C I N T R A F O R

Working Paper

118

Exploring the Market Potential of Pacific Silver Fir in the US Residential Decking Market

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CINTRAFOR
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Executive Summary

Overview

The demand for decking and fencing materials is driven by several factors, including the macroeconomic environment, demographics, construction expenditures, and the repair and remodel sector. In addition, competition within the decking and fencing markets has recently been significantly altered by regulatory constraints on the forest products industry that have restricted harvest levels, by increasing imports of softwood lumber and by expanding competition from non-wood substitute materials. These last two factors are likely to have the greatest impact on the specification and use of decking and fencing materials in the mid to long term as the markets adjust to the changing regulatory environment and changing consumer perceptions and preferences. This report will explore the extant literature related to the demand for decking and fencing materials in the residential, non-residential, public and non-building segments of the construction industry.

US Decking Market

The demand for decking products is projected to increase from 4.7 billion board feet (bbf) in 2000 to 5.6 bbf in 2010, a 19.3% increase over the ten year period. This market expansion will not be distributed evenly across the three major types of deck materials, however. Whereas wood-plastic composite decking (WPC) is expected to increase by an astronomical 491% and plastic decking by a healthy 152%, the demand for wood decking is expected to decline by 8.5%. Further, the demand for redwood is projected to decline by over 15% between 2000-2010, although the decline in the demand for redwood lumber is attributed to supply constraints rather than declining demand. These demand outlooks are driven by two fundamental end-user attributes: durability (long-deck life) and low maintenance. Very little consideration was paid to price and price sensitivity of either new home builders or home owners. As a result, these demand estimates are more heavily weighted towards the higher priced substitute materials than the actual market situation might otherwise justify, particularly in the 2005-2010 period.

The primary construction application for decking is repair and remodel (approximately 86%) followed by new home construction (approximately 14%). While the demand for decking products in new construction is expected to experience strong growth between 2000 and 2010, the sheer size of the repair and remodel market make it a much more attractive market segment for producers. In addition, new home builders are a much more price sensitive set of buyers compared to home owners given the nature of the project expenditures. In addition, decks on new homes tend to be smaller than repair and replacement deck projects.

Residential construction is the primary market for decking materials, followed by non-building projects (docks, marinas, park structures, etc.) and non-residential construction. The demand for decking materials in the residential market is expected to grow by 24.3% between 2000 and 2010 while demand is expected to grow by just 6.9% in the non-building market. Again, contractors in the non-building segment are much more price sensitive given the nature of the bidding process in these types of projects.

Almost 80% of decking material is installed by professionals as opposed to homeowners (DIY). While demand is expected to grow substantially in both segments, the highest growth is projected to occur within the DIY segment (27.7%) rather than the professional segment (15.9%). Given the profit constraints facing most professional installers, this segment of the market tends to be more price sensitive than the DIY segment.

Finally, the deck market can be segmented into deck platforms versus rails and accessories (benches, stairs, planters, etc). It is important to note that only 59% of the total demand for decking materials is derived from the construction of deck platforms. The remaining demand can be attributed to deck rails

and accessories, suggesting that overall demand for a specific product may be influenced to a substantial degree by the availability of rails and accessory products manufactured from the same material. Growth in both of these market segments is expected to be strong.

The projections indicate that the largest demand region for decking products is the US south while the US west is the smallest demand region. Interestingly, the largest growth in demand for decking materials is expected to come from these two regions.

Table of Contents

List of Figures

List of Tables

Introduction

The residential decking market in the US has historically been dominated by pressure-treated lumber (Shook et. al. 2001; Eastin et. al. 2005; Damery et. al. 2001). The dominance of pressure-treated lumber (PTL) in the US decking materials market is such that an estimated 9 out of every 10 existing residential decks in the northeastern US (Damery et. al. 2001) and 8 of every 10 existing residential decks in the whole country are made from pressure-treated lumber (George Carter & Affiliates 1989). During the early years of 2000 concerns surfaced regarding the potential environmental and health impacts of preservative-treated wood used for construction projects in sensitive environments. Reacting to this concern and the threat of government regulation, in 2004 the treated lumber industry voluntarily discontinued the use of chromated copper arsenate (CCA) as a lumber preservative because of health concerns related to the toxicity of the product (Romano 2004). The transition from CCA to alkaline copper quarternary (ACQ) and copper azole (CA-B) preservatives for most residential decking lumber has not resulted in the substantial decline in sales as was initially predicted by industry experts (West 2004). This huge decking market for PTL is dominated by southern yellow pine, which holds about 80% of the market.

This section of the proposed project will explore the market potential of Pacific Silver Fir (a.k.a, Lovely Fir, Cascades Fir, Red Fir, White Fir and Amabalis Fir) as a decking material in the US residential construction industry. Previous studies have considered the treatability of Pacific Silver Fir (PSF) using various wood preservatives. Wood preservatives penetrate sapwood relatively easier than heartwood, largely because extractives in the heartwood reduce the permeability of the heartwood. As a result, southern yellow pine, which has a high percentage of sapwood, is the predominant species used by the pressure treating industry in the US. Previous research has shown that PSF is one of Canada's most treatable species (Morris 1995). While comparing the penetration of CCA, PSF was found to have higher preservative retention than western hemlock and much higher permiability than either white spruce or Douglas fir (Morris 1995). More recent studies have confirmed that the penetration of PSF using ACQ-D and ACQ-D+ was also much higher than with these other species (Morris et. al. 2002).

Objective

Evidence from previous studies suggests the potential marketability of pressure treated PSF for decking applications. This section of the project explores the market potential for PSF in the US residential decking industry and aims to estimate the awareness and appreciation of the material attributes of PSF among deck builders in the US. Currently PSF is not an established product in the US residential decking market. This research will enable us to predict the relative positioning of PSF in the US decking market. The project further aims to provide an optimal pricing and product positioning strategy for PSF in the US decking materials market in general and within the Pacific Northwest (e.g., Oregon and Washington), in particular.

Background

Results of the 2004 CINTRAFOR Survey of Deck Builders

A summary of some of the results of the 2004 CINTRAFOR survey of deck builders material use are presented in Tables 1-6. The deck building industry is dominated by small to medium-sized firms with over 63% of survey respondents indicating that their sales revenue was less than $1 million in 2003, although a little over 11% of deck builders generated sales revenue in excess of $5 million. The average deck builder constructed 93 decks with an average deck size of 456 square feet, Table 1. Since the average construction cost for a new deck was $6,161, the average construction cost for a deck in the US on a square foot basis) was $13.51 per square foot, although this increased to $15.63 per square foot on the west coast. Approximately 45% of the construction cost was attributed to the deck surface while another third was for the substructure and 21% was for accessories. Just over 40% of deck builder projects were new (first time) decks built on existing homes while almost a third were replacement decks

built on existing homes and 25% were new decks built on new homes. It is important to note that approximately 46% of home builders rely on deck builders to build decks on new homes.

The survey data clearly shows substantial differences in deck characteristics based on geographic location, Table 2. For example, deck builders in the eastern US built more than twice as many decks per year as companies in the interior west and three times as many as companies on the west coast. In addition, the average deck size was significantly higher in the west, although the average construction cost in the interior west was substantially lower than in either the eastern US or the west coast. As a result, there was significant variation in the unit construction cost for decks in each region. Unit construction costs in the eastern US were $14.81 per square foot versus $8.18 in the interior west and $15.63 on the west coast. Finally, deck builders on the west coast primarily target new deck construction on both new and existing home with relatively little focus on deck repair/replacement. In contrast, deck builders in the east and interior west have a much more balanced mix of deck building projects.

Table 1. Deck builder demographic information.

Average size of decks built	456 ft^2
Average number of decks built	93
Average total construction cost of decks built	$6,161
Average construction cost of deck structure	34.2% ($2,108)
Average construction cost of deck surface	45.1% ($2,776)
Average construction cost of deck accessories	21.2% ($1,306)
Average % of new decks built on existing home	42.2%
Average % of new decks built on new home	25.2%
Average % of repair/replacement decks built	31.9%
Average number of years firm has been in business	17.8 years

Table 2. Deck builder demographics by region.

	East Coast	Interior West	West Coast
Ave. deck size	395 ft^2	553 ft^2	513 ft^2
Ave. number of decks built	126	65	42
Ave. construction cost	$5,851	$4,524	$8,019
Ave. construction cost/sq. ft.	$14.81	$8.18	$15.63
Deck structure	34.2% ($2,001)	35.0% ($1,583)	31.7% ($2,542)
Deck surface	43.9% ($2,569)	47.4% ($2,144)	46.6% ($3,737)
Deck accessories	21.9% ($1,281)	17.6% ($796)	21.7% ($ 1,740)
Decks on existing home	41.6%	43.7%	42.4%
Decks built on new home	27.9%	27.0%	45.7%
Repair/replacement decks	30.5%	25.5%	11.9%

Sample sizes (East=64-81; West excl. coasts=16-28; West Coast=24-39)

Table 3. Deck builders changing material use over the past two years.

	Increased	Remained the Same	Decreased	Never Used
Western Red Cedar	11.8	27.0	35.5	25.7
Redwood	5.6	16.8	30.1	47.6
Treated Lumber	20.1	37.6	36.2	6.0
Untreated Lumber	4.2	19.4	11.8	64.6
Wood-Plastic Composite	79.6	7.2	2.6	10.5
Tropical Hardwood	24.5	21.1	8.8	45.6
Plastic	27.1	11.1	6.9	54.9

The survey data suggests that deck builders use a broad mix of decking products, much broader than home builders use, Table 3. Deck builders registered their largest increases in material use for WPC, plastic lumber and tropical hardwoods. Interestingly, while 20% of deck builders reported increasing their use of treated lumber, almost twice as many (6.2%) indicated that their use had declined. The data suggests that many deck builders are reducing their use of WRC, RW and treated lumber in favor of WPC, tropical hardwoods and plastic lumber. The deck materials with the largest positive usage values included: WPC-77%, tropical hardwoods-15.7% and plastic lumber-20.2%.

Material Use in Decking End-Use Applications

The survey data shows that treated lumber is the dominant material used in deck substructures with an overall market share of 81.2%, Table 4. Treated lumber and WPC each represent about a third of the deck surface market while WRC and RW together comprise another 22%. Treated lumber has a 34% share of the accessories market while WRC and RW represent another 30% followed by WPC with 22% of the overall market. Material use by deck builders for deck substructures was dominated by treated lumber with a market share of over 90%. Material use in deck surface applications was dominated by wood-plastic composite products followed by treated lumber and western red cedar. Finally, approximately 30% of deck accessories were built using wood-plastic composites and treated lumber while an additional 18% were built from western red cedar.

The research results highlighted that fact that deck builders almost exclusively use treated lumber for deck substructures, whereas home builders are more likely to use naturally durable wood species as well as WPC lumber in this application. This is interesting given the fact that few WPC products are manufactured in cross-sectional sizes that would be appropriate for support beams or primary posts. This would suggest that home builders are most likely using WPC lumber as joists and perhaps intermediate support posts. Interestingly, deck builders, who we could assume are more knowledgeable of deck construction details and material specification, use virtually no WPC lumber in deck substructures. From this we can conclude that either home builders are ahead of the curve in terms of trying WPC as a structural material in deck substructures or else they are mistakenly specifying WPC for an application where its use is not intended. In either case, this finding merits additional investigation into how home builders are using WPC in structural applications.

The summary data suggests that there are three groups of material attributes, Table 5. The most important attributes, those with an importance rating higher than 6, included long life, material quality, beauty and availability. The second group of attributes (those with an importance rating between 5.5 and 6.0) included natural decay resistance, ease of maintenance and price stability. It is interesting to note that while price stability was rated moderately high, the actual price of a decking material was rated as being relatively unimportant, receiving the third lowest importance rating.

Respondents were also asked to indicate the degree to which each decking material possessed a specific material attribute using a Likert-like scale where a rating of 1 meant that the material did not possess the attribute at all and a rating of 7 meant that the material possessed the attribute to a high degree. The average ratings across all survey respondents are summarized in Table 6. The material attributes presented to survey respondents included five of the highest rated attributes in terms of their influence on the material specification process: long life, beauty, ease of maintenance, availability and natural decay resistance. Two of the material attributes, strength and low cost, were also included in this question.

In terms of long life, WPC lumber received the highest rating by far. Other highly rated materials included THW lumber, plastic lumber, treated lumber and RW. In terms of beauty, the highest rated product was RW lumber with a rating of 6.02. Other highly rated materials included THW and western red cedar (WRC). Surprisingly, WPC lumber received a relatively high rating of 5.33, not that much lower than the scores recorded for WRC, RW and THW and much higher than both treated lumber and plastic lumber.

Table 4. Material use in different end-use applications in deck building in 2003.

Deck Builders	Substructure	Surface	Accessories
Western Red Cedar	0.7	10.8	17.5
Redwood	0.0	5.3	6.6
Treated Lumber	91.2	28.3	27.8
Untreated Lumber	6.0	1.5	1.8
Wood-Plastic Composite	0.6	39.6	29.5
Tropical Hardwood	0.7	5.8	4.4
Plastic	0.0	4.2	4.8
Other	0.8	3.5	5.6

Table 5. Average importance ratings for material attributes, by builder type.

