products. Currently, much of the harvested timber from second growth forests are of small diameters and low quality. Fortunately, recent advancements in technology have allowed manufacturers to bring engineered structural wood-based panels into the market to replace solid lumber. OSB and softwood plywood are excellent products for use in industrial applications where strength is critical. They also out-perform both MDF and particleboard, because they are structural products and do not require much bracing for support. One advantage of OSB over softwood plywood is that it uses low quality logs of small diameter, yet the finished product is of similar strength (Crow's, August 1998).

In the 1980s, plywood manufacturers began looking more closely at industrial markets for two main reasons. First, reduced access to public lands and higher quality wood veneers made it very difficult for plywood manufacturers to compete in the residential home sheathing market. As a result, plywood manufacturers were forced to look more closely at value-added markets within the industrial sector. Second, demand for OSB sheathing (a lower cost substitute) was growing substantially, forcing many plywood mills to either shut down permanently or move away from the large sheathing market. As a result, in the late 1980s, many plywood manufacturers began investing in new equipment geared toward processing panels for industrial use. With OSB maintaining its dominant share of the sheathing market, many manufacturers are now beginning to explore other potential markets such as industrial markets (Wood Markets 2000). In the near future, OSB manufacturers will face stiff competition from manufacturers of plywood, nonstructural wood-based panels (MDF, particleboard, hardboard, and the new generation of "strawboard" panels) and other non-wood products (mainly aluminum, steel, vinyl and plastic products), within the industrial market.

Educating industrial manufacturers on the benefits of using OSB should shorten the introductory phase and help initiate its growth phase more rapidly. It is also essential for companies to invest in research and development to improve their product lines and ensure successes in the marketplace. As a result, a detailed market study was seen as an

essential first step toward discovering the extent of acceptability and awareness of OSB by industrial manufacturers. Also, a survey of this nature was believed to help benefit both OSB manufacturers and industrial manufacturers who use OSB in their product lines. Therefore, project sponsors felt the need for an in-depth market study to shed some light on areas where OSB has strengths and, likewise, where improvements are needed to better meet the needs of industrial manufacturers that currently do not use OSB.

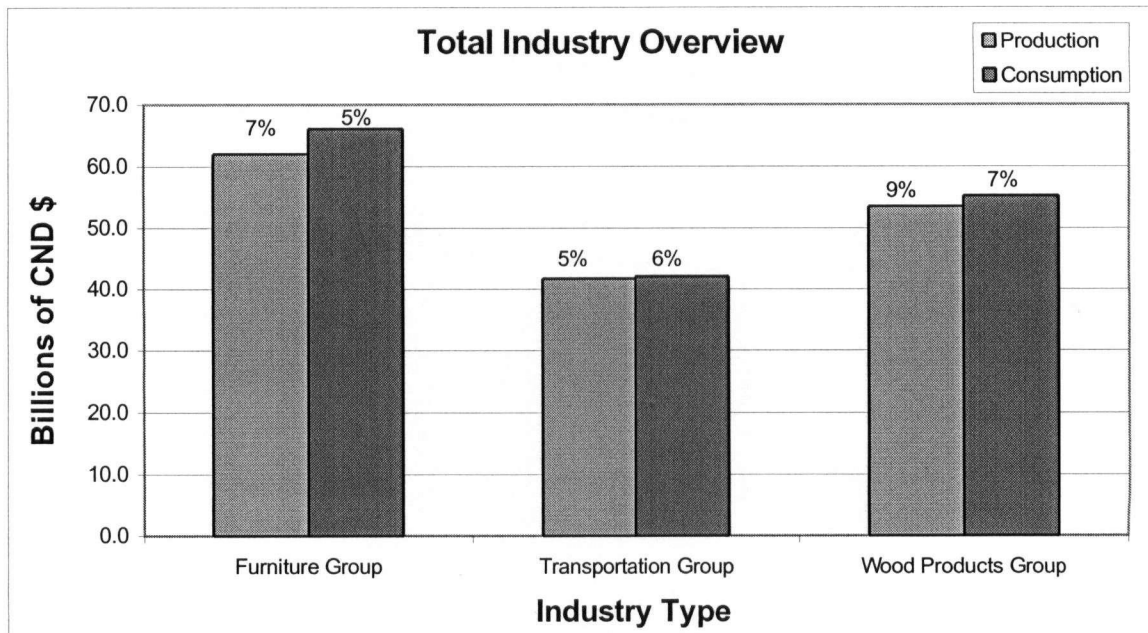
### ***2.1 Overview of Industrial markets:***

Industrial markets can be segmented into five groups (APA – the Engineered Wood Association, 1999):

- furniture
- transportation
- wood products
- manufactured materials handling
- low incidence industries

The last group consists of companies using relatively small volumes of structural panels and is very segmented, making it difficult to estimate its market size. The three largest groups are the furniture group, the transportation group and the wood products group. Figure 2.1 shows the North American market size for these three groups with respect to annual production and consumption (measured in billions of Canadian dollars). Also, at the top of each bar graph is Canada's relative contribution to each total.





**Figure 2.1: North American market size for the furniture, transportation and wood products groups.**  
(Source: Industry Canada, 1998)

The furniture group includes *the Wooden Household Furniture Industry (SIC 2611), the Upholstered Household Furniture Industry (SIC 2612), Other Office Furniture Industries (SIC 2649), the Bed Spring and Mattress Industry (SIC 2691), Hotel, Restaurant and Institutional Furniture and Fixture Industries (SIC 2692), and Other Furniture and Fixture Industries not elsewhere classified (SIC 2699)*. Establishments primarily engaged in manufacturing furniture with materials other than wood (*i.e. SIC 2619*), were not included. In the transportation group, extra effort was taken to include only those industries that use wood as a component material. These industries include *the Truck and Bus Body Industry (SIC 3241), the Commercial Trailer Industry (SIC 3242), the Non-Commercial Trailer Industry (SIC 3243), the Mobile Home Industry (SIC 3244), and the Shipbuilding and Repair Industry (SIC 3271)*. The wood products group includes *the Prefabricated Wooden Building Industry (SIC 2541), the Wood Kitchen Cabinet and Bathroom Vanity Industry (SIC 2542), the Wooden Door and Window Industry (SIC 2543), Other Millwork Industries (SIC 2549), the Wooden Box and Pallet Industry (SIC 2561), the Coffin and Casket Industry (SIC 2581), and Other Wood Industries not elsewhere classified (SIC 2599)*.

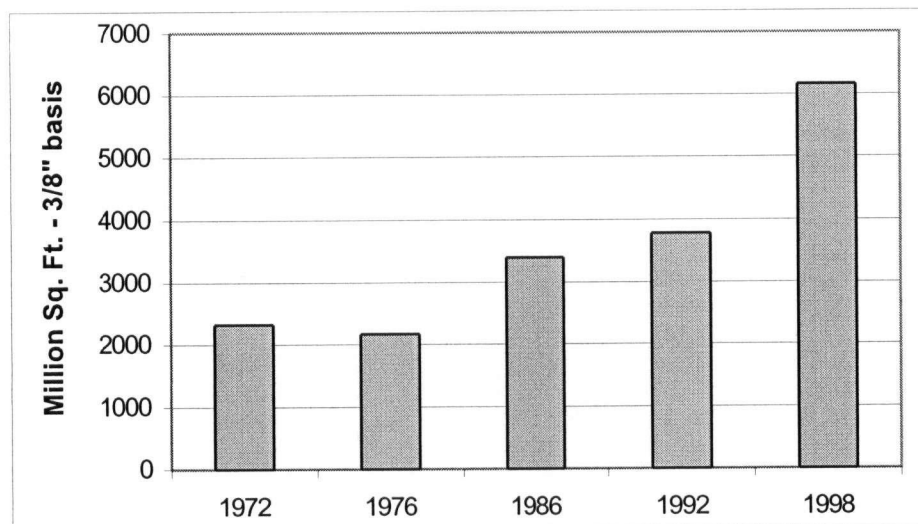
In North America, the furniture group was the largest industrial market with annual production valued at over \$CDN 60 billion. This was followed by the wood products group with an annual production valued at over \$CDN 50 billion and, lastly the

transportation group with an annual production valued at approximately \$CDN 40 billion. Again, it should be noted that all groups have been redefined to include only those industries that use wood as a component material.

## ***2.2 Industrial Structural Panel Usage by Industry Type***

In 1998, the APA – Engineered Wood Association initiated a two-year study of U.S. industrial markets to update a previous 1992 study. As illustrated in Figure 2.2, the total volume of structural panels (OSB & softwood plywood) used by industrial manufacturers in 1992 was 3.8 BSF (3/8" basis). By 1998, this volume had increased 63% to 6.2 BSF (3/8" basis), with plywood accounting for 94% of this share and OSB accounting for the remaining 6%. This volume represents approximately 18% of the total U.S. demand for structural panels (APA – the Engineered Wood Association, 1999).

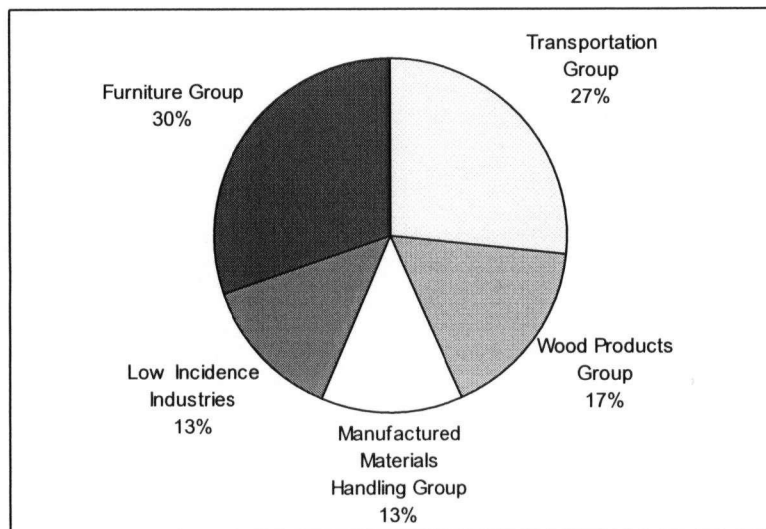
With both plywood and OSB manufacturers continually improving their product lines and coming up with new product applications, the future outlook for structural panels within the industrial market is very promising. In 1998, the total demand for industrial structural panel products was approximately three times higher than in 1972 (APA – the Engineered Wood Association, 1999).



**Figure 2.2: Historical usage of structural panels by the U.S. industrial sector.**  
(Source: APA – the Engineered Wood Association, 1999)

Figure 2.3 shows that the furniture group was the largest industrial consumer of structural panels in the United States in 1998, with an annual consumption of 1.873 BSF

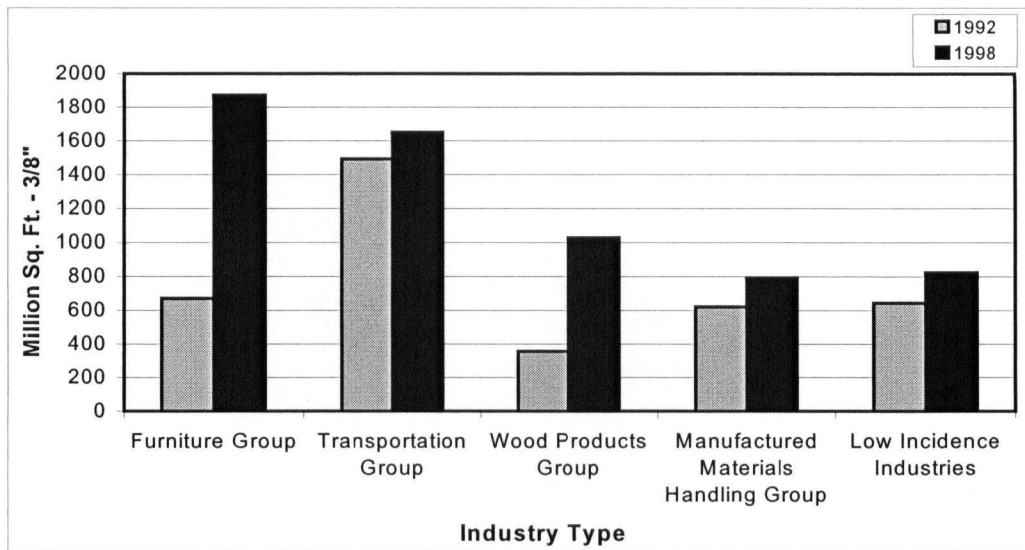
(30.38%). This was followed by the transportation group at 1.650 BSF (26.76%), and the wood products group at 1.027 BSF (16.66%). The two groups that used the least were the low incidence industries and the manufactured materials handling group, with annual consumptions of 0.824 BSF (13.36%) and 0.792 BSF (12.84%), respectively (APA – the Engineered Wood Association, 1999).



**Figure 2.3: 1998 structural panel use (%) by industry type.**  
(Source: APA – the Engineered Wood Association, 1999)

As illustrated in Figure 2.4, the total volume of structural panels consumed by all industrial manufacturers increased significantly from 1992 to 1998. The two groups with the most significant increases in structural panel use during this period were the furniture and wood products groups. The consumption rate for the furniture groups increased by 179% (from 0.671 to 1.873 BSF – 3/8" basis) during this six year period. The wood products group, which includes industries such as millwork and wood kitchen cabinets, increased their structural panel consumption rate by 189% (from 0.356 to 1.027 BSF – 3/8" basis) (APA – the Engineered Wood Association, 1999).

This data suggests that there is a growing market for structural panels in the industrial sector. Continued market research is essential for better understanding the marketplace and maintaining this rate of growth in the future.



**Figure 2.4: Volume of structural panels used by various U.S. industrial groups in 1992 and 1998.**  
(Source: APA – the Engineered Wood Association, 1999)

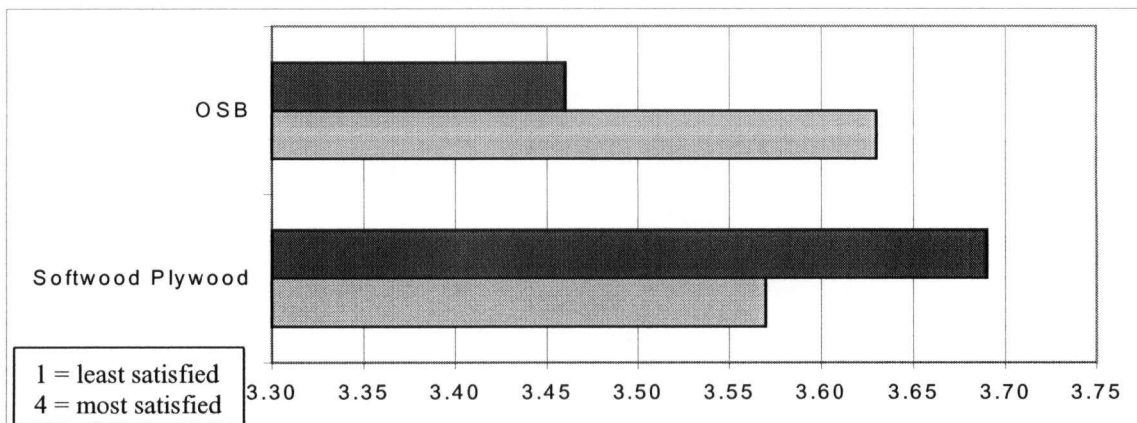
### ***2.3 Industrial Manufacturers' Attitudes towards the Use of Structural Panels***

In 1998, the APA – the Engineered Wood Association conducted a concurrent survey of industrial manufacturers to better understand their attitudes and concerns toward the use of various structural panels and to determine the degree of satisfaction with final products made from structural panels. Respondents (882 in total) were asked to express their levels of satisfaction with respect to product performance of softwood plywood, hardwood plywood and OSB, with 1 being the lowest rating (least satisfied) and 4 being the highest (most satisfied). Results, summarized in Table 2.1, show that hardwood plywood scored highest, on average, exceeding both OSB and softwood plywood. However, it should be noted that OSB scored highest in the furniture category and also outperformed softwood plywood for all categories taken together. This finding is significant because the furniture group consists of manufacturers consuming the highest quantity of structural panels. Indeed, this is a promising result for OSB manufacturers seeking opportunities to increase their market share within the North American furniture sector (APA – the Engineered Wood Association, 1999).

<b>Average Product Performance (1 = Least Satisfied; 4 = Most Satisfied)</b>						
	Furniture	Transportation	Wood Products	Material Handling	Low Incidence Industries	Total
Softwood Plywood	3.63	3.45	3.35	3.76	3.64	<b>3.57</b>
OSB	3.90	3.59	3.33	3.59	3.60	<b>3.63</b>
Hardwood Plywood	3.79	3.64	3.64	3.60	3.74	<b>3.72</b>

**Table 2.1: The degree of satisfaction of industrial manufacturers with various structural panel types**  
(Source: APA – the Engineered Wood Association, 1999)

In a previous survey by APA – the Engineered Wood Association (1992), a similar question was asked of industrial manufacturers using softwood plywood and OSB. Figure 2.5 summarizes these together with the 1998 results for OSB and softwood plywood. The general level of satisfaction for OSB increased from 1992 to 1998 from 3.46 to 3.63, on average. Conversely, users of softwood plywood showed a drop in their satisfaction level from 3.69 to 3.57 in the same period. As manufacturers become more familiar with the attributes and benefits of using OSB in their product lines, these consumption rates should continue to improve. This should eventually move OSB from the introductory phase into the growth phase of its life cycle within industrial markets (APA – the Engineered Wood Association, 1999).



**Figure 2.5: Satisfaction level of industrial manufacturers with OSB and softwood plywood (1992 & 1998).**  
(Source: APA – the Engineered Wood Association, 1999)

In early 1999, the APA – the Engineered Wood Association, extended its 1998 study to determine whether industrial users were more inclined to switch to or away from structural panels. Of the furniture manufacturers that responded, 58% had never considered switching away from structural panels to an alternative product. Fourteen percent of the softwood plywood users had considered using an alternative product, and only 1% of the OSB users had considered switching to an alternative product. The

remaining 27% expressed no opinions on this matter. These results indicate that the majority of industrial structural panel users, especially OSB users, are content with the general performance of the components currently in place, and will likely continue to use them in future (APA – the Engineered Wood Association, 1999).

#### ***2.4 Two Key Industrial Markets for Wood Panel Producers***

As shown in the previous section, industrial consumption of composite panels is growing rapidly. Industrial panels such as particleboard, MDF, and plywood are widely used in the manufacture of furniture, door parts and other industrial applications such as cabinets, millwork, molding, floor underlayment, laminate flooring, etc. (Wu et. al, 2000). In 1997, total panel usage in these industry segments was approximately 4.49 billion ft<sup>2</sup>, accounting for nearly 60% of industrial panel consumption in the U.S. and Canada. Furniture manufacturers accounted for most of the panel use, followed by cabinets, doors, and display fixture industries, respectively (Wu et al., 2000). In the furniture industry, particleboard was the most commonly used panel product, whereas MDF was usually used in producing mouldings, millwork, display fixtures, and furniture. The study found that nearly half of the total value of raw materials used by southern U.S. furniture and cabinet manufacturers in 1997 was comprised of particleboard, MDF, and plywood (Wu et al., 2000). The main reason for respondents' use of composite panels was good economic value, while the main reason for not using composite panels was due to customer objection (the authors used the term "customer objection" in a very broad sense, referring to all of the attributes of composite panels taken as a whole). With the continual increase in population and decrease in high quality timber supply, a continual shift toward composite panels in these industries is thought to be inevitable (Wu et al., 2000).

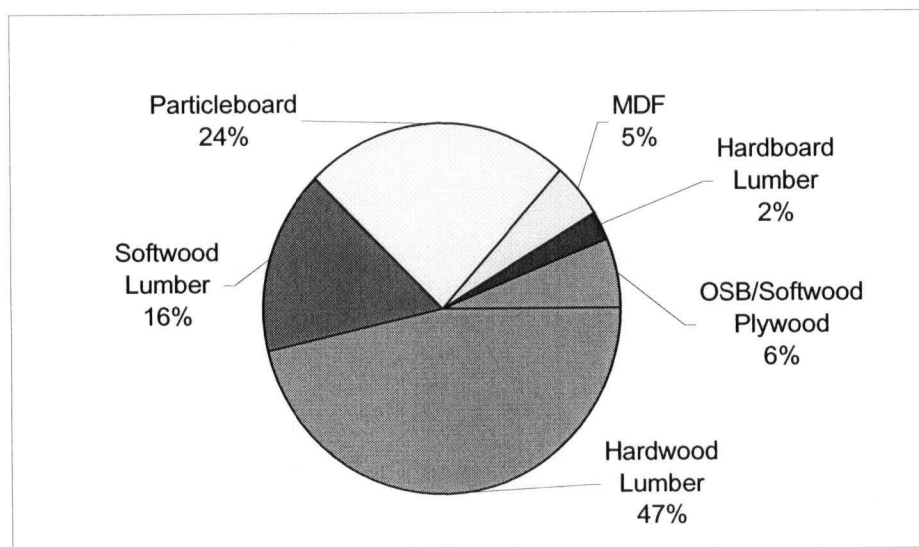
Based on review of literature and discussions with the industry sponsor, two markets were selected for this study: 1) office furniture and 2) doors. There is high growth potential in both of these sectors. As previously mentioned, the wood furniture market was the largest industrial market in North America, with an annual production valued at \$CDN 60 billion. Currently, there is a high volume of wood-based panels (i.e. particleboard, MDF, plywood) being used by furniture manufacturers in North America. This is a good indication that many furniture manufacturers are familiar with wood-based

panels and have first-hand experience with these products. Therefore, they could be more readily acceptable to the use of new wood-based panels.

The total production in the North American door and window industry is valued at \$17.28 billion (Industry Canada, 1998). This too is a large industry and demands serious consideration by new wood-based panel manufacturers. Currently, there is a considerably high volume of wood products used by door manufacturers (see next section). As such, it should be easier for new wood-based panel producers to penetrate this market. Both the office furniture and door markets will be discussed in detail in the following sections.

#### ***2.4.1 The North American Furniture Manufacturing Sector***

A survey of wood household, upholstered, and wood office furniture manufacturers was conducted in the U.S. to assess the total volume of wood products used in 1990 and to make predictions for 1991 and 1992 (Forbes et al., 1993). According to Figure 2.6, hardwood & softwood lumber together accounted for approximately 63% of the furniture components market in the U.S. in 1990, while panel products accounted for the remaining 37%. OSB and softwood plywood together accounted for only 6% of the total market share.



**Figure 2.6: Total volume of wood products used in the U.S. furniture industry in 1990.**  
(Source: Forbes et al., 1993)

A study conducted by Wu et al. (1997), showed similar results for these three furniture sectors. In the southern U.S., solid wood accounted for 62% of the furniture components

market share in 1997, while wood-based panels accounted for 33%. The remaining 5% was attributed to veneers and other products (Wu et al., 2000). However, a close look at the office furniture sector alone revealed a different story. In this sector, solid wood accounted for 37% of the market share, while wood-based panels accounted for 58%. Veneers and other products accounted for the remaining 5% of the market share. Thus, office furniture manufacturers consume a significantly higher volume of wood-based panels compared to the rest of the furniture market.

In 1996, the office furniture sector (excluding metal) in North America had an annual production valued at approximately \$3.75 billion, with Canada accounting for 17.6% of the total (Industry Canada, 1998). In 1998, the total volume of OSB used in wood office furniture was negligible compared to softwood plywood (APA – The Engineered Wood Association, 1999). This is clearly an area in which OSB manufacturers need to make an effort to gain market share. Although no literature was found on the Canadian consumption rate of OSB and softwood plywood in the office furniture market, it can be assumed that the trends closely follow that of the U.S.

#### ***2.4.2 The North American Door Manufacturing Sector***

In 1996, a study was conducted on the volume of doors manufactured in the U.S. by material and application type from 1994 to 1995, making predictions for 1996 to 1999 (Building Component Manufacturing, 1998). The study categorized door applications into two types: 1) residential entry doors; and 2) residential passage doors. It predicted that, in 1999, approximately 12.5 billion units of residential entry doors would be sold in the U.S., 20% of which would be made from wood products. Approximately 30.5 billion residential passage doors would be sold, 95% of which would be made from wood products. It can be assumed that the ratio in Canada would be similar to that of the U.S. market, although volumes in Canada would be much lower.

As previously mentioned, the total production value of the North American wooden door and window industry in 1996 was \$17.28 billion, with Canada accounting for approximately 7% of the total (Industry Canada, 1998). There is a strong correlation between the volume of doors manufactured in North America and annual house construction activity. As housing starts and the amount of repair and remodeling increase, so too does the demand for manufactured building components (i.e. doors, windows, roofs, and siding). In the U.S., total housing starts will be at around 1.5 million



in 2001 and are forecasted to increase to 1.575 million by 2004 (Wood Markets, 2000). Approximately 78% of the existing houses in the U.S. are at least 16 years or older, meaning that they will soon be in need of repair and remodeling (Wood Markets, 2000). In 1998, repair and remodeling in the U.S. had annual expenditures of \$US 124.1 billion. This activity provides good potential for market expansion by wooden door manufacturers. It should lastly be noted that no breakdown of the types of wood products used in doors was found in the literature reviewed. Perhaps this is another reason for conducting this type of downstream market survey.

### ***2.5 Concluding Remarks***

Population increases in North America, along with a decreased supply of high quality wood fiber, have resulted in an ongoing shift towards the use of composite boards in industrial markets. Today, there is an increasing market opportunity for structural panels such as plywood and OSB within the growing industrial market. Given the intense competition amongst composite panels within the industrial market, producers must have a good understanding of their customers' needs in order to stay competitive within the marketplace. Composite panel producers should also focus more on value-added applications instead of merely producing low value commodities. A survey of door and office furniture manufacturers was seen as a crucial step toward helping panel producers improve their products to better serve the needs of these industrial customers.

The door and window industry alone, which uses high volumes of wood products, had an annual production of over \$CDN 17 billion in 1996 in North America. The furniture sector also consumes high volumes of wood products. In North America during 1996, the furniture group (using wood as a component material) had an annual production valued at over \$CDN 60 billion. There is a tremendous market opportunity for OSB products within the office furniture and door sectors. A comprehensive exploration of these industries were seen as an essential step, prior to development of practical marketing strategies.

## Chapter 3

### Research Methods

The main purpose of this study was to obtain information from North American door and office furniture manufacturers on the industrial uses of OSB, specifically for office furniture and doors. Previous studies have concentrated mostly on the use of OSB as a sheathing material for home construction. Until now, very little information has been gathered on other potential uses of OSB. This chapter discusses the research methods employed in this study in four sections: restrictions, methodology, survey design and objectives, and data collection.

#### *3.1 Restrictions*

There are four common methods for conducting market studies, being internet surveys, mail/fax surveys, telephone surveys, and face-to face interviews. Each of these methods has its advantages and disadvantages. Due to time and budgetary constraints, telephone surveys, mail surveys, and personal interviews were not options. Internet surveys were not used due to several wood manufacturers not having personal directory on the internet. As a result, a fax survey was chosen due to the ease of sending bulk faxes to companies across North America and faster rates of data collection. However, one of the limitations of conducting a fax survey was that some companies listed in the sample frame (see next section) did not register a fax number and could not be included in the survey. This may create bias to the survey, especially from the exclusion of smaller companies.

