

AN ASSESSMENT OF THE INDUSTRIAL MARKETS FOR SOFTWOOD CLEARWOOD LUMBER

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ABSTRACT

The purpose of this project was to assess market opportunities for second-growth clearwood lumber by identifying industry segments that currently utilize clearwood lumber and determining whether alternative markets will continue to exist for clearwood lumber produced from intensively managed forests in the Pacific Northwest. A survey of industrial lumber remanufacturers was conducted in 1995 to identify: 1) those industry segments that currently utilize clearwood lumber as a raw material input for their manufacturing process; and 2) those clearwood lumber attributes that are perceived to be important by managers within specific segments of the remanufacturing industry. Frequencies and mean responses were used to analyze the demographic information as well as the softwood lumber attribute ratings. A factor analysis was used to reduce the original 16 lumber attributes to 4 factors: timber quality, manufacturing properties, mechanical properties, and economic/price characteristics. A perceptual map of the survey results indicates that managers in the door and windows industries attached more importance to timber quality and manufacturing properties when purchasing softwood lumber than did managers in the other industry segments. Respondents in the wood remanufacturing industry appeared to value reliability of supply, price, and price stability over other softwood lumber attributes. This would seem to indicate that these manufacturers could not, or would not, continue to accept higher relative prices and rapid price fluctuations for clearwood softwood lumber.

Historically, the clearwood resource used to manufacture appearance grades of lumber has been thought of as knot-free and straight-grained wood with narrow growth rings (2); and until recently, it was derived almost exclusively from naturally occurring old-growth forests. As the supply of this resource has declined, manufacturers have sought alternative sources of clearwood. Substitute raw materials now come from fast-growing natural second growth or plantation-grown timber, with much of this material being nontraditional species. For

example, in the Pacific Northwest, imported radiata pine and southern pine from the southern United States are regularly substituted in the production of value-added wood products (e.g., moulding and millwork). These species, although similar in appearance to those traditionally used, have different text -

ures, colors, and grain patterns. Based on the successful implementation of pruning as a silvicultural treatment in New Zealand, Chile, and elsewhere, it is now becoming a more common practice in the western and southeastern United States. Although it will be more than a decade before substantial volumes of domestically grown pruned material become available in the United States, it is likely that the lumber produced from this resource will differ from both the traditional old-growth resource as well as the substitute species now being imported.

Timber derived from managed forests is characterized by wide growth rings, more knots, different earlywood-latewood ratios, and a higher proportion of juvenile wood (5,6). These differences not only affect the appearance of the lumber but also impact material properties such as dimensional stability, mechanical properties, machinability, and finishing characteristics. Foresters concerned with the different properties of plantation timber have adopted intensive management techniques (e.g., pruning and genetic improvement) to improve timber quality and increase the yield of clearwood. Recent research indicates that

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intensive forest management is a viable method for improving the quality of timber derived from forest plantations, potentially increasing the gross value of the resource, and perhaps generating a higher net return on forest investments (7-9,12,13,15).

Despite the advantages of pruning and thinning regimes on forest growth rates and lumber quality, it is not readily apparent that these silvicultural practices can always increase the rate of return from private forest land investments in the Pacific Northwest. The decision to adopt intensive silvicultural practices is influenced by: 1) whether competitors (both domestic and foreign) can obtain better results at lower costs; 2) the stumpage price when the timber is harvested; 3) how long it takes for the trees to reach a harvestable size; and 4) what timber attributes are valued by end-users and to what extent they are willing to pay a higher price for those attributes (6,11,16).

These factors have contributed to concerns regarding the quality and acceptability of plantation-grown clearwood as a direct substitute for old-growth clearwood in some end-use market segments. Are the attributes associated with old-growth clearwood necessary to achieve the end-use values in changing markets? Perhaps such specifications are inadequate to differentiate raw materials in today's markets. Timber supply shortages, whether actual or perceived, are forcing value relationships to change rapidly, which may imply that the attributes of old-growth clearwood may no longer be an appropriate indicator of the lumber attributes valued by wood remanufacturers today.

