Visual Wood Product Trends in North American Nonresidential Buildings

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Abstract

An exploratory Web survey was implemented in 2012 of 250 architects in North America that specialize in nonresidential building design. Approximately one-third of the respondents had used architectural elements defined as solid wood heavy timbers, glue-laminated timber, and other engineered beams or posts, which are visually exposed. These members can be structural or nonstructural.

Results showed that these visual wood products are used in virtually all types of nonresidential buildings and are growing in popularity. This coincides with an overall growth in popularity for wood interior finish in these buildings. It was also found that there is a link between the architectural elements and interior finish with a desire to match species, color, and character.

The use of wood as an architectural design element has gone a long way in North America in increasing its popularity in nonresidential construction, especially showcase public structures such as educational and recreational buildings. Because the nonresidential building sector has been identified as the sector with a large growth potential for wood, this trend is encouraging. Combined with advances in structural engineered products and building systems, improved engineering and architectural training in wood, and continued efforts to expand the allowance for wood solutions in the building codes, this may be an indication of potential increases in the use of wood products, both nonstructurally and structurally.

There has been a lot of attention in recent years on expanding the envelope for the use of wood in applications that are dominated by steel and concrete. This has included the use of platform framing (dimension lumber with wood-based panel sheathing) in four to six story multifamily and mixed-use buildings, and the desire to capture a higher market share for wood in nonresidential structures. The latter includes aspiration for even greater than six story buildings, examples of which already exist (see, e.g., http://mg-architecture.ca/portfolio/widc).

While this growing interest is primarily focused on wood structural elements and systems, there is an equal desire to further expand the aesthetic applications, that is, the ''living with wood'' aspects over and above ''building with wood.'' With products like glue-laminated timber, heavy timber, and cross-laminated timber, structural and visual attributes can be delivered simultaneously.

This article reports on a recent exploratory survey of architects, the purpose of which is to shed more light on what they see as the primary demand drivers for visual wood products in nonresidential applications throughout North America. After a brief background on overall wood use in North America for perspective, the article discusses the methodology used, summarizes key findings, and discusses implications.

Background

The vast majority of solid softwood products in North America is consumed in structural applications for either new residential construction or in residential repair and renovation. Moreover, the majority of this consumption is in the form of commodity lumber and wood-based panels, which tend to be at the low end of the value spectrum.

While the wood products industry relies on the sales of these commodities for the bulk of the available range in fiber quality, there is an ongoing need to increase profit margins wherever possible. This includes the identification of value-adding products, both in primary manufacture (e.g., sorting out clear, shop grade lumber) and secondary manufacture (e.g., appearance building products and furniture). It also includes engineered applications such as gluing and manufacturing veneers from high-grade lumber to increase availability.

Higher value products such as doors, windows, flooring, mouldings, cabinetry, and furniture tend to be hardwood based, but there are growth opportunities for softwoods. There are also higher value growth opportunities in nonresidential construction and in industrial applications. Finally, there are further higher value opportunities in

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international markets, historically those in Western Europe and Japan (O'Connor et al. 2003; Rice et al. 2006; Gaston et al. 2006, 2010).

Figure 1 illustrates the breakdown in end-use demand, showing Canada exports of solid wood products to the United States in a prerecession year (2004; Global Trade Information Services 2014). The three main categories of wood use are ''building with wood,'' which is predominantly wood used for structural purposes in construction; ''living with wood,'' where wood is used for aesthetic purposes, primarily for interior uses; and ''industrial,'' where wood is used for products such as pallets, packaging, highway infrastructure, and—at the high end—wood used in furniture. Note that 70 percent of the exports were in the form of commodity lumber and wood-based panels, primarily for ''living with wood.'' While the species breakdown is not shown, softwoods totally dominate Canadian production and trade.

US consumption of softwood lumber products is concentrated in residential building construction and home repair and remodeling (Fig. 2; Resource Information Systems, Inc. 2014). Some appearance wood products are included in these totals. Nonresidential construction, currently one of the smallest uses for softwood lumber, likely represents the largest potential for growth in North America. The value of nonresidential construction is greater than for residential, yet represents a small fraction of wood use (McKeever et al. 2004). This reflects the dominance of steel and concrete use both structurally and nonstructurally in industrial and commercial buildings.