#### *3.2 Methodology*

A list of 973 door manufacturers and 894 office furniture manufacturers was obtained using simple random sampling. The listing was gathered from three sources: the "Thomas Register", an internet service; the Window & Door Manufacturers Association (WDMA) membership directory; and Name Finders Lists, Inc., a commercial list provider. For example, when purchasing names from Name Finders Lists, Inc., specific instruction were given to them to randomly select names from their list of wooden door and office furniture manufacturers in Canada and the U.S. More than 95% of the companies within the list were located in the U.S. The reason for the imbalance being

that simply there are higher numbers of door and office furniture manufacturing companies in the U.S. than in Canada.

All of the companies surveyed were contacted via facsimile. The survey was faxed along with a cover letter explaining the survey instrument and main objectives of the research (see Appendices A and B). Extra effort was taken to exclude manufacturers primarily involved in the production of non-wood based products. To ensure higher response rates, a toll-free 1-800 number was provided for the respondents to answer any questions that they may have had.

### ***3.3 Survey Design and Objectives***

In this study, two separate surveys were designed focusing on the two chosen markets for panel products. One survey targeted the North American wooden office furniture manufacturers, while the other targeted North American wooden door manufacturers (see Appendices C and D). The main objective of this research was to ascertain the market potential for industrial OSB products in the North American wooden office furniture and door markets. Specific objectives included the following:

1. to measure North American wooden office furniture and door manufacturers' awareness, use, and perception of OSB as an industrial material;
2. to explore the most effective means of developing and disseminating promotional information regarding OSB's industrial use for wooden office furniture and door manufacturers;
3. to make recommendations to OSB manufacturers on ways of improving their product based on an analysis of actual and perceived product strengths and weaknesses.

The two surveys were very similar, differing only in questions # 6 and #7 (Section I), and question #2 (Section IV), in which respondents from each sector are asked about products and product components specific to their respective industries. Also, question #1 (Section IV) of the door survey, had an additional attribute, "fire performance", which was not included in the furniture survey.

The surveys were divided into four main sections:

1. Company Information
2. Material Used in Doors/Office Furniture
3. Wood Panels Use in Doors/Office Furniture
4. OSB Use in Door/Office Furniture Manufacturing

In general, the surveys asked general questions at the beginning of each section and more specific ones towards the end.

The sample included a wide range of wooden door and office furniture manufacturers with respect to geographical location, firm type and size, material manufacturing type, and production level. For example, the door manufacturers sample included those involved in the production of custom doors, cabinet doors, wooden doors, French doors, industrial doors, etc. The office furniture manufacturers sample included manufacturers of computer office furniture, home office furniture and regular office furniture products. Within each category, companies were also subcategorized in terms of specific items that they manufactured. For example, within the office furniture category, there were companies that specialized in the production of chairs, computer desks or some other office furniture product. This wide diversity helps to capture a representative sample frame of the North American door/office furniture manufacturing population. The questions were designed in such a way that any company regardless of size, geographical location or knowledge level of OSB could answer them. The two surveys were targeted towards the companies' purchasing/specification manager.

Extra effort was taken to ensure a high response rate. The total length of the survey was set at four pages, taking respondents an average of twenty minutes to fill out. A free long distance fax back was offered to respondents to encourage participation. Finally, complete confidentiality was assured to all participants.

### ***3.4 Data Collection***

Primary data collection on North American door and office furniture manufacturers was conducted by using descriptive research techniques. Like most descriptive research, data collection in this study was of a quantitative nature, allowing for inferences onto the population. Companies under study were selected by using simple random sampling procedures. This ensured an unbiased and representative sample of companies.

Companies were contacted on four separate occasions, each within intervals of between two to three weeks. Each time, a reminder letter was sent along with the survey asking companies to fill out the survey questionnaire. These letters reminded companies of the purpose and importance of the project. The final and fourth cover letter had a slightly more intense tone, reminding all those who had not filled out the survey to please do so. To reduce confusion and increase the consistency of results, the surveys were addressed to the Purchasing/Specification Manager of companies.

## Chapter 4

### Results

In this chapter, results have been organized into three sections:

- Analysis of office furniture manufacturers.
- Analysis of door manufacturers.
- Analysis of office furniture versus door manufacturers.

#### ***4.1 Response Rate for Office Furniture Manufacturers:***

An attempt was made to reach 894 office furniture manufacturers across North America by facsimile, and 766 were successfully contacted. Respondents were divided into two categories, those who completed the survey and those who refused to do so. Respondents who made no attempt to complete the survey did so for various reasons. The major reason was likely a lack of knowledge of and experience with OSB products. Others stated that they had no interest or time to fill out a questionnaire that was not related to their work.

The total response rate, calculated using the following equation, was 18.28%:

$$\begin{aligned} \text{total response rate} &= \frac{\# \text{ of completed surveys} + \# \text{ not willing to participate}}{\text{sample size} - \# \text{ of unreachables}} \times 100\% \\ &= \frac{109 + 31}{894 - 128} \times 100\% = 18.28\% \end{aligned}$$

This response rate included those who either completed the survey or refused to do so.

Alternatively, the response rate can be calculated to include only those manufacturers who attempted to complete the survey questionnaire. The result obtained using this method yielded an adjusted response rate of 14.23%:

$$\begin{aligned} \text{adjusted response rate} &= \frac{\# \text{ of completed surveys}}{\text{sample size} - \# \text{ of unreachables}} \times 100\% \\ &= \frac{109}{894 - 128} \times 100\% = 14.23\% \end{aligned}$$

Thus, 14.23% of the North American office furniture companies contacted made an attempt to complete the survey. This is still an acceptable response rate, given the low familiarity of OSB products within the office furniture sector.

The presence of non-response bias was measured using both two-tailed t-test and z-tests depending on the situation. A two-tailed t-test was used for the question related to the number of years companies were in business, and z-tests for the two questions related to proportions:

- Number of years office furniture companies were in business.
- The proportion of office furniture companies' regional markets.
- The proportion of companies' total sales which includes office furniture products.

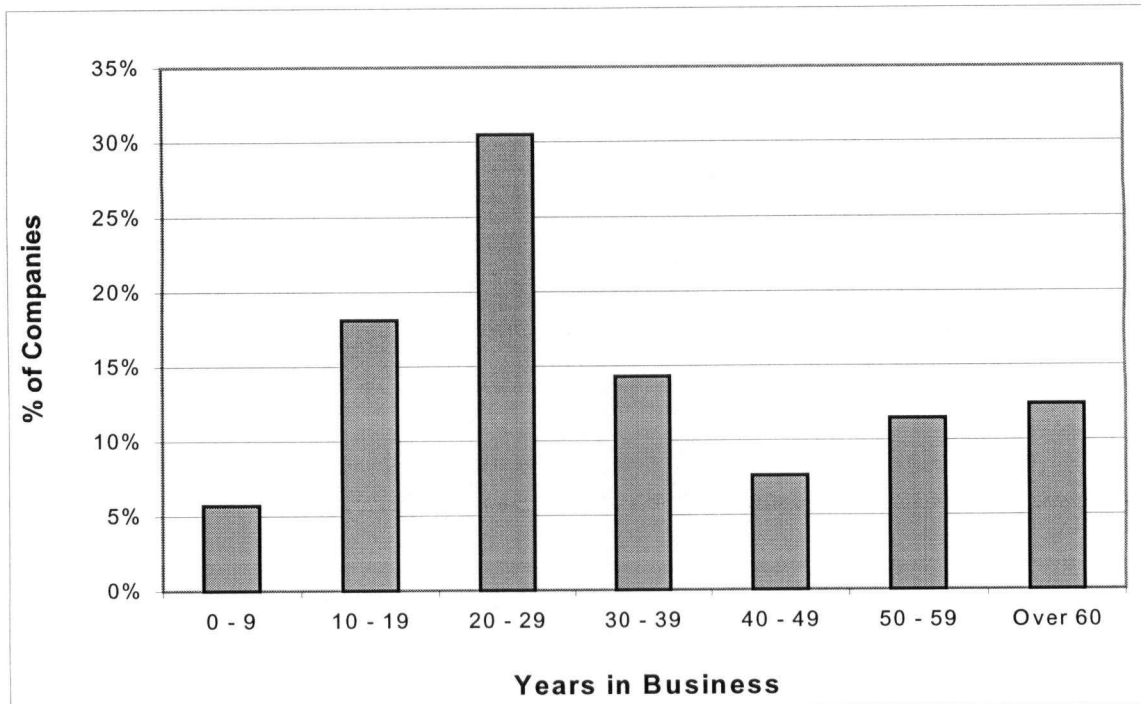
The test for non-response bias is based on the assumption that late respondents would be similar to non-respondents (Wu et al., 2000). In this study, the final and fourth cover letter had a slightly more intense and desperate tone than the previous ones, reminding all those who had not filled out the survey to please do so. Therefore, it can be assumed that the last set of respondents are those who would have not under regular circumstances responded to the survey. Thus, in this situation, a comparison of early respondents versus late respondents would be similar to a comparison of early respondents versus non-respondents. Data from the first set of respondents (early respondents) were compared to the last set of respondents (late respondents) to test for non-response bias. The two-tailed t-test conducted on the first aforementioned variable revealed no significant difference between the two set of respondents at the  $\alpha = 0.05$  level. Next, z-tests were performed on the two latter variables related to proportions and the results also revealed no significant differences between the early and late respondents in both cases at the  $\alpha = 0.05$  level. Therefore, the results of this survey can be inferred to the entire office furniture industry, as there is no indication of non-response bias.

#### ***4.1.1 Company Information (Section I)***

General questions regarding company size, location, market segment and product line are summarized in this section.

The majority of the respondents classified themselves as either company managers, presidents, vice presidents, purchasing agents, or owners. Thus, most people who filled

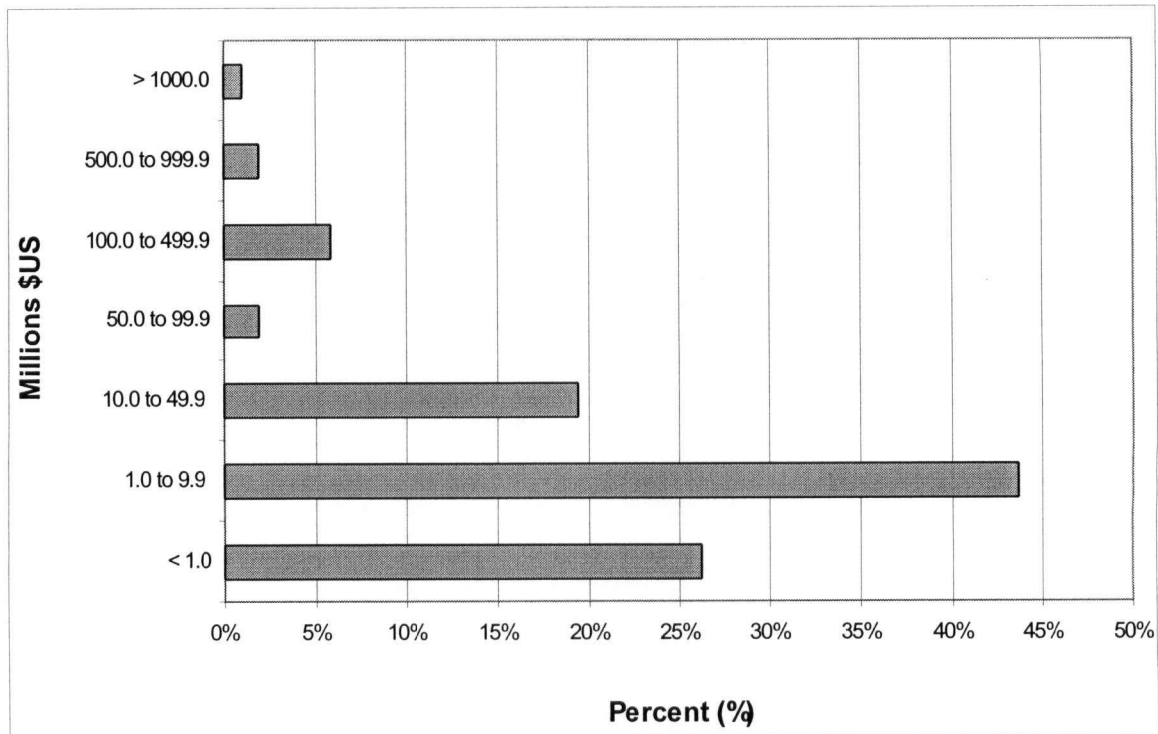
out the survey were fully qualified with great deal of knowledge about their company history and the products being used. As illustrated in Figure 4.1, over 30% of companies included in this survey have been in business for a period of between 20 to 29 years. Only 12% of office furniture companies have been in business for over 60 years. The majority of these companies have been manufacturing office furniture for about the same amount of time as they have been in business.



**Figure 4.1: Number of years in business (office furniture respondents).**

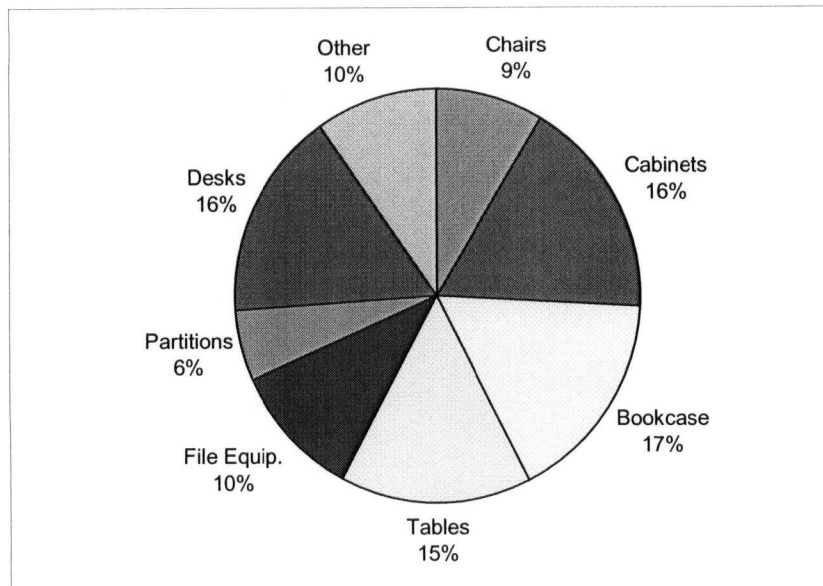
Figure 4.2 illustrates that approximately 44% of the companies that responded had total sales of between \$US 1 to 9.9 million in 1999. Only 11% of respondents reported having sales of over \$US 50 million annually.





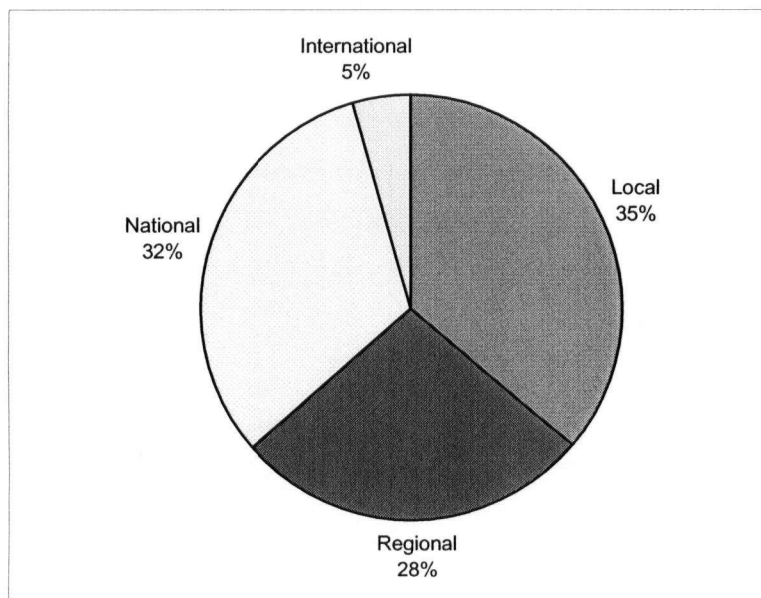
**Figure 4.2: Total sales (\$US) for 1999 (office furniture respondents).**

In addition, respondents were asked to categorize their sales into two categories, namely “office furniture” or “other furniture products”. The results showed that 58% of the total furniture sales were in office furniture while 42% were in other furniture products. Figure 4.3 shows the proportion of different types of office furniture manufactured by the companies surveyed. In general, companies were involved in the production of many types of furniture products. For example, most companies producing bookcases were also involved in the production of desks, tables, etc. Relatively few companies were involved in the production of only one type of office furniture item. Approximately 10% of furniture produced did not fit into any one of the given categories. Some of the more common examples included bedroom and industrial furniture items.



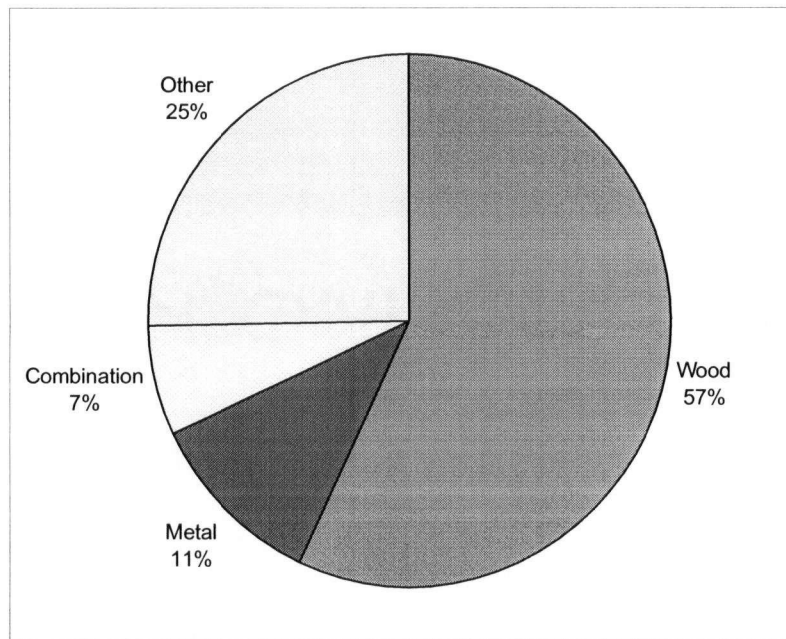
**Figure 4.3: Proportions of furniture types manufactured (office furniture respondents).**

Figure 4.4 summarizes the major market segments of companies on a geographical basis. This segmentation was done on four levels: local, regional, national and international. The majority of the manufacturers' markets were either at local, regional or national levels. Only 5% of companies' markets extended internationally. Perhaps the major reason was due to company size. As mentioned previously, only 11% of companies who participated in the study had annual earnings of over \$US 50 million, and thus, the resources and capabilities to market their products abroad.



**Figure 4.4: Companies' geographical market segments (office furniture respondents).**

The last two questions in Section I related to raw material use in office furniture production. Figure 4.5 summarizes the major components used by companies in office furniture production. Approximately 57% of materials used by office furniture manufacturers included some type of wood product, while only 11% of the materials were metal products. There may be an upwards bias towards wood use in these results as an effort was made in the sampling to include primarily wood office furniture producers. One-quarter of the materials used by these manufacturers included products other than wood or metal, the most common being plastic. The remaining 7% of materials used in furniture production included some combination of different materials.



**Figure 4.5: Major components used in furniture production (office furniture respondents).**

Respondents were also questioned on the proportion of wood-based and non-wood-based products used in furniture applications. They were specifically asked to evaluate the proportion of the volume of solid wood, panels, engineered wood and non wood-based products used in their office furniture production. Means were calculated and the results have been summarized in Figure 4.6. Respondents' furniture production used approximately 83% wood-based and 17% non-wood-based products. Of the total volume of wood-based products used in furniture production, panels and engineered wood products together contributed approximately 64%, while solid wood made up the remaining 36%. Thus, the results indicate that office furniture manufacturers have an obvious preference for wood-based panels over solid lumber products.

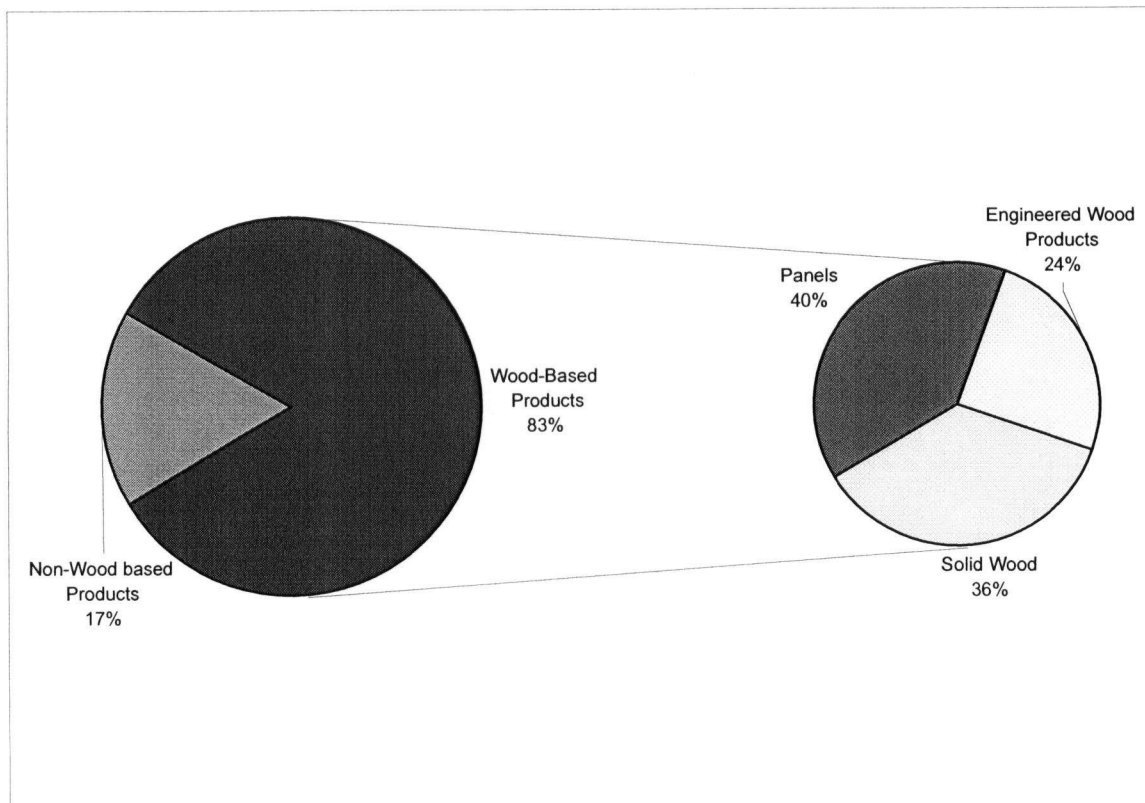


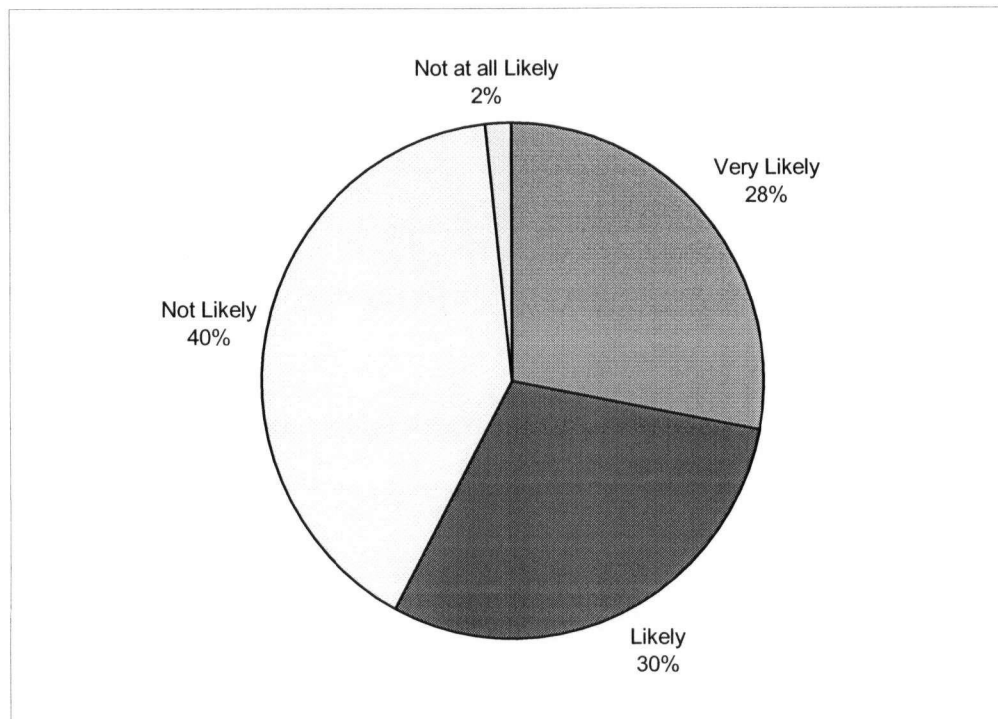
Figure 4.6: Material types used in furniture production (office furniture respondents).

#### 4.1.2 Materials Used in Furniture (Section II)

Respondents were also asked to give their opinions on product attributes and use, covering issues such as product quality, after sales services, price, aesthetics, etc. In addition, respondents were asked about best methods for sharing knowledge within the furniture industry. Specifically, respondents were asked whether they had ever substituted one material for another in furniture manufacturing (Question 1). Results show that approximately half of the respondents (52%) have never substituted one material for another, while the other half (48%) have at least one time made a substitution.

The respondents who indicated that their company had made a product substitution were then asked to provide a recent example. Responses varied to the extent that it was difficult to make any type of classification. However, some of the more popular responses included “MDF to particleboard” and vice versa, “solid wood to MDF/particleboard/plywood”, and “plywood to MDF/particleboard”. A few respondents even reported switching from “plywood/particleboard/MDF to OSB”. The follow-up

question asked the respondents to state whether they were actually thinking of making yet another switch within the next three years. Mean proportions have been computed and the results summarized in Figure 4.7. Approximately 42% of the respondents indicated to some degree that they had no intention of making another switch, while 58% noted that it was a possibility. Thus, opportunities still exist for wood-based products such as OSB to be introduced as a component to innovative and early adoptive companies interested in exploring new products.