If the current price premiums for clearwood lumber hold over the long-term, then the financial return associated with intensive forest management practices intended to increase the yield of clearwood lumber should generate a positive economic return. On the other hand, if the characteristics of clearwood lumber derived from intensively managed forests are sufficiently different from traditional old-growth clearwood lumber, end-users may perceive a large enough change in product quality to cause them to reduce the premium they are willing to pay for plantation-grown clearwood.

Even with a well-recognized grading system, clearwood as a product is poorly defined, primarily due to the fact that clearwood is used in a wide variety of

different industry segments, each of which values a different set of product attributes. The idea that the desired set of lumber attributes varies between the different segments of the wood remanufacturing industry greatly complicates the task of defining clearwood. For example, the moulding and millwork industry prefers longer clearwood lengths for stain grade moulding products, but furniture and furniture component manufacturers can often utilize short pieces of clearwood. These differences in end-user requirements are reflected in the grading specifications for Moulding and Shop grade lumber. But do these grades adequately reflect the changing technological requirements of the rapidly evolving wood remanufacturing industries?

Increasing price trends for clearwood lumber products suggest that greater returns might be derived from the application of intensive forest management practices in the Pacific Northwest (12, 17,20). While technological innovations have increased the recovery of clearwood (1,4,10,18,21), new methods of grading and predicting clearwood removals have been adopted to further increase yields of clearwood lumber (19). Despite this, questions remain as to whether industrial end-users and consumers are willing to accept fast-grown plantation clearwood as a direct substitute for old-growth clearwood and whether past price differentials (premiums) would likely be maintained. The purpose of this study was to assess whether the users of clearwood perceive substantial changes in clearwood quality and if they are likely to continue using clearwood in the future.

RESEARCH OBJECTIVES

The purpose of this project was to assess the changing market opportunities for clearwood lumber by identifying those industry segments that currently utilize clearwood lumber grades and determine how markets for clearwood are changing with respect to relative price differentiation and quality premiums. In particular, this project was designed to address the following research objectives: 1) identify those segments of the forest products industry that currently utilize clearwood lumber (including species and grade) as a raw material input for their manufacturing process; and 2) identify those clearwood timber attributes that are perceived to be important by

managers within the forest products industry in general and within the specific industry segments in particular.

SURVEY DESIGN AND METHODOLOGY

A national survey of clearwood users was carried out in the spring and summer of 1995. An advisory board, comprised of managers from the forest products industry, industry associations, and the USDA Forest Service was assembled to provide guidance during the course of the project. A preliminary questionnaire was developed through exploratory interviews with managers of firms that utilize clearwood lumber as a raw material input in their manufacturing process. The preliminary questionnaire was submitted to the members of the advisory board for comment before being pre-tested by industry managers, industry experts, and a marketing faculty member.

The population of interest consisted of secondary manufacturers in those industry segments that have traditionally utilized clearwood lumber, including: moulding, millwork, doors, windows, stairs, and flooring. The sample population was compiled from several industry directories and the final sample frame consisted of 1,719 manufacturers. Each participant was mailed a survey questionnaire with a stamped, self-addressed, return envelope. A cover letter described the purpose of the study and ensured participants that their responses would be kept strictly confidential. Follow-up post cards were mailed to each participant at 2nd and 4-week intervals to increase the likelihood of their participation in the project.

Of the 1,719 questionnaires mailed, a total of 319 responses were obtained, of which approximately half (142) were deemed to be unusable because they were either incomplete or the respondents indicated that they did not utilize clearwood softwood lumber in their manufacturing process. Based on the remaining 177 usable responses, the effective response rate for the survey was calculated to be 11.6 percent. In order to test for non-response bias, the Armstrong Overton method for analyzing time responses across early and late respondents was employed (3). Early and late respondents were tested across a number of survey questions and no significant differences were detected.