Material Attribute	Deck Builders
Long Life	6.35
Beautiful & Aesthetically Pleasing	6.29
Consistent Material Quality	6.17
Availability	5.76
Naturally Decay Resistant	5.71
Ease of Maintenance	5.68
Resistance to Splintering	5.63
Price Stability	5.34
High Workability/Ease of Use	5.30
High Strength Properties	5.08
Little Product Waste	4.80
Low Heat Retention in Service	4.50
Low Material Cost	4.49

Both WPC and plastic lumber were widely perceived as being the easiest materials to maintain. Further behind were the naturally durable species followed by pressure treated lumber (PT) and untreated lumber. The naturally durable timber species were the lowest rated material in terms of availability, and this lack of availability was often cited by respondent s as a major factor in their low use rates. Respondents indicated that the lowest cost materials were perceived to be treated and untreated lumber. In contrast, redwood was perceived to be the most expensive material followed by THW and WPC. However, there was little difference in the relative ratings for these four materials, suggesting that cost does not pose a major disadvantage for any of the naturally durable materials. Finally, the materials perceived to have the highest level of natural durability were WPC and plastic lumber. The naturally durable wood materials, while highly rated, were rated substantially lower both of the non-wood materials.

Table 6. Average ratings for each decking material with respect to the degree to which each material possesses each specific material attribute.

Long Life	**WRC**	**RW**	**PT**	**UT**	**WPC**	**THW**	**Plastic**
Non User	5.20	5.49	5.56	2.24	6.18	5.56	5.53
User	4.94	5.04	5.26	2.75	6.27	5.55	5.45
Total	5.17	5.44	5.53	2.30	6.19	5.55	5.52
Beauty							
Non User	5.86	6.11	4.09	2.94	5.45	5.89	4.48
User	5.77	5.97	3.68	3.61	4.34	5.82	3.48
Total	5.85	6.10	4.05	3.01	5.33	5.88	4.34
Ease of Maintenance							
Non User	4.50	4.72	4.63	2.36	6.28	4.89	5.69
User	4.50	4.70	4.10	2.48	5.89	4.96	5.86
Total	4.50	4.72	4.58	2.37	6.24	4.90	5.72
Availability							
Non User	5.30	4.92	6.59	6.30	6.39	4.74	5.37
User	5.34	4.16	6.28	5.73	6.20	4.44	4.88
Total	5.30	4.84	6.56	6.24	6.37	4.70	5.30
High Strength							
Non User	5.05	5.18	6.01	4.86	4.97	5.97	4.44
User	4.61	4.88	5.62	5.08	4.00	5.67	3.76
Total	5.00	5.15	5.97	4.88	4.87	5.93	4.35
Low Cost							
Non User	4.12	3.75	5.36	5.08	3.98	3.57	3.92
User	4.13	3.18	5.00	5.00	3.62	3.39	3.95
Total	4.12	3.69	5.32	5.07	3.94	3.55	3.93
Natural Decay Resistance							
Non User	5.19	5.44	5.66	1.86	6.45	5.63	6.36
User	4.97	5.24	5.22	2.52	6.17	5.42	6.18
Total	5.17	5.42	5.62	1.93	6.42	5.60	6.34

This question refers to builder's relative perceptions of specific deck materials. Respondents were asked to indicate the degree to which each material possesses each attribute using a Likert-like scale where a rating of 1 means the material does not possess the specific attribute at all and a rating of 7 means that the material possesses the attribute to a high degree.

Exploratory Survey of Deck Builders

Survey Methodology

Researchers at FP Innovations have developed a preservative treated, profiled decking board manufactured from Pacific Silver Fir (PSF). Preliminary research suggests that this product performs well in outdoor decking applications. The introduction of parallel grooves on the surface of the deck board through a profiling process increases skid resistance and reduces visible surface checking. However, since this is a new species with which deck builders are unfamiliar, an exploratory market research project was designed to obtain a preliminary understanding of deck builders perceptions of this new product relative to existing decking materials. To conduct the exploratory market research, a structured interview was designed that would give the interviewers an opportunity to introduce PSF to deck builders by providing samples of the PSF decking lumber along with a brief written description of the product prior to the respondent receiving the survey. To remove bias from the study, the survey respondents were shown comparable samples of all the major decking materials used to build decks in the US along with brief written descriptions of each product. Retail pricing estimates were not provided for the decking materials.

The exploratory research was conducted at FenceTech & DeckTech '09, held in New Orleans from the 13th to 16th of January 2009. FenceTech & DeckTech '09 was organized by the American Fence Association (AFA), a national association of fence and deck builders, and is one of the largest deck building trade shows in the country. The target population for the survey was tradeshow attendees who were deck builders. A brief on the spot interview was conducted to recruit eligible deck builders to take the survey. As an incentive to encourage participation, survey participants were entered in a daily drawing for a $200 gift certificate.

Survey Setup

The survey booth was located in the deck demonstration area of the trade show where new decking products and construction techniques were demonstrated hourly during the trade show, Figure 1. Being located adjacent to the demonstration area ensured a high traffic flow of deck builders past the booth. A three-paneled poster was displayed at the booth explaining the purpose of the survey and providing the results from previous CINTRAFOR surveys of the decking industry. The poster also informed deck builders that each survey respondent would be entered in a daily drawing for a $200 gift card. The tradeshow organizers made periodic announcements of the survey using the public announcement system.

The decking materials selected for the survey included (a) pressure treated southern yellow pine decking (SYP), (b) wood plastic composite decking (WPC), (c) pressure-treated, profiled PSF decking, (d) western red cedar decking (WRC) and (e) plastic decking (PVC). The material selection was designed to include all of the major types of decking materials available to deck builders, Figure 2. Three complete sets of labeled samples were used to allow multiple surveys to be conducted simultaneously. The survey respondents were introduced to the samples and the survey instrument. Additional explanation of the decking materials was provided only if specifically requested by the respondent. As the target respondents were professional deck builders, price information of the products were not provided for any of the samples. However, since PSF decking lumber is not currently available in the market, survey respondents were told that the price of the product would likely fall between SYP and WRC.

Figure 1. Survey booth at DeckTech'09, New Orleans.

Figure 2. Labeled samples displayed at DeckTech'09, New Orleans.

Interviewer Observations

The results in this section reflect the responses from the surveys collected during FenceTech & DeckTech '09. The nature of the show, geographic location of the show, the membership distribution of AFA and the cost associated with attending such a show determine the demographic and psychographic characteristics of the sample frame. The generalizability and interpretation of the results from the survey should be based on the following observations obtained from interacting with the tradeshow attendees.

a. A greater percentage of attendees at the trade show were fence builders, although only deck builders were surveyed.
b. A good percentage of the deck builders who attended the show were also involved or interested in fence building (and vice-versa). Among the survey respondents, about 20% are primarily fence builders who also build decks.
c. The deck builders who attended the show tend to be innovators who want to stay ahead of the curve in terms of deck building practices and are more interested in trying new decking materials. This characteristic of the survey respondents will influence the results of the survey.
d. Finally, as a result of the current economic downturn, the attendance at the show was much lower than normal. According to one of the organizers, this year's attendees reflect a higher representation of builders from the two extremes of the US decking industry spectrum: 1) highly established deck builders, and 2) fence builders looking to expand into deck building.

Some of these observations are specific to the DeckTech '09 trade show, whereas others are common for transect sampling techniques. Unfortunately, the lower attendance rate reduces the sample size and can further influence the survey results. Therefore, caution should be exercised in drawing conclusions from the survey and triangulation of the survey results with other surveys can help in reaching generalizable conclusions.

Survey Results

Sample Size

Following the initial interview, a total of 33 eligible respondents were recruited to complete the self administered survey. Upon review, five surveys were removed from the dataset because of a high non-response rate to survey questions. Hence, this report is based on data collected from 28 structured interviews.

Demographic Characteristics of the respondents

The demographic characteristics of the respondents plays a significant role in the interpretation of the survey results. In transect surveys, the interviewers have little control over the sample population as the sample frame is defined by the attendees of the tradeshow. Hence, the analysis of the results obtained through transect surveys needs to be performed while keeping the survey demographics in mind. In this section of the report we analyze the demographic characteristics of the survey respondents.

Primary Area of Business

Though the trade show was supposed to have a national representation, based on the location of the tradeshow it was expected that a higher percentage of the attendees would be from the southeastern part of the United States. An analysis shows that the survey respondents represented 14 states and the survey had representation from all regions of the country, Table 7. A total of 9 respondents (32%) were located in the southeastern US, while 25% of the respondents were located in the southwestern US, 21% of the respondents were located in the northeastern US and 18% of the respondents were located in the northwestern US. Finally, 4% of the respondents indicated that their business was national in scope.

Table 7. Respondents' primary states of business.

Region	# of Respondents	% of Respondents	Region	# of Respondents	% of Respondents
Northwest			**Northeast**		
Iowa	1	3.6%	Indiana	3	10.7%
Montana	1	3.6%	Pennsylvania	3	10.7%
Washington	2	7.1%	**Total NE**	**6**	**21.4%**
WA, OR & CA	1	3.6%			
Total NW	**5**	**17.9%**	**Southeast**		
			Alabama	1	3.6%
Southwest			Florida	2	7.1%
Missouri	3	10.7%	Louisiana	1	3.6%
Texas	1	3.6%	N. Carolina	2	7.1%
Utah	2	7.1%	Tennessee	3	10.7%
S. California	1	3.6%	**Total SE**	**9**	**32.1%**
Total SW	**7**	**25.0%**	National	1	3.6%

Firms' Sales Revenue

The income distribution of the firms included in the survey is presented in Table 8. Of all the respondents, 29% indicated that their firm's annual sales revenue in 2008 was between $1 and $2 million. The survey also represents smaller firms with annual revenue less than $100,000 (14% of total) and very large firms with annual sales revenue over $5 million (14% of total). Though annual sales can be used as a proxy for a firm's size, it does not always correlate well with the number of decks built by the firm. For example, a number of the respondents indicated that their firms were involved in other construction activities apart from deck building. To get a better representation of the firms' deck building experience, respondents were asked to indicate the number of decks and the average size of the decks built by their firms in 2008.

Table 8. Respondents' firms' annual sales revenue.

Firm's approximate total sales revenue in 2008	Frequency	Percent
0 - $100,000	4	14.3%
$100,001 to $250,000	3	10.7%
$250,001 to $500,000	2	7.1%
$500,001 to $1,000,000	5	17.9%
$1,000,001 to $2,000,000	8	28.6%
$2,000,001 to $3,000,000	1	3.6%
$3,000,001 to $5,000,000	1	3.6%
Over $5,000,000	4	14.3%
Total	**28**	**100%**

Number of decks built in 2008

As can be observed from Figure 3, a large proportion of the deck builders (42%) who took the survey indicated that they built less than 10 decks in 2008. Another 42% of the respondents indicated that they built between 10 - 50 decks in 2008. Three of the respondents (14%) indicated they built more than 300 decks in 2008 and represent very large deck building firms. Hence, the survey represents a good mix of respondents with various levels of deck building experience.

Average size (in square feet) of decks built in 2008

The average size of the decks built was 381 square feet and ranged between 144 square feet and 1,000 square feet. However, the largest percentage of the responses is between 200 and 400 sqaure feet with over 50% of all the responses falling in that range. The distribution also has a very long tail towards the higher end of the distribution with some builders building larger decks. (Figure 4).

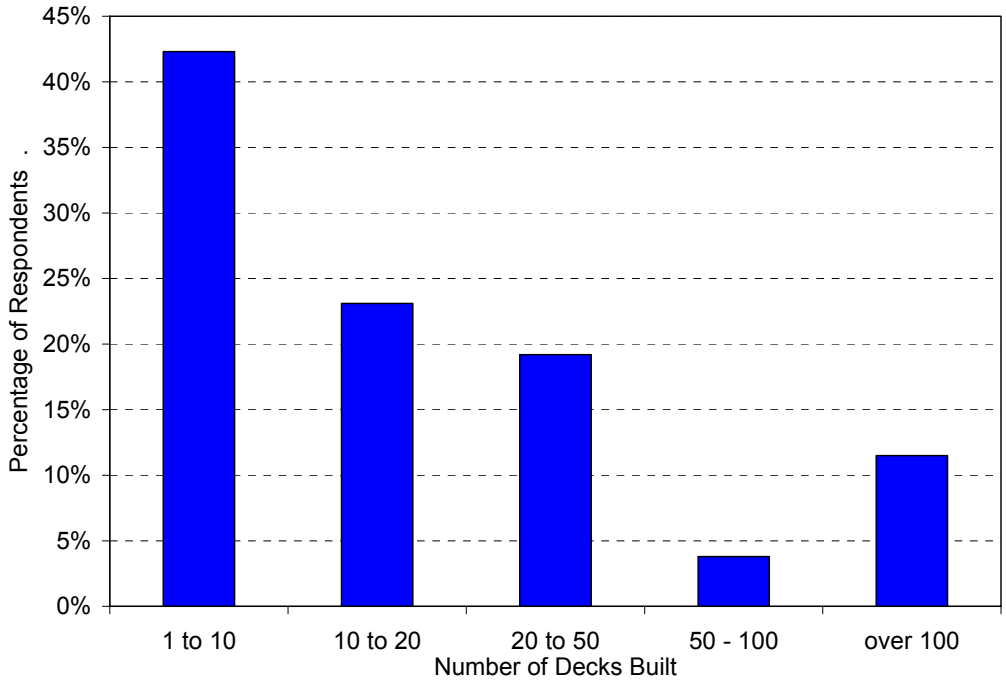

Figure 3. Number of decks built in 2008.