A number of studies have reported on the barriers and challenges of increased wood use in the nonresidential sector, with a particular focus on wood as a structural material (e.g., Kozak and Cohen 1996, 1997, 1999; Gaston et al. 2001; O'Connor et al. 2003, 2004a, 2004b; Robichaud et al. 2009). A common thread of these studies is that this sector has remained dominated by nonwood structural products, beyond that imposed by code restrictions.

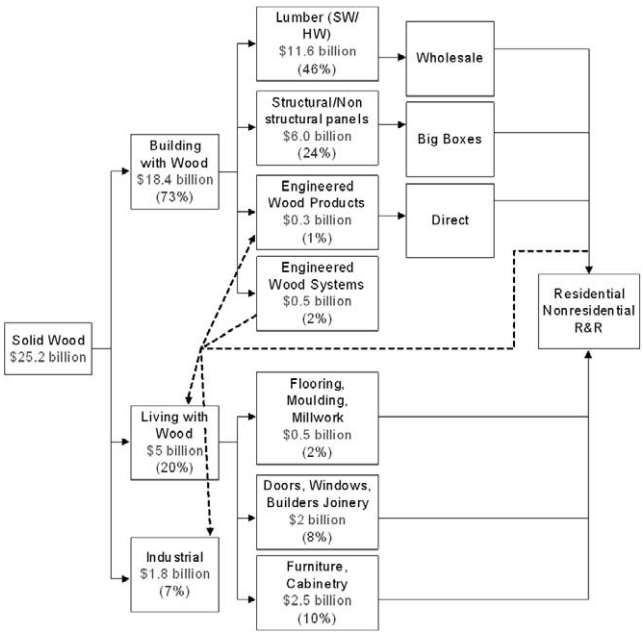

Figure 1.—Canada exports of wood products by value, 2004.

In recent years, particularly in Canada, there has been a concerted effort to increase the level of wood use in nonresidential construction, in part as a means to lower the carbon footprint of these buildings (see, e.g., Skidmore, Owings, and Merrill 2013). The effort has promoted the positive attributes of building with wood: environmental performance as compared with steel and concrete, and appearance. The focus for the latter is to showcase wood as an aesthetic building material, including large visible elements such as posts, beams, arches, staircases, and ceilings. Example programs include Wood *WORKS!* (http://www.wood-works.org) and the Wood Solutions Fair (http://www.cwc.ca/index.php/en/events/wood-solutions-fairs), both programs of the Canadian Wood Council. Another successful effort has been the Wood First Initiative with the Province of British Columbia, which strongly encourages the use of wood in public buildings (http://www.jtst.gov.bc.ca/woodfirst). This is being replicated in other provinces in Canada.

The present study grew out of the growing efficacy of promoting wood in high-viability nonresidential buildings and particularly in architectural elements such as heavy timbers (Fig. 3). The objective of this exploratory work is to document the British Columbia experience and regional trends throughout North America by gathering the perspectives of architects, identified as one of the most influential material specifiers (Gaston et al. 2001, O'Connor et al. 2003).

Methods

Personal interviews with architects were conducted in Vancouver to validate the value proposition for an increased use of visual wood members in nonresidential construction. Individuals were chosen from firms known for designing nonresidential buildings that had used wood timbers (solid or engineered) in visual applications.

Based in part on what was learned from these in-person interviews, an exploratory Web-based survey was subsequently designed and implemented in conjunction with the National Association of Homebuilders (NAHB) Research Center in Maryland. Both the survey design and execution followed standard practices (Dillman 2000). NAHB obtained a sample list of active architects that had designed nonresidential projects within the past year from RSMeans.[1]

In mid-April 2012, 4,000 US-based and 900 Canada-based architects were mailed an invitation to participate. Whenever possible, returned mail was resent to a new address if one could be found. A reminder letter was mailed in early May. Completed surveys were rewarded with a $10 gift certificate. The Web survey was closed at the end of May, with 250 completed, usable surveys, yielding a response rate of just over 5 percent. This included 208 completed surveys for the United States and 42 for Canada. The regional breakdown was 36.4 percent for the US North, 33.2 percent for the US South, 13.6 percent for the US West, 6.0 percent for Canada West, and 10.8 percent for Canada East.