TABLE 1. — Summary of the demographic characteristics of survey respondents, by industry segment.

Industry segment	No. of firms	Average no. of employees	Average volume of lumber used (MBF) ^a	Average annual sales (\$1,000)
Moulding	48 to 51 (33%)	53	2,453	6,318
Millwork	19 to 22 (14%)	131	8,730	17,326
Windows	9 to 12 (8%)	415	9,815	15,188
Doors	12 to 15 (10%)	106	7,023	16,320
Pallets	10 to 11 (7%)	56	2,886	9,195
Structural materials	9 to 10 (6%)	61	7,187	7,602
Other products	29 to 34 (22%)	56	5,401	5,609

^a MBF = thousand board feet.

TABLE 2. — Summary of timber species used by responding firms, by industry segment.

Timber species	Total	Moulding	Millwork	Windows	Doors
	----- (%) -----				
Domestic species					
Ponderosa pine	27	53	51	74	15
Southern pine	15	10	3	4	12
Douglas-fir	9	2	4	4	31
Hem-fir	19	11	25	2	33
White pine	9	9	1	8	6
Other domestic	14	6	1	2	4
Imported species					
Radiata pine	7	8	14	5	0
Other imported	<1	1	0	0	0

RESULTS AND DISCUSSION

DEMOGRAPHIC DESCRIPTION OF SURVEY RESPONDENTS

The results of the data analysis indicated that the total volume of softwood lumber utilized by responding firms was approximately 889 million board feet (MMBF). While the average annual volume of softwood lumber used totaled 5.8 MMBF per firm, the median annual volume of softwood lumber used was 700,000 board feet (BF). The average volume used was skewed by a small number of large firms that used well over 10 MMBF of lumber annually. Almost 60 percent of the respondents indicated that their manufacturing operation used less than 1 MMBF per annum and about one-third used less than 100,000 BF. This suggests that the typical firm using clearwood lumber was a small- to medium-sized firm.

The survey data indicated that the average sales revenue of the responding firms was almost \$9.1 million, although the median sales revenue was determined to be a more modest \$2.8 million. Further analysis indicated that almost half of the respondents reported an annual sales revenue below \$2.5 million, while approx-

mately one-third reported annual sales revenues of less than \$1 million. This provides further support that survey respondents tended to be small- to medium-sized firms.

The survey results indicated that the largest segment of respondents was located in the northeastern United States (33%), followed by the northwest (26%), the southwest (25%), and the southeast (16%). The number of employees reported per firm ranged from 1 to 3,000. The average number of employees was 94, with 23 percent of the respondents employing 10 people or less, and just under two-thirds of the firms employed 50 people or less. The median number of employees was 30. The survey data indicated that moulding manufacturers, on average, tended to be small firms, which purchased the smallest volume of softwood lumber, and had low sales revenues, while window manufacturers, on average, had the highest number of employees, purchased the largest volume of softwood lumber, and had the third highest sales revenues (Table 1).

Respondents were asked to estimate the annual volume of lumber utilized within individual product lines. This information

was used to segment firms by their primary manufacturing activity since many firms surveyed manufactured more than one product line. The analysis of the survey data indicated that moulding manufacturers comprised the single largest industry segment (33%), followed by millwork (14% of respondents), doors (10%), windows (8%), pallet and packaging (7%), structural products (e.g., roof trusses) (6%), and miscellaneous products (22%) (Table 1).

TIMBER SPECIES AND GRADES USED

The survey data indicated that ponderosa pine was the most prevalent species used by the respondent firms, comprising 27 percent of softwood lumber purchases (Table 2). Other important timber species/species groupings included hem-fir (19%), southern pine (15%), Douglas-fir (9%), and white pine (9%), with other domestic softwood species/species groupings (e.g., western redcedar, redwood, lodgepole pine, and spruce-pine-fir) representing 14 percent of the lumber input. Radiata pine was the only offshore imported softwood species used in significant volumes, representing 7 percent of the raw material input.