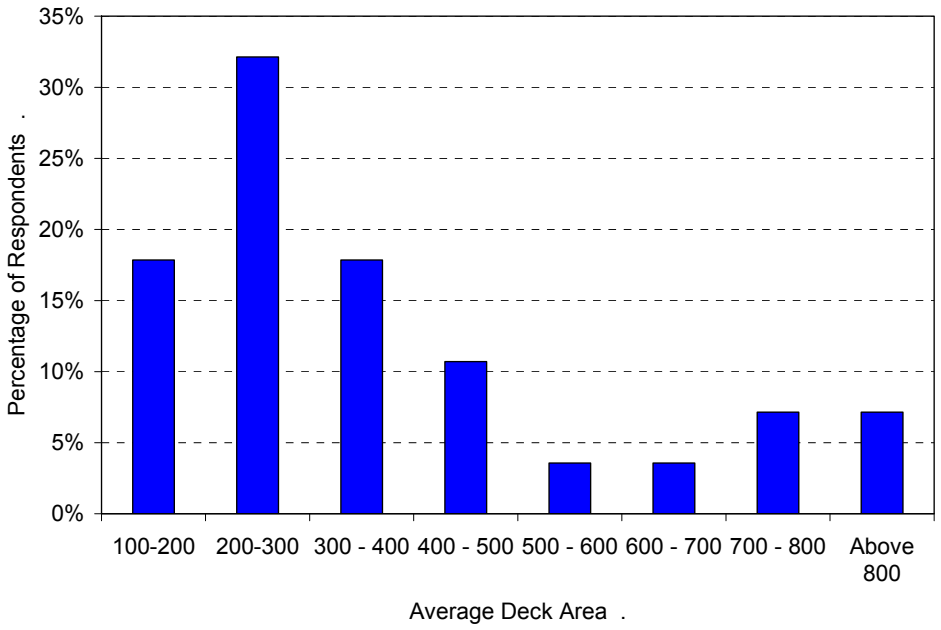

Figure 4. Average size (in square feet) of decks built in 2008.

Area of business

More than 80% of the respondents primarily conduct their businesses in the urban areas with the remaining occurring in small towns, Figure 5. None of the respondents indicated that they primarily worked in rural areas. This bias in the sample may influence the results of the survey although previous research has found that only a small percent of decks are built in rural areas. Such overrepresentation of urban and semi-urban deck builders in the sample makes it a non representative sample of the US deck building industry. Hence, information drawn from the survey results is representative of urban and semi-urban deck builders only and does not necessarily represent the views of rural deck builders.

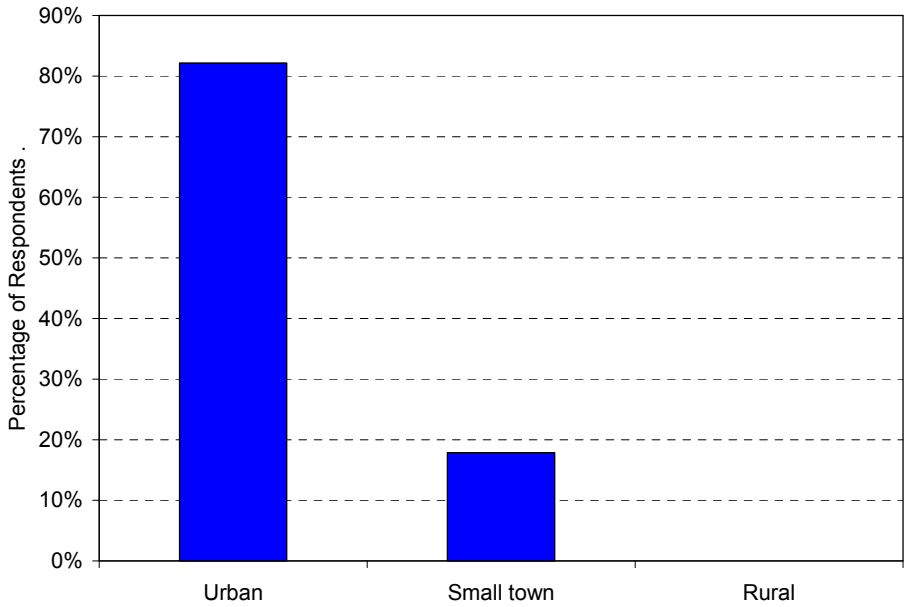

Figure 5. Area of business distribution of the respondents

Respondents' primary business

All the respondents interviewed during the survey had some professional deck building experience. However, not everybody's primary area of business was deck building. Two of the respondents identified themselves as homebuilders/contractors and one of the respondents was primarily a deck designer. As can be observed from Figure 6, more than 60% of the respondents identified themselves as deck builders. 25% of the respondents who listed themselves in the 'other' category were primarily fence builders who also build decks.

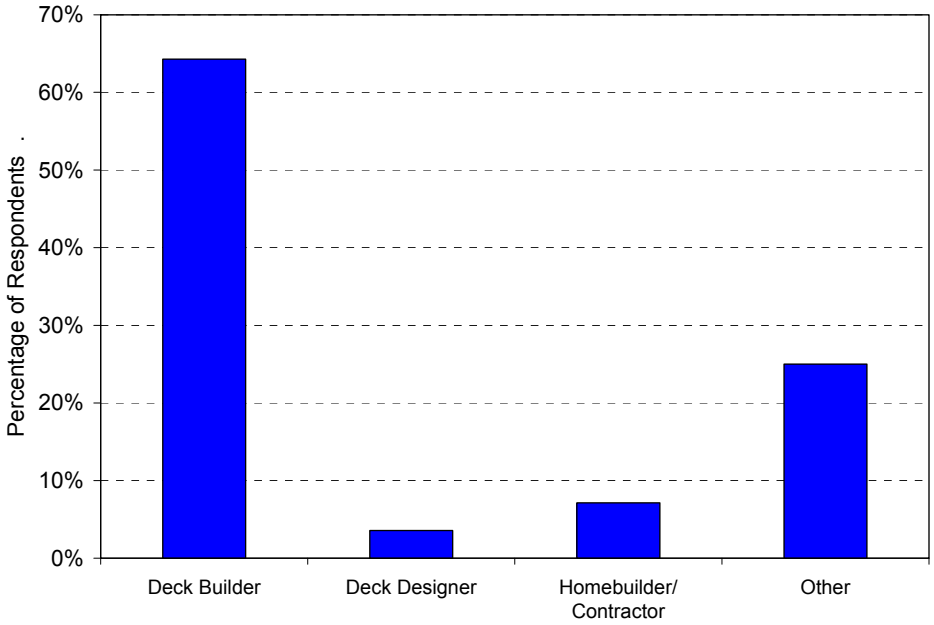

Figure 6. Primary occupation distribution of the respondents.

Who specifies decking materials

The results of the survey indicate that builders (deck or home) and deck designers specify decking materials just under half of the time, which is consistent with previous CINTRAFOR surveys. Informal discussions with deck builders at DeckExpo '09 revealed important information in this aspect not reflected in the data. Even though the homeowners specify the material to be used in just over 50% of the cases, the deck builders often help the homeowner to make this decision. Hence, in practice the influence of the deck builders in specifying decking materials extends beyond the result indicated in the survey, Table 9. While this is hardly surprising, given deck builders extensive and detailed knowledge of, and experience with, decking materials, it is important to recognize that deck builders exert substantial influence on the material selection process, even if they do not make the final material decision.

Table 9. Decking material specification.

Material Specifier	Specification
Home Owner	51.1%
Deck Builder	27.8%
Home Builder	8.5%
Deck Designer	8.5%
Other:	4.4%

Decks built by project type

Survey respondents were asked to indicate the percentage distribution of their 2008 revenue that came from building (a) new decks for new homes, (b) new decks for existing homes and (c) repair and replacement work. Respondents reported that over 50% of their revenue came from building decks for existing houses. Taken together, the combination of building new decks in existing house along with repair and replacement of existing decks accounted for more than 70% of deck builder's revenue, Table 10. This suggests that, despite the poor state of new housing construction, deck builders may be somewhat protected from the economic downturn. Moreover, more and more homeowners are perceiving decks and patios as outdoor living areas and are integrating these areas into their daily living by expanding deck size and investing in deck features such as outdoor lighting, built-in seating and storage and food preparation areas with built in cabinets and counter spaces. Not only do these expand the livability of outdoor areas, but they greatly increase the cost of decks and generate additional profits for deck builders.

Decking Material Usage and Preference

The survey was designed to provide an estimate of the material usage and preference of the respondents. Similar to demographic characteristics, the behavioral characteristics of the respondents are also greatly moderated by the event chosen for conducting the transect survey. Past research have shown that attendees of tradeshows, business workshops and conferences are proactive, are more likely to evaluate and specify innovative new materials, and are more likely to adopt new business practices. Hence, the external validity of the results obtained from such transect studies should be carefully moderated based on the existing usage and preference behavior of the respondents. In this section of the report we will analyze the existing product usage and preference of the respondents.

Changes in Material Use

In the survey the respondents were asked to indicate their company's changes in the use of decking materials over the past two years. Almost 60% of the respondents indicated that their usage of plastic lumber has increased over the past two years and 48% of the respondents indicated that their usage of wood plastic composites has increased over the same period, Figure 7. Comparing the increase and decrease in usage of decking materials, it is evident that the market shares for plastic and wood plastic have significantly increased among the survey respondents, Figure 8. Pressure treated lumber seems to be holding steady, whereas western red cedar showed the largest decrease in use and the highest rate of having never been used. From past studies we know that pressure treated lumber is the traditional decking material in the US with the largest market share. However, 42% (10 out of 24) of the respondents of this survey indicated that their company has never used pressure treated lumber which is a strong indicator of material usage bias among the respondents. An analysis of the characteristics of these individuals shows that these builders primarily use plastic and wood-plastic composite lumber when building decks.

Table 10. Percentage of decks built by project type.

	Percentage
New deck for an existing home	52.5%
Deck repair/replacement on an existing home	28.3%
New deck for a new home	19.2%

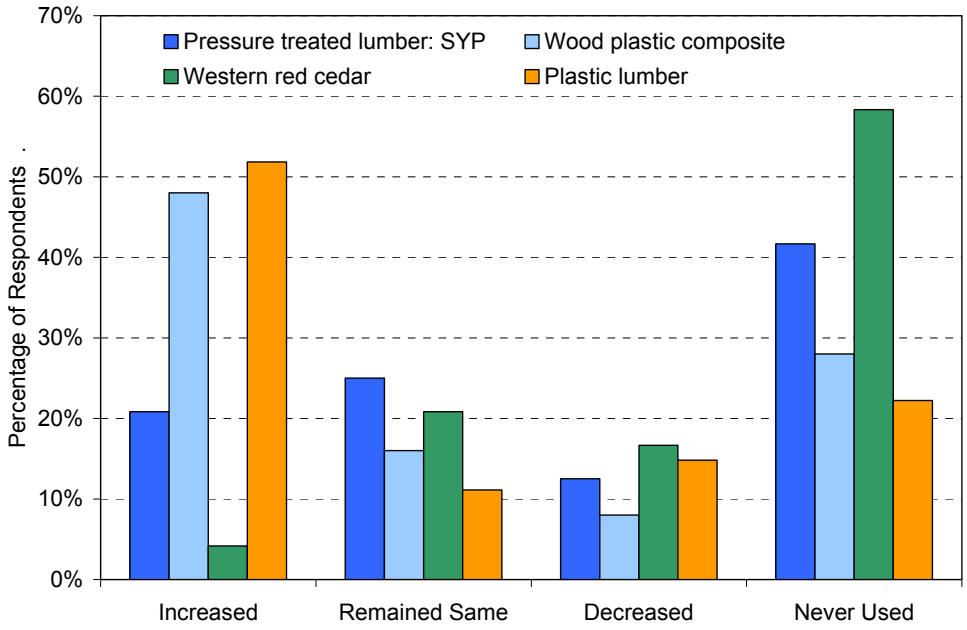

Figure 7. Change in material usage from 2006 to 2008: by change categories.

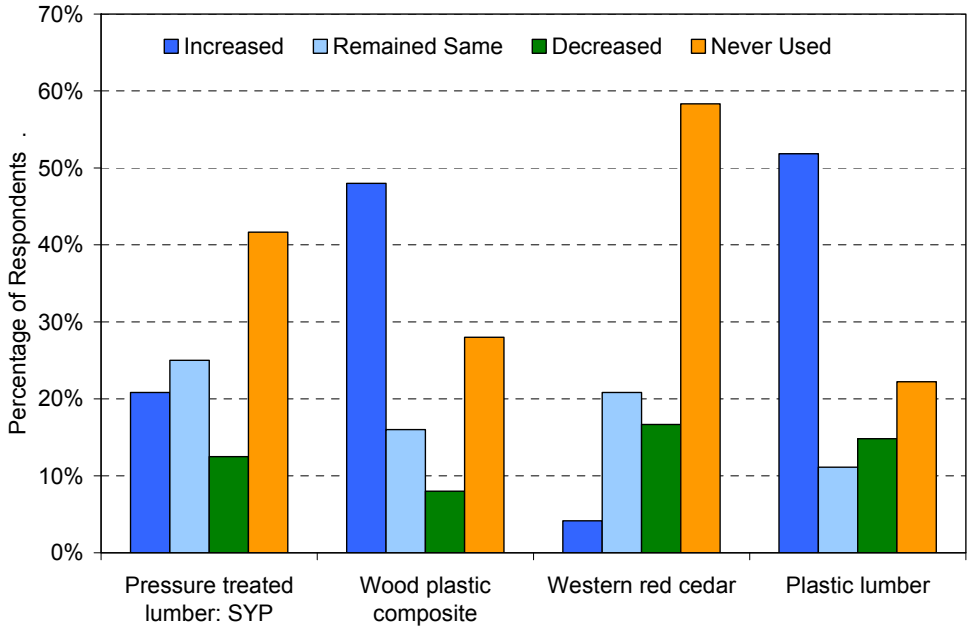

Figure 8. Change in material usage from 2006 to 2008: by products.

Material Preferences

Respondents were asked to rate the displayed decking materials, in terms of their preferences. PVC lumber (36%) and WPC lumber (29%) were the first choice of almost two-thirds of the deck builders surveyed. PVC lumber is interesting in that it was highly preferred as the primary material of choice by

some respondents, whereas, a large proportion of respondents indicated that they would never consider using PVC lumber as a decking material. This dichotomy can be observed in Figure 9, where 36% of the respondents reported that PVC is their primary choice of decking material, while 21% of the respondents said that they would never use PVC as a decking material. After combining the 'primary' and 'secondary' choices of the survey respondents, WPC lumber emerged to the favored decking material. More importantly, only 7% of the survey respondents indicated that they would be unwilling to use WPC lumber, the lowest value among all of the decking materials included in the survey.