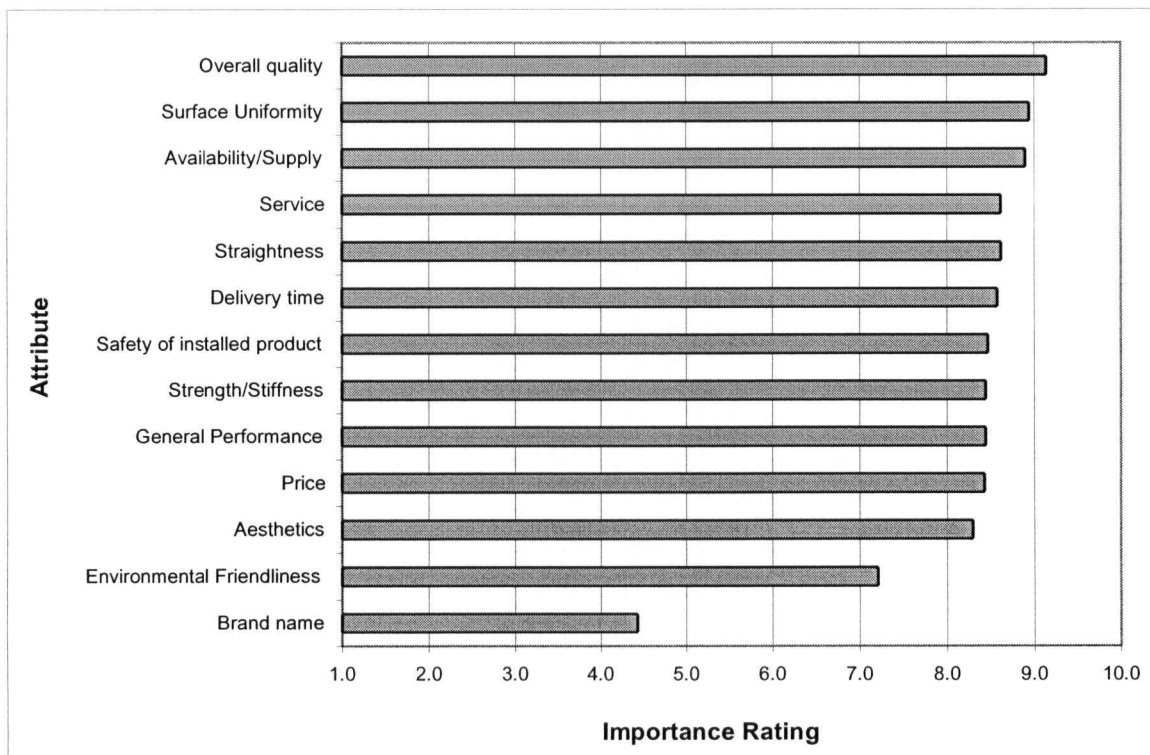


**Figure 4.7: Likelihood of another material substitution within the next three years (office furniture respondents).**

Respondents were also given a list of product attributes and asked to rate their level of importance on the final purchasing decision (Question 4). A ten-point numerical scale was used to measure the importance of these product attributes, with 1 being “not at all important” and 10 being “extremely important”. Means for each attribute were computed and the results are summarized in Figure 4.8. All of the product attributes are rated as being equally important, except for two. A one-way analysis of variance (ANOVA) test ( $\alpha = 0.05$ ) was conducted using MINITAB. No post-hoc tests were conducted. Rather, confidence intervals were constructed using the mean square (within) measure of variation. Two product attributes, “environmental friendliness” and “brand name”, with

means of 7.2 and 4.5, respectively rated significantly lower than the rest of the product attributes. The rest of product attributes, “strength/stiffness”, “general performance”, “straightness”, “surface uniformity”, “overall quality”, “delivery time”, “availability/supply”, “service”, “price”, “aesthetics”, and “safety of installed product”, all rated between 8.2 to 9.1 and deserve special attention from office furniture manufacturers.

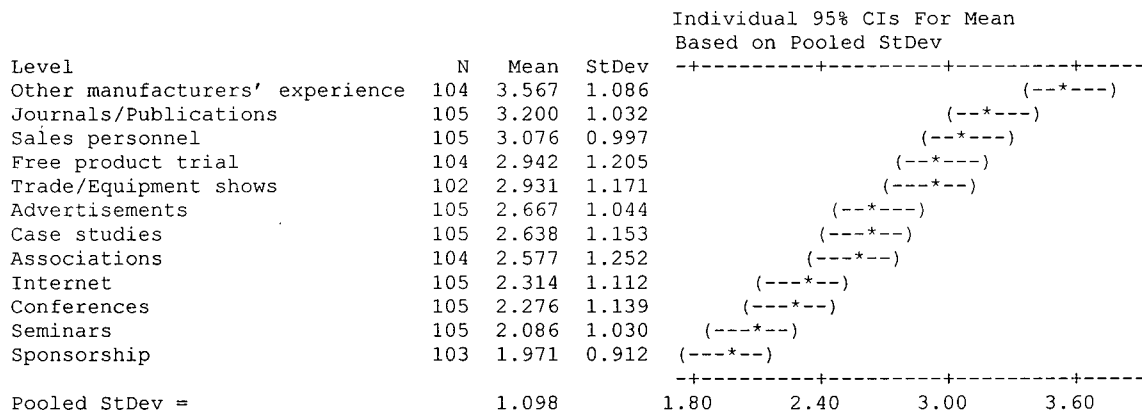
				Individual 95% CIs For Mean Based on Pooled StDev
Level	N	Mean	StDev	-----+-----+-----+-----+
Overall quality	108	9.139	1.343	(-*-)
Surface uniformity	108	8.944	1.611	(--*-)
Availability/Supply	108	8.898	1.504	(-***)
Straightness	108	8.620	1.898	(-*--)
Service	107	8.617	1.815	(-*--)
Delivery time	107	8.579	1.843	(-*--)
Safety of installed product	107	8.551	1.914	(-*-)
General performance	107	8.523	1.712	(--*-)
Strength/Stiffness	108	8.444	1.851	(-*--)
Price	107	8.430	1.733	(-*--)
Aesthetics	108	8.222	1.659	(--*-)
Environmental friendliness	106	7.208	2.381	(-*-)
Brand name	107	4.477	2.714	(--*-)
Pooled StDev =		1.875		-----+-----+-----+-----+
				4.5          6.0          7.5          9.0



**Figure 4.8: Importance of selected product attributes to furniture manufacturers (office furniture respondents).**

One objective of the survey was to find the most effective means of developing and disseminating promotional information to the furniture industry. A five-point numerical

scale was constructed as follows: 1 = never use; 2 = rarely use; 3 = sometimes use; 4 = usually use; 5 = always use. Using this scale, respondents were asked to rate the sources of information that they used when deciding to learn more about new materials. Means were computed for each promotional method and the results have been summarized in Figure 4.9. According to the respondents, the top three methods used for disseminating promotional information were "other manufacturers' experience" (3.6), "journals/publications" (3.2), and "sales personnel" (3.1). A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB was conducted. Confidence intervals using mean square (within) were constructed. The results showed no significant difference between the two highest rated promotional methods "other manufacturers' experience" and "journals/publications". On the opposite side of the scale, the three promotional methods that received the lowest average ratings were "sponsorships" (2.0), "seminars" (2.1), and "conferences" (2.3). The one-way ANOVA test ( $\alpha = 0.05$ ) revealed no significant difference between them.



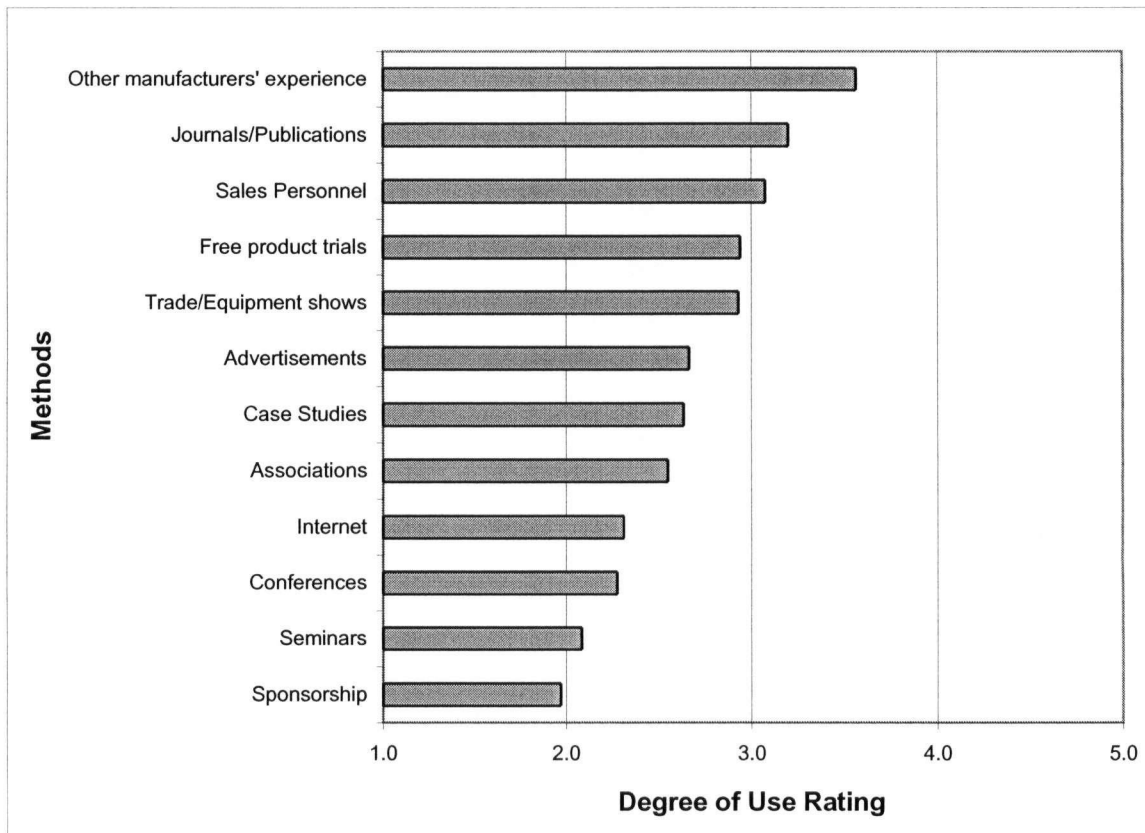
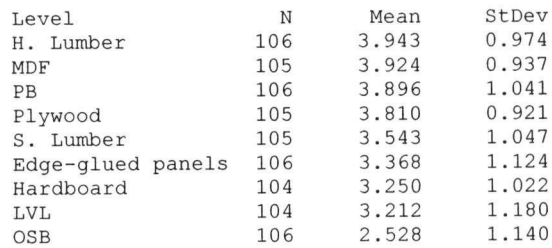


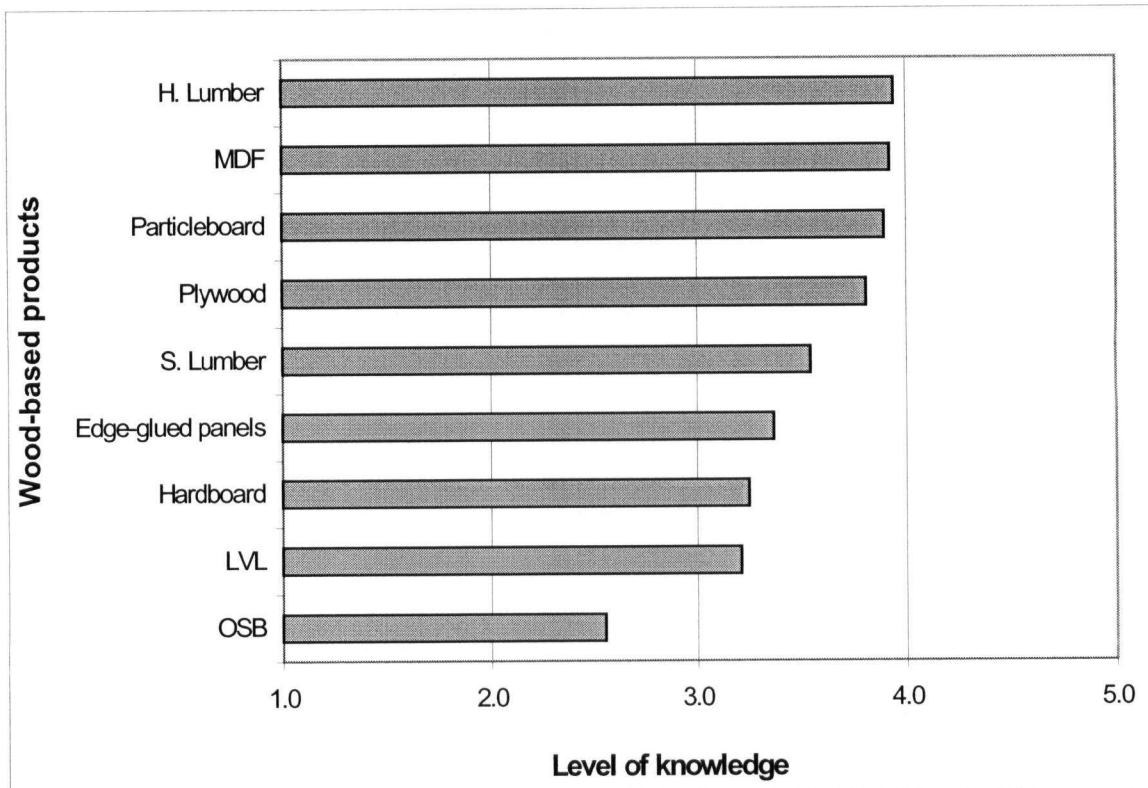
Figure 4.9: Degree of use of various forms of promotional information (office furniture respondents).

In the last question of Section II, respondents were asked to state their level of knowledge regarding various wood products such as hardwood lumber, softwood lumber, laminated veneer lumber (LVL), oriented strand board (OSB), plywood, particleboard, hardboard, edge-glued panels, and medium density fiberboard (MDF). A five-point metric scale was used as follows: 1 = not at all knowledgeable; 2 = below average knowledge; 3 = average knowledge; 4 = above average knowledge; 5 = very knowledgeable. The mean results have been summarized in Figure 4.10. The results show that, on average, respondents were most familiar with hardwood lumber, MDF, particleboard, and plywood. A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB revealed no significant difference, between means of these four wood products. In general there was a lack of knowledge with OSB products. According to the ANOVA test, a significant difference was found between the mean of OSB (2.6) and the means of the other wood products.





Pooled StDev =

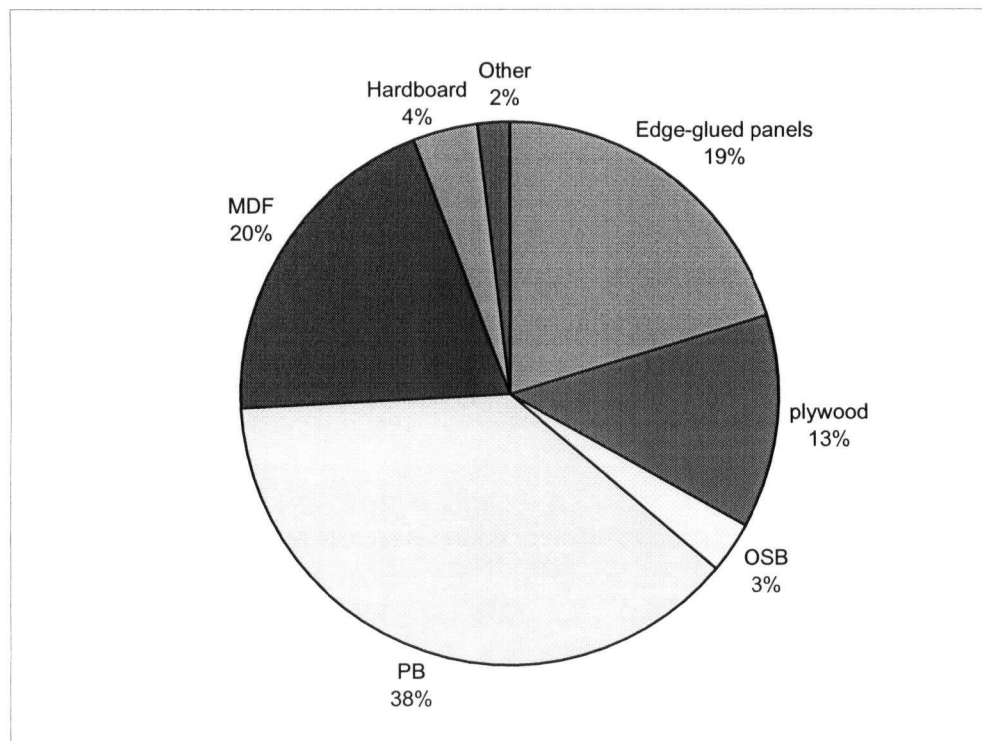


**Figure 4.10: Level of knowledge of wood-based products used in furniture (office furniture respondents).**

#### 4.1.3 Wood Panel Use in Furniture (Section III)

In this section, respondents were asked various questions regarding the use of wood-based panels in furniture applications. First, they were asked to indicate the proportion (by volume) of different types of wood-based products used in their furniture manufacturing (Question 1). The results, summarized in Figure 4.11, show particleboard as being the most commonly used wood-based product at 38%, followed by MDF at 20%, edge-glued panels (made from solid lumber) at 19%, plywood at 13%, hardboard at 4%, and OSB at 3%. Approximately 2% of the materials used by the wood furniture manufacturers did not fit into any one specific category and therefore was categorized as

“other materials”. Products here included veneer, melamine, and oriented strand lumber. Many respondents mistakenly put some non-wood products such as metal, fiberglass, aluminum, etc., in this category. To avoid bias, these erroneous responses were removed and the total was recalculated out of 100%. These results are supported by the previous question, which showed furniture manufacturers, on average, to be more knowledgeable about particleboard, MDF, solid lumber and plywood.



**Figure 4.11: Wood-based panels used in furniture manufacturing (office furniture respondents).**

Next, respondents were asked whether they believed that their customers cared about the types of panel products that were used in furniture manufacturing. Approximately 46% of the respondents stated that they did not believe that their customers cared what type of panel product was being used in their furniture products, while 44% did. The remaining 10% stated that they did not know whether or not their customers cared about the types of panel product being used in furniture production.

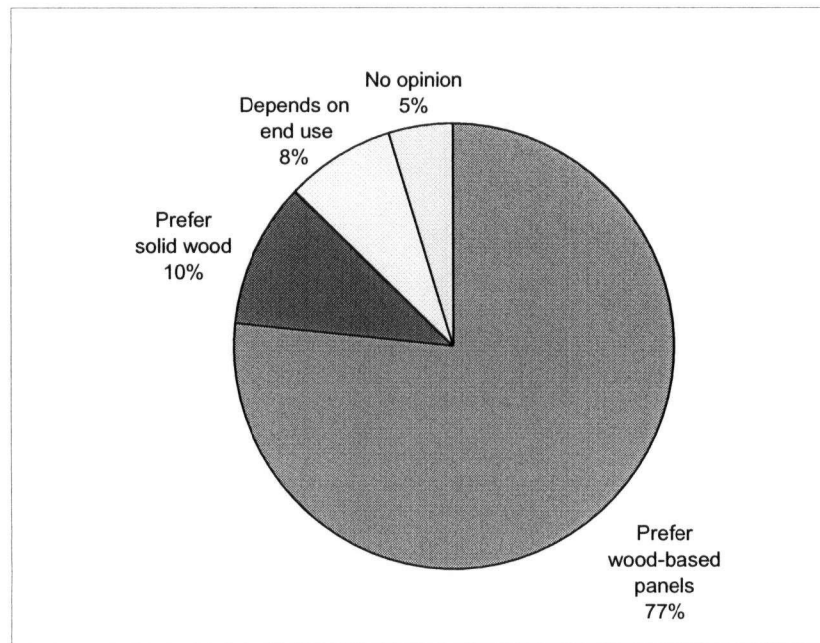
Respondents' opinions were also solicited on the use of wood-based panels in place of solid lumber in furniture applications. As illustrated in Figure 4.12, the majority of respondents (77%) stated that they preferred wood-based panels over solid wood in this context. Some of the more common underlying reasons behind this way of thinking include the following:

- Wood-based panels are less expensive, more environmentally friendly, and more available.
- Wood-based panels are more stable, uniform, durable, consistent, and have fewer defects than solid wood.
- Less warp, twist, split and shrinkage is seen in wood-based panels compared to solid lumber.
- Wood-based panels are less labour intensive, longer-lasting, and overall have a superior quality compared to solid wood.

On the other hand, 10% of the respondents stated that they preferred using solid wood over wood-based panels. Some of the common reasons behind this have been identified as follows:

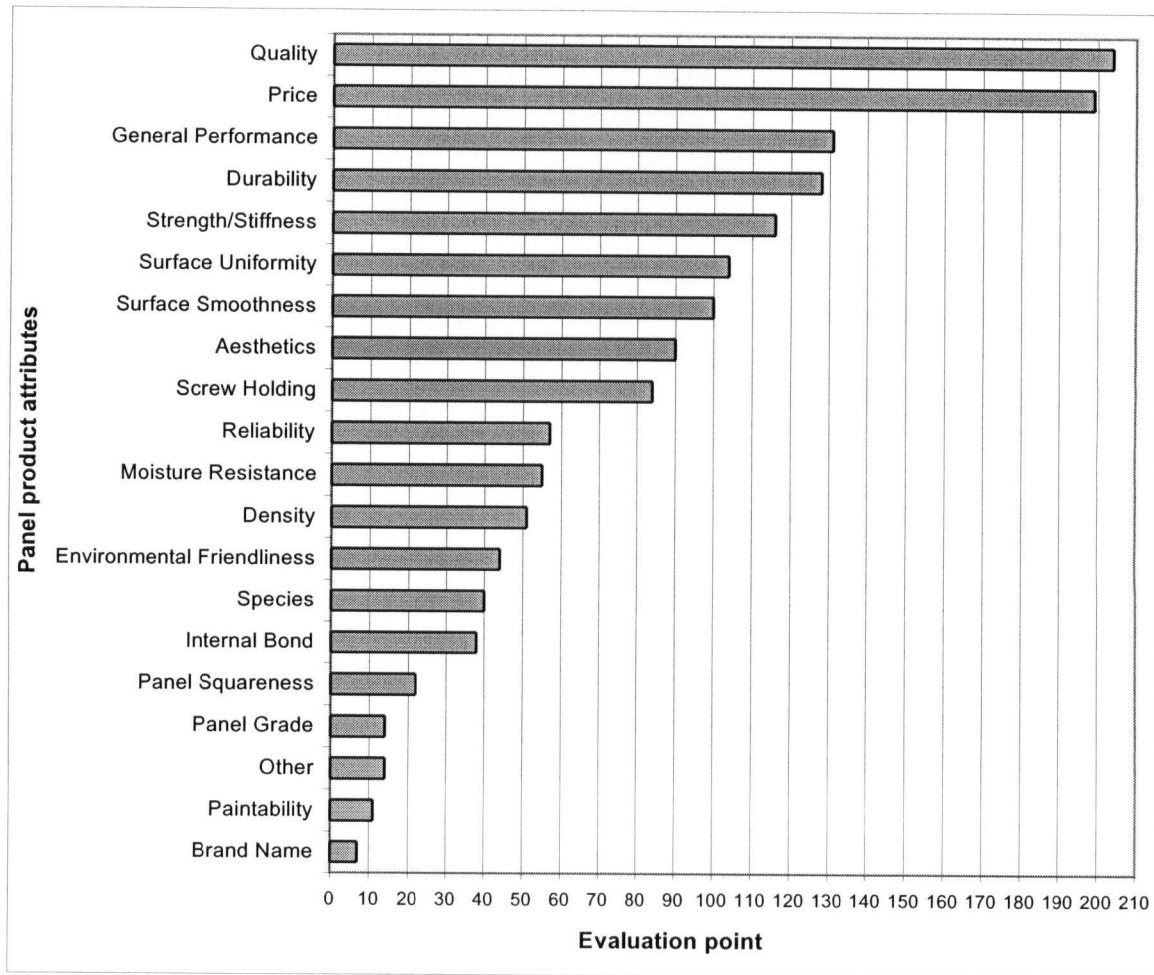
- Customers at the high-end of the market demand solid wood and accept no substitutes.
- Custom wood furniture should be made of solid wood.
- Solid wood is thought of as longer lasting.

Approximately 8% of respondents stated that the use of solid wood or wood-based panels depends on application type and end use. For example, some respondents stated that solid lumber should be used in the high-end of furniture market, whereas wood-based panels would be more appropriate in educational and other commercial applications. In addition, some respondents mentioned that for the low-end of the market (e.g. knock-down furniture), wood-based panels are ideal. Lastly, 5% of the respondents stated that they had no opinion on this matter.



**Figure 4.12: Furniture manufacturers' opinion on the preference of wood-based panels versus solid wood (office furniture respondents).**

Lastly, respondents were asked to rank their top five panel product attributes in order of preference. Results have been summarized in Figure 4.13. The adjusted rank score for each product attribute was obtained by weighting the ranks arbitrarily as follows: five points for the first preference, four points for the second, three points for the third, two points for the fourth, and one point for the fifth. In situations where the respondent did not assign any rank to the attributes, but instead put a check mark in its place, a three point average weighted rank was assigned to each chosen attribute. Although the scores are statistically meaningless as the points have been arbitrarily assigned, they do serve a practical purpose in showing the relative importance of each product attribute to furniture manufacturers. The top five product attributes, according to manufacturers, in order of importance, are quality, price, general performance, durability, and strength/stiffness.



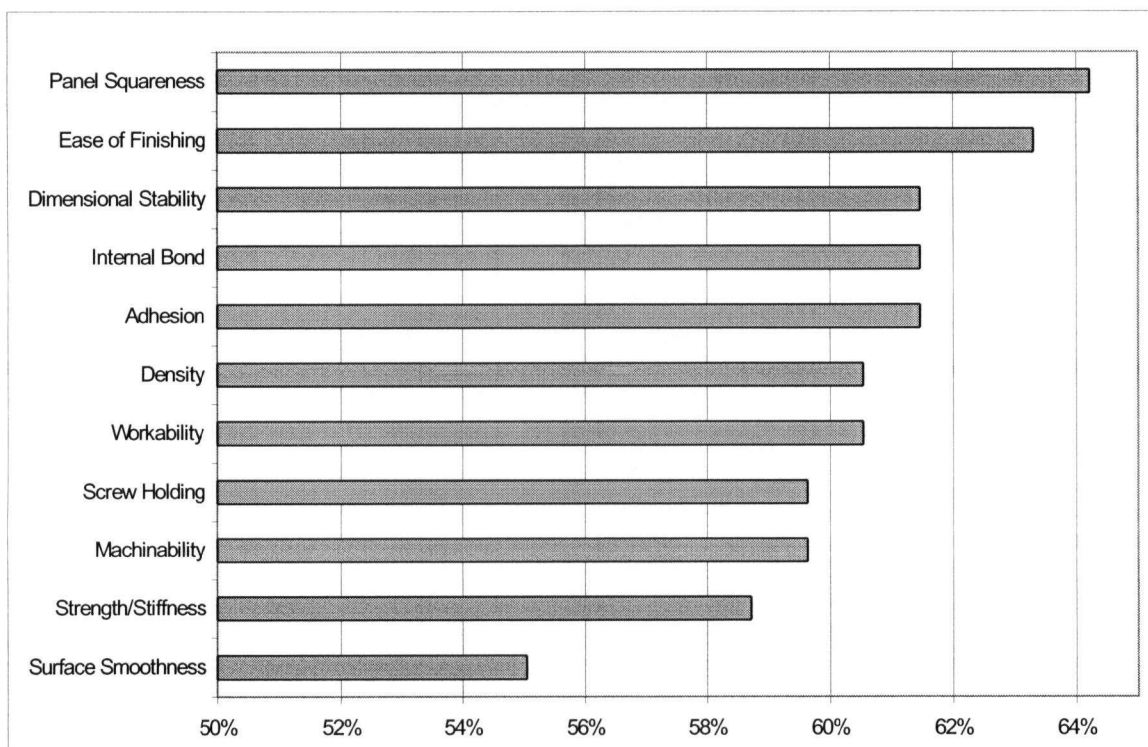
**Figure 4.13: Top rated panel product attributes as they pertain to furniture manufacturing (office furniture respondents).**

#### ***4.1.4 OSB Use in Furniture (Section IV)***

In this section, respondents were asked specific questions regarding their perceptions of OSB and its attributes. Eleven attributes were listed and respondents were asked to use a five-point interval rating scale as it relates to OSB's performance, from "very poor (1)" to "excellent (5)" (Question 1). The second part of the same question asked respondents to indicate how important each of those attributes were in furniture production. Again, a five-point rating scale was used ranging from "not at all important (1)" to "extremely important (5)". For those respondents who were not familiar with OSB, they were asked to check the "don't know" category. This allowed everyone to participate in the survey even if they were not familiar with some of OSB's attributes. In addition, it gave an indication of the proportion of manufacturers who were not familiar with OSB products. It should be noted that in this case, no direct comparison of performance level and importance level could be made. For example, many

manufacturers might feel that using a product with high strength properties is important, but not be critical to their manufacturing. Therefore, they might be quiet happy with using a product of regular strength properties for their applications. The fact that OSB has very high strength characteristics is irrelevant in this case.