The analysis of the survey data indicated a definite relationship between the timber species used and the industry segment (Table 2). While over half of the raw material utilized by the moulding and millwork industries was ponderosa pine, it represented almost three-quarters of the raw material input for the window industry. Almost two-thirds of the raw material purchased by door manufacturers consisted of hem-fir (33%) and Douglas-fir (31%). Hem-fir was an important raw material input within each of the industry segments with the exception of windows, where it represented just 2 percent of the raw material. White pine was used to some extent in each of the main industry segments, with the exception of the millwork industry, although its use never exceeded 10 percent of the raw material mix. Southern pine was primarily used in the door and moulding industries, although it represented a small percentage of the raw material used by millwork and window manufacturers.

Radiata pine represented a substantial component of the raw material mix for manufacturers in the moulding and millwork industries. Millwork manufacturers relied on radiata pine for 14 percent of their raw material input while it represented 8 percent of the raw material mix for moulding

manufacturers. Of the total volume of radiata pine lumber imported, 87 percent was used by the moulding and millwork industry, with millwork manufacturers using approximately 2.5 MMBF.

The two most commonly used softwood lumber grades across all of the industry segments were Shop and Common (Table 3). The primary softwood lumber grades used by moulding manufacturers were Moulding-stain and Shop, while millwork manufacturers favored Shop grade lumber (Fig. 1). Although both window and door manufacturers reported using a similar mix of softwood lumber grades, window manufacturers used more Common grade lumber while door manufacturers used more C & Better grade lumber. Finally, manufacturers of structural products (e.g., roof trusses) used more Common, Standard & Better, and Shop grades of lumber than any other grade.

As mentioned earlier, moulding, millwork, door, and window manufacturers reported using more Shop lumber than any other grade of softwood lumber. Traditionally, the greatest volume of high grade lumber (Moulding and C & Better) has been utilized within the moulding, millwork, and door industries. While this still appears to be the case, the proportion of high grade lumber in their raw material mix appears to be declining. It is possible that this change in raw material mix can be largely attributed to the reduced availability and high price of high grade softwood lumber. In addition, changes in products and product lines have also impacted the type of raw material used in these industry segments.

CLEARWOOD LUMBER ATTRIBUTES

Survey participants were asked to rate the importance of 16 different softwood lumber attributes with respect to their manufacturing operation. The importance of each softwood lumber attribute was rated using a seven-point Likert-like scale where a score of 1 indicated that the attribute was not important, while a score of 7 indicated that the attribute was considered to be very important with respect to the respondents' manufacturing operation. The mean importance rating obtained for each lumber attribute is summarized in Table 4.

The results of the Scheffe statistical test identified reliability of supply, price, and price stability as three of the four most important attributes. In contrast, factors traditionally associated with oldgrowth, clearwood lumber (e.g., absence of knots

TABLE 3. — Summary of lumber grades used by responding firms.

Lumber grade/ grade categories	No. of firms	Lumber volume (MMBF) ^a	Percent of total (%)
Moulding: stain	46	39.3	4.4
Moulding: paint	26	38.0	4.3
C & Better	69	58.0	6.5
D	36	22.4	2.5
Common	46	138.9	15.6
Standard & Better	40	105.4	11.9
Cutstock	30	73.4	8.3
Shop	52	404.8	45.5
Other	4	8.6	1.0

^a MMBF = million board feet.