Respondents perceptions of PSF were quite favorable (considering that it is not available in the market), with 21% of the respondents citing PSF as their second material choice and an additional 36% reporting that they would consider using PSF decking. Significantly, only 11% of the respondents reported that they would never use PSF decking lumber. In contrast, 29% of the respondents said that they would never use SYP lumber and 21% of the respondents said that they will never use PVC lumber. Finally, reflecting the lack of market information regarding PSF and the perception of risk associated with using a new decking material, 29% of the respondents refrained from reporting their willingness to use PSF.

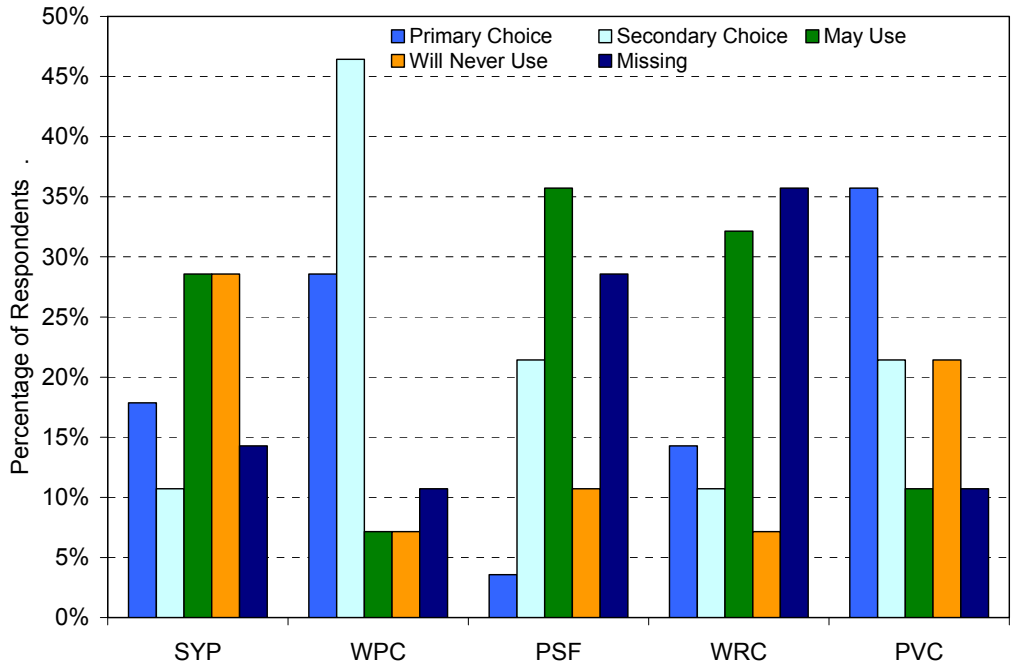

Figure 9. Material preferences choices for building a standard deck.

Material of choice given the type of deck project

Previous reports suggest that the choice of decking materials is often influenced by the nature of the decking project (e.g. the choice of decking surface material for new decks might differ from the choice of decking material for repair and remodeling projects). In the survey, we asked the respondents to indicate their choice of decking materials for three different decking projects: a) new decks for new houses, b) new decks for existing houses and c) deck repair and replacement projects. Survey respondents were allowed to select multiple decking materials for each of these projects. WPC lumber and PVC lumber were chosen as the favored material for all the three types of decking projects, Figure 10. The preference for both PVC lumber and WPC lumber were highest for building 'new decks in new houses' and lowest for 'repair and remodeling' projects. In contrast, SYP lumber received its highest rating for repair and remodeling projects.

Based on the sample of PSF decking lumber shown to the respondents along with the verbal description of the material, 19% of the respondents said that they would consider using PSF for repair and remodeling projects. However, none of the respondents indicated that they would be willing to use PSF for building new decks. This result may be due to uncertainty associated with using a new product. Additionally, it appears that deck builders may be more likely to initially evaluate a new product like PSF in repair and replacement projects where the potential risk is lower. The higher interest in using PSF in repair and replacement projects may also be due to deck builder's perceptions that PSF and SYP are substitutable with each other. If true, this suggests that further research in this area might help with the introduction of PSF into the market as a substitute for SYP lumber.

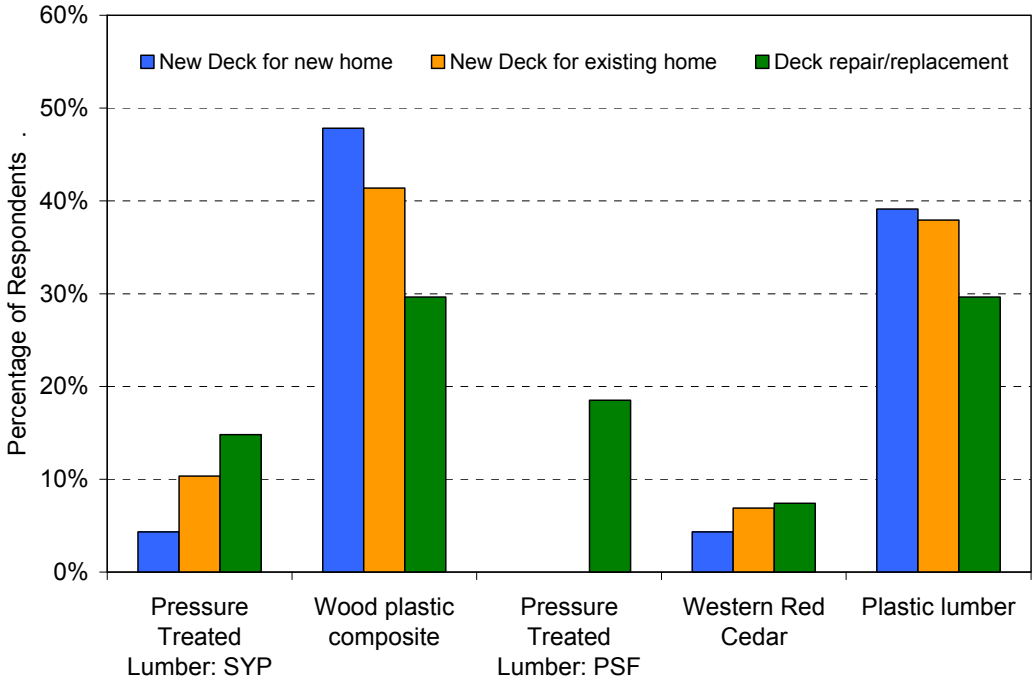

Figure 10. Primary material of choice for given the type of deck project.

Attribute importance rating

Survey respondents were asked to rate a variety of decking material attributes using a Likert-like scale of 1 – 7; where a rating of 1 meant that the attribute was not important in selecting a decking material, a rating of 4 meant it was somewhat important and a rating of 7 meant that it was extremely important in selecting a decking material. The survey results show that longevity was rated as being the most important decking material attribute, followed by beauty and ease of maintenance. Low material cost was rated as being the least important decking material attribute followed by reduced environmental impact.

In selecting the decking material attributes to be used in this study, only those identified in previous research as being important were included in the survey. As a result, it was expected that all the material attributes would be rated highly. For market research, the relative importance of these material attributes are more important, since the most important variables play a greater role in influencing material purchase decisions. Because of this consideration, the neutral score of "4" was used as the base of the x-axis. The heavy black vertical line in Figure 11 represents the overall mean (5.7) for all of the material attribute scores. Those material attributes which had an importance rating that was greater than the mean rating

can be considered to have the greatest influence on the material specification process of deck builders. Longevity of the decking material and beauty emerged as the two most important attributes of decking materials followed by ease of maintenance and decay resistance.

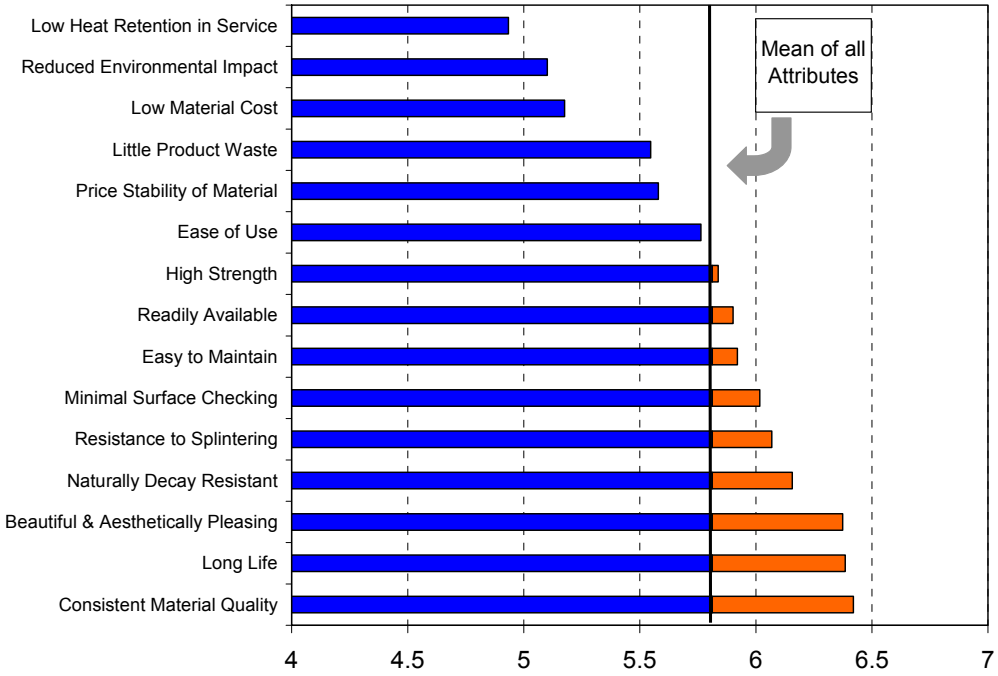

Figure 11. Attribute importance rating

Product attribute ratings

Survey respondents were also asked to rate each product relative to the others in terms of 8 different material attributes using a 7 point Likert-like scale. For example, if product 'A' was perceived to be very beautiful and aesthetically pleasing that product will be rated very high (6 or 7) by the respondent. A low rating of 1 or 2 for a product on the same attribute would indicate that the product is not perceived to be a beautiful product. The midpoint of the scale is 4 which was labeled as being neutral in the questionnaire. Table 11 presents the averages attribute ratings for the products obtained from the survey. In the table the shaded boxes indicate the decking material that received the highest rating for a particular material attribute. The material attribute values displayed with a bold red colored font indicate the highest rated attribute for that particular decking material. Among all the products included in the survey, plastic lumber was perceived to be decking material that possesses the longest serviceable life, is the easiest to maintain and has the least amount of surface checking. Longevity and ease of maintenance were rated as being the best attributes of plastic lumber. Low material cost was rated as the best attribute of SYP. Ready availability was considered to the best attribute of WPC lumber. WRC was perceived to be the most beautiful decking material in the market, and it was also perceived as being the easiest to use and having lowest environmental impact. Relative to SYP, PSF was perceived to have higher longevity, greater beauty, easier to maintenance and higher resistance to surface checking.

Table 11. Average attribute ratings for the decking materials.

	SYP	WPC	PSF	WRC	PVC
Long life	3.7	5.4	4.2	4.7	**6.2**
Beautiful & Aesthetically Pleasing	3.8	4.8	4.4	**5.6**	4.8
Readily Available	5.5	**5.9**	3.8	4.7	5.2
Low Material Cost	**5.8**	3.9	4.1	4.2	3.2
Ease of Use	5.3	5.3	**5.0**	5.5	5.4
Reduced Environmental Impact	4.4	4.6	4.3	4.7	4.4
Easy to Maintain	3.2	5.2	3.5	3.6	**6.2**
Minimal Surface Checking	3.3	5.2	3.9	4.0	6.0
Average product score	4.3	5.1	4.2	4.6	5.3

Environmental impact

Survey respondents were asked to rank the top three environmental attributes of decking materials in terms of reducing their impact on the environment, Figure 12. Incorporating recycled materials in the decking material was perceived as being the most important environmental attribute of a decking material followed by not using preservatives or chemicals in the decking materials. Five builders rated "material made with no wood" as being the most important environmental attribute, whereas, a total of 10 respondents rated this attribute in the top-three list. The builders who rated materials made with 'no wood' as the most important environmental attribute are primarily the plastic lumber users. Two thirds of the respondents rated 'wood sourced from sustainably managed forest/certified wood' in their top-three list, which is highest of all the environmental attributes listed in the questionnaire. However, only three individuals rated it as the most important attribute. This indicates that 'wood sourced from sustainably managed forests or certified wood' has a wider appeal compared to other attributes listed in the survey, although it is not considered to be the most important environmental attribute by this group of respondents. As observed earlier, this group of respondents displayed a higher preference for PVC and WPC decking materials, and their responses in this section of the survey further support this preference.

In order to assess the relative importance of the environmental attributes, we used a weighting system to provide an environmental score for each attribute. Respondents first choice was given a weight of 3 while their second choice received a score of 2 and their third choice got a score of 1. The overall ranking of the environmental attributes are contained in the boxes in Figure 12. The rankings show that the most important environmental attribute is that the decking material contains recycled material. This attribute was substantially more important than all of the other environmental attributes. The second and third ranked environmental attributes were: made from certified wood (environmental score of 31) and decking material made without preservatives or chemicals (environmental score of 27).