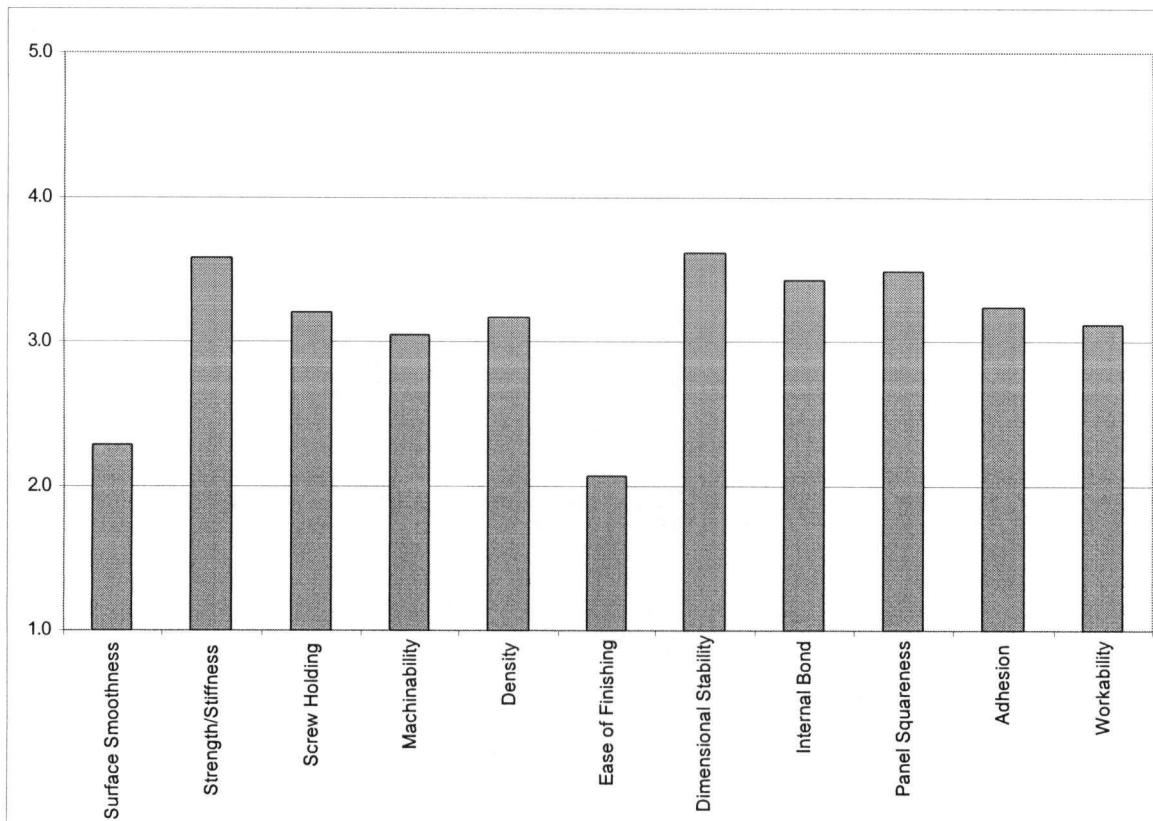
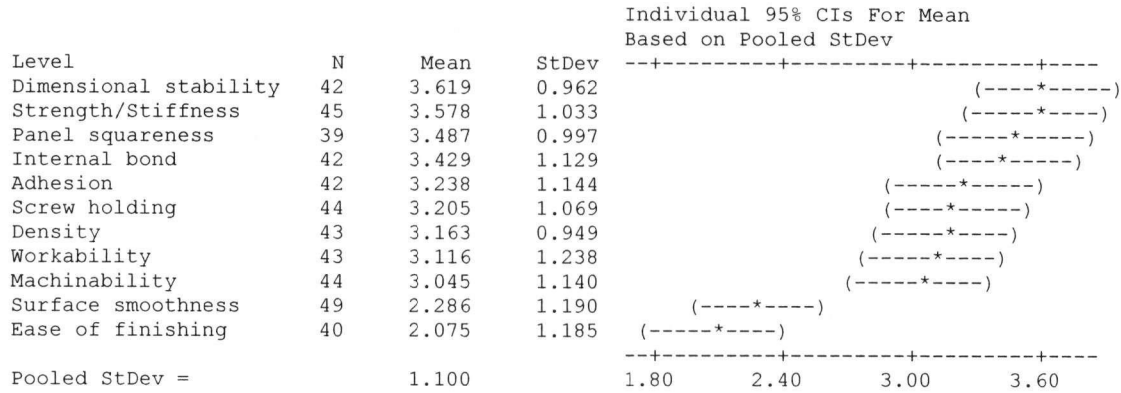
According to Figure 4.14, between 55% to 64% of the respondents surveyed were not aware of OSB's performance level depending on the attribute in question. These results indicate that a high proportion of furniture manufacturers have very limited familiarity and experience with OSB products.



**Figure 4.14: Proportion of respondents that are not familiar with OSB's performance on various products attributes (office furniture respondents).**

For those able to rate OSB's performance levels and the importance of each product attribute, the mean results have been summarized in Figure 4.15 and 4.16 respectively. A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB revealed that the majority of respondents believed OSB's performance level on two attributes to be significantly lower than the remaining applications: "surface smoothness" and "ease of finishing". On average, OSB scored 2.1 and 2.3 on performance in ease of finishing and surface smoothness, respectively. However, OSB scored an average of 3.0 to 3.6 on the performance levels for the remaining attributes: strength/stiffness (3.6), screw holding

(3.2), mechinability (3.0), density (3.2), dimensional stability (3.6), internal bond (3.4), panel squareness (3.5), adhesion (3.2), and workability (3.1). The one-way ANOVA test ( $\alpha = 0.05$ ) revealed no significant difference between these attributes.

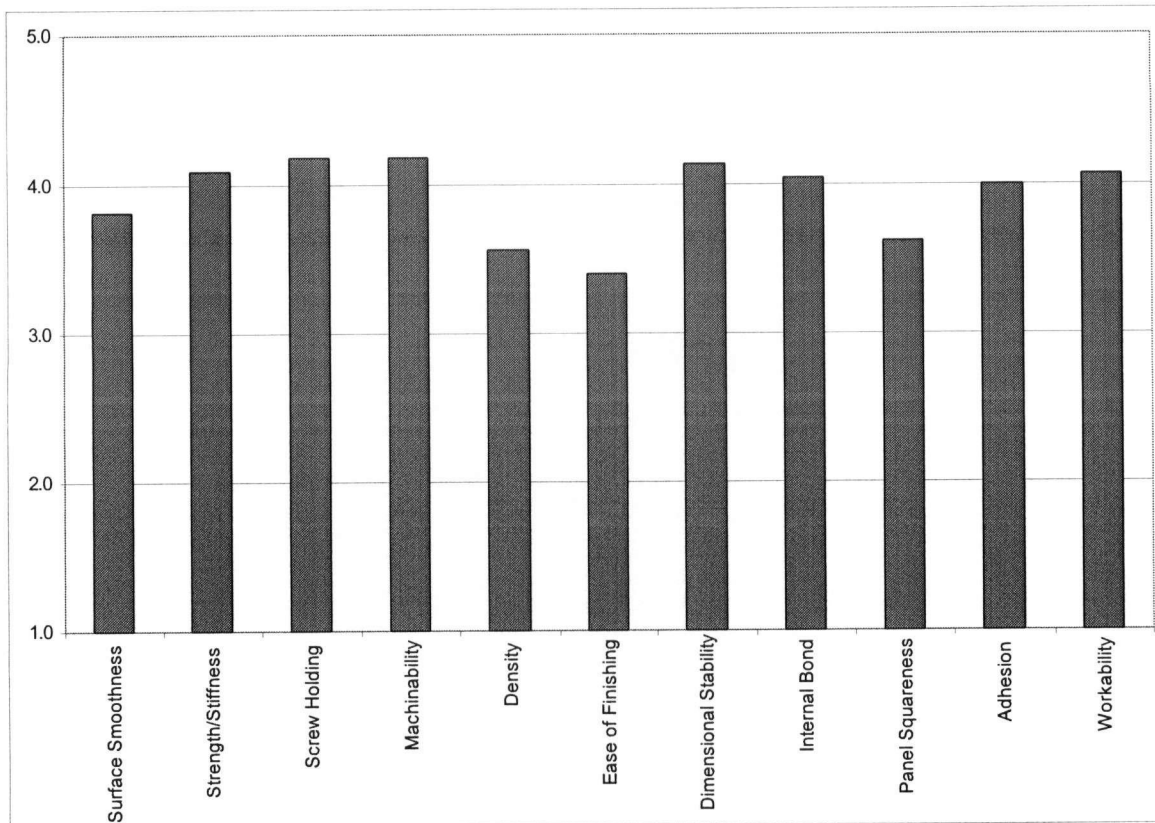


**Figure 4.15: Performance levels of OSB on various product attributes (office furniture respondents).**

A one-way ANOVA test ( $\alpha = 0.05$ ) was conducted to test for differences in the importance level of various product attributes in office furniture manufacturing. According to Figure 4.16, the majority of respondents indicated that screw holding (4.2) and machinability (4.2) of a panel product were significantly more important in furniture

production than attributes such as panel squareness (3.6), density (3.6), and ease of finishing (3.4).

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
Screw holding	43	4.1860	0.8239	(-----*-----)
Machinability	43	4.1860	0.7639	(-----*-----)
Dimensional stability	43	4.1395	0.6755	(-----*-----)
Strength/Stiffness	43	4.0930	0.8111	(-----*-----)
Workability	44	4.0682	0.7894	(-----*-----)
Internal bond	44	4.0455	0.8614	(-----*-----)
Adhesion	43	4.0000	0.8997	(-----*-----)
Surface smoothness	44	3.8182	1.1467	(-----*-----)
Panel squareness	44	3.6136	1.0830	(-----*-----)
density	43	3.5581	0.8811	(-----*-----)
Ease of finishing	43	3.3953	1.3652	(-----*-----)
Pooled StDev =		0.9384		

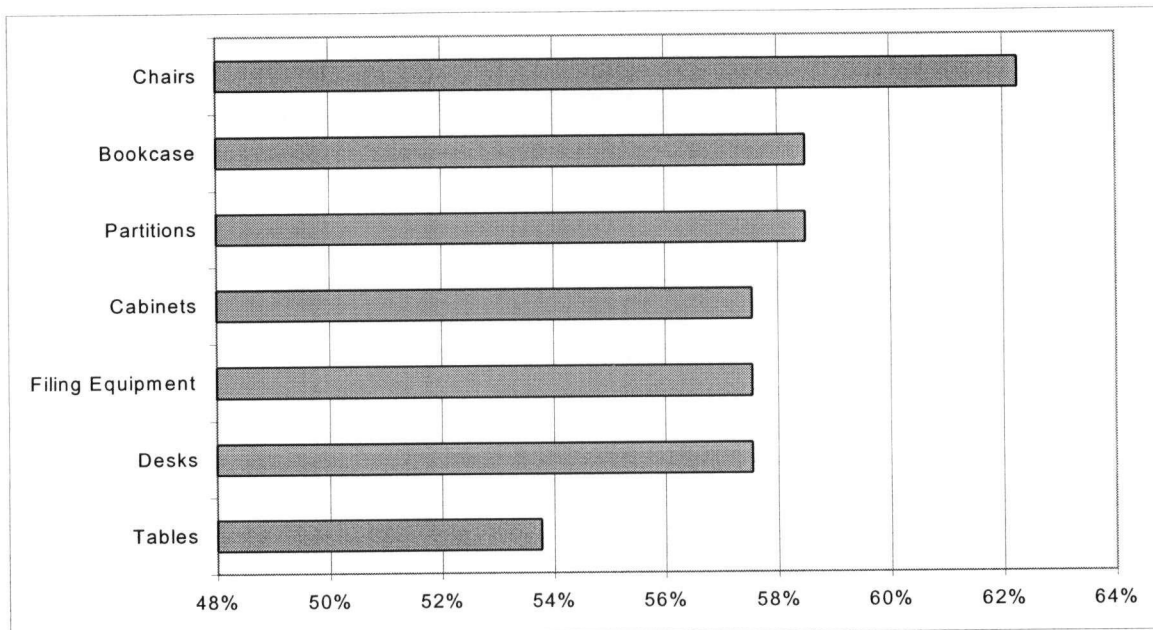


**Figure 4.16: Importance level of various product attributes to furniture manufacturers (office furniture respondents).**

Respondents were also asked to rate OSB's applicability in the following furniture products: chairs, cabinets, bookcases, tables, filing equipment, partitions, and desks. A five-point interval rating scale was used to measure the applicability of OSB in the aforementioned furniture products as follows: 1 = should never be used; 2 = should



rarely be used; 3 = should sometimes be used; 4 = should usually be used; 5 = should always be used. Respondents not familiar with OSB were given the opportunity to check a “don’t know” category. Means were computed and the results have been summarized in Figure 4.17. Depending on the furniture product under consideration, between 54% and 62% of the respondents were not aware of OSB’s applicability in manufacturing. The results show that 54% of the respondents were not familiar with OSB’s use in tables, approximately 58% each in cabinets, bookcases, filing equipment, partitions, desks and 62% in chairs. Overall, there seems to be a lack of knowledge and awareness amongst furniture manufacturers with regards to the application of OSB in various furniture items.



**Figure 4.17: Proportion of respondents unaware of the applicability of OSB in various furniture products (office furniture respondents).**

A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB revealed that, on average, respondents believed OSB to have significantly greater applicability in partitions (e.g., a wall system dividing a unit into two or more sections) compared to other furniture items such as chairs, cabinets, bookcases, tables, filing equipment, and desks (all statistically similar).

				Individual 95% CIs For Mean Based on Pooled StDev	
Level	N	Mean	StDev	-----+-----+-----+-----+-----	
Partitions	43	3.302	0.989	(-----*-----)	
Desks	43	2.605	1.158	(-----*-----)	
Filing equipment	44	2.568	0.925	(-----*-----)	
Cabinets	44	2.545	1.022	(-----*-----)	
Chairs	39	2.538	1.211	(-----*-----)	
Tables	48	2.479	1.072	(-----*-----)	
Bookcase	43	2.442	0.983	(-----*-----)	
Pooled StDev =				-----+-----+-----+-----+-----	
				2.50 3.00 3.50	

Respondents were asked to state whether or not they thought their customers perceived furniture made from OSB as being of low, medium, or high quality. Again, for those respondents with no experience or knowledge of OSB, a choice was given to withhold their opinion. Approximately one-quarter (27%) of respondents indicated that they did not know their customers' opinion with respect to furniture made from OSB. As for those with an opinion on this matter, almost half (48%) believed that their customers would perceive furniture made from OSB as being of low quality, 21% as being of medium quality, and only 4% as being of high quality.

Respondents were also given simple statements pertaining to OSB's use in furniture manufacturing and asked to indicate their level of agreement with these statements. A five-point Likert scale was used as follows: 1 = strongly agree; 2 = agree; 3 = neither agree nor disagree; 4 = disagree; and 5 = strongly disagree. The mean results were calculated and summarized in Table 4.1. A one-way ANOVA test ( $\alpha = 0.05$ ) was used to check for significant differences amongst the mean responses. No significant differences were found between the means of statements #2 and #8, both of which were rated statistically higher than the remaining statements. Thus, there was a general disagreements with statement #2, "OSB surface does not cause finishing problems", and #8, "furniture made from OSB is of higher quality compared to other panel products". In addition, there was a moderate disagreement with statement #3, "OSB panels have excellent workability compared to other panel products", although not statistically different. As for the rest of the statements there seemed to be neither a noticeable agreement or a disagreement. Perhaps this is an indication of lack of knowledge and experience amongst respondents with OSB products. This is not surprising given a high percentage of manufacturers who indicated their unfamiliarity with OSB throughout the survey. Perhaps the most essential step at this time is educating the industry on OSB and its attributes. Response patterns have also been summarized in Figure 4.18.

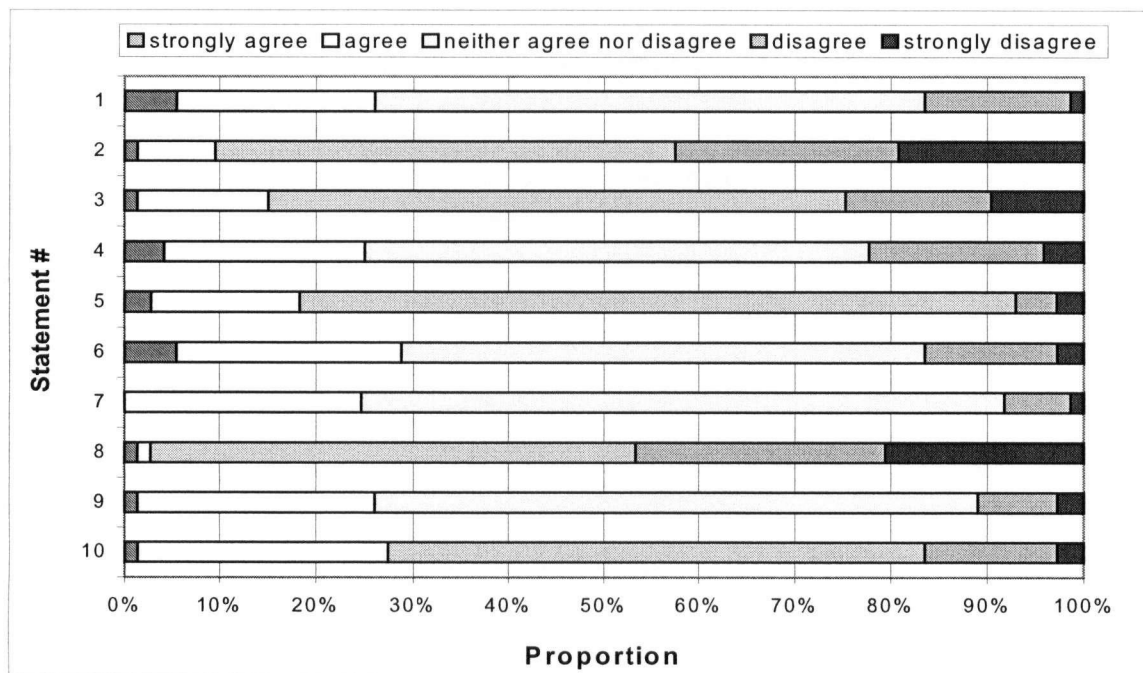
Individual 95% CIs For Mean  
Based on Pooled StDev

Level	N	Mean	StDev	
Statement #8	73	3.6301	0.8741	(-----*-----)
Statement #2	73	3.5068	0.9446	(-----*-----)
Statement #3	73	3.1781	0.8390	(-----*-----)
Statement #4	72	2.9722	0.8553	(-----*-----)
Statement #10	73	2.9041	0.7484	(-----*-----)
Statement #5	71	2.8873	0.6447	(-----*-----)
Statement #1	73	2.8630	0.7873	(-----*-----)
Statement #9	73	2.8630	0.6935	(-----*-----)
Statement #6	73	2.8493	0.8278	(-----*-----)
Statement #7	73	2.8493	0.5933	(-----*-----)
Pooled StDev =		0.7880		

2.80      3.15      3.50      3.85

	Mean
1. OSB panels made for use in furniture tend to have good moisture resistance.	2.86
2. OSB surface does not cause finishing problems.	3.51
3. OSB panels have excellent workability compared to other panel products.	3.18
4. In general, OSB panels do not have good screw holding ability.	2.97
5. OSB panels in use result in low formaldehyde emissions.	2.89
6. OSB panels are strong compared to other panels.	2.85
7. OSB prices are generally stable compared to other panel products.	2.85
8. Furniture made from OSB are of higher quality compared to those made from other panels.	3.63
9. OSB panels can be easily connected to other components.	2.86
10. In the near future, OSB will be used more in the furniture manufacturing industry.	2.90

**Table 4.1: Respondents' mean levels of agreement with statements regarding OSB use in Furniture (office furniture respondents).**



**Figure 4.18: Response patterns for respondents' agreement level with statements regarding OSB use in furniture (office furniture respondents).**

In the latter part of Section IV, respondents were asked to give any additional comments they had regarding the use of OSB or any other wood-based panel in furniture manufacturing. Many of the respondents stated that they have never dealt with OSB products and had minimum amount of knowledge of the product. A few respondents stated that they were interested in obtaining further information about OSB products. However, some of the major complaints with OSB were as follows:

- It is too expensive.
- It has poor surface uniformity and smoothness.
- Any moisture (even in the air) might make the chips swell, destroying the paint finish.
- Veneers and laminates do not adhere properly to OSB.
- It has low screw or staple holding ability on edge.
- It has poor aesthetics.

The problems related to high prices, poor surface quality, and poor moisture resistance seemed to be very common complaints among the respondents.

Finally, the last question in the survey was optional asking those respondents interested in receiving a free copy of the results to give their mailing address. Approximately 32% of the respondents requested a free copy of the results.

#### ***4.2 Response Rate for Door Manufacturers:***

An attempt was made to reach 973 door manufacturers across North America by facsimile, and 853 were successfully contacted. Respondents were divided into two categories, those who completed the survey and those who refused to do so. Respondents who made no attempt to complete the survey did so for various reasons. Some of the more common reasons are as follows:

- Lack of knowledge and experience with OSB products.
- No interest or time to fill out questionnaires not directly related to their work.
- No use of wood products in their door manufacturing.

The total response rate, calculated using the following equation, was 18.87%:

$$\begin{aligned}\text{total response rate} &= \frac{\# \text{ of completed surveys} + \# \text{ not willing to participate}}{\text{sample size} - \# \text{ of unreachables}} \times 100\% \\ &= \frac{83 + 78}{973 - 120} \times 100\% = 18.87\%\end{aligned}$$

This response rate included those who either completed the survey or refused to do so.

Alternatively, the response rate can be calculated to include only those manufacturers who attempted to complete the survey questionnaire. The result obtained using this method yielded an adjusted response rate of 9.73%:

$$\begin{aligned}\text{adjusted response rate} &= \frac{\# \text{ of completed surveys}}{\text{sample size} - \# \text{ of unreachables}} \times 100\% \\ &= \frac{83}{973 - 120} \times 100\% = 9.73\%\end{aligned}$$

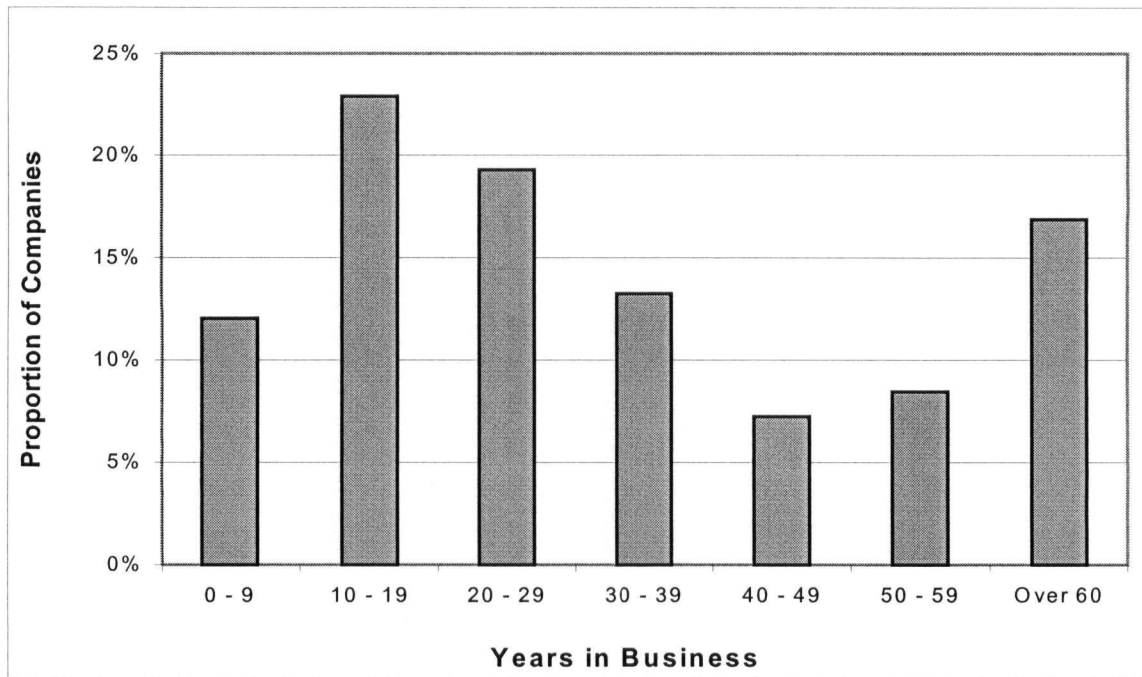
Thus, approximately 9.73% of the North American furniture companies contacted made an attempt to complete the survey. Given the low familiarity of door manufacturers with OSB, this was still an acceptable response rate within this sector.

Non-response bias was measured using same tests and same assumptions as for furniture. Again, no indication of non-response bias was detected.

#### ***4.2.1 Company Information (Section I)***

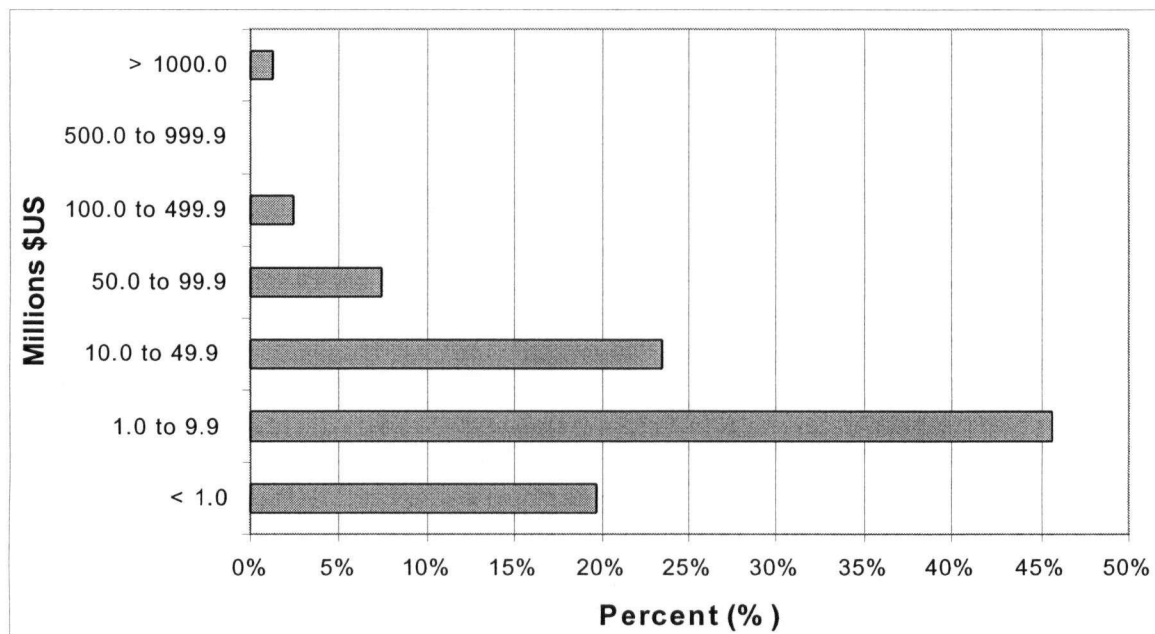
General questions regarding company size, location, market segment, and product line are summarized in this section.