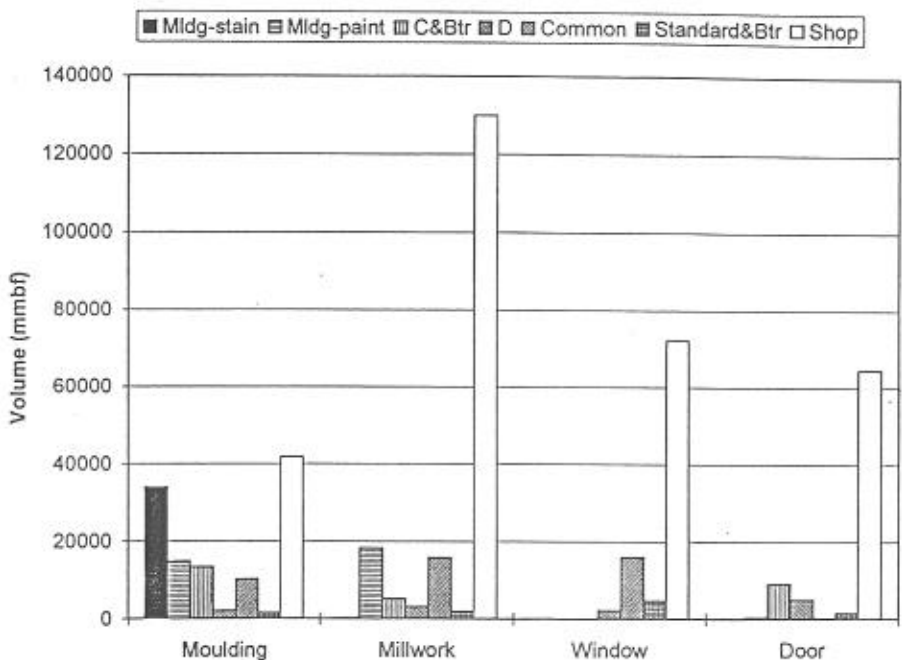


Figure 1. — Lumber grades purchased by respondents, by industry segment.

straight grain, uniform color, narrow growth rings, and vertical grain), were rated as being less important than the other attributes. Lumber attributes associated with the technical properties of lumber received intermediate importance ratings when compared to attributes associated with economics and those associated with old-growth characteristics.

A comparison of the importance ratings across industry segments indicates there was some variation in mean importance ratings for the different lumber attributes, although generally they were not too different from the overall mean importance

ratings. However, as mentioned previously, those lumber attributes typically associated with clearwood lumber grades were rated lower than many of the other attributes on an industry segment basis as well.

FACTOR ANALYSIS OF SOFTWOOD LUMBER ATTRIBUTES

One of the objectives of this study was to identify a subset of softwood lumber attributes that could be used to operationalize the concept of clearwood lumber. This was done using a multivariate statistical technique known as a principal component factor analysis. The basic premise of a factor

TABLE 4. — Mean importance rating for softwood lumber attributes, by industry segment.

Softwood lumber attribute	Industry segment					
	All	Moulding	Millwork	Window	Door	Structural
Reliability of supply	6.17	6.25	5.90	6.55	6.40	6.60
Price	5.99	6.08	5.60	6.09	6.20	5.50
Moisture content	5.89	6.32	5.95	6.45	6.47	5.70
Price stability	5.81	5.90	5.48	6.09	5.73	5.90
Machinability	5.78	6.25	5.62	6.09	6.07	5.40
Appearance	5.64	5.67	5.71	6.00	6.13	6.00
Dimensional stability	5.63	5.59	5.81	6.09	6.27	5.50
Absence of knots	5.06	5.42	5.76	5.27	5.67	4.60
Treatable with paint/stain	4.69	5.18	4.62	5.82	5.27	3.80
Durability	4.63	4.35	5.10	5.09	5.43	5.00
Available in longer lengths	4.60	5.12	4.52	4.70	4.60	4.70
Straight grain orientation	4.44	4.80	4.71	5.27	5.14	4.30
Uniform color	4.34	4.52	4.57	5.36	4.67	3.80
Narrow growth rings	4.16	4.37	4.24	5.10	5.13	3.90
Mechanical strength	4.04	3.77	4.00	4.27	4.40	4.40
Vertical grain	3.77	3.53	4.19	4.82	4.40	3.20

TABLE 5. — Summary of the factor analysis solution and the factor loading scores.

