Holz als Roh- und Werkstoff (2006)
DOI 10.1007/s00107-005-0071-y

ORIGINALARBEITEN · ORIGINALS

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Lumber attributes, characteristics, and species preferences as indicated by secondary wood products firms in the continental United States

Abstract The purpose of this research was to evaluate selected lumber attributes, species preferences, and lumber use properties among secondary wood manufacturers in the United States. Our sample included producers of kitchencabinets, furniture, doors, windows, and molded products who attended regional and national wood manufacturing events. More than 51% of respondents had annual sales of less than $500 000, and the median company size was five employees. Results are presented for 17 selected lumber attributes, and indicate that appearance-related attributes were generally the most important, and that use of certified lumber was generally the least important. Price-related attributes (including low price and price stability) were generally intermediate in importance. There were statistically significant differences among geographic regions for four of the attributes, and among business types for three of the attributes. The most popular species for use by secondary manufacturers included the oaks, maple, and cherry, and there were strong preferences for kiln-dried, 4/4 (2.54 cm) lumber having random length and width.

Von US-amerikanischen Holz verarbeitenden Betrieben bevorzugte Holzeigenschaften und Holzarten

Zusammenfassung Ziel dieser Untersuchung war die Bewertung der von der Holz verarbeitenden Industrie in den Vereinigten Staaten bevorzugten Holzeigenschaften und -arten einschließlich derer Verwendungseigenschaften. Zu den Befragten gehörten Hersteller von Küchenmöbeln, Wohnmöbeln, Türen, Fenstern und Formteilen, die an regionalen und nationalen Veranstaltungen der Holzindustrie teilnahmen. Über 51% der Befragten hatten einen Jahresumsatz von unter USD 500 000 und beschäftigten im Durchschnitt fünf Mitarbeiter. Die Untersuchung umfasste 17 ausgewählte Holzeigenschaften. Sie zeigte, dass aussehensrelevante Eigenschaften als am wichtigsten angesehen wurden, wohingegen die Verwendung von zertifiziertem Holz an letzter Stelle lag. Kostenfaktoren (einschließlich eines niedrigen Preises und Preisstabilität) waren in der Regel von mittlerer Bedeutung. Signifikante Unterschiede ergaben sich für vier Eigenschaften zwischen den geographischen Regionen und für drei Eigenschaften zwischen den Herstellern der verschiedenen Produkte. Zu den beliebtesten Holzarten der verarbeitenden Betriebe zählten Eiche, Ahorn und Kirsche. Daneben wurde technisch getrocknetes, 1 Zoll dickes Holz mit variabler Länge und Breite besonders bevorzugt.

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1 Introduction and literature review

Lumber attributes and properties are important because they have a direct bearing on market opportunities and consumer acceptance for many types of manufactured wood products. Secondary wood products firms in particular represent a diverse industry segment characterized by many types of materials, production techniques, and products (Briggs and Bialozynski 1995). In addition to the wood furniture industry, which in recent years has used more than 2 billion board feet (4.72×10^6 cubic meters) annually (Meyer et al. 1992), the kitchencabinet industry also uses substantial volumes of hardwood lumber (Olah et al. 2003), as do the window and door industries. The choice of species, and its influence on consumer aesthetics and preferences can be an important consideration for appearance-based evaluations of secondary wood products (Bumgardner and Bowe 2002).

On a national level, lumber use preferences regarding species, preferred dimensions, and regional variations have been well documented for a number of wood-using industries and company sizes. The millwork industry consumed more than 2.5 billion board feet (5.90×10^6 cubic meters) of hardwood and softwood lumber in 1990 (Briggs and Bialozynski 1995). A total of 17 factors influencing business operations were rated in this study. Shipment value for the millwork industry has included doors (32% of shipments), windows (27% of shipments),

and mouldings (12% of shipments). In a separate study it was found that the domestic U.S. kitchencabinet industry also requires significant amounts of lumber, with consumption of about 484 million board feet (1.14×10^6 cubic meters) per year, 95% of which is No. 1 Common and Better (Olah et al. 2003).