The majority of respondents classified themselves as either company managers, presidents, vice presidents, purchasing agents or owners. Thus, most people who completed the survey were qualified individuals with great deal of knowledge about their company and product lines. As shown in Figure 4.19, the majority of companies (67%) have been in business for less than 40 years and only 17% for more than 60 years. The majority of these companies have been manufacturing furniture for about the same amount of time as they have been in business.



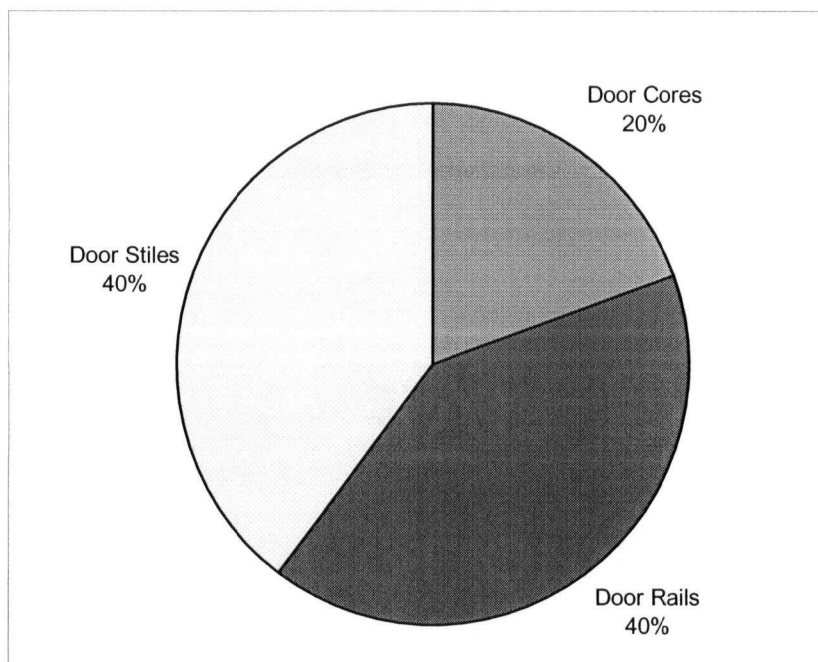
**Figure 4.19: Number of years in business (door respondents).**

Respondents were asked to indicate their total amount of sales in US dollars for 1999. Figure 4.20 shows the proportion of companies that fall within each of seven categories. Approximately 46% of the companies that responded had total sales of between \$US 1 to 9.9 million in 1999. Only 10% of respondents reported having total sales of over \$US 50 million annually.



**Figure 4.20: Total sales (\$US) for 1999 (door respondents).**

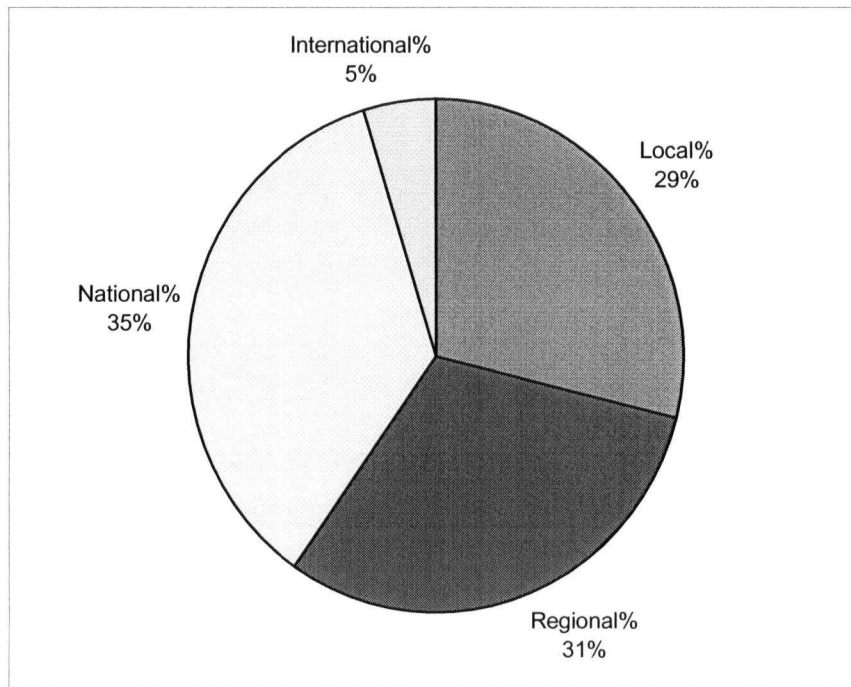
In addition, respondents were asked to categorize their sales of doors and windows. The results showed that 86% of the total sales included doors, while only 14% included windows. This is not surprising since door manufacturers were the main targets of the survey. Respondents were then given a choice of three door components and asked to indicate the one(s) that they manufactured in their firm: door cores, door rails, and door stiles. Respondents were also given an option to state if they manufactured any other door component(s) not listed. However, most respondents did not include door component(s) in this response category, but instead erroneously listed door type(s) manufactured. Therefore, to avoid bias in the results, the other category has not been included in the results. Figure 4.21 shows the proportion of door components manufactured by the companies. According to the results, an equal proportion of door stiles and rails were manufactured at 40%, while door cores accounted for 20%.



**Figure 4.21: Proportion of door types manufactured (door respondents).**

Figure 4.22 summarizes the major market segment of companies on a geographical basis. Approximately 35% of the manufacturers' markets were national, 31% on the regional level and 29% on the local level. Only 5% of the manufacturers' markets extended to the international field. Perhaps the major reason was due to company size. Approximately 46% of the companies who responded had an annual sales of between

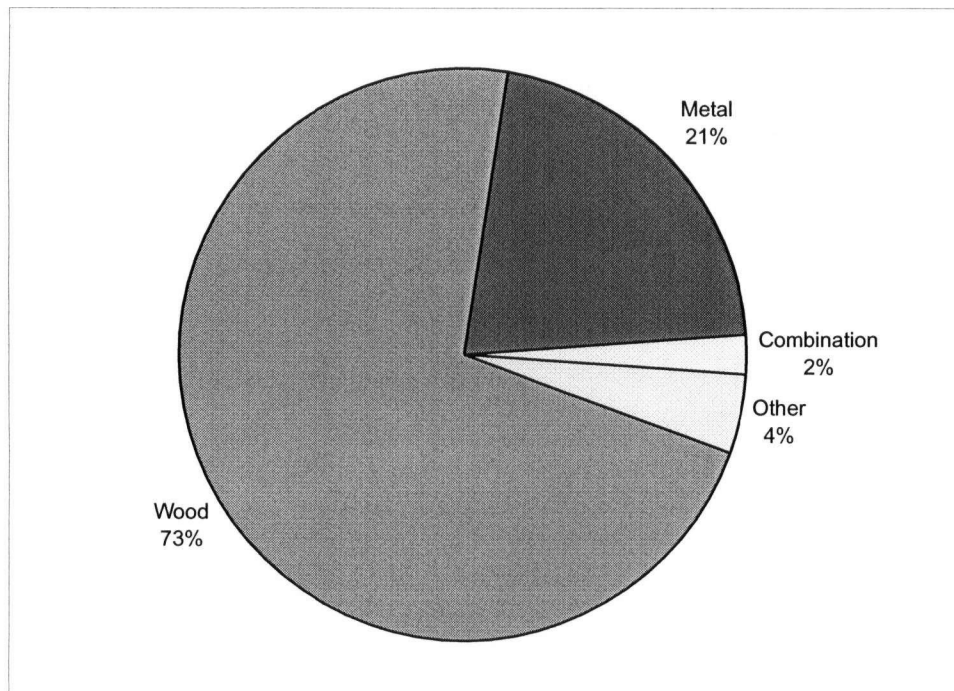
\$US 1 to 9.9 million annually, and thus, did not have the resources and capabilities to market their products abroad.



**Figure 4.22: Companies' geographical market segment (door respondents).**

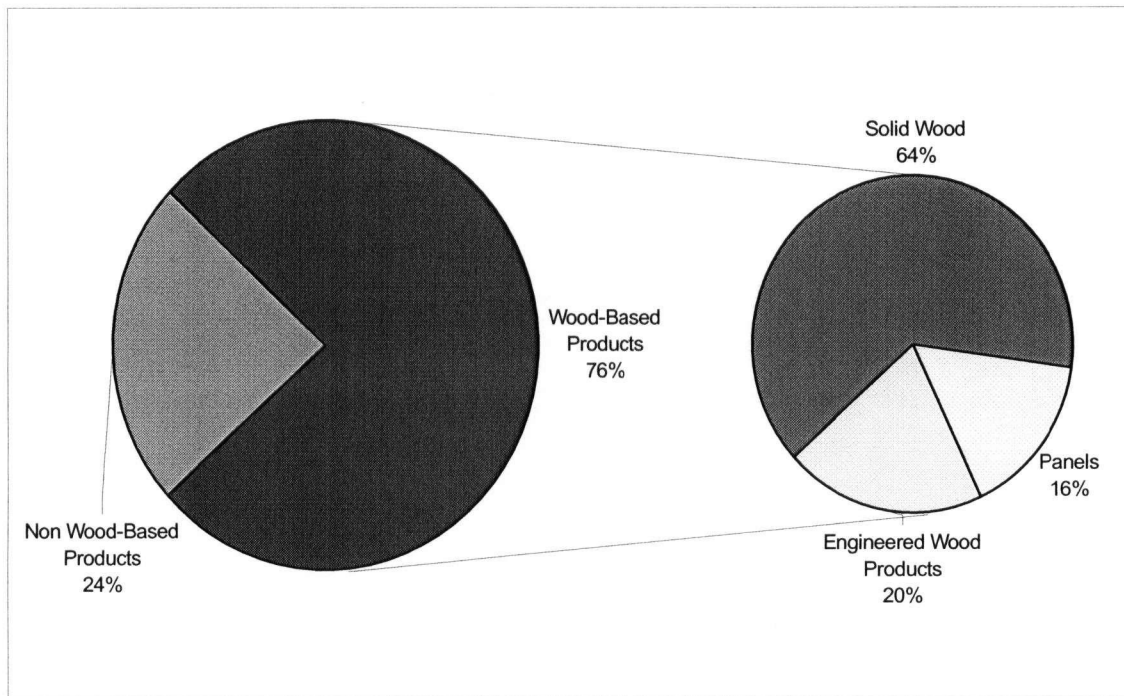
The last two questions in Section I related to raw material use in door production. Figure 4.23 summarizes the major components used by companies in door production. Approximately 73% of raw materials used by door manufacturers included some type of wood product, while 21% of the materials were metal products. There may be an upward bias towards wood use in these results as an effort was made in the sampling procedure to include as many wood door producers as possible. Only 4% of the materials used in door production included a component other than wood or metal. The remaining 2% of materials used in door production included some combination of different materials.





**Figure 4.23: Components used by companies in door production (door respondents).**

Respondents were also questioned on the type and proportion of wood-based and non-wood-based products used in door production. They were specifically asked to evaluate the proportion of solid wood, panels, engineered wood products and non-wood-based products used in their door production. Means were calculated and the results have been summarized in Figure 4.24. Respondents' door production used approximately 76% wood-based and 24% nonwood-based products. Of the total volume of wood-based products used in door production, solid wood products contributed 64%, while engineered wood products contributed 20% and panels made up the remaining 16%. These results indicate that door manufacturers have an obvious preference for solid wood products over wood-based panels.



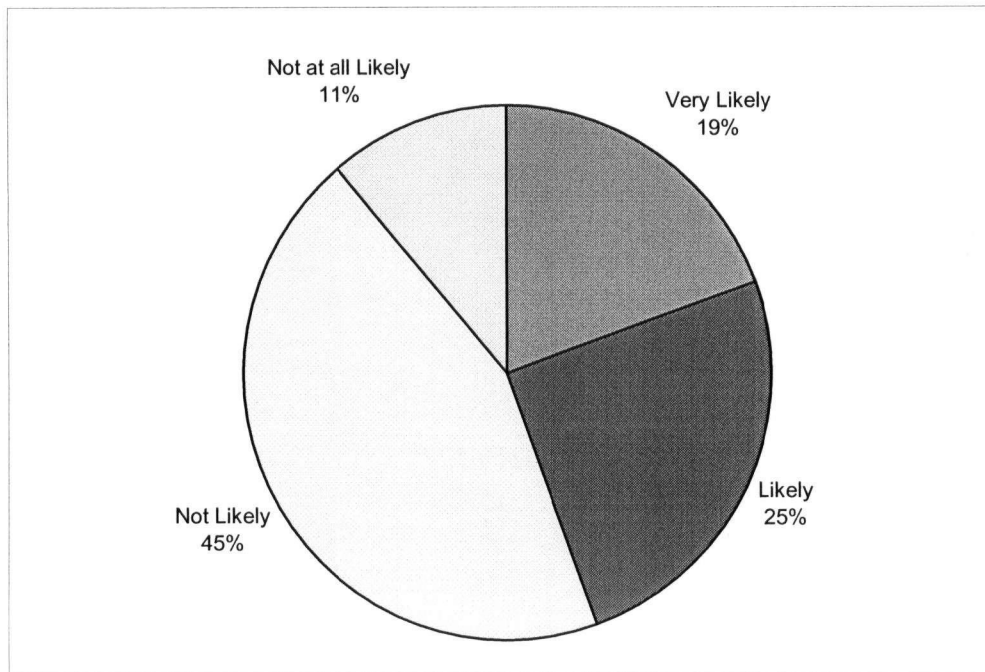
**Figure 4.24: Materials used in door production (door respondents).**

#### ***4.2.2 Materials Used in Doors (Section II)***

Respondents were also asked to give their opinions on product attributes and use, covering issues on product quality, after sales services and various other product issues including price, aesthetics, etc. In addition respondents were asked about the best methods for sharing knowledge within the door industry. Specifically, they were asked whether they had ever substituted one material for another in door manufacturing (Question 1). Results show that approximately 64% of the respondents have never substituted one material for another, while the remaining 36% have at least at one time made a substitution.

The respondents who indicated that their company had made a product substitution were then asked to provide a recent example. Like the furniture results, the responses varied to the extent that it was hard to make any type of classification. However, some of the more popular responses included “particleboard to solid lumber and MDF”, “solid wood to various types of veneered wood products and strand lumber”. The follow-up question asked respondents to state whether they were actually thinking of making yet another switch within the next three years. Mean proportions were computed and the results summarized in Figure 4.25. Approximately 56% of the respondents indicated to some degree that they had no intention of making another switch, while 44% noted that it

was a possibility. Thus, opportunities do exist for wood-based products such as OSB to be introduced as a component to those companies interested in exploring new products.



**Figure 4.25: Likelihood of another material substitution within the next three years (door respondents).**

Respondents were also given a list of product attributes and asked to rate their level of importance when making final purchasing decisions (Question 4). A ten-point numerical scale was used to measure the importance of these product attributes, with 1 being “not at all important” and 10 being “extremely important”. Means for each attribute were computed and the results are summarized in Figure 4.26. A one-way ANOVA test ( $\alpha = 0.05$ ) was conducted using MINTAB and confidence intervals were constructed. Four product attributes, “brand name (4.3)”, “environmental friendliness (6.4)”, “safety of installed product (7.7)”, “price (7.8)”, rated significantly lower than others. The remaining product attributes, “overall quality”, “straightness”, general performance”, “surface uniformity”, “availability/supply”, “service”, “delivery time”, “strength/stiffness”, and “aesthetics”, all rated between 8.5 to 9.5 and warrant attention from door manufacturers.

				Individual 95% CIs For Mean Based on Pooled StDev	
Level	N	Mean	StDev	+-----+-----+-----+-----+-----	
Overall quality	80	9.450	0.884		(-*-)
Straightness	79	9.291	1.252		(-*-)
General performance	80	9.038	1.373		(-*-)
Availability/Supply	80	8.863	1.376		(-*-)
Surface uniformity	81	8.864	1.498		(-*-)
Service	78	8.590	1.937		(-*-)
Delivery time	80	8.588	1.741		(-*-)
Strength/Stiffness	81	8.543	1.878		(-*-)
Aesthetics	81	8.543	1.817		(-*-)
Price	81	7.840	2.283		(-*-)
Safety of installed product	81	7.728	2.707		(---*)
Environmental friendliness	80	6.425	2.859		(-*-)
Brand name	80	4.313	3.145	(---*)	
Pooled StDev =				+-----+-----+-----+-----+-----	
				4.0	6.0 8.0 10.0

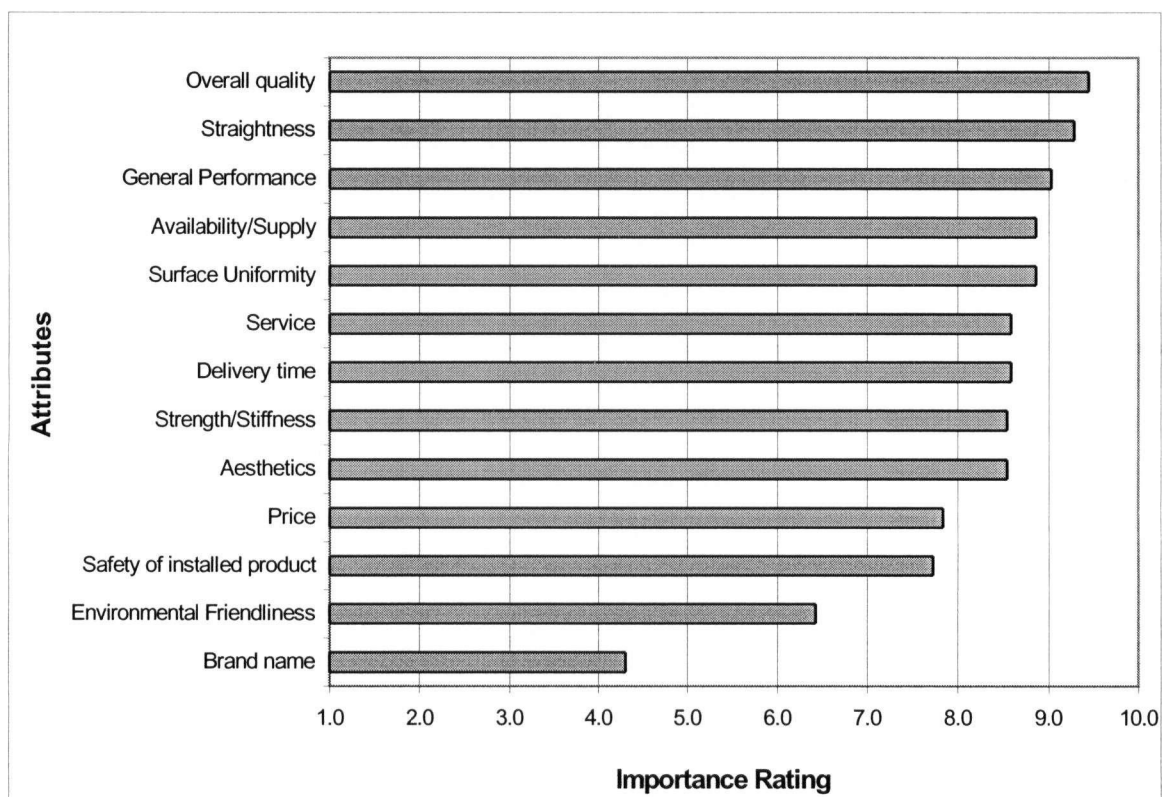
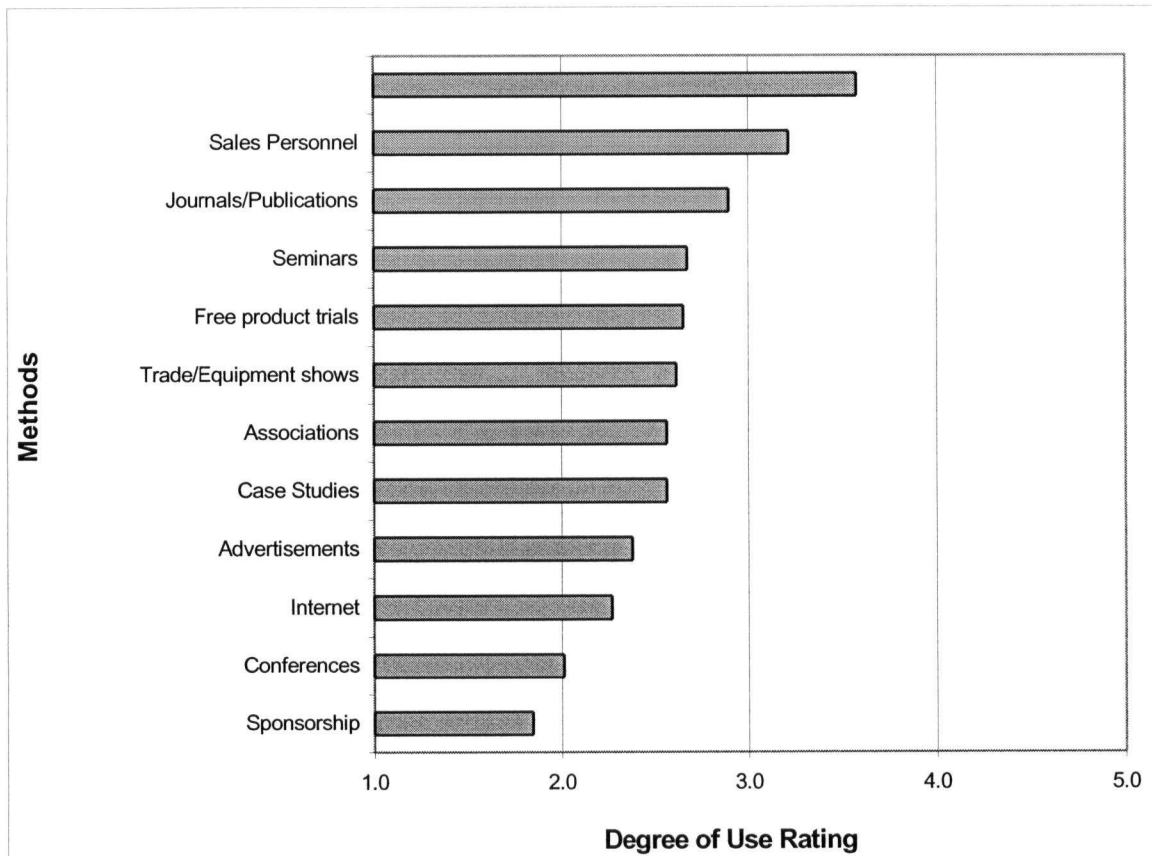
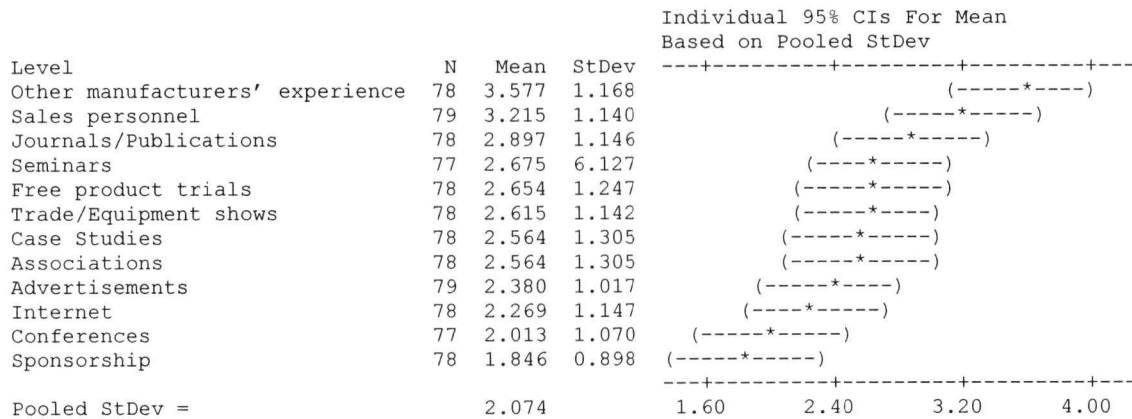


Figure 4.26: Importance of various product attributes to door manufacturers (door respondents).

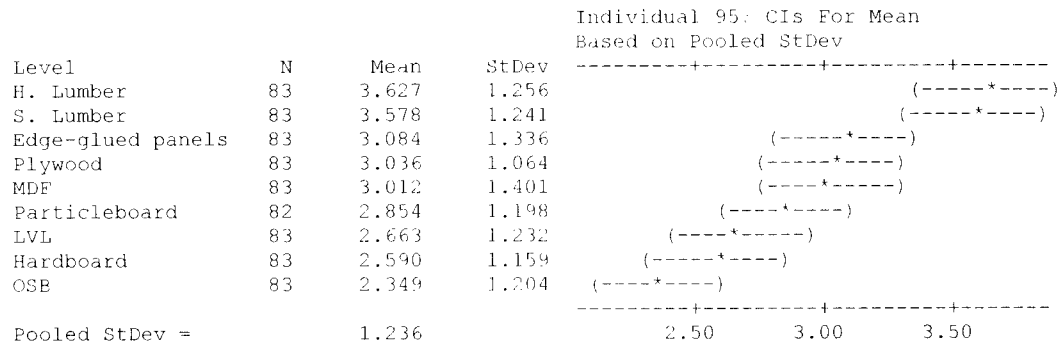
The next objective of the survey was to find the most effective means of developing and disseminating promotional information to the door industry. A five-point numerical scale was constructed as follows: 1= never use; 2 = rarely use; 3, sometimes use; 4, usually use; 5, always use. Using this scale, respondents were asked to indicate the sources of information that they used when deciding to learn more about new materials. Means were computed for each promotional method and the results are seen in Figure 4.27. According to the respondents, the top three methods used for disseminating

promotional information were “other manufacturers’ experience” (3.6), “sales personnel” (3.2), “journals/publications” (2.9). A one-way ANOVA test ( $\alpha = 0.05$ ) revealed no significant difference between these top three promotional methods. As for the remaining promotional methods, ANOVA test ( $\alpha = 0.05$ ) revealed no significant difference among means.



**Figure 4.27: Degree of use of various forms of promotional information (door respondents).**

In the final question of this section, respondents were asked to indicate their level of knowledge regarding various wood products, namely hardwood lumber, softwood lumber, LVL, OSB, plywood, particleboard, hardboard, edge-glued panels, and MDF. A five-point metric scale was used as follows: 1 = not at all knowledgeable; 2 = below average knowledge; 3 = average knowledge; 4 = above average knowledge; 5 = very knowledgeable. The mean results have been summarized in Figure 4.28. A one-way ANOVA test ( $\alpha = 0.05$ ) revealed a significant difference between means of solid wood products (hardwood & softwood lumber) and those of wood-based panel products (plywood, MDF, particleboard, LVL, hardboard, and OSB). Thus, on average, respondents were significantly more familiar with solid wood products than wood-based panel products. These results are also supported by question # 11 in section I as higher volumes of solid wood products (64%) were consumed by door manufacturers than wood-based panels (36%).