[1] RSMeans is a US-based research organization that specializes in construction costing services (see http://rsmeans.reedconstructiondata.com/default.aspx).

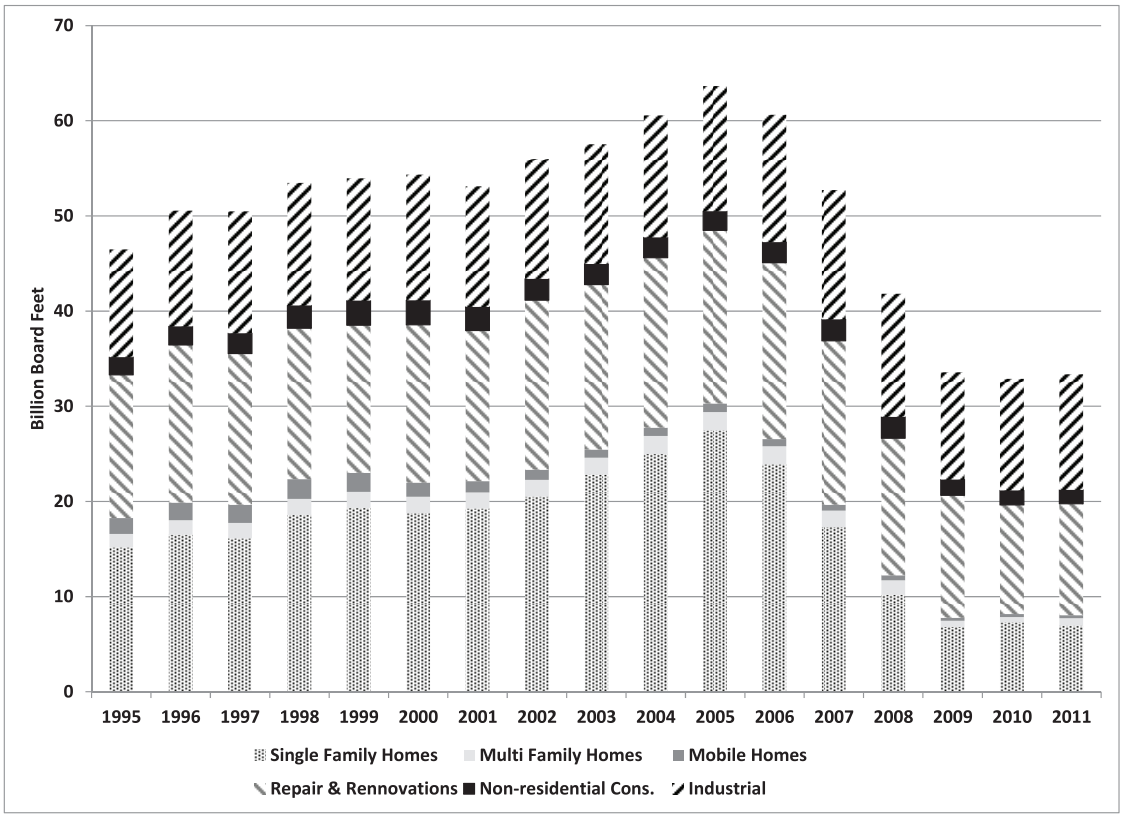

Figure 2.—US lumber consumption by end use (Resource Information Systems, Inc. 2014).

There was a strong interest to include architects who specialize in nonresidential buildings; to adequately represent all regions of North America; to adequately represent architects who use wood, steel, and concrete as structural materials; and to adequately represent architects who use architectural elements. To ensure adequate numbers in each category does introduce the possibility of nonresponse bias. Because the sample was segmented to ensure adequate representation of each of the specific segments desired, it is not necessarily representative of the population. It is for this reason that the study is considered exploratory and that no inference to the population of North American architects is made.

An average of 81.3 percent of the 250 respondent architects did the majority of their design work in urban areas. The respondents had an average of 17.7 years of experience, and on average 15.9 architects worked for their firm.