Forbes et al. (1994) evaluated attributes within the hardwood furniture industry, and found that product quality, company reputation, and accurate lumber grading practices were important, while price was less important. Product and supplier attributes have also been evaluated for four segments of the hardwood lumber industry, including furniture producers, millwork producers, kitchencabinet manufacturers, and dimension and flooring producers (Bush et al. 1991). In this study, a total of 33 attributes were rated, including several attributes related to lumber drying. Attributes receiving high importance ratings were often appearance-related, and included moisture content accuracy, straightness, absence of surface checks, and absence of end splits. Forbes et al. (1994) also evaluated product and supplier attributes within the furniture industry. The most important four attributes were all related in some way to lumber drying, and included (1) consistency between lumber loads, (2) accurate grading practices, (3) absence of warp, crook, or bow, and (4) accurate moisture content. Competitive pricing was ranked fifth most important attribute, indicating that many other attributes can be just as important as price, if not more so.

Eastin et al. (1998) evaluated importance ratings for various softwood lumber attributes, by industry segment. This study found that 2 out of the top 4 softwood lumber attributes were related to price (in contrast to many of the hardwood attribute studies in which price was found to be less important). Brandt and Shook (2005) evaluated three different methods of attribute elicitation for two different paper-based products. Their work also considered an extensive summary and review of product and service attribute studies conducted for various wood products. Common areas between this research and our current work include products such as furniture (9 studies), hardwood lumber (5 studies), moulding and millwork (1 study), softwood lumber (8 studies), and wood species (general) (2 studies).

Red oak (*Quercus rubra*) is a leading species within the furniture and kitchencabinet industry, and one study found that width classes ranging from 5.00 to 6.75 inches (12.7 to 17.1 cm) accounted for 47% of all boards, while only 16% of measured boards were narrower than 5.00 inches (Wiedenbeck et al. 2003). Yellow poplar (*Liriodendron tulipifera*) is commonly used in the architectural moulding and millwork industry, and it was found that close to 90% of yellow-poplar lumber purchased for architectural millwork was FAS (First and Second) grade (Flowers et al. 1990). Cassens and Bradtmueller (1996) evaluated custom woodworkers in a national mail survey, and found that most companies were small (51% had three or fewer employees), and that kitchencabinets were the most common product type.

The goal of our current research is to summarize information regarding choice of species, lumber attributes, and lumber use characteristics that would be most desired by lumber using firms within continental U.S. markets.

2 Methods

Data were collected at three national industrial woodworking events in California, Michigan, and Washington during 2003 and 2004. Respondents were screened only on the basis that they used lumber in a commercial woodworking enterprise. Therefore, the sample population did not include other users, such as home hobbyists or those who worked for companies manufacturing woodworking equipment. Respondents were offered an incentive (a chocolate bar) for completing a survey, and a total of 508 usable surveys were received.

A total of 17 lumber attributes were evaluated, and included attributes related to appearance, wood properties, and marketing. Attributes were rated on a 1 to 7 scale, where 7 was the highest importance level. In addition, information regarding the following lumber use preferences was obtained:

- use of green vs. kiln-dried vs. air-dried lumber
- preferred lumber dimensions (random vs. fixed dimensions)
- average lumber order size (volume per order)
- total lumber use (volume per year)
- species used (top 10 species, by percent of total volume)

Demographic information regarding company size, primary and secondary business categories, years in business, and state of headquarters was also obtained. Comparisons between treatment means were conducted using SPSS statistical software, and included ANOVA procedures and the Bonferroni posthoc multiple comparison test. Similar to a t-test, the Bonferroni procedure tests for significant differences between paired combinations of variables within a larger set of variables.

The primary comparisons of interest in our analysis were between business types and between geographic regions for the various lumber attributes and lumber use preferences. The four business types evaluated in this study (Table 1) represent the four most common businesses sampled at the industrial woodworking

Table 1 Business category of secondary wood products manufacturers, by geographic region (number of times listed as primary business category (percent))
Tabelle 1 Geschäftssparte der Holz verarbeitenden Betriebe unterteilt nach geographischer Region (Anzahl Nennungen als Hauptgeschäftssparte (in Prozent))

Primary Business Category	Northeast region	Northwest region	Southwest region	Total (all regions combined)
Furniture	44 (35.5%)	29 (23.4%)	51 (41.1%)	124 (100%)
Moulding & Millwork	11 (29.7%)	9 (24.3%)	17 (46.0%)	37 (100%)
Kitchencabinets	61 (38.4%)	48 (30.2%)	50 (31.4%)	159 (100%)
Windows & Doors	9 (47.4%)	8 (42.1%)	2 (10.5%)	19 (100%)

events. Due to some respondents not identifying their geographic region (Table 5) and/or industry group classifications (Table 6), the total means do not always match.