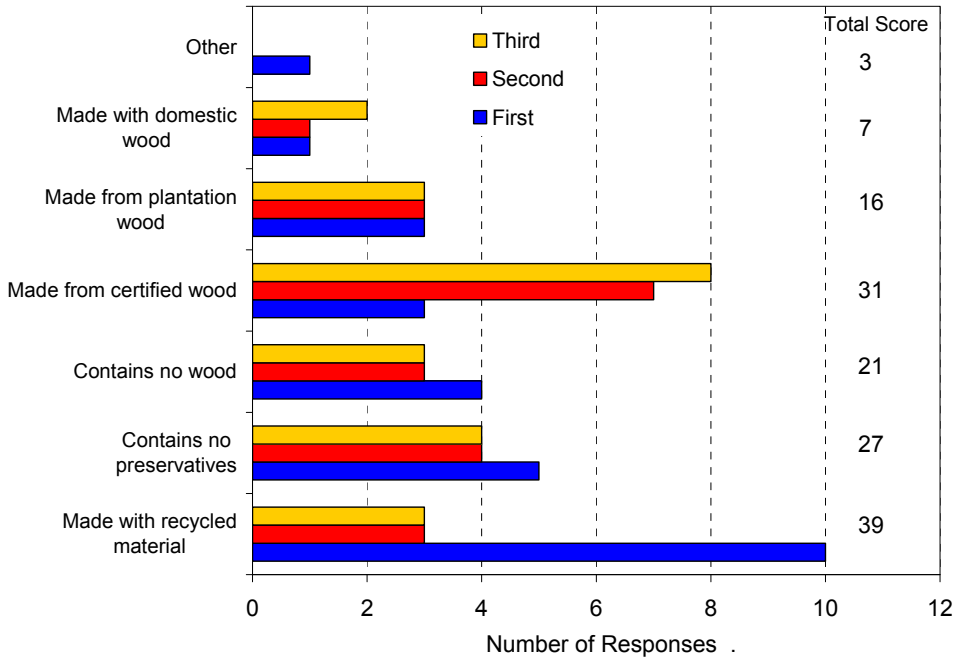

Figure 12. Ranking of attributes of decking materials with the most favorable environmental impact.

Multivariate Analysis of Survey Data

Attribute rating comparison between PSF and SYP

The two pressure treated species included in the survey were SYP and PSF. Pressure treated lumber has traditionally been the dominant decking material used in the US decking industry and the majority of the PTL market is supplied by southern yellow pine because of its high availability, low price and its ease of treating and high preservative retention levels. The success of PSF in the US decking market would be largely dependent on its ability to be compete with SYP, particularly in decking surface applications. Hence, a comparison of deck builders perceptions of the attributes of SYP and PSF was performed.

A paired t-test was conducted for each of the eight decking material attributes included in the survey. The mean attribute ratings of the two pressure treated species are summarized in Table 12. The results of this analysis show that significant differences in ratings were observed for four of the attributes and these have been highlighted in the table. Deck builders perceived that SYP was superior to PSF along two attributes (ready availability and low cost) whereas they rated PSF as being superior to SYP along two other attributes (beauty and minimal surface checking). Further, they also rated PSF as having substantially better performance in terms of durability (long life) and ease of maintenance. These differences are important because they imply that it is possible for PSF to achieve a competitive advantage over SYP by increasing its market supply and establishing a competitive pricing structure, two attributes that can be easily controlled by PSF manufacturers. In contrast, it will be difficult for SYP manufacturers to counter the perceived competitive advantages of PSF (better durability, more beautiful, less surface checking and ease of maintenance) assuming that PSF manufacturers are able to firmly establish these attributes as being superior to those of SYP in the minds of deck builders.

Table 12. Paired t-statistics results identifying the differences between SYP and PSF

	SYP ratings	PSF ratings	Significance Values
Long life	3.74	4.22	0.13
Beautiful & Aesthetically Pleasing	**3.84**	**4.44//**	**0.06**
Readily Available	**5.74****	**3.83**	**0.00**
Low Material Cost	**5.59****	**4.09**	**0.01**
Ease of Use	5.17	5.04	0.65
Reduced Environmental Impact	4.30	4.30	1.00
Easy to Maintain	3.14	3.45	0.18
Minimal Surface Checking	**3.14**	**3.91***	**0.02**

*** - significantly higher at .01 significance level; * - significantly higher at .05 significance level;*
// - significantly higher at .1 significance level

Cluster Analysis – respondents' willingness to use PSF in the future

Cluster analysis is a statistical technique used to identify common traits among survey respondents and help to classify the respondents in terms of their perceptions of PSF as an alternative decking material (*an explanation of cluster analysis and the methodology adopted is explained further in Appendix B*). The cluster analysis was based on those questions where the deck builders were asked to express their outlook regarding PSF. As mentioned earlier, the respondents were asked to categorize each decking material into one of four categories, (i) 'primary material' of choice, (ii) 'secondary material' of choice, (iii) 'may use the product' and (iv) 'will never use the product'. The results obtained from this section of the questionnaire are presented in Figure 9. The respondents were also asked if they would consider using each decking material in three specific projects types: (i) new decks for existing homes, (ii) deck repair and replacement and (iii) new decks for new homes. The results from this section of the questionnaire are presented in Figure 13. In these questions, the respondents were asked to express their likelihood of using PSF. The cluster analysis was based on those questions pertaining to the respondent's attitude towards PSF. Specifically, the following four variables were used to generate the clusters:

i. Consideration given to PSF for standard decking applications (options: primary choice, secondary choice, may use or will never use)
ii. Consideration given to PSF as a material of choice for building new decks in existing homes (options: yes & no)
iii. Consideration given to PSF as a material of choice for deck repair and replacement (options: yes & no)
iv. Consideration given to PSF as a material of choice for building new decks in new homes (options: yes & no)

Objectives for conducting the cluster analysis

The primary objective of conducting the cluster analysis was to determine if there were natural clusters within the sample of respondents in terms of their attitude towards using PSF. The secondary objective of the cluster analysis was to identify any demographic or psychographic differences among groups identified as a result of the cluster analysis. It should be noted that there was a higher percentage of non-response for questions about PSF, most likely because the respondents felt that the sample and the verbal description of PSF lumber were not sufficient to make an informed decision about the in-service performance of PSF lumber in decking applications. Only 17 survey participants responded to all the silver fir questions and the cluster analysis is based on those 17 respondents.

Methodology and Results

A Hierarchical Cluster analysis was used to identify the groups within the survey population. Cluster analysis is used to identify common traits among the respondents by measuring the proximity between them based on some distance measure. In this case the distance measures were developed based on the respondents' attitude towards PSF. Ward's Sum of Squares was used with a Camberra metric index as the distance measure. In the hierarchical cluster analysis, individuals are grouped into smaller clusters based on their distance scores and then those smaller clusters are joined together into larger clusters interactively. The hierarchical clustering process is illustrated in the dendrogram presented in Figure 13. From the dendrogram it can be observed that a strong two-group solution emerged from the cluster analysis, although a three-group and a four-group solution were also identified as possibilities as a result of the cluster analysis. A subsequent analysis of the mean '*niche width*' confirmed that the two group solution was a far more efficient solution than either the three group and four group solutions.

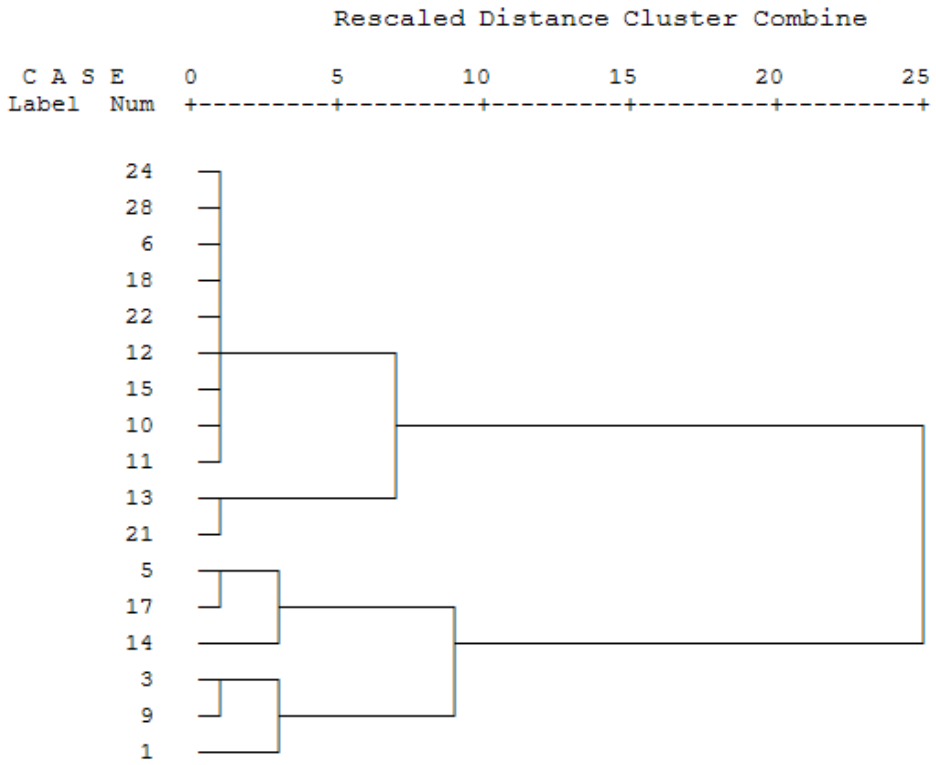

Figure 13. Dendogram showing the clusters within the survey population (using Ward's method)

Table 13. Classification of the clusters

Variables with their respective categories		Cluster results		Pearson Chi-Square Tests	
		Number of Respondents in cluster 1	Number of Respondents in cluster 2	Indicators	Values
PSF	Primary Choice	1	0	Chi-square:	13.059
	Secondary Choice	4	0	df:	3
	May Use	1	9	Sig.:	.005
	Will Never Use	0	2		
New deck for existing home: PSF	No	6	11	Not Valid	
	Yes	0	0		
Deck repair/replacement: PSF	No	3	11	Chi-square:	6.679
	Yes	3	0	df:	1
				Sig.:	.010
New Deck for new home: PSF	No	6	11	Not Valid	
	Yes	0	0		
Nomenclature		**Pro PSF**	**Unsure of PSF**		

Further analysis of characteristics of the segments

It was noted that the respondents who refrained from answering any potential PSF usage questions were also unsure of the product and could be placed into the second group, Table 13. As a result' the 'Pro-PSF' group consisted of 6 respondents and the 'Unsure' group consisted of the remaining 22 respondents. A thorough analysis was conducted to identify differences in demographic or psychographic characteristics of these groups identified by the cluster analysis. Statistically significant differences in the importance ratings of several material attributes were identified between the clusters. The results of a series of T-tests on the importance ratings for three product attributes, longevity, natural decay resistance, and ease of maintenance, were found to be significantly lower for the Pro-PSF group, Table 14. The mean importance ratings of low cost, price stability and minimal surface checking is higher among the Pro-PSF group, although none of these differences emerged as being statistically significant. These results suggest that economy-oriented deck builders, who value low price and price stability and are less concerned about durability and beauty, are more likely to react positively to PSF. However, the small sample size makes it impossible to confirm this trend.

An analysis was also undertaken to identify the differences in the demographic factors of the respondents grouped into the two segments, however, none of the demographic variables emerged as being significantly different between the two clusters. Lack of variation in the sample along with the small sample size, made it difficult to identify statistical differences between the groups.

Table 14. Differences in attribute importance ratings between the groups

Attributes	Mean importance ratings		t-statistic	Degrees of Freedom	Significance (2-tailed)
	Pro PSF (n=6)	Unsure of PSF (n=22)			
Long Life	6.00*	6.68*	-2.30	26	0.03
Beautiful & Aesthetically Pleasing	6.40	6.52	-0.32	24	0.75
Naturally Decay Resistant	5.17*	6.25*	-1.79	24	0.09
High Strength	5.50	5.71	-0.46	25	0.65
Readily Available	5.50	5.57	-0.12	25	0.90
Low Material Cost 00	5.17	4.48	0.93	25	0.36
Minimal Surface Checking 00	5.83	5.60	0.38	24	0.71
Ease of Use	5.83	5.91	-0.14	26	0.89
Price Stability of Material 00	5.67	5.05	1.18	25	0.25
Consistent Material Quality	5.50	6.14	-1.63	25	0.11
Easy to Maintain	5.50*	6.38*	-2.35	25	0.03
Little Product Waste	4.83	5.73	-1.33	26	0.19
Resistance to Splintering	5.83	6.00	-0.31	25	0.76
Reduced Environmental Impact	4.50	4.90	-0.51	25	0.61

To gain a better understanding of the perceptions of PSF and SYP among the individuals contained within each of the clusters, a paired t-test was conducted. The results show significant differences in the attribute ratings for the two pressure treated species among the two clusters, Table 19. Deck builders located in the 'Pro-PSF' cluster rated the beauty and ease of maintenance aspects of PSF to be significantly better than SYP while the 'Unsure of PSF' cluster rated PSF significantly lower in terms of low cost and product availability. Deck builders in both clusters agreed that PSF was superior to SYP in terms of surface checking. Since both 'ease of maintenance' and 'beauty of decking materials' were rated as being very important decking material attributes, we may infer that the superior perception of PSF over SYP in terms of these two attributes could provide PSF with a competitive advantage in the market, always assuming that PSF manufacturers are able to overcome the supply and pricing concerns of deck builders. Interestingly, respondents in both clusters rated PSE as being superior to SYP in terms of surface checking.