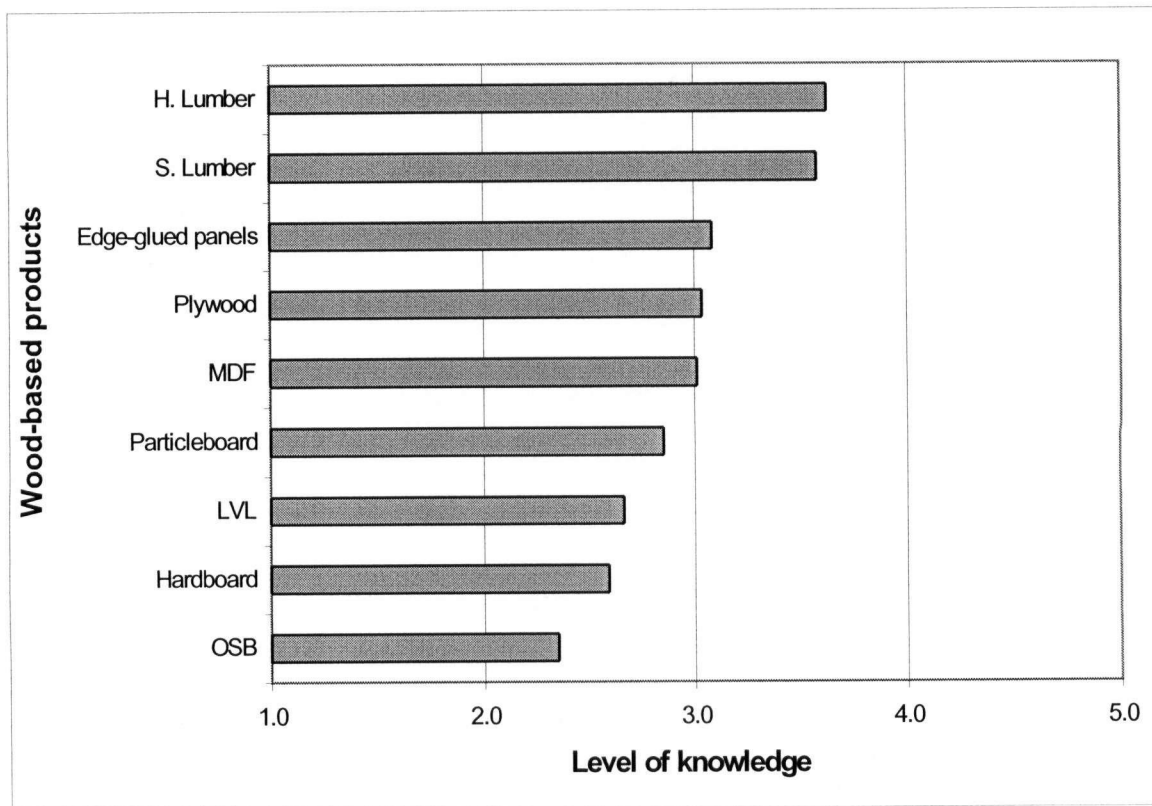
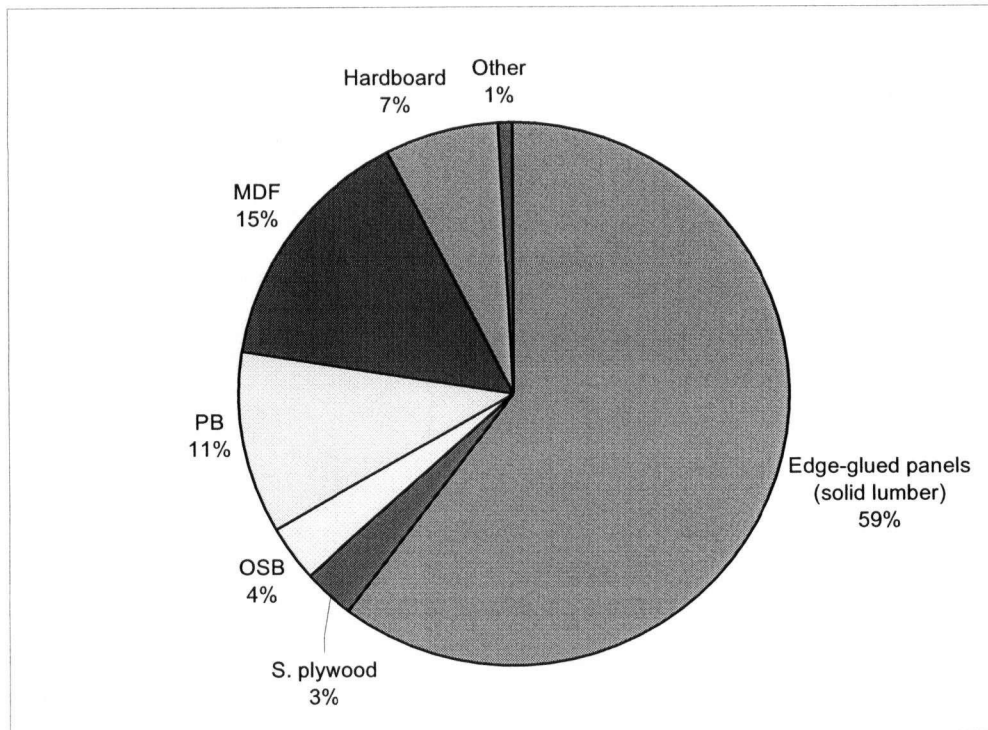


Figure 4.28: Level of knowledge of wood-based products used in doors (door respondents).

#### 4.2.3 Wood Panel Use in Doors (Section III)

In this section, respondents were asked various questions regarding the use of wood-based panels in door manufacturing. First, they were asked to indicate the proportion (by volume) of different types of wood-based products used in their door manufacturing (Question 1). The results, summarized in Figure 4.29, show edge-glued panels (solid lumber) as, by far, being the most commonly used wood-based product at 59%, followed by MDF at 15%, particleboard at 11%, hardboard at 7%, OSB at 4%, and softwood plywood at 3%. Only 1% of the materials used by the respondents did not fit into any one particular category and were therefore categorized as “other materials”. Some respondents mistakenly included some non-wood based products, such as metal, fiberglass, aluminum, in this category. To avoid any type of bias, these erroneous responses were removed and the total was recalculated out of 100%. All the results up to this point seem to indicate that, on average, door manufactures have more knowledge of solid lumber and prefer using it over wood-based panel products.



**Figure 4.29: Wood-based panels used in door manufacturing (door respondents).**

Next, respondents were asked whether they believed their customers cared about the types of panel products that were used in door manufacturing. The findings show that approximately 65% of respondents believed that their customers did care about the type of panel product being used in door manufacturing, while 22% did not. The remaining 13% stated that they did not know whether or not their customers cared about the types of panel product being used in door production.

Respondents' opinions were also solicited on use of wood-based panels in place of solid lumber in door applications. As illustrated in Figure 4.30, approximately 39% of respondents stated that they preferred wood-based panels over solid wood in this context. Some respondents stated that although they personally preferred using wood-based panels, they could not because of their customers' demand for solid wood. For example, one respondent stated that, although using wood-based panels is advantageous, customers need to be educated on these advantages. Also, some respondents mentioned that because they produced custom-made doors, using wood-based panels was not acceptable by their customers at the high end of the market. However, those same respondents stated that they had positive opinions of wood-based panels.



Perhaps one of the major reasons for low volumes of wood-based panels used in door manufacturing is due to low customer (end-user) demand in that sector. On the other hand, there seems to be a common underlying reason behind both furniture and door manufacturers' positive attitudes toward wood-based panels, most of which have already been discussed in the furniture section. In addition, one respondent stated that engineered-type stiles, rails, and panels are the most stable type of wood doors available in the market today.

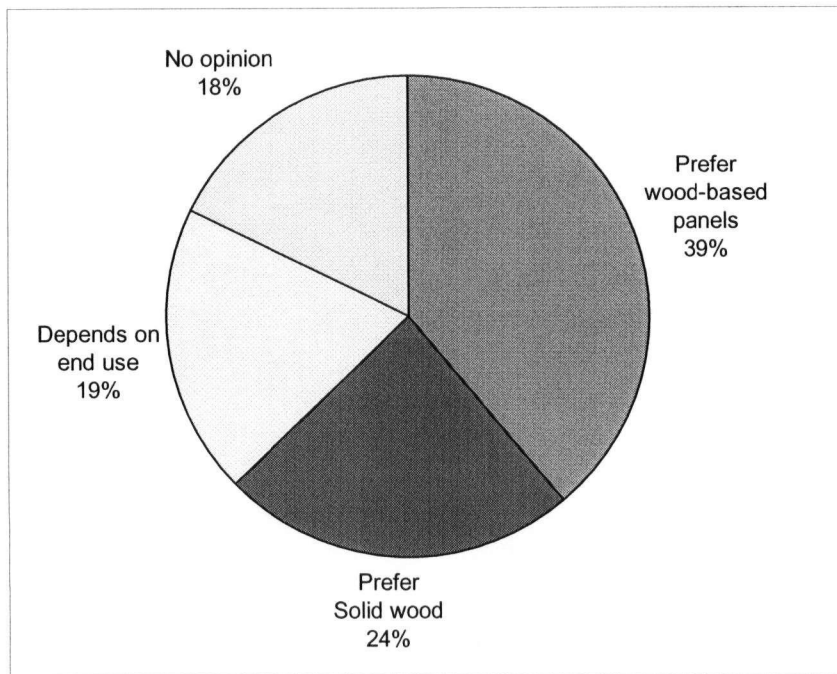
Approximately 24% of the respondents stated their preference for solid wood over wood-based panels. One of the main reason for door manufacturers' high consumption rate of solid wood is customer demand at the high end of the market. Other reasons behind this have been identified as follows:

- Too many veneer failures.
- Poor aesthetics associated with wood-based panel products.
- Panels absorb moisture over time, causing doors to warp, rot, and delaminate.

About 19% of respondents stated that the use of solid wood or wood-based panels depends on many different factors, some of which have been identified as follows:

- Overall design, application type, target market, and end use.
- For paint grade doors, wood-based panels are fine.
- For stain grades, solid hardwoods are best.
- The type of wood-based panel being used is a major factor: i.e., particleboard has unfavorable strength/weight ratio and limited resistance to mechanical fatigue. On the other hand, plywood has good all around attributes.

Lastly 18% of the respondents said that they had no opinion on this topic.



**Figure 4.30: Door manufacturers' opinion on the use of wood-based panels versus solid wood (door respondents).**

Next, respondents were asked to rank the top five panel product attributes in order of preference. The adjusted rank score for each product attribute was obtained by weighting the ranks in the same manner as with the office furniture survey (Section III). Results can be seen in Figure 4.31. Again, although the scores are statistically meaningless as the points have been arbitrarily assigned, they do serve a practical purpose, in showing the relative importance of each product attribute to door manufacturers. The top five product attributes according to door manufacturers, in order of importance are: quality, aesthetics, price, durability, and general performance.

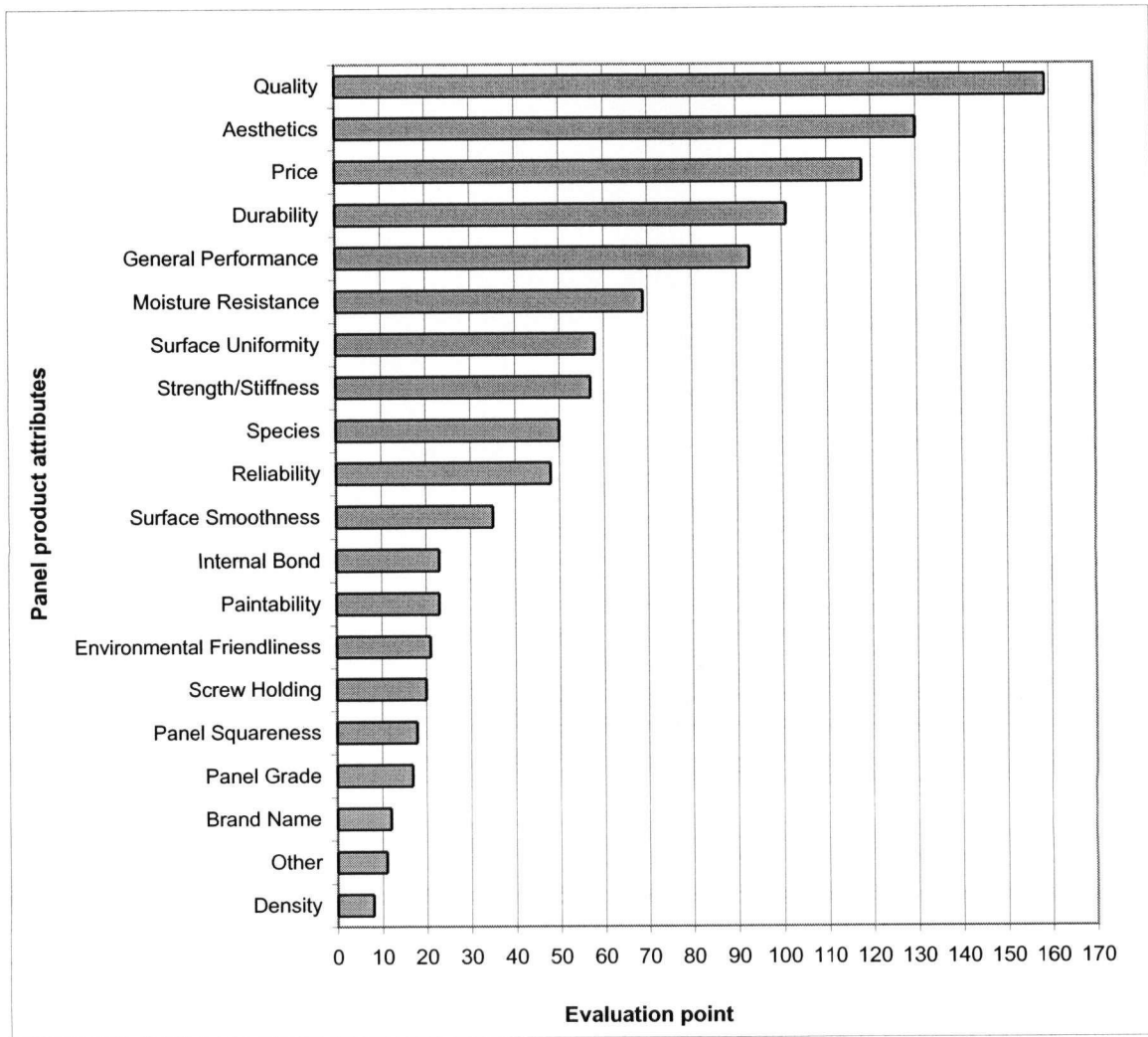
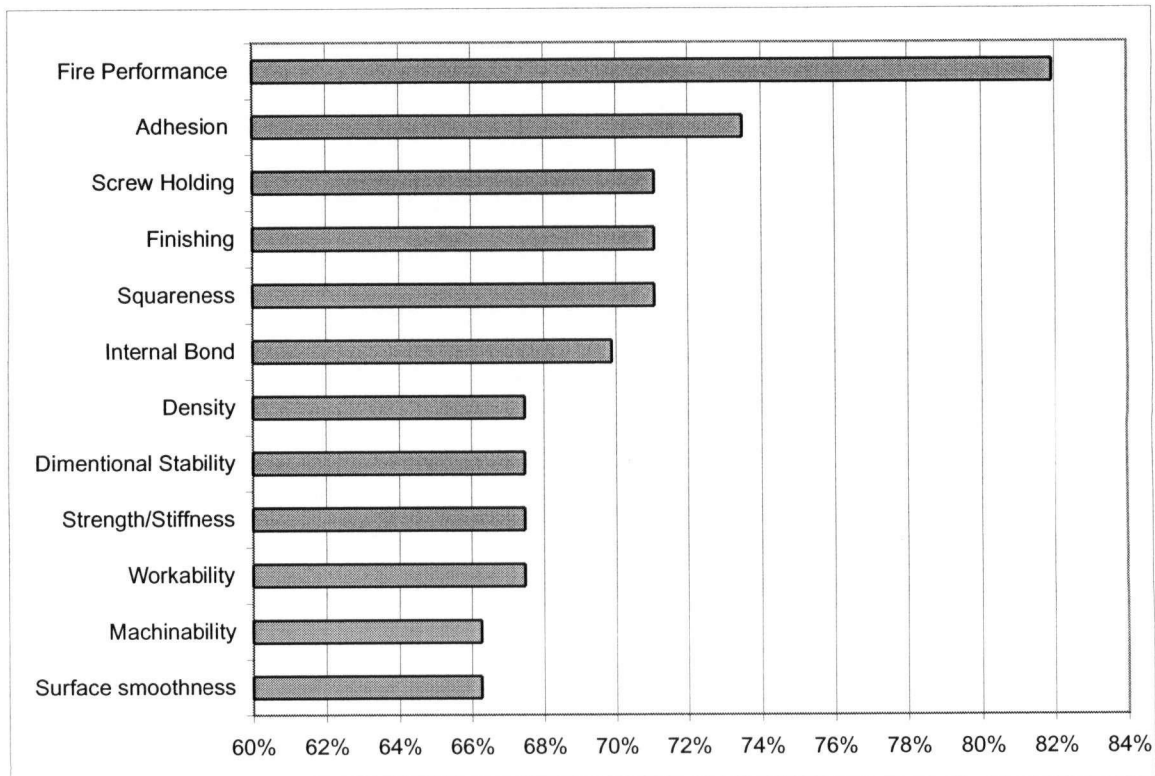


Figure 4.31: Top panel product attributes as they pertain to door manufacturing (door respondents).

#### 4.2.4 OSB Use in Doors (Section IV)

In this section, respondents were asked various questions regarding their perceptions of OSB and its attributes. Eleven attributes were listed and respondents were asked to rate OSB's performance level using a five-point interval rating scale ranging from "very poor (1)" to "excellent (5)" (Question 1). In the second part of the same question, respondents were asked to indicate the importance of each of those attributes in door production. A five-point rating scale was used ranging from "not at all important (1)" to "extremely important (5)". For those respondents who were not familiar with OSB and its performance level, they were asked to check the "don't know" category. The results have been summarized in Figure 4.32. Depending on the attribute in question, between 66% to 82% of the respondents surveyed were not aware of OSB's performance. These

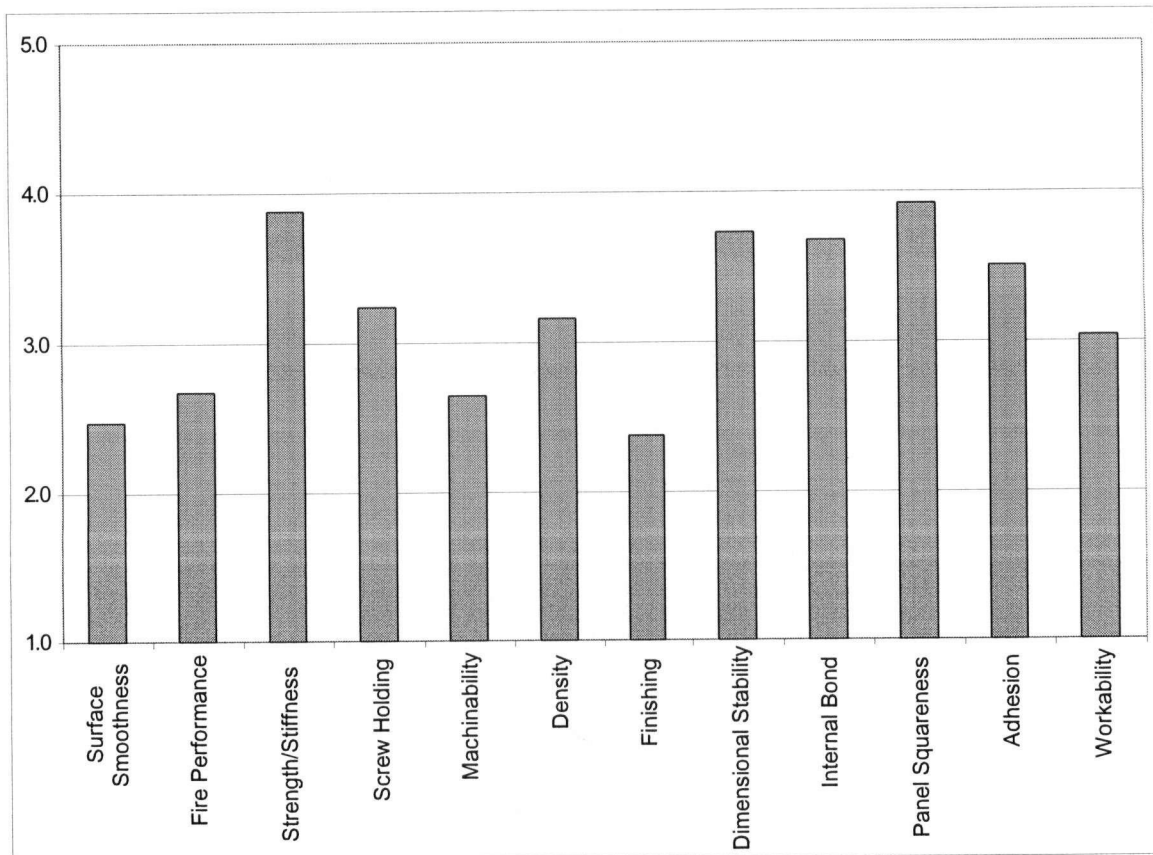
results are alarming in that they show that a high proportion of door manufacturers are unfamiliar with OSB's performance level on various important attributes.



**Figure 4.32: Proportion of respondents that do not know OSB's performance levels on various attributes (door respondents)**

For those respondents able to rate OSB's performance levels and the importance of each product attribute, the mean results have been summarized in Figure 4.33. A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB revealed that the majority of respondents believed OSB's performance level to be significantly higher for the top four attributes compared to the bottom four attributes. On average, OSB scored significantly higher on the attributes of "strength" (3.9), "panel squareness" (3.9), "dimensional stability" (3.7), and "internal bond" (3.7) compared to "ease of finishing" (2.4), "surface smoothness" (2.5), "machinability" (2.6), and "fire performance" (2.7).

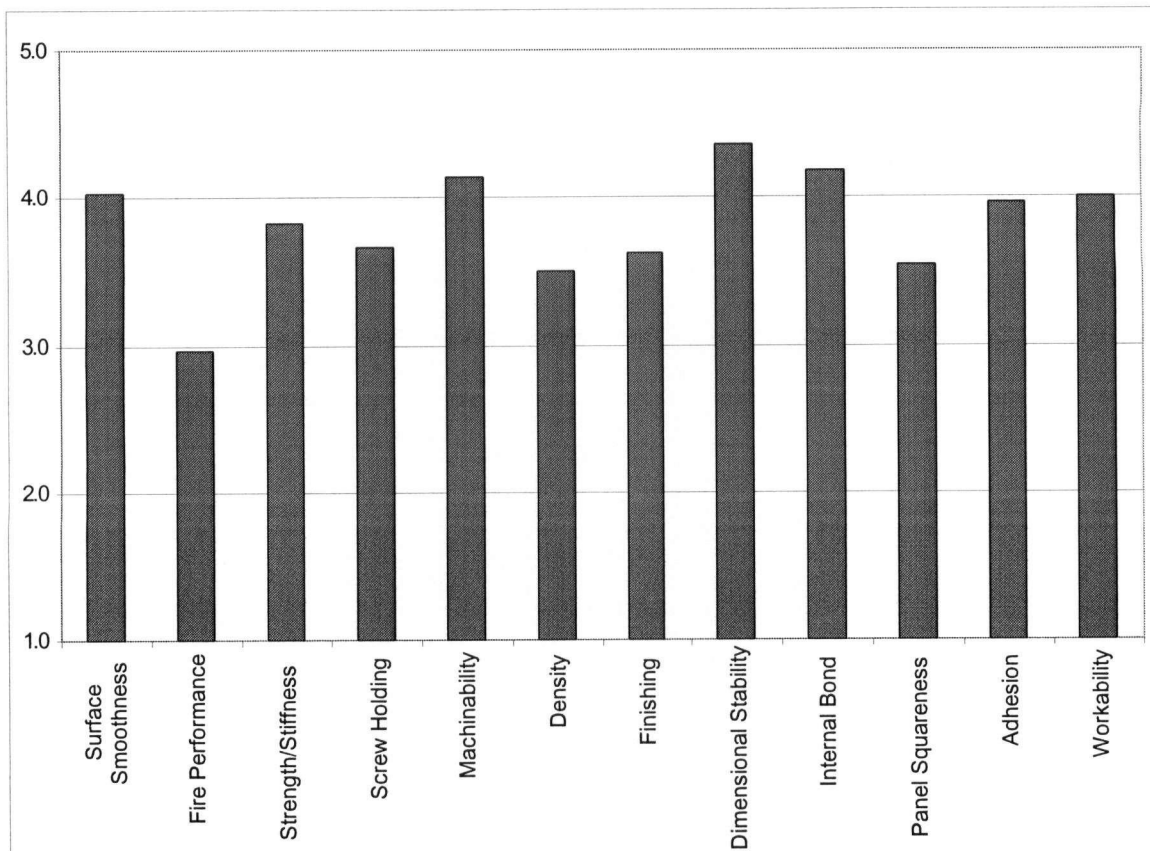
Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
Strength/Stiffness	27	3.889	0.974	(-----*-----)
Panel squareness	23	3.870	0.920	(-----*-----)
Dimensional stability	27	3.741	1.228	(-----*-----)
Internal bond	25	3.680	0.748	(-----*-----)
Adhesion	22	3.500	0.964	(-----*-----)
Screw holding	25	3.240	1.200	(-----*-----)
Density	27	3.148	0.907	(-----*-----)
Workability	27	3.037	1.018	(-----*-----)
Fire performance	15	2.667	1.113	(-----*-----)
Machinability	28	2.643	1.193	(-----*-----)
Surface smoothness	28	2.464	1.319	(-----*-----)
Finishing	24	2.375	1.439	(-----*-----)
Pooled StDev =		1.104		



**Figure 4.33: Performance levels of OSB on various product attributes (door respondents).**

A one-way ANOVA test ( $\alpha = 0.05$ ) was conducted to test for differences in the importance level of various product attributes in door manufacturing. The results in Figure 4.34, there were no significant differences in the importance level of all attributes, with the exception of “fire performance”. On average, respondents indicated that fire performance was significantly less important than the top 7 listed product attributes.