3 Results

3.1 Firm demographics (product line, company size, region of headquarters)

Furniture manufacturers and kitchencabinet manufacturers were the most commonly reported industry types for respondents, with more than 65% of the total responses being represented by these two categories (Table 1). The northeast was the region having the highest proportion of kitchencabinet makers, while the southwest was the region having the highest proportion of furniture producers. More than 51% of respondents had annual sales of less than $500 000, and median company size was five employees, indicating a strong presence of small businesses. These results compare favorably with a survey of 168 custom woodworkers in which 54% of firms had 10 or fewer employees (Cassens and Bradtmueller 1996).

3.2 Lumber attributes

3.2.1 Overall differences in attribute preferences

Lumber attributes that received high importance ratings included most appearance-related attributes, such as straightness, dimensional stability, absence of checks & splits, and overall appearance (Tables 2 and 3). Consistent moisture content was also rated relatively important, an attribute that is indirectly related to appearance (in that inconsistent moisture content can lead to dimensional instability, including warp).

Table 2 Lumber attribute mean importance ratings, by geographic region of secondary wood products manufacturer (attributes rated on a 1 to 7 scale, where 7 = highest importance)
Tabelle 2 Durchschnittliche Bewertung der Holzeigenschaften durch die Holz verarbeitende Industrie unterteilt nach geographischer Region (auf einer Skala von 1–7, mit 7 = größte Bedeutung)

Attribute	Mean importance rating (by geographic region) northeast	northwest	southwest	total	F-value
strength	5.21	5.20	4.99	**5.13**	1.30
straightness	6.19	6.38	6.24	**6.26**	1.06
dimensional stability	6.10	6.10	6.01	**6.07**	0.34
stable supply	5.84	5.93	5.84	**5.86**	0.22
price stability	5.73	5.65	5.54	**5.64**	0.83
low price	5.20	4.83	5.05	**5.04**	1.59
Free of checks & splits	6.16	5.96	5.95	**6.03**	1.57
after sale support	5.50	4.93	4.65	**5.03**	9.65**
sustainable forest certification	4.69	4.30	4.58	**4.54**	1.50
appearance	6.15	6.24	6.41	**6.27**	2.18
ability to accept finish	6.28	6.13	6.22	**6.22**	0.50
consistency of color	5.83	5.86	5.70	**5.79**	0.56
natural decay resistance	4.94	4.28	4.41	**4.57**	5.46**
no knots	5.16	4.72	4.90	**4.95**	2.63
Ease of machining	5.74	5.42	5.33	**5.50**	4.85**
Lack of stain defect	5.62	5.43	5.51	**5.53**	0.51
consistent moisture content	6.36	5.94	5.98	**6.11**	5.46**

** significant at the 0.01 level

Table 3 Lumber attribute mean importance ratings, by business type of secondary wood products manufacturer (attributes rated on a 1 to 7 scale, where 7 = highest importance)
Tabelle 3 Durchschnittliche Bewertung der Holzeigenschaften durch die Holz verarbeitende Industrie unterteilt nach Betriebsart (auf einer Skala von 1–7, mit 7 = größte Bedeutung)