Table 15. Group-wise paired t-statistics results identifying the differences between SYP and PSF

Attributes	Pro PSF (n=6)			Unsure of PSF (n=22)		
	SYP	PSF	Sig. (2-tailed)	SYP	PSF	Sig. (2-tailed)
Long life	3.80	4.40	0.37	3.72	4.17	0.23
Beautiful & Aesthetically Pleasing	**3.67**	**4.33**$^{//}$	**0.10**	3.89	4.47	0.15
Readily Available	6.00	4.40	0.26	**5.67****	**3.67**	**0.00**
Low Material Cost	5.40	4.00	0.34	**5.65***	**4.12**	**0.02**
Ease of Use	5.00	4.80	0.78	5.22	5.11	0.73
Reduced Environmental Impact	5.40	5.00	0.37	4.00	4.11	0.71
Easy to Maintain	**3.00**	**3.80**$^{//}$	**0.10**	3.18	3.35	0.53
Minimal Surface Checking	**3.20**	**4.00**$^{//}$	**0.10**	**3.12**	**3.88**$^{//}$	**0.06**

N.B: ** *- significantly higher at .01 significance level;* * *- significantly higher at .05 significance level;*
$^{//}$ *- significantly higher at .1 significance level*

Perceptual Mapping: PSF positioning analysis

Discriminant analysis based perceptual mapping was used to perform a positioning analysis of PSF. For conducting the perceptual mapping exercise, the survey respondents were asked to rate each of the five decking materials along 8 decking material attributes, Table 11. The rating scale ranged from 1 to 7, where a rating of 1 meant that the particular product did not possess the attribute at all and a rating of 7 meant that the product possessed the attribute to a high degree.

In this analysis, each product is rated on its attributes by multiple respondents and for analyzing the data with Multiple Discriminant Analysis (MDA) each product may be considered a distinct group. The objective of the discriminant analysis is to determine whether these groups are statistically different from one another based on the measured attribute variables. Using a similar seven point scale, the respondents were asked to specify the relative importance of each product attribute when they specify decking materials. These relative attribute importance ratings are used to identify the overall ideal attribute combination (market centroid) for the market.

An MDA was undertaken using 6 products (5 actual products and an ideal product category) based on each respondents' rankings of the 8 product attributes. The resultant product positioning scores and ideal point scores were standardized across respondents and decking materials. To create a two-dimensional perceptual map, by convention the first two discriminant functions were used. More than 78.3% of the variation in the dataset was captured by these two dimensions, with 54.2% of the variation in the data explained by the first discriminant function and 24.1% of the variation explained by the second discriminant function.

In the perceptual map presented in Figure 14, the perceptual space is defined by the material attributes. The perceptual map ties together two elements of the map (the attribute vectors and the product centroids), through the two discriminant functions represented as the x and y axes. Information that can be observed from the map includes: the perceptual relationship between the attributes, the positioning of the products and the role of the attributes in differentiating the products. The circles denote the centroids or mean positioning of each decking material. Each decking material is perceived differently by each individual respondent and the product centroids displayed on the map represent the mean response. The perceptual map presented in Figure 14 is derived from Figure C1.

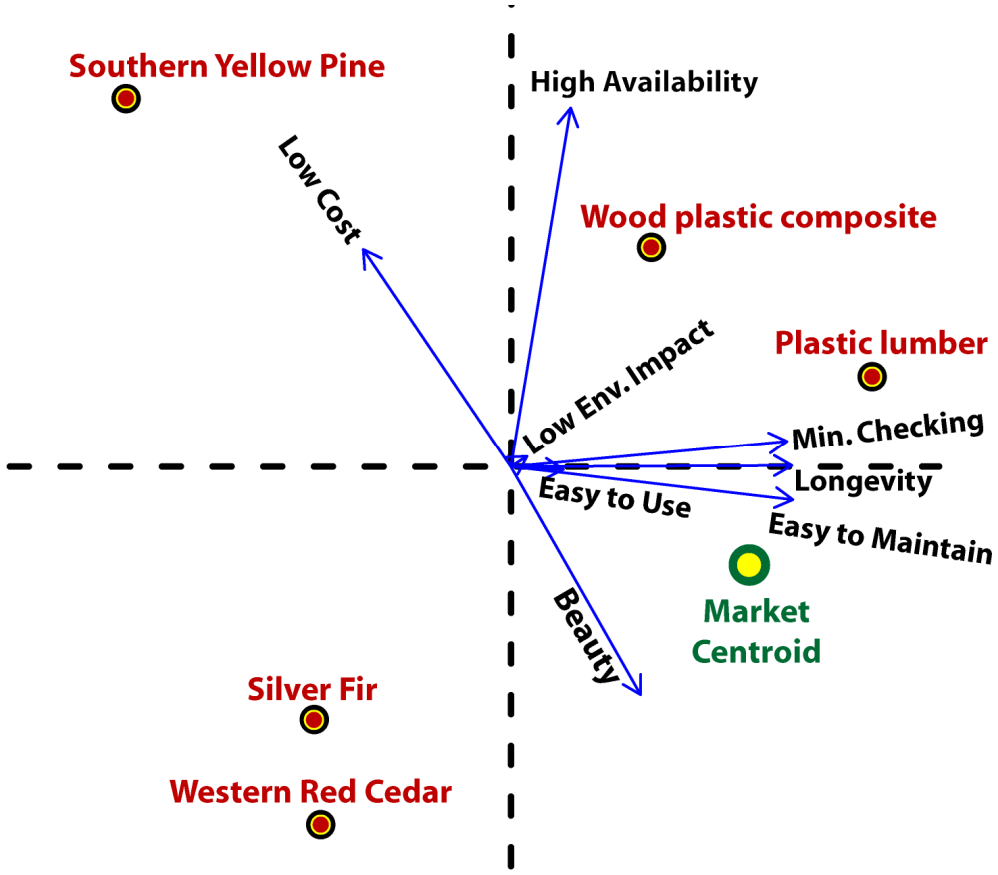

Figure 14. Perceptual map based on responses at the trade show responses

Please note that this perceptual map does not represent the overall US market as the sample used to develop the map cannot be considered a representative sample of the US domestic decking industry

Reading the Perceptual Map

Attribute vectors

The decking material attributes are represented as vectors in the perceptual map. These attribute vectors are the most important aspect of the perceptual map since the perceptual space is defined by these attribute vectors via the two axes (discriminant functions). There are two important aspects of the attribute vectors to consider; the length of the vectors and the angles between the vectors and the axes (or the direction of the vectors). A longer vector indicates the greater discriminating power of that particular attribute in differentiating between the decking materials. In Figure 14, it can be observed that 'beauty' and 'availability' possess relatively long vectors, indicating that these attributes play important roles in differentiating between the decking materials. In contrast, the short length of the vectors for the material attributes 'environmental impact' and 'ease of use' indicates that the respondents felt that all of the decking materials were quite similar with respect to these material attributes, and therefore these attributes were not effective in discriminating between the different decking materials.

Further, the relationship between the material attributes, and the relationship between an axis and a material attribute, can be inferred from the angle between the vectors. The relationship between the attributes may be inferred by referring to the smallest angle between vectors. An acute angle between the attribute vectors means that the attributes are perceived to be positively correlated to each other by the survey respondents. If the attributes are close to 90 degrees (orthogonal) to each other, the attributes are

perceived to be independent of each other. Finally, an obtuse angle between the material attributes would indicate an inverse relationship between the material attributes. The larger the angle (nearing 180 degrees), the stronger the inverse relationship.

Referring to Figure 14, the attributes 'minimal checking', 'longevity' and 'easy maintenance' can be inferred to be highly correlated to each other and are perceived to be similar for all of the decking materials. Moreover, these attributes are orthogonal to the vector 'availability' implying that 'minimal checking', 'longevity' and 'easy maintenance are not related to the availability of a decking material. Finally, the attributes 'beauty' and 'low cost' are positioned at an obtuse angle to each other (almost 180 degree) which implies that these attributes are considered to be trade-offs.

Analyzing the perceptual positioning of PSF

Product Positioning

Interpreting the relative positioning of the decking materials on the perceptual map should be done with reference to the length and direction of the attribute vectors. A convenient way of interpreting the positioning of the decking materials, using the direction of the attribute vectors, can be done with reference to the quadrants in which the products are positioned. For example, the quadrant diametrically opposite to the beauty vector is the top-left quadrant. The decking material located in this quadrant (i.e., SYP) is perceived to have a lower aesthetic value. Using the attribute vector lengths is also important in interpreting the positioning of the decking materials. In Figure 14 it can be observed that the attribute 'strength' has a very short length, indicating that this attribute plays a very small role in differentiating between the products, whereas the attribute 'beauty' has a longer length indicating the greater discriminating power of this variable among the decking materials.

Initial observations made on the locations of the PVC and WPC decking materials were further reinforced by the perceptual map. From the perceptual map it is evident that the demand centroid is closer to PVC lumber and WPC lumber. In contrast to earlier CINTRAFOR surveys, the respondents of this survey indicated that PVC and WPC decking materials possess higher durability characteristics (long life and easy to maintain). However, the relationship between the products and the material attributes are comparable to those in previous perceptual maps developed from national surveys. Hence, an analysis of product positioning will have lower external validity and the conclusions should not be extended to the national market.

As compared to the other decking materials, PSF is positioned closer to WRC. The respondents have differentiated PSF from SYP along three attributes: (i) beauty, (ii) cost and (iii) availability. While respondents perceived that PSF decking was more aesthetically appealing than SYP decking, they also perceived that PSF decking would be more expensive and less readily available than SYP decking. Equally important is the perception that PSF decking is more resistant to splitting/checking and that it is easier to maintain than SYP decking. WRC decking was perceived as being both more expensive and more beautiful than PSF decking.

Cluster Analysis – Respondents' Perceptions of Pacific Silver Fir

A second cluster analysis was conducted to identify clusters of individuals based on their perceptions of PSF. The PSF material attribute ratings were used to conduct this second cluster analysis. As mentioned earlier, we requested the respondents to rate each product on the 8 different attributes listed in the survey. For this cluster analysis we used the following variables from the material attribute rating list:

i. Rating of PSF on the 'Long Life' attribute
ii. Rating of PSF on the 'Beauty' attribute
iii. Rating of PSF on the 'Ready Availability' attribute

iv. Rating of PSF on the 'Low Material Cost' attribute
v. Rating of PSF on the 'Ease of Use' attribute
vi. Rating of PSF on the 'Reduced Environmental Impact' attribute
vii. Rating of PSF on the 'Easy to Maintain' attribute
viii. Rating of PSF on the 'Minimal Surface Checking' attribute

Objectives for conducting the cluster analysis

The primary objective for conducting this cluster analysis was to determine if there were natural clusters within the sample of respondents in terms of their perception towards PSF. We might refer to these as the 'impressed by PSF' Cluster and the 'not impressed by PSF' Cluster. The secondary objective of the cluster analysis was to identify any demographic or psychographic differences between the clusters identified. A total of 20 survey participants responded to all of the PSF attribute questions and the cluster analysis is based on those 20 respondents.

Methodology and Results

Similar to the previous cluster analysis, a Hierarchical Cluster analysis was used. Cluster analysis is used to identify common traits among the respondents by measuring the proximity between them based on some distance measure. In this case the distance measures were developed based on the respondents' attitude towards PSF. The idea here is to minimize the distance measures for individuals included in the cluster while maximizing the distance between individuals included in other clusters. The hierarchical clustering process is illustrated by the dendrogram presented in Figure 15. From the dendrogram it can be observed that a strong two-group solution emerged from the cluster analysis, although a three-group and a four-group solution were also identified as possible solutions. A subsequent analysis of the mean '*niche width*' confirmed that the two group solution was a far more efficient solution than either the three group and four group solutions.

A statistical analysis of the differences between the two clusters based on the material attribute scores was conducted using a t-test for all eight variables, Table 16. Based on the t-test results, it was evident that the 'impressed by PSF' deck builders (n=6) rated PSF significantly higher in terms of the material attributes long life, beauty, ease of use, ease of maintenance, and minimal environmental impact, than did the deck builders included in the 'not impressed by PSF' cluster (n=14).

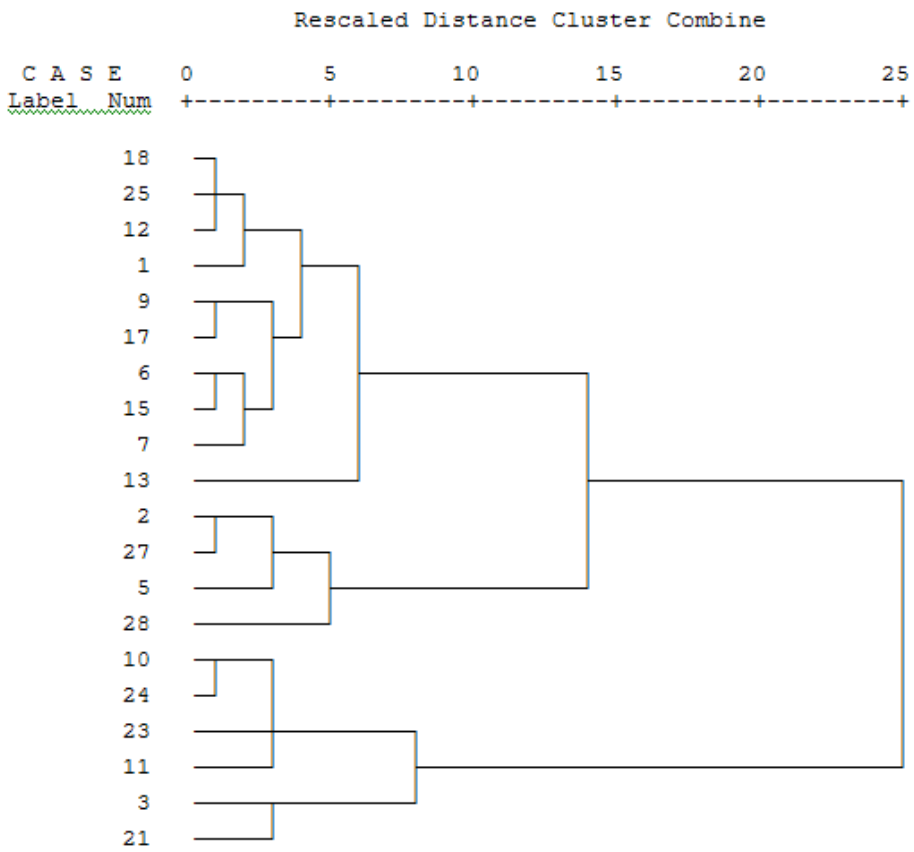

Figure 15. Dendogram showing the clusters within the survey population (using Ward's method)

Further analysis of characteristics of the groups

A further analysis was undertaken to identify additional differences in the demographic and psychographic factors among the individuals identified in these two clusters. Only one variable 'number of decks built' was found to be significantly different between the two clusters. The average number of decks built by the individuals located in the 'not impressed by PSF' cluster was 18 deck per year whereas the average number of decks built by individuals located in the 'impressed by PSF' cluster built an average of 126 decks per year (significant at the 0.028 level).