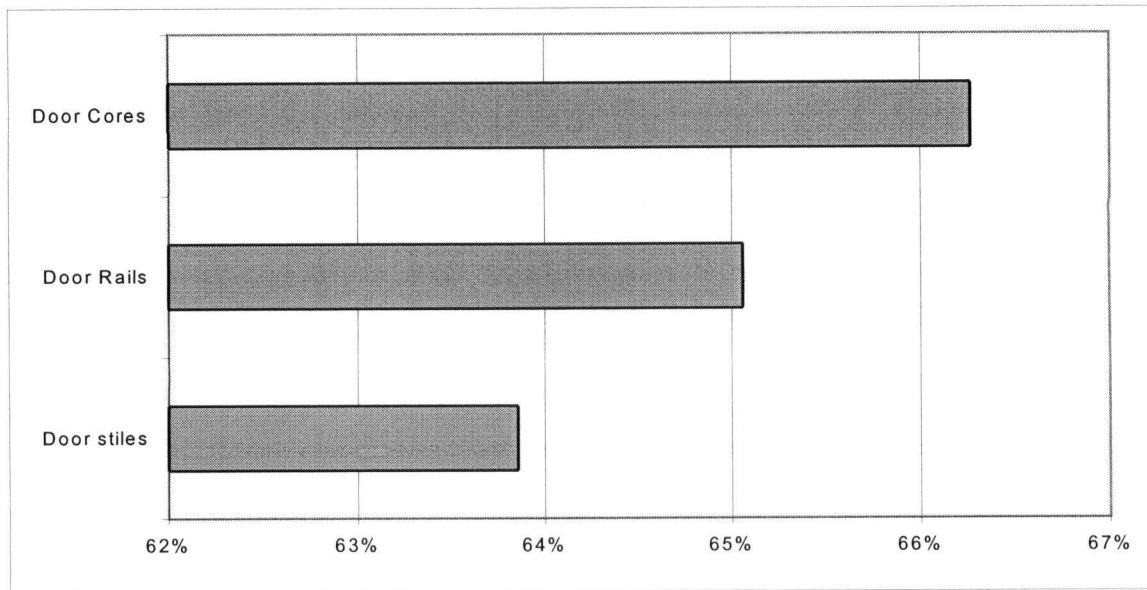
Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
Dimensional stability	28	4.357	1.224	(-----*-----)
Internal bond	28	4.179	0.863	(-----*-----)
Machinability	28	4.143	1.079	(-----*-----)
Surface smoothness	28	4.036	1.138	(-----*-----)
Workability	28	4.000	0.943	(-----*-----)
Adhesion	27	3.963	1.126	(-----*-----)
Strength/Stiffness	28	3.821	0.983	(-----*-----)
Finishing	26	3.615	1.551	(-----*-----)
Screw holding	28	3.607	1.315	(-----*-----)
Panel squareness	28	3.536	1.503	(-----*-----)
Density	26	3.500	1.030	(-----*-----)
Fire performance	25	2.960	1.541	(-----*-----)
Pooled StDev =		1.208		2.80 3.50 4.20 4.90



**Figure 4.34: Importance level of various product attributes to door manufacturers (door respondents).**

Respondents were also asked to rate OSB's applicability in the following door product components: door cores, door rails, and door stiles. A five-point interval rating scale was used to measure the applicability of OSB in the aforementioned door components as follows: 1 = should never be used; 2 = should rarely be used; 3 = should sometimes be used; 4 = should usually be used; 5 = should always be used. Respondents not familiar

with OSB were given the opportunity to check a “don’t know” category. Means were computed and the results have been summarized in Figure 4.35. Depending on the door product under consideration, between 64% to 66% of the respondents were not aware of OSB’s applicability in manufacturing components. Overall, there seems to be a lack of knowledge, awareness and experience between door manufacturers with regards to the application of OSB in various door components.



**Figure 4.35: Proportion of respondents unaware of the applicability of OSB in various door components (door respondents).**

A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB showed that, on average, respondents did not believe OSB to have significantly greater applicability in any one door component.

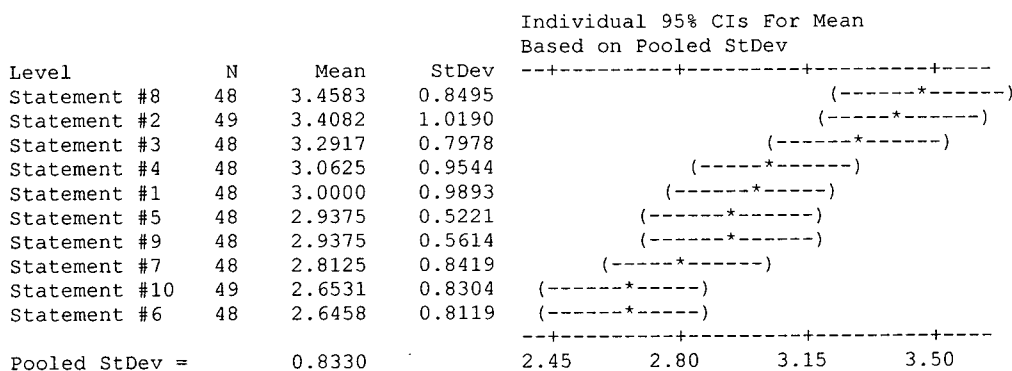
Individual 95% CIs For Mean

Level	N	Mean	StDev	Based on Pooled StDev
Door Cores	28	3.143	1.044	-----+-----+-----+-----+-----+ (-----*-----)
Door Rails	29	2.655	1.317	(-----*-----)
Door stiles	30	2.633	1.402	(-----*-----)
Pooled StDev = 1.267				-----+-----+-----+-----+-----+
				2.40 2.80 3.20 3.60

Respondents were asked to state whether or not they thought that their customers perceived doors made from OSB as being of low, medium, or high quality. For those

respondents not familiar with OSB, a choice was given to withhold their opinion. Approximately one-half (47%) of respondents believed that their customers would perceive doors made from OSB as being low of quality, 14% as being of medium quality, and only 4% as being of high quality. The results also show that a high percentage (35%) of respondents indicated that they did not know their customers' opinion with respect to doors made from OSB.

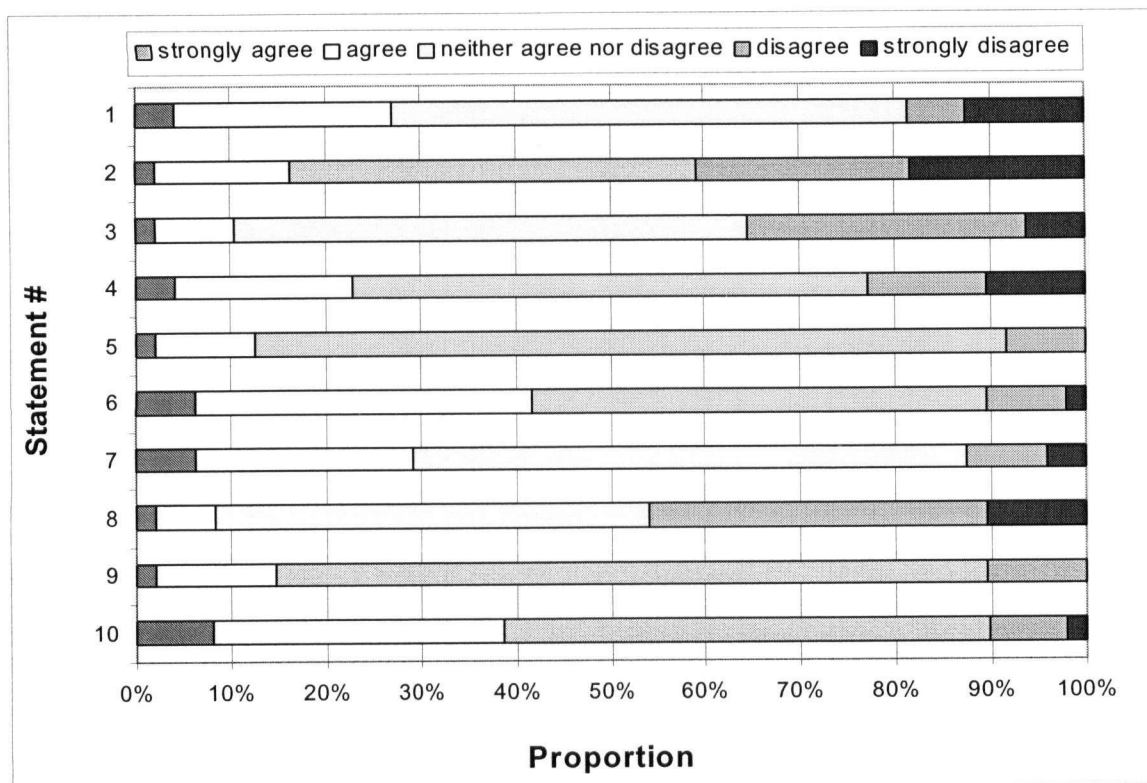
Respondents were also given simple statements pertaining to OSB's use in door manufacturing and asked to indicate their level of agreement with these statements. A five-point Likert scale was used as follows: 1 = strongly agree; 2 = agree; 3 = neither agree nor disagree; 4 = disagree; and 5 = strongly disagree. The mean results were calculated and summarized in Table 4.2. Response patterns have also been summarized in Figure 4.36. A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB was used to check for significant differences among mean responses. Again, the results have been organized in the order from the highest to lowest mean. No significant differences were found between the means of the top four statements: #2, #3, #4, and #8. Therefore, there was a general disagreement with statement #2, "OSB surface does not cause finishing problems", #3 "OSB panels have excellent workability compared to other panel products", #4 "In general, OSB panels do not have good screw holding ability", and #8 "Furniture made from OSB is of higher quality compared to those made from other panels".





	Mean
1. OSB panels made for use in doors tend to have good moisture resistance.	3.00
2. OSB surface does not cause finishing problems.	3.41
3. OSB panels have excellent workability compared to other panel products.	3.29
4. In general, OSB panels do not have good screw holding ability.	3.10
5. OSB panels in use result in low formaldehyde emissions.	2.94
6. OSB panels are strong compared to other panels.	2.65
7. OSB prices are generally stable compared to other panel products.	2.81
8. Doors made from OSB are of higher quality compared to those made from other panels.	3.46
9. OSB panels can be easily connected to other components.	2.94
10. In the near future, OSB will be used more in the door core manufacturing industry.	2.65

**Table 4.2: Respondents' level of agreement with statements regarding OSB use in doors (door respondents).**



**Figure 4.36: Response patterns for respondents' agreement level with statements regarding OSB use in doors (door respondents).**

In the latter part of Section IV, respondents were asked to give any additional comments they had regarding the use of OSB or any other wood-based panel in door manufacturing. Lack of knowledge and experience with OSB was a common response amongst the door manufacturers. Some respondents showed an interest in obtaining further information about OSB products. However, overall there were many complaints about OSB, most of the more common ones being as follows:

- It is too expensive.
- It is too hard on tooling.
- Its surface is not smooth enough for veneer lay-up.
- It has voids on the face which are not acceptable.
- It is too coarse to machine well.
- It has poor paintability.
- It was tested as core material and results were unfavourable.
- It was used in door stiles and it expanded too much and delaminated.
- It requires more engineering.
- Manufacturers may need to design a new OSB product for door applications.

According to these findings, there seems to be obvious negative attitudes toward OSB products. Most respondents have clearly indicated that unless major improvements are made to the product, it is unsuitable for this industrial application.

In the last question, respondents interested in obtaining a free copy of the results were asked to give their mailing address. Approximately 33% of the respondents were so inclined.

#### ***4.3 Comparison of Furniture and Door Manufacturers***

In total, an attempt was made to reach 1,867 door and office furniture manufacturers across North America through facsimile, of which 1619 were reached successfully. The total response rate, calculated using the following equation, was 18.59%:

$$\begin{aligned} \text{total response rate} &= \frac{\# \text{ of completed surveys} + \# \text{ not willing to participate}}{\text{sample size} - \# \text{ of unreachables}} \times 100\% \\ &= \frac{192 + 109}{1867 - 248} \times 100\% = 18.59\% \end{aligned}$$

This response rate included those who either completed the survey or refused to do so.

Alternatively, response rate can be calculated to include only those manufacturers who attempted to complete the survey questionnaire. The results obtained using this methods yielded an adjusted response rate of 11.86%:

$$\begin{aligned}\text{adjusted response rate} &= \frac{\text{\# of completed surveys}}{\text{sample size} - \text{\# of unreachables}} \times 100\% \\ &= \frac{192}{1867 - 248} \times 100\% = 11.86\%\end{aligned}$$

According to the results, less than 20% of both office furniture and door manufacturers had been in business for more than 60 years. Approximately 10% of the companies reported having sales of over \$US 50 million annually. In addition, only 5% of both office furniture and door manufacturers' market extended internationally. These findings indicate that the majority of office furniture and door companies in North American do not have the proper resources nor the capabilities to market their products abroad.

Door manufacturers reported using a higher proportion (73%) of wood products than office furniture manufacturers (57%). Also, there was ample evidence to support the idea that door manufacturers had a stronger preference for solid wood than wood-based panel products. From the total volume of wood products used by door manufacturers, 64% consisted of solid wood and 36% consisted of wood-based panel products. However, for furniture manufacturers the results were the exact opposite. In addition, door manufacturers were found to be more conservative than furniture manufacturers in terms of trying new raw materials for their manufacturing. For example when asked if they had ever substituted one material for another, 64% of door manufacturers stated "never", compared to 52% for furniture manufacturers. When those who made a product substitution were asked if they were thinking of making another within the next three years, 56% of door manufacturers responded negatively, compared to 42% for furniture manufacturers. These results indicate that perhaps office furniture manufacturers have a more ready acceptability for new panel products (i.e. OSB) compared to door manufacturers.

A list of thirteen product attributes were presented to respondents, covering issues on product, quality, and after sales (Section II, Question 4). Respondents were asked to rate their level of importance on a ten-point numerical scale. Results showed that all manufacturers rated overall quality as being the most important product attribute, and environmental friendliness and brand name as least important. A one-way ANOVA test ( $\alpha = 0.05$ ) using MINITAB revealed statistically significant differences only between the most and the least important product attributes. This finding indicate that both door and office furniture manufacturers are more concerned about using a product that has good overall attribute and quality rather than a product that has a famous brand name or if it has been harvested from an environmentally friendly forest. Thus, one can assume that most manufacturers are inclined to pay extra for a good quality product, rather than for a famous brand name, or an environmentally friendly product.

Another objective of this study was to find the most effective means of disseminating promotional information to wooden office furniture and door manufacturers. Respondents were given a list of twelve promotional methods and asked to rate their degree of use (Section II, Question 5). The top three promotional methods according to door and furniture manufacturers were other manufacturers' experience, sales personnel, and journals/publications. Conversely, the least effective means of disseminating promotional information were through sponsorship, conferences, and internet. The only major difference between the door and furniture manufacturers' responses was in the importance level of seminars. For door manufacturers, seminars was rated as the fourth most important method of obtaining information, whereas for furniture manufacturers, seminars were rated as the second least important method of obtaining information. These findings tend to indicate that direct personal communication methods tend to be more effective with office furniture and door manufacturers rather than indirect methods such as internet, conferences, etc.

Respondents were asked to rate their level of knowledge with respect to various wood-based products as they pertained to their manufacturing items. Both door and furniture manufacturers were most familiar with hardwood lumber and least familiar with OSB. However, with respect to panel products such as plywood, particleboard and MDF, it was found that furniture manufacturers had significantly higher knowledge compared to door manufacturers. The follow up question asked manufacturers to state the proportion (by volume) of various wood-based panels used in their manufacturing firm. From the total

volume of panels consumed by furniture manufacturers, plywood, particleboard, and MDF accounted 71%. On the other hand, the proportion of plywood, particleboard and MDF used by door manufacturers was 29% of all wood-based products consumed. This explains furniture manufacturers' higher familiarity with non-solid wood panels. The proportion of edge-glued panels (solid lumber) used by furniture manufacturers was 19%, whereas for door manufacturers the proportion of edge-glued panels used was 59% relative to their total panel consumption. These are very strong evidence to suggest that office furniture manufacturers have higher preference for non-solid wood panels compared to door manufacturers, who prefer mostly solid wood products.

Respondents were then asked their opinion on whether consumers cared about which type of panels were used in manufacturing. In total, 44% of furniture manufacturers stated that their customers cared about the type of panels being used in the manufacturing process, compared to 65% for door manufacturers. Perhaps this is another reason why more door manufacturers are paying extra money for solid lumber rather than choosing to use more economical composite panel products such as particleboard and MDF. Respondents were also questioned on their opinion regarding the use of wood-based panels instead of solid lumber. Not surprisingly, 77% of furniture manufacturers stated that they preferred using wood-based panels over solid wood. In comparison, 39% of door manufacturers stated that they preferred using wood-based panels over solid lumber. High customer demand for solid wood was the main reason for door manufacturers' preference for solid lumber.

In the last question of section III, both door and furniture manufacturers were asked to rank the top five panel product attributes, taking into consideration their manufacturing needs. Not surprisingly, price and quality were ranked in the top three as the most important selection criteria. For door manufacturers, aesthetics was ranked second overall, whereas for furniture manufacturers aesthetics was ranked eighth. This was the most noticeable difference between the door and furniture manufacturers' responses. Considering door manufacturers' high preference for solid lumber, it is not surprising that aesthetics was ranked very highly. In general, solid wood is considered aesthetically more appealing than composite panels.

The last section of the survey questions that were asked related to the use of OSB in manufacturing of doors and furniture. More specifically, questions pertaining to

respondents' perceptions of OSB and its attributes were asked. The results revealed that a high percentage of manufacturers had no knowledge or experience with OSB products. In the case of furniture manufacturers, depending on the application type, the range of respondents not aware of OSB's performance level was between 55% and 64%. In comparison, for door manufacturers this range was between 66% to 82%. However, those who did rate OSB's performance level indicated serious problems with the product that need to be taken into consideration. A high number of respondents indicated problems with OSB's surface smoothness, ease of finishing, and machinability, just to name a few examples. In general most respondents felt that OSB's general performance did not quite meet up to their standards and expectations.

Respondents were also asked whether they believed their customers perceived doors and furniture made from OSB as low, medium, or high quality. Over one-quarter of respondents did not know what their customers thought of products made from OSB. Approximately half of the respondents thought that furniture and doors made from OSB would be considered to be of low quality, compared to only 4% who thought it would be of high quality. In addition, respondents were given an open ended question for additional comments on the use of OSB or any other wood-based panel products. In general, most comments on OSB were negative in nature. For example, some of the more common complaints included OSB's high price, and its many technical problems, such as poor surface quality, swelling problems, and poor machinability. These results should be very alarming to some OSB manufacturers who are seeking opportunities to penetrate the industrial market. OSB manufacturers have a lot of hard work ahead of them in order to boost their image and become as competitive within the office furniture and door markets as they are in the home sheathing market.

#### ***4.4 Multivariate Data Analysis***

Two types of multivariate statistics were employed as a means of better understanding underlying similarities amongst the respondents and uncovering variable market segments. The two types of analyses used were cluster analysis and discriminate function analysis. Each is discussed in turn. Note that, the office furniture and door manufacturers surveys were collapsed (together) for the purpose of these analyses.

#### 4.4.1 Cluster Analysis

Cluster analysis was performed on the importance of various product attributes (Question #4 of Section II). The purpose of this analysis was to group companies with similar characteristics into clusters. Cluster analysis functions by moving objects (i.e., companies) around from cluster to cluster with the goal of minimizing the within-cluster variance and maximizing the between-cluster variance (Statistica, 1995). Using the K-means clustering method, four clusters of companies were created based on shared similarities in perceptions of product attributes. In other words, product attributes were used to group companies into clusters, giving each a cluster membership.

The results showed that 46 companies belonged to cluster # 1, 39 to cluster #2, 62 companies to cluster #3, and 29 companies to cluster #4. One-way ANOVA tests ( $\alpha = 0.05$ ) were then conducted using MINITAB to determine whether any differences between the four groups of companies exist. For this purpose, four separate variables under company information in Section I were selected and four ANOVA tests were conducted to see if any differences existed between the four clusters of companies.

First, the four clusters were tested on the average number of years that they have been manufacturing doors and furniture (Question 4, Section I):

				Individual 95% CIs For Mean Based on Pooled StDev	
Level	N	Mean	StDev	-----+-----+-----+-----	
Cluster1	43	27.09	28.63	(-----*-----)	
Cluster2	39	30.94	25.10	(-----*-----)	
Cluster3	61	34.69	32.26	(-----*-----)	
Cluster4	26	34.71	30.75	(-----*-----)	
Pooled StDev = 29.59				-----+-----+-----+-----	
				24.0 32.0 40.0	

The one-way ANOVA test ( $\alpha = 0.05$ ) revealed no significant differences between the number of years that the four group of companies manufactured doors and furniture.

Next, groups were tested on the proportion (%) of sales marketed nationally (Question 9, Section I):

				Individual 95% CIs For Mean Based on Pooled StDev	
Level	N	Mean%	StDev%	-----+-----+-----+-----	
Cluster1	46	32.17	35.45	(-----*-----)	
Cluster2	39	29.10	34.85	(-----*-----)	
Cluster3	62	37.74	36.98	(-----*-----)	
Cluster4	28	30.86	40.55	(-----*-----)	
Pooled StDev = 36.72				-----+-----+-----+-----	
				20 30 40 50	

The one-way ANOVA test ( $\alpha = 0.05$ ) revealed no significant differences between these proportions.

Third, the four clusters were tested on the proportion (%) of furniture and doors made from wood products (Question 10, Section I):

				Individual 95% CIs For Mean Based on Pooled StDev
Level	N	Mean%	StDev%	
Cluster1	46	70.17	38.89	(-----*-----)
Cluster2	39	67.06	37.86	(-----*-----)
Cluster3	62	69.98	40.37	(-----*-----)
Cluster4	28	79.61	32.38	(-----*-----)
Pooled StDev = 38.25				60 72 84 96

The one-way ANOVA test ( $\alpha = 0.05$ ) revealed no significant differences between these proportions.

Finally, the four clusters were tested on the proportion (%) of solid wood that they used in manufacturing doors and furniture (Question 11, Section I):

				Individual 95% CIs For Mean Based on Pooled StDev
Level	N	Mean%	StDev%	
Cluster1	46	30.07	34.01	(-----*-----)
Cluster2	39	41.57	38.43	(-----*-----)
Cluster3	62	37.56	38.25	(-----*-----)
Cluster4	28	36.32	33.10	(-----*-----)
Pooled StDev = 36.43				20 30 40 50

Again, the one-way ANOVA test ( $\alpha = 0.05$ ) revealed no significant differences between these proportions.

According to the one-way ANOVA tests ( $\alpha = 0.05$ ), no significant differences were found between the cluster means with respect to all the company characteristics mentioned above. Therefore, it is reasonable to assume that the final results cannot be used to effectively segment the population for marketing purposes.

#### 4.4.2 Discriminate Function Analysis

Discriminate analysis is the appropriate statistical technique to use for solving a problem that involves predicting a categorical (nominal or nonmetric) dependent variable with several metric independent variables (Hair et al., 1998). The result will then



determine which independent variables discriminate between the categorical dependent variable. The purpose of this test from a marketing point of view was to discriminate between companies that have substituted one material for another in the past versus those that did not make any such substitution (the dependent variable). This information can then be used in developing appropriate marketing strategies for companies that are amenable to product substitution and companies that are not. Three independent variables were tested to see which variables discriminated most between companies that substituted versus those that did not:

- 1) Number of years manufacturing doors or furniture (Question 4, Section I)
- 2) Proportion of wood used as a major component (Question 10, Section I)
- 3) Proportion of panels used in production (Question 11, Section I)

Results (from Statistica) have been partially summarized in Table 4.3. The proportion of panels used in production of doors or furniture loaded first and had the most significant affect, followed by number of years manufacturing doors or furniture and finally the proportion of wood used as major component. Wilks' Lambda is the standard statistic used to test the statistical significance of the discriminatory power of the model (Statistica, 1995). Its value will range from 1.0 (no discriminatory power) to 0.0 (perfect discriminatory power). The partial Wilk's Lambda looks at the unique contribution of the respective variable to the discrimination between groups. In this example, the Wilk's Lambda for each of the independent variables calculated is approximately one, meaning that none of the variables had any significant contribution to the overall discrimination. Thus, the end result can not be used to discriminate between companies that readily substitute versus companies that do not.

Discriminant Function Analysis Summary						
Step 3, N of vars in model: 3; Grouping: SUB (2 grps)						
Wilks' Lambda: .96866 approx. F (3,182)=1.9626 p< .1212						
	Wilks'	Partial	F-remove			1-Toler.
	Lambda	Lambda	(1,182)	p-level	Toler.	(R-Sqr.)
%PANEL	0.99657	0.971992	5.244292	0.023166	0.97817	0.02183
#YEARS	0.97034	0.998267	0.315938	0.57475	0.999657	0.000343
%WOOD	0.96891	0.99975	0.045518	0.831292	0.977981	0.022019

Table 4.3: Summary of the Discriminate Function Analysis.

In addition, the summary results reveal no significant correlation between the independent variables. The results of pooled within-groups correlations are seen in table 4.4 below.

Pooled Within-Groups Correlations			
	#YEARS	%WOOD	%PANEL
#YEARS	1	-0.02	0.01
%WOOD	0-.02	1	0.15
%PANEL	0.01	0.15	1

**Table 4.4: Summary of pooled within-group correlation.**

Given that the discriminate function analysis test produced no significant results, an alternative approach was employed. Those companies that had made a product substitution were manually compared to those that had not made any substitution, using the three aforementioned variables. The two-tailed t-test conducted on the first variable “number of years manufacturing doors or furniture”, revealed no significant difference between the two set of respondents at the  $\alpha = 0.05$  level. Also, the z-tests performed on the two latter variables “proportion of wood used as a major component”, and “proportion of panels used in production”, revealed no significant difference between those that substituted and those that did not.

## Chapter 5

### Discussion and Conclusion

In the last few decades, North American forest companies' access to high quality wood fiber has decreased significantly. The advantage of using OSB is that it can be made from low quality trees with fast growth rates. Aspen and yellow pine are two examples of fast growing trees that are used in the production of OSB products. However, the end result is an engineered wood panel that is more stable, uniform and lower priced than solid wood.

This survey showed that most industrial manufacturers are content with the general performance of wood-based panels in comparison to solid wood products. The majority of door and furniture manufacturers stated that wood-based panels are more economical, environmentally friendly, and available. Technically, wood-based panels were found to be more stable, uniform, durable, consistent, and defect-free than solid wood. These are just a few of the positive comments that door and furniture manufacturers had pertaining to panels.

Of the 1867 surveys faxed out, 248 did not reach their final destination. Of those successfully contacted, 192 returned usable surveys, resulting in an adjusted response rate of approximately 12%. Given that industrial surveys typically have response rates ranging from 10 to 35% (Kozak, 2000 & Wu et al, 2000), a response rate of 12% is acceptable, albeit slightly on the low side.

The first objective of this study was to measure North American office furniture and door manufacturers awareness, use, and perception of OSB as an industrial material. The findings showed that for both office furniture and door manufacturers, the level of knowledge for OSB was the lowest compared to any other competing material. Office furniture manufacturers, on average, had higher levels of knowledge of wood-based panel products compared to door manufacturers, who seemed to be more familiar with solid wood products. Door manufacturers, unlike office furniture manufacturers, consumed solid wood products more than wood-based panels. Of the total volume of wood products consumed by door manufacturers, solid wood accounted for approximately 64%, while engineered wood products and panels accounted for the remaining 36%. These results are the exact opposite of those found for office furniture manufacturers.

This indicates that perhaps office furniture manufacturers have a more ready acceptability for wood-based panel products than door manufacturers who have higher preference for solid wood. However, in the case of OSB, both office furniture and door manufacturers believed that approximately half of their customers would perceive a product made from OSB to be of low quality. This perhaps is also a good reflection of their own feelings and attitudes toward products made from OSB. These results should be alarming for many OSB manufacturers interested in exploring the industrial market. As previously mentioned, of the total volume of OSB manufactured in North America, only 4% is used in the industrial market. Thus, strong marketing efforts are needed to ensure that OSB is well positioned within this highly competitive marketplace.