Attribute	Mean importance rating (by business type) doors and windows	moulding and millwork	kitchen cabinets	furniture	total	F-value
strength	5.30	4.78	5.18	5.27	**5.14**	2.08
straightness	6.30	6.32	6.41	6.06	**6.26**	2.65*
dimensional stability	5.85	6.00	6.16	5.99	**6.05**	0.84
stable supply	5.78	6.10	5.96	5.73	**5.86**	1.64
price stability	5.69	5.69	5.70	5.57	**5.66**	0.30
low price	5.27	5.20	4.93	4.94	**5.06**	2.02
free of checks & splits	6.11	6.10	6.02	6.07	**6.05**	0.13
after sale support	5.38	5.35	5.20	4.83	**5.06**	1.74
sustainable forest certification	4.72	4.36	4.64	4.76	**4.61**	1.08
appearance	6.07	6.38	6.35	6.24	**6.26**	1.41
ability to accept finish	6.48	6.37	6.29	6.25	**6.22**	4.97**
consistency of color	5.96	5.93	5.94	5.63	**5.80**	1.67
natural decay resistance	5.38	4.80	4.60	4.53	**4.64**	1.63
no knots	5.22	5.26	5.02	5.10	**5.06**	0.62
ease of machining	5.59	5.76	5.56	5.47	**5.52**	1.36
lack of stain defect	6.07	5.61	5.60	5.46	**5.54**	1.93
consistent moisture content	6.59	6.46	6.17	5.94	**6.09**	5.25**

* significant at the 0.05 level
** significant at the 0.01 level

It is worth noting that four of the six most important attributes could all be related to quality kiln-drying practices, and many of these were related to overall appearance.

Consistency of color and lack of stain defect were two appearance-related attributes that rated only moderately important. It is interesting that most price-related attributes (including low price and price stability) also received only intermediate importance ratings. Attributes related to the mechanical properties of lumber (including "strength" and "ease of machining") were also generally rated moderately important.

Lumber attributes that received low importance ratings included sustainable forest certification and natural decay resistance. It should be pointed out that the sample group (primarily industrial woodworkers) did not necessarily reflect the population of wood products consumers at large (including retail consumers), who might possibly have different values regarding wood products certification. Lumber strength was also rated relatively unimportant for this group (comprised mainly of kitchencabinet and furniture makers). Surprisingly, absence of knots was rated relatively unimportant (ranked 15 out of 17). This could suggest that knots would be tolerated, or even preferred, for applications where character or rustic looks would be desired. Only one service attribute was evaluated; "after sale support" was rated relatively unimportant (ranked 14th out of 17) (Table 2).

Both "price stability" and "stable supply" were rated as moderately important attributes.

"Consistency of color", "lack of stain defect", and "no knots" were all rated as moderately important. It is interesting that, although these are all appearance attributes related in some way to coloration, they were not rated as important as the appearance attributes influenced by shape or overall integrity (for example "straightness", "dimensional stability", and "free of checks and splits"). This result might suggest that lumber producers should concentrate on good machining and kiln-drying practices, while giving less attention to surface appearance features.

3.2.2 Business type differences in attribute preferences

Statistical differences between business types were found for three of the attributes, as summarized below:

- "straightness" (rated highest by kitchencabinet manufacturers; rated lowest by furniture manufacturers)
- "ability to accept finish" (rated highest by door and window manufacturers, rated lowest by furniture manufacturers)
- "consistent moisture content" (rated highest by door and window manufacturers, rated lowest by furniture manufacturers)

3.2.3 Geographical differences in attribute preferences

Statistical differences between geographic regions were found for four of the attributes, as follows:

- "after sale support" (rated highest in the northeast; rated lowest in the southwest)
- "natural decay resistance" (rated highest in the northeast; rated lowest in the northwest)
- "ease of machining" (rated highest in the northeast; rated lowest in the southwest)
- "consistent moisture content" (rated highest in the northeast; rated lowest in the southwest)

3.2.4 Factor analysis

Principal components factor analysis is a statistical method used to analyze interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions called factors. Factor analysis requires a degree

Table 4 Factor loadings for attributes scales (54.3% = total explained variance)
Tabelle 4 Auf vier Kategorien bezogene Bewertungsfaktoren für die Holzeigenschaften (54,3% = durch die vier Faktoren erklärte Varianz)