Results

Vancouver interviews

The in-person architect interviews revealed a strong indication that the aesthetic use of wood in nonresidential construction in Vancouver had increased significantly over the past decade and that this would continue into the future. While comments along this line were on the use of wood generally (including interior finish, interior doors, etc.), specific mention was made on the growing popularity of architectural elements, including local, solid, large dimension members. One respondent commented: ''Big wood posts and beams are rare and should be in public spaces so many people can enjoy them.''

Architectural elements were used most frequently in educational and government buildings, offices, sports facilities, and high-end homes. The most common application was for exposed, structural post and beam members. Aside from aesthetic reasons, architects also note that post and beam building types were used where maximizing open space was desired. Wood was chosen when there was a desire for a ''natural/environmental looking solution,'' or to ''express quality.'' Respondents considered both solid timbers and glulam when specifying architectural elements. For solid timbers they specified Douglas-fir (*Pseudotsuga menziesii*), followed by cedar and imported species. Hemlock (*Tsuga* spp.) was occasionally used. Engineers are more likely to specify glulam over timbers, in part because they are after specific structural ratings. For glulam, architects are more likely to specify ''aesthetic ratings,'' including a lack of black glue.

Only a few architects used Parallam and laminated veneer lumber (LVL), and rarely for exposed members. A few architects have experimented with the use of cross-laminated timber for floor, wall, and roof applications, some of which were visual.

The interviews confirmed the growing popularity of wood for interior finish and heavy timbers and engineered wood products used for appearance and not just structural purposes. They also offered excellent insight on demand attributes of competing products that guided the formulation a North American–wide architect survey.

Figure 3.—Example of architectural elements (engineered timbers); University of British Columbia CIRS Building. Photo by C. Gaston.

The North American Web survey

Segmentation ensured that every type of nonresidential building was represented in the 250 respondents. There were thousands of projects, with individual respondents designing more than one building type between 2009 and 2012 (the time frame in the survey questionnaire). In terms of the number of buildings, educational buildings, public (government) buildings, and offices were the top three, followed by hospitals, stores, restaurants, and warehouses.

The main structural material for the nonresidential buildings designed by the respondents was either steel, concrete, or a hybrid of materials. The use of wood was much lower, yet remained substantial, especially for offices, restaurants, and commercial residential mixed-use buildings.

When asking the same question for those projects that used architectural elements, it is interesting to note that the highest percentages still belonged to concrete and steel in most cases. In other words, architectural elements are just as popular (if not more so) in steel and concrete buildings as they are in wood buildings.

When asked what percentage of the projects designed by building type used architectural elements, over 50 percent of the projects for all building types except industrial buildings, offices, and hospitals made some use of these elements (Fig. 4).

Respondents were asked to pick one ''showcase'' project that they designed as the main focus of the survey. Educational and public buildings were selected most frequently, followed by offices and hospitals/care facilities. This was the same regardless of whether respondents had used wood architectural elements.