Softwood lumber attributes	Rotated discriminant function loading scores			
	Factor I: Timber quality	Factor II: Manufacturing properties	Factor III: Mechanical properties	Factor IV: Economic/price characteristics
Narrow growth rings	.853	.153	.086	.090
Vertical grain	.814	-.010	.264	.066
Straight grain orientation	.755	.354	.264	.066
Absence of knots	.665	.377	.156	-.083
Uniform color	.556	.541	-.187	.081
Uniform moisture content	.140	.759	.133	.109
Treatable with paint/stain	.376	.671	.066	.118
Machinability	.124	.657	.453	.231
Available in longer lengths	.469	.544	.060	-.129
Appearance	.395	.525	-.130	.117
Mechanical strength	.083	-.055	.825	.114
Durability	.195	.095	.795	.028
Dimensional stability	.004	.506	.622	.083
Price stability	.079	.147	.148	.873
Price	-.053	-.005	-.027	.865
Reliability of supply	.048	.481	.280	.572

analysis is that a subset of underlying, often undetected, and uncorrelated factors can be used to simplify and explain the complex relationships within a larger set of correlated attributes (14). These factors are based on the original attributes and can be represented by a linear combination of the attributes. In order for the factor analysis to be useful, each factor should be composed of a small subset of the original attributes. Because some of the attributes scored moderately high on more than one factor, varimax rotation procedure was used orthogonally transform the initial factor into a solution where each attribute scored high on only a single factor (Table 5).

The factor analysis reduced the original 16 softwood lumber attributes down to 4 factors that explained 65 percent of the total variance in the data (Table 5). Factor I accounted for 35.5 percent of the total variance, while Factor II accounted for 14.2 percent, and Factors III and IV accounted for 9.8 and 7.0 percent of the total explained variance, respectively. Bartlett's test of sphericity, the Kaiser-Meyer-Olkin measure of sampling adequacy, and the anti-image correlation matrix each indicated that a factor analysis was appropriate for the survey data.

Factor I consisted of the following softwood lumber attributes: narrow growth rings, vertical grain, straight grain, absence of knots, and uniform color. Because each of these softwood lumber attributes relates to lumber quality, this factor was labeled as timber quality. Similarly, Factor II was labeled as manufacturing properties, while Factors III and IV were labeled as mechanical properties and economic characteristics, respectively. It is important to note that the factor solutions are not listed in any particular order with respect to their perceived importance by the survey respondents. Rather, the factors are listed in a declining order based on their ability to account for the variance contained within the survey data. For example, while the factor analysis listed timber quality as the first factor, the lumber attributes contained in this factor generally received the lowest mean importance ratings by the survey respondents (Table 4.)

The results of the factor analysis suggest that rather than using 16 attributes to describe softwood lumber, we can describe softwood lumber based on just four composite attributes defined as: product quality, manufacturing properties, mechanical properties, and economic/price characteristics. It is interesting to note that all of the softwood lumber attributes generally associated with old-growth clearwood lumber (narrow growth rings, vertical grain, straight grain, absence of knots, and uniform color) were grouped together under the timber quality factor. This would suggest that these five lumber attributes might form the basis for defining clearwood lumber.

PERCEPTUAL MAP OF
INDUSTRY SEGMENTS

The preferences of survey respondents for particular lumber attributes can be further analyzed using a perceptual map that graphically displays the location of each industry segment within a two-dimensional space based on the importance ratings obtained for individual factors (Fig. 2). The axes of the perceptual map are defined by the factors generated from the factor analysis, where the scale of the axis indicates the distance of each industry segment (in standard deviations) from the mean score for that factor. For example, industry segments that rated a factor as being important are located in a positive direction from the center of the map, while those segments that rated a factor as being less important are located in a negative direction. The closer that an industry segment is located to the center of the plot, the closer its members were to the mean importance rating for that particular factor.