To gain a better understanding of the perceptions of PSF and SYP among the individuals clustered in each of these clusters, a paired t-test was conducted, Table 17. The results show that several of the relative attributes ratings for PSF and SYP were significantly different between the clusters. For example, both of the clusters rated PSF as having a higher cost and lower availability relative to SYP. The 'impressed by PSF' group rated the longevity of PSF as being significantly better than SYP, whereas, the 'not impressed group' rated PSF and SYP almost identically in terms of this attribute. In summary, we found that deck builders could be grouped into two segments based on the number of decks that they build. The group that was impressed by PSF rated it significantly higher than SYP in 5 of the 8 attributes. Further, both groups rated SYP significantly higher in terms of availability and low cost. Finally, the group that was impressed by PSF rated it as being significantly better than SYP in terms of its longevity, whereas the group that was not impressed by PSF rated its longevity as being the same as that of SYP.

Table 16. Classification of the clusters based on PSF attributes perception

Material Attributes	Group-1 (n=14)	Group-2 (n=6)	Significance (2-tailed)
Long Life	**3.71**	**5.67****	**0.001**
Beauty	**3.57**	**6.33****	**0.000**
Available	3.79	4.50	0.238
Cost	3.79	4.33	0.394
Ease Use	**4.64**	**5.83***	**0.041**
Minimal Environmental Impact	**4.00**	**5.33**$^{//}$	**0.053**
Ease of Maintenance	**3.00**	**4.83****	**0.005**
Minimal Checking	3.57	4.50	0.109
Nomenclature	**Not impressed by PSF**	**Impressed by PSF**	

N.B: ** - significantly higher at .01 significance level; * - significantly higher at .05 significance level;
// - significantly higher at .1 significance level

Table 17. Group-wise paired t-statistics results identifying the differences between SYP and PSF

Attributes	**Impressed by PSF (n=6)**			**Not impressed by PSF (n=14)**		
	SYP	PSF	Sig. (2-tailed)	SYP	PSF	Sig. (2-tailed)
Long life	**4.67**	**5.67**$^{//}$	**0.08**	3.64	3.71	0.84
Beautiful & Aesthetically Pleasing	5.67	6.33	0.39	3.14	3.57	0.32
Readily Available	**6.17***	**4.50**	**0.05**	**5.79****	**3.79**	**0.00**
Low Material Cost	**6.17**$^{//}$	**4.33**	**0.07**	**5.64****	**3.79**	**0.01**
Ease of Use	6.17	5.83	0.36	5.00	4.64	0.29
Reduced Environmental Impact	5.33	5.33	[a]	4.29	4.00	0.30
Easy to Maintain	4.67	4.83	0.36	2.64	3.00	0.34
Minimal Surface Checking	4.17	4.50	0.17	2.93	3.57	0.12

*N.B: ** - significantly higher at .01 significance level; * - significantly higher at .05 significance level;*
// - significantly higher at .1 significance level
[a]: The correlation and t cannot be computed because the standard error of the difference is 0.

Strategic Marketing Recommendations

The marketing recommendations provided in this section of the report specifically relate to the preservative treated and profiled PSF decking material used for the survey. Moreover, these recommendations are based on the structured survey responses and the open ended comments and reactions obtained from the survey participants. Strategic recommendations on the positioning and pricing of PSF decking are provided. Some peripheral recommendations on product distribution are also provided.

Product Positioning

The US residential building industry is known for its low propensity to adopt new or innovative materials and introducing a new product into a market where there is no shortage of decking materials represents a significant challenge. Though there is an ample supply of PVC and WPC decking materials in the market, the supply of domestically available, naturally durable species is on the decline (e.g., RW and WRC). However, a large proportion of deck builders have expressed their dissatisfaction with plastic lumber. The cluster analysis suggests that there is a distinct segment of deck builders who appreciate the attributes of PSF in terms of material longevity, beauty, ease of use and ease of maintenance, which could help to position it well against treated SYP. Past research indicates the existence of a niche market for aesthetically appealing wooden decking materials. Given the declining supply of naturally durable domestic species, this niche market has increasingly looked to imported tropical hardwoods. However, many deck builders and home owners are increasingly concerned about the environmental sustainability of tropical hardwoods. In addition, public procurement policies in the EU, Japan and the US require that imported wood products be certified as being sourced from legally harvested timber. This requirement is liable to further reduce the supply and increase the cost of THW lumber in the US. This research suggests that PSF decking can be positioned to be competitive in the solid wood segment of the decking market.

The survey results also suggest that the respondents are conservative by nature and reluctant to try an untested material in new construction projects. Given this reluctance, PSF decking might initially be positioned for use in the repair and replacement segment of the decking market. Deck builder uncertainty regarding PSF could be reduced by displaying demonstration decks at lumber yards and retail stores, where DIY homeowners tend to shop for decking materials more often. Most importantly, the successful introduction of PSF into the US decking market will require that an adequate supply of the decking material be made available in the target market.

While there is a small segment of deck builders who would be willing to use PSF decking lumber, more than 75% of the respondents indicated that they would be unlikely to use PSF. This research suggests that deck builder's reluctance to use PSF can be attributed to the lack of availability of the product. The study clearly shows that PSF could be differentiated from SYP by emphasizing its perceived advantage along four important material attributes; ease of maintenance, beauty, minimal surface checking, and longevity.

Both ease of maintenance and minimal checking were rated as important decking material attributes. The second cluster analysis also indicated that a certain proportion of deck builders were impressed by the 'ease of maintenance' and 'ease of use' attributes of PSF. Hence, PSF could be well positioned to compete with SYP decking lumber in terms of these attributes. It was also perceived as being an attractive product. These two combinations of attributes suggest that PSF could compete well in two segments of the decking market. The first target market would be for large size structural lumber in non-visual end-use applications in the deck substructure (such as posts and joists), where SYP enjoys a near monopoly in the marketplace. This is especially important since virtually no WPC or PVC decking materials have received code approval for use in substructure applications. Included in this category would be stair stringers and thinner fascia boards. The second target market would be for higher grade decking lumber that is preservative treated that has a profiled surface that would compete against RW and

WRC in deck surface applications. Included in this category would be a railing system(s) using PSF which could include more than a single profile for the top rail. This strategy of producing an integrated system of decking products is strategically important because it would allow sawmills to better utilize their logs, maximize their product yield and reduce material waste. It would also provide a market for lower grade logs in the production of structural lumber for use in decking substructures where the visual quality of the lumber is much less important.

Product Pricing

Deck builders tended to rate material cost as being less important in the specification of decking materials, and from this we conclude that price does not significantly influence the specification of decking materials. This may be due to the fact that the total cost of materials used to build the deck surface, even for a custom deck, is relatively modest. Given the range of decking materials available to US deck builders, many appear to be willing to pay a higher price for a more aesthetically pleasing decking material. Similar perceptions have also been observed in the DIY decking market. While PSF structural lumber cannot complete with pressure treated SYP lumber in supply, at least in the near-term, it should be competitively priced with SYP structural lumber in the markets where it competes (i.e., the PNW region including BC, WA, ID, MT, NV, and OR). Similarly, PSF decking lumber should not be priced at par with the naturally durable species against which it will be competing. Rather, high quality PSF profiled deck boards should be sold at a slight discount, at least initially, to WRC and RW deck boards.

Product Placement

In order to address the respondents concerns about the supply of PSF decking lumber, it is important to make the product readily available in local lumberyards with the target market. As is generally suggested in cases of new product introduction, the material should be introduced in carefully selected test markets. The proper selection of the test market where the product will be introduced plays a crucial role in the success of the product during the early stages of its introduction into the market. As discussed earlier, PSF decking lumber should be targeted to two niche markets (substructure and decking surface). The most important criterion for identification of an ideal market for product introduction is a market where there is existing demand for treated lumber in substructure applications and naturally durable species in deck surface applications. Based on previous CINTRAFOR deck market research (and taking into account transportation logistics), western Washington, western Oregon and/or Northern California would be good candidates as test markets for a PSF product introduction.

Given the nature of the decking market, a push strategy is deemed to be an effective way of introducing the PSF product into these markets. Apart from displaying demonstration decks at local lumber yards, the lumber yards should be provided necessary incentives for promoting the product. These incentives can be in the form of providing local workshops and product orientation for lumber yard employees, deck designers and deck builders. The incentives could also include deck design software that incorporates structural values for PSF lumber and development of PSF decking accessories such as railings and stairs. Attractive product brochures and attendance at trade shows and remodeling shows would also be important. Providing certification of sustainability labels or brands on the PSF products would be useful in marketing this product in the environmentally conscious northwest region.

Concluding Observations

The data collected for the study provided some insights about deck builders' perceptions of PSF. The researchers used several multivariate data analysis techniques that are known to be more effective with datasets of small sample sizes and only the ones that showed significant insights were reported in this report. A comparison of the results obtained from the PSF study and previous studies has also helped provide helpful insight into deck builder's perceptions of PSF. Given the results obtained from this study, we are confident that there is substantial market for a line of PSF decking products in the PNW region. Currently, pressure treated SYP is the dominant material used to frame deck sub-structures based on the combination of high material strength and low material cost. While some treated Douglas-fir is used for deck substructures in the western US, difficulties in treating this species limits its appeal. Given its good strength and costs characteristics, it is expected that pressure treated PSF framing lumber would be competitive with the SYP product, particularly in the US west coast markets where lower transportation costs could give a PSF products a potential competitive advantage over SYP. In the deck surface market, the aesthetic appeal of the profiled and stained PSF deck board could also position it as a competitive product in the US west.

However, limitations associated with transect sampling have been identified in this study and the resultant biases tend to influence the study findings. In the report we have attempted to identify these biases and minimize them by comparing the results with those obtained from previous 'more representative' studies. In particular, the limited sample size posed a substantial limitation during the analysis of the survey data. Given the small sample size, differences in deck builders' responses based on demographic and psychographic traits were difficult to observe. As a result we were unable to observe differences based on some important demographic variables such as geographic location and area of operation (rural vs. urban).

However, given the promise this small dataset has shown, we strongly recommend conducting a larger study on the market potential of PSF prior to its test market introduction. In order to better assess deck builder's perceptions of a new product with which they are unfamiliar, it is critical that they be able to observe and handle the actual product so that they can compare it directly to samples of competing decking materials. We strongly recommend that a second survey be conducted at a future Deck Expo, a national trade show of the North American Decking and Railing Association. Finally, it would be useful to conduct a survey at a decking show located in the PNW to corroborate this region is an appropriate test market.

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Appendix A

CINTRAFOR
2009 DECK BUILDER SURVEY

We're conducting a survey on behalf of the University of Washington regarding the different types of materials used to build residential decks. The purpose of this survey is to learn how certain types of decking materials are used by deck builders and homebuilders. All responses will be kept strictly confidential.

The survey will take approximately 12 – 15 minutes.

We value your time. At the end of the survey we will give you a small token of our appreciation and your name will be entered in the daily drawing for a $200 Home Depot Gift Card.