Many door manufacturers mentioned that their customers demanded high quality solid wood and no substitutes (wood-based products). On the other hand, office furniture manufacturers were more open to the idea of using different wood-based panels (i.e. particleboard, MDF, plywood, etc.) with layers of melamine or veneer covering the surfaces. The study conducted by Wu et al. in a 1997, showed that wood office furniture manufacturers in the southern U.S. consumed 37% solid wood, 58% wood-based panels, and 5% veneers & other products (Wu et. al, 2000). These results are very similar to those found in this study of North American office furniture manufacturers.

Today, most low to medium quality furniture in the market are made from either plywood, particleboard, or MDF with a layer of melamine or veneer covering the surfaces. A good quality veneer serves to increase the market value of a furniture product and gives it aesthetic qualities comparable to that of high-end solid hardwood furniture, but at a much lower cost. Many manufacturers mentioned that by using wood-based panels, they get a product that is more stable, uniform, durable, consistent, and less defective than solid wood products. All of these attributes, along with excellent economical value, make wood-based panels a sensible choice for many manufacturers. Even some door manufacturers acknowledged the excellent attributes of wood-based panels, at the same time they mentioned that they had no choice but to use solid wood, due to high customer demand – end-users still believe that solid wood products are superior to wood-based panels. As one respondent simply put it, “education is perhaps the best tool for informing end-users of the excellent properties of wood-based panels.” In general, door manufacturers were found to be more conservative in their ways of thinking and behavior in terms of wood use. For example, they were more reluctant to

try new products compared to furniture producers. Approximately 64% of the door manufacturers surveyed have never substituted one material for another, compared to 52% for furniture manufacturers. Regardless of being a furniture or door manufacturer, all respondents unanimously indicated that a product with excellent overall quality was more important to them than any other product attribute. On the other hand, they indicated that using a product with a well known brand name was the least of their concerns. Environmental friendliness was also ranked significantly lower than other product attributes. Thus the OSB producers should focus their attention on qualities seen as important by door and furniture manufacturers rather than products with a famous brand name or those advertised as being environmentally friendly.

The next objective was to find the most effective means of disseminating promotional information to wood office furniture and door manufacturers regarding OSB's industrial uses. Direct personal communication methods, such as other manufacturers' experience or the use of sales personnel, were found to be the most effective means of promoting information related to new products or materials, whereas indirect methods such as sponsorships, the Internet, or conferences, were found to be least effective. In general, it is easier to gain the attention of a producer when communication is done on a personal level rather than in a group or indirectly.

The final objective of this study was to make recommendations to OSB manufacturers on ways of improving their product based on an analysis of actual and perceived product strengths and weaknesses. In general, both door and furniture manufacturers had very limited knowledge and experience with OSB products. Those with limited knowledge of OSB had very negative attitudes towards the product. Many respondents indicated that unless major improvements were made to OSB, it would be inadequate for use in many industrial applications. OSB is currently considered a commodity product, and according to many respondents, requires much improvement before it can successfully penetrate the value-added marketplace. Some respondents stated that OSB needs to improve on attributes such as surface quality, workability, paintability, swelling, and aesthetics, before successfully entering the industrial market. As one respondent stated, "OSB requires further engineering". Perhaps this statement sums up many industrial manufacturers' reactions towards the use of OSB in the office furniture and door markets.

### ***5.1 Recommendations***

Today, the market share for OSB within industrial sectors is very limited. According to wooden office furniture and door respondents, OSB is presently consumed at a proportion of 3% and 4% within the furniture and door sectors, respectively. In order to increase OSB's use in the marketplace, specific target markets and strategies must be undertaken.

Some potential marketing strategies include, but are not limited to:

- OSB manufacturers must address some of the major technical problems mentioned by many respondents (i.e. surface smoothness, aesthetics, moisture resistance, etc.), prior to entering the competitive office furniture and door markets.
- OSB manufacturers should emphasize OSB's strengths (i.e. strength, dimensional stability, etc.), and ensure that all consumers are aware of them by having brochures and fact sheets in door and office furniture outlets.
- OSB manufacturers need to ensure that their product is price competitive in the marketplace.
- Furniture and doors made from OSB should be displayed in trade shows and show rooms, so that other manufacturers can see the end product in person.
- Partnerships between OSB manufacturers and office furniture and door manufacturers are essential to help introduce OSB to these markets.

### ***5.2 Study Limitations***

Some limitations were encountered in this study. The first limitation was that in the survey of door manufacturers, no distinctions were made between residential entry door manufacturers and residential passage door manufacturers. As mentioned in a study cited in chapter 2, it was predicted that in 1999, 20% of residential entry doors in the US would be made from wood products, whereas 95% of residential passage doors would be made from wood products (Building Component Manufacturing, 1998). These predictions suggest that we are dealing with two independent markets and that distinctions between the two are crucial. Another limitation of this study was that the two surveys did not gather information on respondents' opinions regarding the final cost of product installation. For example, many respondents argued that OSB is more expensive than

other composite panels (i.e. MDF, and particleboard). However, no consideration was made in the survey on the final installation costs of the products. In the case of OSB, no bracing is required, which means that final installation costs may be lower compared to MDF and particleboard. Another limitation of this study was that no explicit questions on industrial buyers' "trade-offs" of attributes were asked (e.g. price vs. quality, appearance vs. strength). In addition, no specific questions on data collection on pricing and on their willingness to pay were asked.

### ***5.3 Future Research***

The major purpose of this study was to provide information to OSB manufacturers interested in penetrating the office furniture and door markets. This study helped evaluate OSB's market position within the sizeable office furniture and door markets. Presently, OSB is at the introductory phase within these industrial markets and in order to expand its market share, a great deal of marketing intelligence is needed. Hopefully, the results will serve as a starting point for OSB producers to develop industry-specific marketing plans which target office furniture and door manufacturers.

Future studies along the same lines are crucial to solve the problem of how end-users feel about OSB products being used in doors and office furniture items. This study helped solve part of the puzzle with respect to how industrial manufacturers perceive OSB products compared to other wood products. However, end-users are also a major factor in this chain and need to be taken into account.

## References

1. Anderson, R.E., Black, W.C., Hair, J.F., and Ronald L. Tatham, 1998. "*Multivariate Data Analysis – Fifth Edition*". Upper Saddle River, New Jersey, United States. pp. 244 – 246.
2. APA – the Engineered Wood Association, 1999. "*Industrial Markets 1998*". Tacoma, WA, United States.
3. Bluman, Allan G., 2001. "*Elementary Statistics: A Step by Step Approach – Fourth Edition*". New York, NY, United States.
4. Building Component Manufacturing, 1998. "*Rebound Forecast for Window and Door Market: AAMA Study Predicts Better Days to Come*". Volume 109: 14 – 16.
5. Crow's Forest Industry Journal (August, 1998). *OSB*. Volume 13, Number 4: 18 – 20.
6. Dutmers, Bob, 1999. "*Haworth Corporation*". Personal Communication.
7. Forbes, Craig L., Sinclair, Steven A., and William G. Luppold, 1993. "*Wood Material Use in the U.S. Furniture Industry: 1990 to 1992*". Forest Products Journal 43(7/8): 59 – 65.
8. Forintek Canada Corporation (October, 1998). "*Wood-based panel products*". Vancouver, BC, Canada.
9. G & M Enterprises, LLC., 1998. "*Oriented Strand Board (OSB)*". Internet Site: <http://www.unihome.com/OSB.htm> (no longer exists).
10. Industry Canada, 1998. Internet Site: <http://www.strategis.ic.gc.ca>
11. Kozak, Robert A., 2000. "*Wood Science Course, 463*". University of British Columbia, Vancouver, BC, Canada.
12. Magnuson, Blair, 1999. "*Ainsworth Lumber Corporation*". Personal Communication.
13. NAHB Research Center Inc., 1996. "*Wood Used in New Residential Construction 1995*". Upper Marlboro, Maryland, United States.
14. Statistica, 1995. "*Statistics II*". Volume III: 3063 – 3106; 3165 – 3196.
15. Structural Board Association, 1996. "*OSB Pamphlet*".
16. Thomas Register, 2000. Internet Site: <http://www.thomasregister.com>
17. Umstattd, William D., 1996. "*Modern Cabinetmaking*". The Goodheart-Willcox Company, Inc. Tinley Park, Illinois, USA. (pp. 528, 616-617).



18. West, Cynthia D., and Steven A. Sinclair, 1992. "*A measure of Innovativeness For a Sample of Firms In the Wood Household Furniture Industry*". *Forest Science* 38(3): 509 – 524.
19. Window and Door Manufacturers Association, 2000. "*Membership and Product directory*."
20. Wood Markets, 2000. "*The Solid Wood Products Outlook 2000 to 2004, Section E: Structural Panels*". Vancouver, BC, Canada.
21. Wu, Qinglin and Richard P. Vlosky, 2000. "*Panel Products: A Perspective From Furniture And Cabinet Manufacturers in the Southern United States*". *Forest Products Journal* 50(9): 45 – 50.
22. Zhaozhen, Bao, 1990. "*APA – the Engineered Wood Association*". Personal Communication.

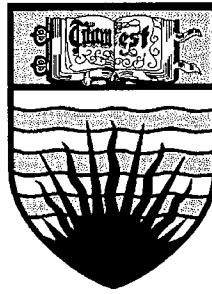
## **Appendix A:**

**Cover Letters  
(4-Point Contact With Office Furniture Manufacturers)**

**Appendix B:**  
**Cover Letters**  
**(4-Point Contact With Door Manufacturers)**

**Appendix C:**  
**Survey Questionnaire**  
**(Fax Questionnaire Sent To Office Furniture Manufacturers)**

*Department of Wood Science  
University of British Columbia*



**SECTION I – COMPANY INFORMATION**

We would like to begin by asking you some general questions about your company and product line.

1. What is your job title? \_\_\_\_\_
2. Please list the top regions (by volume) where you manufactured furniture in 1999.  
[List as many as are applicable]  
State(s)/Province(s) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. How many years has your company been in business? \_\_\_\_\_ Years
4. How many years has your company been manufacturing furniture? \_\_\_\_\_ Years
5. Please indicate your company's total sales in U.S. dollars during 1999. [Please check the appropriate box]
 

<input type="checkbox"/> Less than \$ 1 million	<input type="checkbox"/> \$ 100 million to \$ 499.9 million
<input type="checkbox"/> \$ 1 million to \$ 9.9 million	<input type="checkbox"/> \$ 500 million to \$ 999.9 million
<input type="checkbox"/> \$ 10 million to \$ 49.9 million	<input type="checkbox"/> Over \$ 1 billion
<input type="checkbox"/> \$ 50 million to \$ 99.9 million	
6. What proportion of your total sales includes office furniture and other furniture products? [Total does not have to equal 100%]  
% \_\_\_\_\_ Office Furniture  
% \_\_\_\_\_ Other Furniture Products
7. Which of the following types of furniture does your company manufacture? [Check all that apply]
 

<input type="checkbox"/> Chairs	<input type="checkbox"/> Tables	<input type="checkbox"/> Desks
<input type="checkbox"/> Cabinets	<input type="checkbox"/> Filing Equipment	<input type="checkbox"/> Other [Please specify] _____
<input type="checkbox"/> Bookcase	<input type="checkbox"/> Partitions	<input type="checkbox"/> Other [Please specify] _____
8. Please describe your major market segments for furniture (e.g. geography, retail type, demographics, etc.).  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
9. Approximately what proportion of your markets are the following? [Total should equal 100%]  
% \_\_\_\_\_ Local                      % \_\_\_\_\_ National  
% \_\_\_\_\_ Regional                      % \_\_\_\_\_ International
10. What proportion of your total furniture production has following as major component? [Total should equal 100%]  
% \_\_\_\_\_ Wood                      % \_\_\_\_\_ Combination [Please specify] \_\_\_\_\_  
% \_\_\_\_\_ Metal                      % \_\_\_\_\_ Other [Please specify] \_\_\_\_\_

**KEY**  
1 – Never  
2 – Rarely  
3 – Sometimes  
4 – Usually  
5 – Always

6. Please rate your knowledge level for the following wood-based products as they pertain to furniture.  
[Please check the appropriate box for each product category]

	Not At All Knowledgeable	Below Average Knowledge	Average Knowledge	Above Average Knowledge	Very Knowledgeable
Hardwood Lumber	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Softwood Lumber	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LVL (Laminated Veneer Lumber)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OSB (Oriented Strand Board)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plywood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Particleboard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hardboard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Edge-glued Panels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MDF (Medium Density Fiberboard)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### SECTION III – WOOD PANELS USE IN FURNITURE

We would like to ask you some questions on the use of panels in the furniture industry.

1. What proportion (by volume) of the following do you currently use in the manufacturing of furniture products?[Total should equal 100%]

% \_\_\_\_\_ Edge-glued Panels (solid lumber)

% \_\_\_\_\_ Softwood Plywood

% \_\_\_\_\_ OSB

% \_\_\_\_\_ Particleboard

% \_\_\_\_\_ MDF

% \_\_\_\_\_ Hardboard

% \_\_\_\_\_ Other [Please specify] \_\_\_\_\_

% 100 Total

2. In general, do you think consumers care about which types of panel products are used in the manufacturing of furniture?

☐ Yes

☐ No

☐ Don't know

3. What is your opinion on the use of wood-based panels instead of solid lumber by furniture manufacturers?

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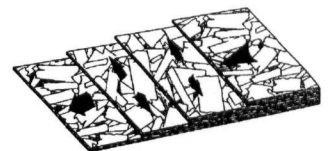
4. Please rank the top 5 panel product attribute(s) that you feel would be important in terms of manufacturing furniture products.

_____ Aesthetics	_____ General Performance	_____ Panel Squareness	_____ Species
_____ Brand Name	_____ Internal Bond	_____ Price	_____ Strength/Stiffness
_____ Density	_____ Moisture Resistance	_____ Quality	_____ Surface Smoothness
_____ Durability	_____ Paintability	_____ Reliability	_____ Surface Uniformity
_____ Environmental Friendliness	_____ Panel Grade	_____ Screw Holding	_____ Other _____

### SECTION IV – OSB (Oriented Strand Board)<sup>1</sup> USE IN FURNITURE

In this section we would like to ask you some specific questions regarding your perception of OSB and its attributes.

<sup>1</sup>OSB is a structural panel product made from wood strands, flakes or wafers bonded under heat and pressure with a waterproof resin adhesive. OSB is manufactured in three or more layers with the strands of both surface layers running the length of the panel, while those core layers perpendicularly, providing structural strength.



OVER →

1. For each of the attributes mentioned below, please rate how well OSB performs and how important you feel each of these attributes are in furniture production.

	Don't know	Performance					Don't know	Importance				
Surface Smoothness	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Strength/Stiffness	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Screw Holding	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Machinability	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Density	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Ease of Finishing	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Dimensional Stability	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Internal Bond	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Panel Squareness	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Adhesion	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5
Workability	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5

**Performance Level**  
1 – Very Poor  
5 – Excellent

**Importance Level**  
1 – Not At All Important  
5 – Extremely Important

2. Please rate the applicability of OSB in the following furniture products.

	Don't know	1	2	3	4	5
Chairs	<input type="checkbox"/>	1	2	3	4	5
Cabinets	<input type="checkbox"/>	1	2	3	4	5
Bookcase	<input type="checkbox"/>	1	2	3	4	5
Tables	<input type="checkbox"/>	1	2	3	4	5
Filing Equipment	<input type="checkbox"/>	1	2	3	4	5
Partitions	<input type="checkbox"/>	1	2	3	4	5
Desks	<input type="checkbox"/>	1	2	3	4	5
Other _____	<input type="checkbox"/>	1	2	3	4	5

**KEY**  
1 – Should never be used  
2 – Should rarely be used  
3 – Should sometimes be used  
4 – Should usually be used  
5 – Should always be used

3. In your opinion, would your customers perceive furniture made from OSB as low, medium or high quality? Please check the appropriate box

☐ Low      ☐ Medium      ☐ High      ☐ Don't know

4. In the following section, please indicate the extent to which you agree with the following statements as they pertain to OSB used in furniture manufacturing.

Rate each factor from 1 to 5 as follows:  
1 – Strongly Agree    2 – Agree    3 – Neither Agree Nor Disagree    4 – Disagree    5 – Strongly Disagree

OSB panels made for use in furniture tend to have good moisture resistance.	1	2	3	4	5
OSB surface does not cause finishing problems.	1	2	3	4	5
OSB panels have excellent workability compared to other panel products.	1	2	3	4	5
In general, OSB panels do not have good screw holding ability.	1	2	3	4	5
OSB panels in use result in low formaldehyde emissions.	1	2	3	4	5
OSB panels are strong compared to other panels.	1	2	3	4	5
OSB prices are generally stable compared to other panel products.	1	2	3	4	5
Furniture made from OSB are of higher quality compared to those made from other panels.	1	2	3	4	5
OSB panels can be easily connected to other components.	1	2	3	4	5
In the near future, OSB will be used more in the furniture manufacturing industry.	1	2	3	4	5

5. Do you have any additional comments on the use of OSB or other wood-based panel products in the manufacture of furniture?

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6. If you would like to receive a copy of these survey results, please fill in your contact information: (optional)

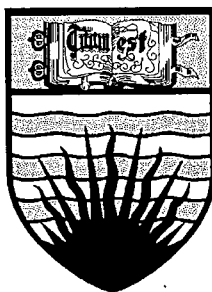
Company Name: \_\_\_\_\_  
 Contact Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 Phone/Fax/Email: \_\_\_\_\_

**Thank you for your time and effort in completing this survey!**  
**Please return the completed form either by fax or mail to the address provided in the cover letter.**  
**All replies are strictly confidential.**



**Appendix D:**  
**Survey Questionnaire**  
**(Fax Questionnaire Sent To Door Manufacturers)**

*Department of Wood Science  
University of British Columbia*



## SECTION I – COMPANY INFORMATION

We would like to begin by asking you some general questions about your company and product line.

1. What is your job title? \_\_\_\_\_
2. Please list the top regions (by volume) where you manufactured doors in 1999.  
[List as many as are applicable]  
State(s)/Province(s) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. How many years has your company been in business? \_\_\_\_\_ Years
4. How many years has your company been manufacturing doors? \_\_\_\_\_ Years
5. Please indicate your company's total sales in U.S. dollars during 1999. [Please check the appropriate box]
 

<input type="checkbox"/> Less than \$ 1 million	<input type="checkbox"/> \$ 100 million to \$ 499.9 million
<input type="checkbox"/> \$ 1 million to \$ 9.9 million	<input type="checkbox"/> \$ 500 million to \$ 999.9 million
<input type="checkbox"/> \$ 10 million to \$ 49.9 million	<input type="checkbox"/> Over \$ 1 billion
<input type="checkbox"/> \$ 50 million to \$ 99.9 million	
6. What proportion of your total sales includes door and window products? [Total does not have to equal 100%]  
% \_\_\_\_\_ Doors  
% \_\_\_\_\_ Windows
7. Which of the following door components does your company manufacture? [Check all that apply]
 

<input type="checkbox"/> Door Cores	<input type="checkbox"/> Other [Please specify] _____
<input type="checkbox"/> Door Rails	<input type="checkbox"/> Other [Please specify] _____
<input type="checkbox"/> Door Stiles	
8. Please describe your major market segments for doors (e.g. geography, retail type, demographics, etc.).  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
9. Approximately what proportion of your markets are the following? [Total should equal 100%]  

% _____ Local	% _____ National
% _____ Regional	% _____ International
10. What proportion of your total door production has following as major component? [Total should equal 100%]  

% _____ Wood	% _____ Combination [Please specify] _____
% _____ Metal	% _____ Other [Please specify] _____

11. What proportion (by value) of your door production includes solid wood, panels, engineered wood products or non wood-based products? [total should equal 100%]

% \_\_\_\_\_ Solid Wood

% \_\_\_\_\_ Panels

% \_\_\_\_\_ Engineered Wood Products

% \_\_\_\_\_ Non Wood-Based Products

% 100 Total

## SECTION II – MATERIALS USED IN DOORS

We would like to ask you some questions regarding your opinion on product attributes, product use, and best methods for sharing knowledge within the door manufacturing industry.

1. Have you ever substituted one material for another in the manufacture of doors?

☐ Yes

☐ No → Go to # 4

2. If YES, please provide the most recent example.

\_\_\_\_\_ → \_\_\_\_\_  
original material                      switched to                      alternative material

3. How likely do you think it is that your company will actually make another switch within the next three years?

☐ Very Likely

☐ Likely

☐ Not Likely

☐ Not At All Likely

4. When choosing a basic material for use in your door products, how important are the following attributes to your final decision?  
[For each attribute, please circle one number indicating the level of importance]

### PRODUCT ATTRIBUTES

#### Quality Issues...

Strength/Stiffness	1	2	3	4	5	6	7	8	9	10
General Performance	1	2	3	4	5	6	7	8	9	10
Straightness	1	2	3	4	5	6	7	8	9	10
Surface Uniformity	1	2	3	4	5	6	7	8	9	10
Overall Quality	1	2	3	4	5	6	7	8	9	10

Rate Each Factor From  
1 to 10 As Follows:

1 – Not At All Important  
10 – Extremely Important

#### After Sales Issues...

Delivery Time	1	2	3	4	5	6	7	8	9	10
Availability/Supply	1	2	3	4	5	6	7	8	9	10
Service	1	2	3	4	5	6	7	8	9	10

#### Product Issues...

Price	1	2	3	4	5	6	7	8	9	10
Aesthetics	1	2	3	4	5	6	7	8	9	10
Environmental Friendliness	1	2	3	4	5	6	7	8	9	10
Safety of Installed Product	1	2	3	4	5	6	7	8	9	10
Brand Name	1	2	3	4	5	6	7	8	9	10

5. When deciding to invest in a new material, how often do you rely on the following sources for information.

Associations	1	2	3	4	5
Advertisements	1	2	3	4	5
Case Studies	1	2	3	4	5
Conferences	1	2	3	4	5
Free Product Trials	1	2	3	4	5
Internet	1	2	3	4	5
Journals/Publications	1	2	3	4	5
Other Manufacturers' Experience	1	2	3	4	5
Sales Personnel	1	2	3	4	5
Seminars	1	2	3	4	5
Sponsorship (Publicity)	1	2	3	4	5
Trade/Equipment Shows	1	2	3	4	5
Other [Please specify] _____	1	2	3	4	5

#### KEY

1 – Never  
2 – Rarely  
3 – Sometimes  
4 – Usually  
5 – Always

6. Please rate your knowledge level for the following wood-based products as they pertain to doors.  
[Please check the appropriate box for each product category]

	Not At All Knowledgeable	Below Average Knowledge	Average Knowledge	Above Average Knowledge	Very Knowledgeable
Hardwood Lumber	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Softwood Lumber	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LVL (Laminated Veneer Lumber)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OSB (Oriented Strand Board)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plywood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Particleboard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hardboard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Edge-glued Panels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MDF (Medium Density Fiberboard)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### SECTION III – WOOD PANELS USE IN DOORS

We would like to ask you some questions on the use of panels in the door manufacturing industry.

1. What proportion (by volume) of the following wood-based panels do you currently use in the manufacturing of door products? [Total should equal 100%]

% \_\_\_\_\_ Edge-glued Panels (solid lumber)

% \_\_\_\_\_ Softwood Plywood

% \_\_\_\_\_ OSB

% \_\_\_\_\_ Particleboard

% \_\_\_\_\_ MDF

% \_\_\_\_\_ Hardboard

% \_\_\_\_\_ Other [Please specify] \_\_\_\_\_

% 100 Total

2. In general, do you think consumers care about which types of panel products are used in the manufacturing of doors?

☐ Yes

☐ No

☐ Don't know

3. What is your opinion on the use of wood-based panels instead of solid lumber by door manufacturers?

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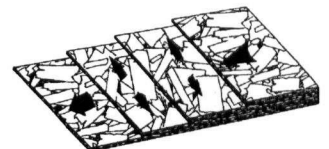
4. Please rank the top 5 panel product attribute(s) that you feel would be important in terms of manufacturing door products.

_____ Aesthetics	_____ General Performance	_____ Panel Squareness	_____ Species
_____ Brand Name	_____ Internal Bond	_____ Price	_____ Strength/Stiffness
_____ Density	_____ Moisture Resistance	_____ Quality	_____ Surface Smoothness
_____ Durability	_____ Paintability	_____ Reliability	_____ Surface Uniformity
_____ Environmental Friendliness	_____ Panel Grade	_____ Screw Holding	_____ Other _____

### SECTION IV – OSB (Oriented Strand Board)<sup>1</sup> USE IN DOOR MANUFACTURING

In this section we would like to ask you some specific questions regarding your perception of OSB and its attributes.

<sup>1</sup>OSB is a structural panel product made from wood strands, flakes or wafers bonded under heat and pressure with a waterproof resin adhesive. OSB is manufactured in three or more layers with the strands of both surface layers running the length of the panel, while those core layers perpendicularly, providing structural strength.



OVER →

1. For each of the attributes mentioned below, please rate how well OSB performs and how important you feel each of these attributes are in door production.

	Don't know	Performance ← →					Don't know	Importance ← →					
	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Surface Smoothness	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	<b>Performance Level</b> 1 – Very Poor 5 – Excellent
Fire Performance	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Strength/Stiffness	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Screw Holding	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Machinability	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Density	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	<b>Importance Level</b> 1 – Not At All Important 5 – Extremely Important
Ease of Finishing	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Dimensional Stability	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Internal Bond	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Panel Squareness	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Adhesion	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	
Workability	<input type="checkbox"/>	1	2	3	4	5	<input type="checkbox"/>	1	2	3	4	5	

2. Please rate the applicability of OSB in the following door components.

	Don't know	1	2	3	4	5
Door Cores	<input type="checkbox"/>	1	2	3	4	5
Door Rails	<input type="checkbox"/>	1	2	3	4	5
Door Stiles	<input type="checkbox"/>	1	2	3	4	5
Other _____	<input type="checkbox"/>	1	2	3	4	5

3. In your opinion, would your customers perceive doors made from OSB as low, medium or high quality? [Please check the appropriate box]

☐ Low      ☐ Medium      ☐ High      ☐ Don't know

4. In the following section, please indicate the extent to which you agree with the following statements as they pertain to OSB used in door manufacturing.

Rate each factor from 1 to 5 as follows:  
 1 – Strongly Agree    2 – Agree    3 – Neither Agree Nor Disagree    4 – Disagree    5 – Strongly Disagree

OSB panels made for use in doors tend to have good moisture resistance.	1	2	3	4	5
OSB surface does not cause finishing problems.	1	2	3	4	5
OSB panels have excellent workability compared to other panel products.	1	2	3	4	5
In general, OSB panels do not have good screw holding ability.	1	2	3	4	5
OSB panels in use result in low formaldehyde emissions.	1	2	3	4	5
OSB panels are strong compared to other panels.	1	2	3	4	5
OSB prices are generally stable compared to other panel products.	1	2	3	4	5
Doors made from OSB are of higher quality compared to those made from other panels.	1	2	3	4	5
OSB panels can be easily connected to other components.	1	2	3	4	5
In the near future, OSB will be used more in the door core manufacturing industry.	1	2	3	4	5

5. Do you have any additional comments on the use of OSB or other wood-based panel products in the manufacture of doors?

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6. If you would like to receive a copy of these survey results, please fill in your contact information: (optional)

Company Name: \_\_\_\_\_  
 Contact Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 Phone/Fax/Email: \_\_\_\_\_

**Thank you for your time and effort in completing this survey!**  
**Please return the completed form either by fax or mail to the address provided in the cover letter.**  
**All replies are strictly confidential.**