The vertical axis represents timber quality (Factor I), while the horizontal axis represents manufacturing properties (Factor II). Those industry segments that rated the attributes in both factors as being important are located in the upper right quadrant of the map, while an industry segment that rated both factors as being less important are located in the lower left quadrant.

The perceptual map indicates that door and window manufacturers appear to attach similar importance to timber quality and manufacturing properties when purchasing softwood lumber. These industry segments attached a higher importance to the quality and manufacturing properties of softwood lumber than did any other group of manufacturers (as indicated by their location in the upper right quadrant of the map). In contrast, pallet and structural products manufacturers rated both factors as being less important in their raw material purchase decision, although pallet manufacturers considered both sets of factors to be considerably less important than did the manufacturers of structural products.

CONCLUSIONS

Those respondents who utilize softwood lumber as a raw material input in their manufacturing process indicated that they value reliability of supply, price, and price stability over timber quality. This would seem to indicate that manufacturers cannot,

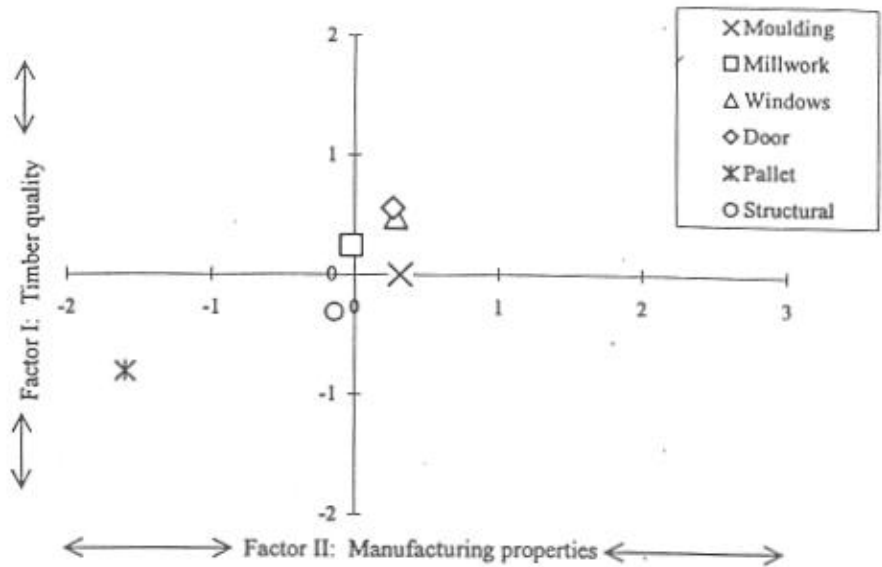


Figure 2. — Perceptual map of industry segments along timber quality and manufacturing properties.

or will not, continue to accept a market environment characterized by increasing lumber prices and rapid price fluctuations. Obviously, demand for clearwood lumber will continue, although the results of this study suggest that many manufacturers are reevaluating both their use of clearwood lumber as well as the intrinsic value of these products. The survey results indicate that substitution of lower grade material for clearwood is extensive and there is little reason to believe that it will not continue in the future.

The price structure of softwood lumber indicates that softwood lumber products are highly differentiated in terms of their perceived market value, reflecting the unique attributes of specific lumber grades. The results of this study indicate clearwood lumber grades are differentiated products for which end-users in specific industry segments are willing to pay a substantial premium. Clearwood lumber grades represent a true differentiation of lumber based on a specific combination of product attributes that are important to end-users. However, a complex price structure exists between different species and product grades, as well as between lumber grades of the same species. The real price premiums commanded by clearwood grades of softwood lumber have been steadily increasing over the long term, providing above average returns to timber producers

where the yield of clearwood lumber can be enhanced through cost effective intensive forest management. Over time, these price premiums may provide a stimulus to increase the volume of clearwood lumber produced through intensive forest management, although the relationship between the timber attributes sought by end-users and the price premiums that they are willing to pay to obtain those attributes has yet to be determined.

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