	Factor I Aesthetics	Factor II Quality/Support	Factor III Structural	Factor IV Price/Supply
Consistency of Color	**0.76**	0.17	0.14	0.02
Ability to Accept Finish	**0.74**	0.05	0.18	0.06
Appearance	**0.72**	−0.12	0.29	0.11
Lack of Stain Defect	**0.68**	0.36	0.04	0.07
No Knots	**0.53**	0.50	0.01	−0.08
Ease of Machining	**0.45**	0.44	−0.02	0.25
Natural Decay Resistance	0.09	**0.72**	0.09	0.11
After Sale Support	0.05	**0.53**	0.18	0.34
Free of Checks & Splits	0.44	**0.48**	0.19	−0.14
Sustainable Forest Certification	0.14	**0.45**	0.08	0.18
Dimensional Stability	0.23	−0.05	**0.78**	0.03
Straightness	0.24	0.18	**0.58**	−0.01
Strength	−0.16	0.40	**0.53**	0.06
Consistent Moisture Content	0.35	0.29	**0.46**	−0.02
Price Stability	0.11	0.13	0.04	**0.83**
Low Price	−0.05	0.30	−0.14	**0.76**
Stable Supply	0.10	−0.06	0.53	**0.63**
Variance Explained by Factor (%)	27.9	13.1	11.5	11.4
Eigenvalue	4.74	1.90	1.42	1.12
Factor Means	5.72	5.11	5.53	5.52
Cronbach Alpha Reliability Test	.79	.58	.52	.67

of correlation among variables and this can be tested utilizing the Bartlett's Test of Sphericity (Hair et al. 1998). This test was run on the data set and the results showed a high chi square value, indicating ample correlations among the variables as required by factor analysis (Chi-square = 1574, df = 136, P < .00) (Table 4). Eigenvalue is the sum of squared factor loadings and represents the amount of variance accounted for by the factor. Factor analysis with a varimax rotation was run on the seventeen variables and the eigenvalue was set to produce factors with minimum eigenvalue of 1.1. The results grouped the seventeen variables into four orthogonal factors. This method requires the researcher to examine the variables that loaded on each factor and name the factors based on variables that loaded on each respective factor. After examining the factor loadings of each variable, the factors appeared to represent four underlying concepts: aesthetics, quality/support, structural, and price/supply and these titles were used to name the factors (Table 4). As described above, each variable was measured utilizing a Likert scale anchored at 1 "not important at all" to 7 "extremely important". Examination of the factor means revealed that all four were significantly different from and above the mid-point of 4.0 (alpha = .01) on the importance scale. The internal validity of the factors was measured utilizing the Cronbach alpha measure (0 low to 1 high). The Cronbach alpha values revealed a high internal validity for the aesthetics and price/supply factors and moderate internal validity for the quality/support and structural factors. This reflects a lower inter-factor correlation among the member variables in the quality/support and structural factors. Overall, the factor analysis produced four factors, which accounted for 54.3% of the total variance in the seventeen variables (Table 4).

3.3 Lumber species preferences

Overall lumber use, by business type. Lumber species preferences were measured based upon the percentage of respondents who had used a given species at least once (and the top 10 species were evaluated). There were statistically significant differences between business types for seven of the ten top species (Table 6) including cherry, Douglas-fir, mahogany, maple, pine, and walnut and oak. For five out of six of these species, differences were significant at the 0.01 level (while for cherry, differences were significant only at the 0.05 level). The following species preferences between business types were noted:

- Cherry (preferred by furniture manufacturers)
- Douglas-fir (preferred by door & window manufacturers)
- Mahogany (preferred by door & window manufacturers)
- Maple (preferred by kitchencabinet manufacturers)

Table 5 Mean species use, by geographic region (percentage of total use)^
Tabelle 5 Durchschnittliche Holzartenverwendung unterteilt nach geographischer Region (Prozentualer Anteil an gesamter Verwendung)

Species	Northeast region	Northwest region	Southwest region	Total	F-value
Red alder	1.37^{ab}	8.67^{a}	11.70^{b}	6.80	13.467**
Cedar	2.46	0.62	0.83	1.43	1.584
Cherry	13.73	16.95^{a}	8.28^{a}	12.68	5.911**
Douglas-fir	0.02^{a}	5.05^{a}	2.98	2.32	5.493**
Mahogany	1.34	1.60	3.86	2.28	2.920
Maple	14.26	17.01	16.89	15.87	0.806
Oaks (red and white)	22.54	17.50	14.55	18.49	2.933
Pine	5.74	2.42	7.65	5.54	2.340
Poplar	6.34	3.64	7.84	6.17	1.975
Walnut	3.29	2.11	3.88	3.19	0.885

* significant at the 0.05 level
** significant at the 0.01 level
^ values sharing the same letter are significantly different at the 0.05 level using the Bonferroni posthoc multiple comparison test