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deck WORLD

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2. **Considering the decking materials on the table, please indicate which of these you would use as your primary and secondary choices for building a standard deck.**

Deck Material	For your standard decking needs			
	Primary Choice (Check one)	**Secondary Choice** (May check more than one)	**I might use it** (May check more than one)	**I would never use it** (May check more than one)
Product A (Pressure Treated Lumber: SYP)	❑	❑	❑	❑
Product B (Wood plastic composite)	❑	❑	❑	❑
Product C (Pressure Treated Lumber: SF)	❑	❑	❑	❑
Product D (Western Red Cedar)	❑	❑	❑	❑
Product E (Plastic lumber)	❑	❑	❑	❑

3. **What would be your primary material of choice for each of the following type of deck project?**

Deck Material	Primary Choice of Decking Material for		
	New deck for an existing home (Check one)	Deck repair/replacement on an existing home (Check one)	New deck for a new home (Check one)
Product A (Pressure Treated Lumber: SYP)	❑	❑	❑
Product B (Wood plastic composite)	❑	❑	❑
Product C (Pressure Treated Lumber: SF)	❑	❑	❑
Product D (Western Red Cedar)	❑	❑	❑
Product E (Plastic lumber)	❑	❑	❑
Other: _____	❑	❑	❑

4. **Please indicate whether your company's use of these decking materials has *Increased*, *Remained the Same* or *Decreased* over the past two years.**

Deck Material	Over Past Two Years, My Company's Use of Deck Material Has…..			My Company Has Never
	Increased	**Remained the Same**	**Decreased**	**Used This Product**
Product A (Pressure Treated Lumber: SYP)	❑	❑	❑	❑
Product B (Wood plastic composite)	❑	❑	❑	❑
Product C (Pressure Treated Lumber: SF)	❑	❑	❑	❑
Product D (Western Red Cedar)	❑	❑	❑	❑
Product E (Plastic lumber)	❑	❑	❑	❑

5. **What was the average size (in square feet) and the number of decks that your company built in 2008?**

   a. **Average size of deck built:** _____ **square feet**

   b. **Number of decks built:** _____

6. **On a scale of 1 – 7 (1=not important and 7=extremely important), how important are the following decking material attributes to you when selecting a decking material.**

Material Attributes	NOT IMPORTANT			NEUTRAL			EXTREMELY IMPORTANT
Long Life	1	2	3	4	5	6	7
Beautiful & Aesthetically Pleasing	1	2	3	4	5	6	7
Naturally Decay Resistant	1	2	3	4	5	6	7
High Strength	1	2	3	4	5	6	7
Readily Available	1	2	3	4	5	6	7
Low Material Cost	1	2	3	4	5	6	7
Minimal Surface Checking	1	2	3	4	5	6	7
Ease of Use	1	2	3	4	5	6	7
Price Stability of Material	1	2	3	4	5	6	7
Consistent Material Quality	1	2	3	4	5	6	7
Easy to Maintain	1	2	3	4	5	6	7
Little Product Waste	1	2	3	4	5	6	7
Resistance to Splintering	1	2	3	4	5	6	7
Reduced Environmental Impact	1	2	3	4	5	6	7

7. **Who specifies the material for the decks your company builds?**

Home Owner	_____ %
Deck Builder	_____ %
Home Builder	_____ %
Deck Designer	_____ %
Other:	_____ %
	100%

8. **Approximately what percentage of the decks you built in 2008 were:**

New deck for an existing home	_____ %
Deck repair/replacement on an existing home	_____ %
New deck for a new home	_____ %
	100%

9. **Which of the following best describes the area where your company conducts most of its business? *(Please check only one)***

- ❑ **URBAN/SUBURBAN:** A city or group of contiguous communities with a population greater than 50,000.
- ❑ **SMALL TOWN:** A city or town that is generally isolated from a major urban area with a population less than 50,000.
- ❑ **RURAL:** Low density population scattered over a wide area

10. **Which of the following best describes the type of work your company does?** (Please select only one)**.**

- ❑ Deck Builder
- ❑ Home Builder/Contractor
- ❑ Deck Designer
- ❑ Other (please specify): _____

11. **Please indicate the degree to which each of the decking materials possesses each product attribute, using a 7 point scale.**

DECK MATERIAL ATTRIBUTE

	Not At All						To a High Degree
➢ **Long Life**							
Product A (Pressure Treated Lumber: SYP)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (Pressure Treated Lumber: SF)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7
➢ **Beautiful & Aesthetically Pleasing**							
Product A (PTL, Southern yellow pine)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (PTL, Hem fir)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7
➢ **Readily Available**							
Product A (PTL, Southern yellow pine)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (PTL, Hem fir)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7
➢ **Low Material Cost**							
Product A (PTL, Southern yellow pine)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (PTL, Hem fir)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7
➢ **Ease of Use**							
Product A (PTL, Southern yellow pine)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (PTL, Hem fir)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7
➢ **Reduced Environmental Impact**							
Product A (PTL, Southern yellow pine)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (PTL, Hem fir)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7
➢ **Ease of Maintenance**							
Product A (PTL, Southern yellow pine)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (PTL, Hem fir)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7
➢ **Minimal Surface Checking**							
Product A (PTL, Southern yellow pine)	1	2	3	4	5	6	7
Product B (Wood plastic composite)	1	2	3	4	5	6	7
Product C (PTL, Hem fir)	1	2	3	4	5	6	7
Product D (Western Red Cedar)	1	2	3	4	5	6	7
Product E (Plastic lumber)	1	2	3	4	5	6	7

12. **Based on your experience, please rank the top three environmental attributes of decking materials in terms of their effectiveness in protecting the environment**

Environmental Attributes	Identify the rank (① or ② or ③)
Decking material made with recycled material	
Decking material made with no preservatives/chemicals	
Decking material made with wood sourced from sustainably managed forests	
Decking material made with wood sourced from plantation forests	
Decking material made with domestically sourced wood	
Decking material made with no wood	
Decking material made with certified/eco-labeled wood	
Any other _____	

13. **What was your firm's approximate total sales revenue in 2008? *(Please check only one)***

- ❑ 0 - $100,000
- ❑ $100,001 to $250,000
- ❑ $250,001 to $500,000
- ❑ $500,001 to $1,000,000
- ❑ $1,000,001 to $2,000,000
- ❑ $2,000,001 to $3,000,000
- ❑ $3,000,001 to $5,000,000
- ❑ Over $5,000,000

14. **In what state does your company conduct the majority of its business?**

_____

15. **Approximately how many years has your company been building decks? _____ years**

Thank you for your time and cooperation in completing this survey. Please indicate if you would like to receive a summary of the survey results?

❑YES ❑NO

Name: _____

Address: _____

_____

Email: _____

Appendix B

An Explanation of Cluster Analysis Adopted for the Study

There are a number of analyses pertaining to distance measures and grouping algorithms. In this paper we have used a hierarchical approach, where the number of groups is identified through a bottom-up exploratory method. In this clustering method we begin by identifying each individual as a cluster and at each step of the analysis, the closest two clusters are joined. At the end of the analysis, all of the individuals are grouped into a single cluster. In this way, the range of potential solutions provided by the cluster analysis begins with the individual and ends with the entire group in a single cluster.

At this point, it is the role of the researcher to identify a particular cluster solution from the range of solutions provided. There are two primary criterion used to identify the optimal number of clusters. The first criterion is the practicality and usefulness of the solutions using visual judgments about the clusters, a large number of small clusters with few individuals in them is generally not considered to be a useful solutions. In cases where there are no visible clusters in the data, researchers often conclude that no clustering is possible based on the variables chosen. In the analysis for this project, however, we were able to identify distinct clusters, despite the small size of the data set.

The second job of the researcher is to identify the best clustering solution out of the range of practical solutions available. This step is important and relies upon the experience of the researcher since it combines statistics and judgment. Similar to other multivariate techniques, cluster analysis also provides indicators, usage of those indicators are research specific and involves researchers' judgment. The basic principles for calculating the optimal clustering solution are (i) the longer it takes for the individuals to join a cluster, the more distinct are the clusters and the longer the length of the line in the dendogram (e.g., A, B and C in Figure B1)and the stronger is the cohesiveness of the groups and (ii) groups having a reasonable number of individuals assigned to them make the grouping solution more meaningful. Following are the steps we followed to identify an optimal clustering solution (refer to Figure B1):

1. Make a visual judgment as to whether there are distinct clusters in the solution
2. Draw a vertical line and slide it across the distance scale (refer to lines P, Q and S) to identify potential solutions by noting how many times the line intersects the grouping solutions. For example, line P provides a 4 cluster solution (intersections shown by 4 green arrows) while lines Q and S provide a 3 cluster and 2 cluster solution, respectively.
3. Identifying the most efficient solution requires a simple calculation for each of the solutions, where you multiply the length of the clustering lines by the number of individuals contained in the cluster. The highest value indicates the most efficient result. For example,
   a. the result for the 2 cluster solution is ([length{A}*11 individuals] + [length{B}*6 individuals] = (18*11)+(16*6) = **294**
   b. the result of the 2 cluster solution is ([length{A}*11 individuals] + [length{C}*3 individuals] + [length{C}*3 individuals] = (18*11)+(6*6)+(6*6) = **270**
   c. Based on the analysis of the 3 cluster solution and the two cluster solutions we conclude that we should go with the 2 cluster solution as it provides the highest clustering value (a.k.a. niche width solution). Similarly, we would perform the same calculation for the 4 cluster solution as well.
4. Note that while for this research we used the niche width method, there is no hard and fast rule requiring that we use this method and researchers might choose to use another clustering method if the resultant groups were found to be meaningful or useful.

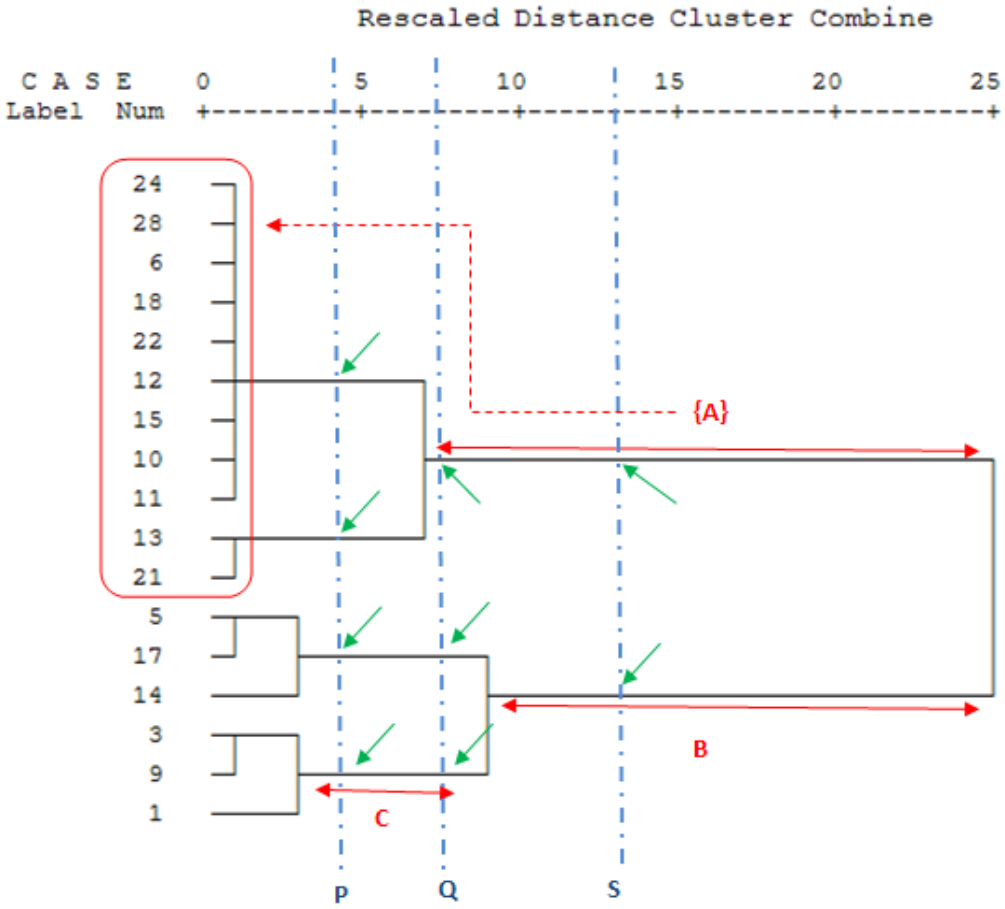

Figure B1: Dendogram used for explaining the clustering method

Appendix C

Development of the Perceptual Map

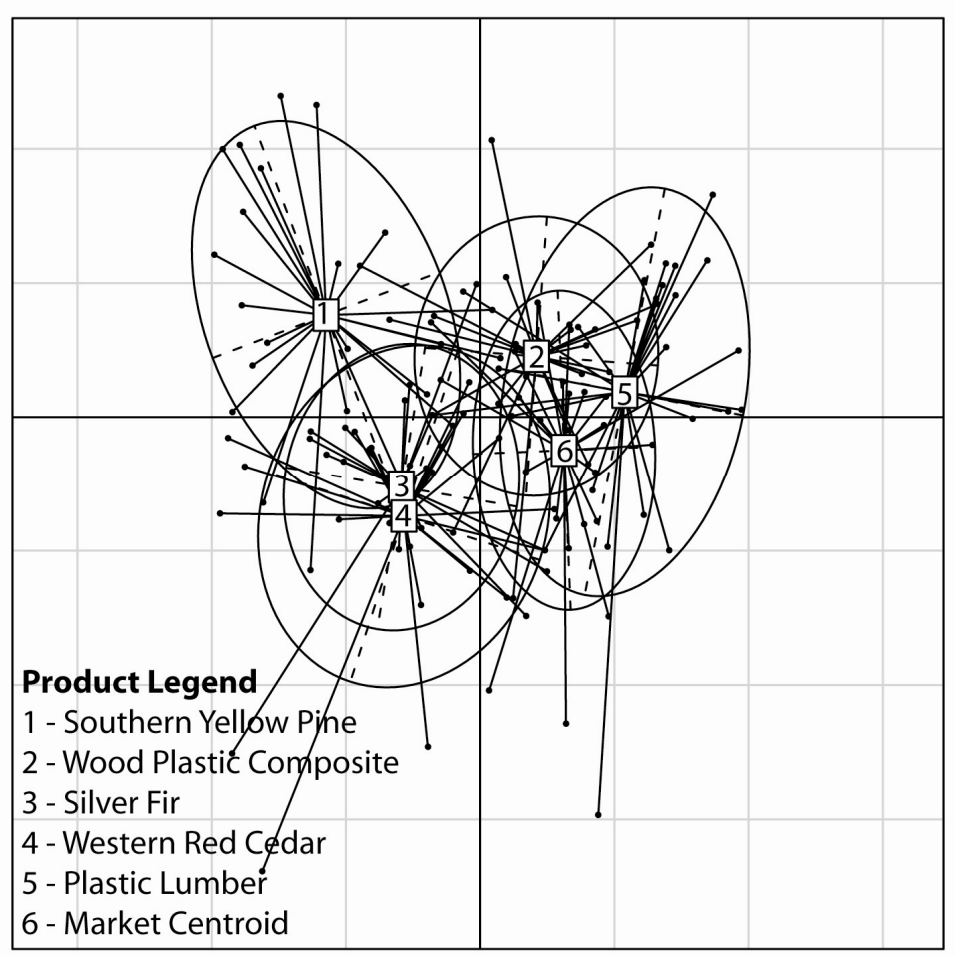

Figure C1: Locating the product centroids on perceptual space