Table 6 Mean lumber use of major species, by business type (percentage of total use)*
Tabelle 6 Durchschnittliche Holzartenverwendung unterteilt nach Betriebsart (Prozentualer Anteil an gesamter Verwendung)

Species	Doors and Windows	Moulding & Millwork	Kitchencabinets	Furniture	Total	F-value
Red alder	4.12	11.72	8.47	4.82	7.27	1.593
Cedar	3.24	1.11	0.59	2.30	1.40	0.929
Cherry	14.59	7.66	11.62	15.17	12.64	2.452*
Douglas-fir	6.65^{ab}	3.25	1.33^{a}	1.13^{b}	1.74	6.201**
Mahogany	8.24	0.50	1.74	4.46	2.93	2.704*
Maple	5.94^{a}	12.69	21.11^{ab}	13.02^{b}	16.54	6.741**
Oaks (red and white)	21.47	16.36	22.74	15.69	19.51	
Pine	6.06	11.58^{a}	3.41^{a}	5.09	4.99	8.207**
Poplar	9.41	8.75	6.21	3.60	5.72	1.362
Walnut	1.65	1.61	1.69^{a}	6.20^{a}	3.28	5.032**

* footnotes see Table 5

- Oaks (red and white) (preferred by kitchencabinet manufacturers)
- Pine (preferred by moulding & millwork manufacturers)
- Walnut (preferred by furniture manufacturers)

Overall lumber use, by region. There were significant differences in lumber species used by geographic region (Table 5). For this analysis, the continental U.S. was divided into four regions- northeast, southeast, northwest, and southwest, as defined by state of company headquarters[1]. The following species had significant regional differences in use- red alder, cherry, and pine (all were significant at the 0.01 level). These results indicate different species preferences for secondary manufacturers, based on geographic region. In general, red alder was preferred in western locations (northwest and southwest regions), and cherry preferred in northern locations (northeast and northwest regions). Douglas-fir was generally preferred in the northwest, but was not a widely used species.

3.4 Use of kiln-dried lumber

Differences in lumber drying preferences between business groups. There was a strong preference among responding firms to use kiln-dried lumber (average of 81.7% of total lumber use[2], by respondent). Air-dried lumber accounted for only 14.5% of use, and green (undried) lumber only 3.3% (Table 7), indicating that there is very little opportunity for rough green lumber. There were statistically significant differences in lumber drying preferences between furniture producers and kitchencabinet producers for both air-dried lumber (significant at the 0.01 level), and kiln-dried lumber (significant at the 0.05 level).

[1] Since there were very few responses from the southeast region, it was not included as part of this analysis

[2] Based on percent lumber purchases, by responding firm, without regard to total volume purchased

3.5 Preferred lumber thickness

Differences between business groups. There were statistically significant differences between business groups for all lumber thicknesses except 7/4 thickness (Table 8). The greatest level of significance occurred for the 4/4, 6/4, and 8/4 thicknesses (significant at the 0.01 level). 4/4 lumber was the most commonly used thickness by a wide margin, being the preferred thickness for almost 66% of the respondents. Kitchencabinet manufacturers were the industry group showing the greatest preference for 4/4 lumber (preferred more than 75% of the time) while window and door manufacturers were less likely to prefer 4/4 lumber. 7/4 lumber was overall the least popular thickness, being preferred by slightly more than 1% of respondents. 8/4 lumber, although relatively unpopular in overall use, was favored by window & door manufacturers. Furniture manufacturers showed statistically greater use of 8/4 lumber vs. kitchencabinet manufacturers (Table 8).

3.6 Random vs. fixed lumber dimensions

Differences between business groups There were no statistically significant differences between business groups regarding preferences for random vs. fixed lumber dimensions (Table 9). However, random width and random length lumber dimensions were preferred by a wide margin over the other 3 categories (preferred by more than 2/3 of the total respondents). Random width lumber accounted for close to 84% of total lumber use (Table 9).

4 Conclusions and Recommendations

Lumber attributes generally considered as important included most appearance-related attributes, such as straightness, dimensional stability, absence of checks & splits, and overall appearance. Four of the leading six attributes could all be related to

Table 7 Mean lumber use by business type (percentage of total use, by drying condition)*
Tabelle 7 Durchschnittliche Holzverwendung unterteilt nach Betriebsart (Prozentualer Anteil an gesamter Verwendung, unterteilt nach Art der Trocknung)*

Lumber drying condition	Furniture	Architectural Moulding & Millwork	Kitchen cabinets	Windows & Doors	Total	F-Value
green (undried) lumber	3.74	5.45	2.35	3.75	3.28	0.71
air-dried lumber	20.42[a]	12.63	11.15[a]	7.08	14.49	3.99**
kiln-dried lumber	75.18[a]	81.92	85.91[a]	89.17	81.72	3.73*

* footnotes see Table 5

Table 8 Lumber thickness by business type (percentage of total lumber used, by respondent)*
Tabelle 8 Holzdicke unterteilt nach Betriebsart (Prozentualer Anteil an gesamter Holzverwendung, je Befragten)

Preferred lumber thickness *inches (mm)*	Furniture	Architectural Moulding & Millwork	Kitchen cabinets	Windows & Doors	Total	F-Value
4/4 (25.4)	56.73[c]	54.24[b]	75.14[abc]	50.33[a]	64.94	11.98**
5/4 (31.75)	16.71	16.86	11.75	25.62	14.88	2.91*
6/4 (38.1)	8.49	10.25	4.64	5.76	6.65	4.05**
7/4 (44.45)	1.57	3.08	0.87	0.76	1.34	0.96
8/4 (50.8)	11.94[a]	10.71	5.45[a]	15.14	8.88	5.49**

* footnotes see Table 5

Table 9 Mean lumber use, by primary business type- random vs. fixed lengths and widths (*percentage of total use*)
Tabelle 9 Durchschnittliche Holzverwendung unterteilt nach Hauptgeschäftssparte – unterteilt nach variabler und fester Länge und Breite (Prozentualer Anteil an gesamter Verwendung)

Width	Length	Furniture	Architectural Moulding & Millwork	Kitchen cabinets	Windows & Doors	Total	F-Value
Random	Random	68.29	58.95	71.47	58.04	68.14	1.513
Random	Fixed	12.61	14.74	17.02	23.91	15.68	1.091
Fixed	Random	10.83	13.95	7.04	13.70	9.54	1.386
Fixed	Fixed	8.10	12.63	4.47	3.91	6.58	2.318

quality kiln-drying practices, and many of these were related to overall appearance. Most price-related attributes (including low price and price stability) received only intermediate importance ratings, and sustainable forest certification and natural decay resistance were rated low in importance. A broad recommendation of our attributes research is that lumber producers should concentrate on quality kiln-drying practices aimed at ensuring dimensionally stable lumber.

Statistically significant differences were found between business types for four of the five lumber thicknesses, suggesting that thickness is an important consideration. The greatest opportunities are indicted for 4/4 thick lumber, the preferred thickness close to 65% of the time. Statistically significant differences in species preferences, by region, were found for red alder, cherry, and pine, but none of the remaining top 10 species. Most notable were the differences in preferences for cherry between northwest and southwest locations. An important characteristic impacting marketing of red alder lumber could be its ability to accept stain, potentially simulating the appearance of other, more popular species such as cherry.

Statistically significant differences in species preferences, by primary business type, were found for six of the ten leading species. This would suggest the importance of targeting specific business types when marketing lumber of these species. In particular, cherry was preferred by furniture manufacturers and maple was preferred by kitchencabinet manufacturers.

Appendix

States comprising the geographic regions of the continental U.S., as used in this study.

Northwest Region

Alaska
Idaho
Minnesota
Nebraska
Oregon
Washington
California (north)
Iowa
Montana
North Dakota
South Dakota
Wyoming

Southwest Region

Arizona
Colorado
California (south)
Hawaii
Kansas
Nevada
Oklahoma
Utah
Missouri
New Mexico
Texas

Northeast Region

Connecticut
District of Columbia
Indiana
Maine
Massachusetts
New Hampshire
New York
Pennsylvania
Vermont
West Virginia
Delaware
Illinois
Kentucky
Maryland
Michigan
New Jersey
Ohio
Rhode Island
Virginia
Wisconsin

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