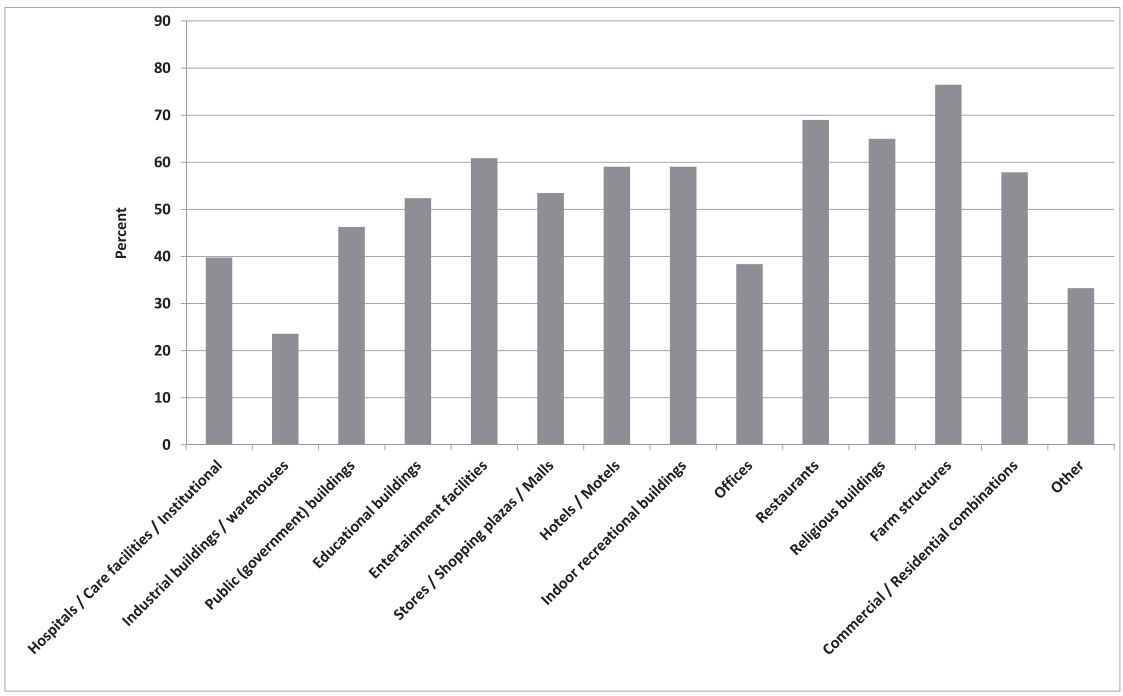

Figure 4.—North American architect survey; percentage of projects using architectural elements (by building type).

In this showcase building, respondents were first asked in what applications wood was specified for interior finish. Figure 5 shows the results, comparing three categories of respondents: (1) those that used architectural elements (regardless of the structural material of the building), (2) those that did not use architectural elements and used wood as the main structural material for the exterior walls, and (3) those that did not use architectural elements and used steel and/or concrete as the main structural material for the exterior walls.

Wood finish tends to be specified most often for respondents that used architectural elements, except for exterior applications (exterior doors, exterior facing windows, and exterior wall finishes). These exterior product categories also show the lowest likelihood of specifying wood with all respondents. Overall, all three categories of respondents stated that clients and design teams placed a high level of priority in using wood finish.

Domestic hardwoods are specified most frequently for interior finish items, followed by softwoods (Fig. 6).

Respondents that used architectural elements were just as likely to specify steel and concrete products for framing as those that did not use architectural elements. Further, respondents that used wood framing for the exterior wall structure were the most likely to specify wood products such as lumber joists, I-joists, roof trusses, and most engineered wood products and systems.

Respondents clearly stated that architectural elements are sometimes used purely for visual appeal, although they are used most frequently for structural purposes (Fig. 7).

The final portion of the survey was restricted to only those respondents who stated that they do use architectural elements. The first of these questions asked the architects to rank attributes on a scale of 1 to 7, with 1 being not at all important and 7 being very important. Respondents scored all but one of the attributes as a 4 or a 5. This included attributes related to appearance (aesthetics, lack of splitting), performance (strength, dimensional stability), supply considerations (price, availability of lengths/dimensions/species, supply consistency, and dried), and environmental considerations, in that order (Fig. 8).

Domestic hardwoods are not only commonly specified by respondents for interior finish, but also for architectural elements. The incidence of domestic hardwoods use was the highest, followed by Douglas-fir, spruce-pine-fir, Southern yellow pine (SYP), California redwood (*Sequoia sempervirens*), Hem-fir, western red cedar (*Thuja plicata*), imported hardwoods, and ''other softwoods,'' in that order (Fig. 9). The percentages do change by individual region; for example, respondents favor SYP in the US South and Douglas-fir in the US West.

Over 60 percent of respondents indicated that there did not need to be consistency between the types of products or species between vertical and horizontal members (Fig. 10). This is not unlike Japan, where one species (such as Douglas-fir) is typically used for the beams and another (such as a European ''white wood'') is more typically used for the posts (see Gaston et al. 2006).

Over 60 percent of the respondents also indicated that it was important to match species, color, and grain between the architectural elements and the interior finish used for the project (Fig. 10). For example, if the interior finish uses a particular domestic hardwood, it is likely that the architectural element will also be specified in that same domestic hardwood. Or, it will at least have the same color and/or grain character of that domestic hardwood. For example, matching Douglas-fir timbers with cherry wood paneling on

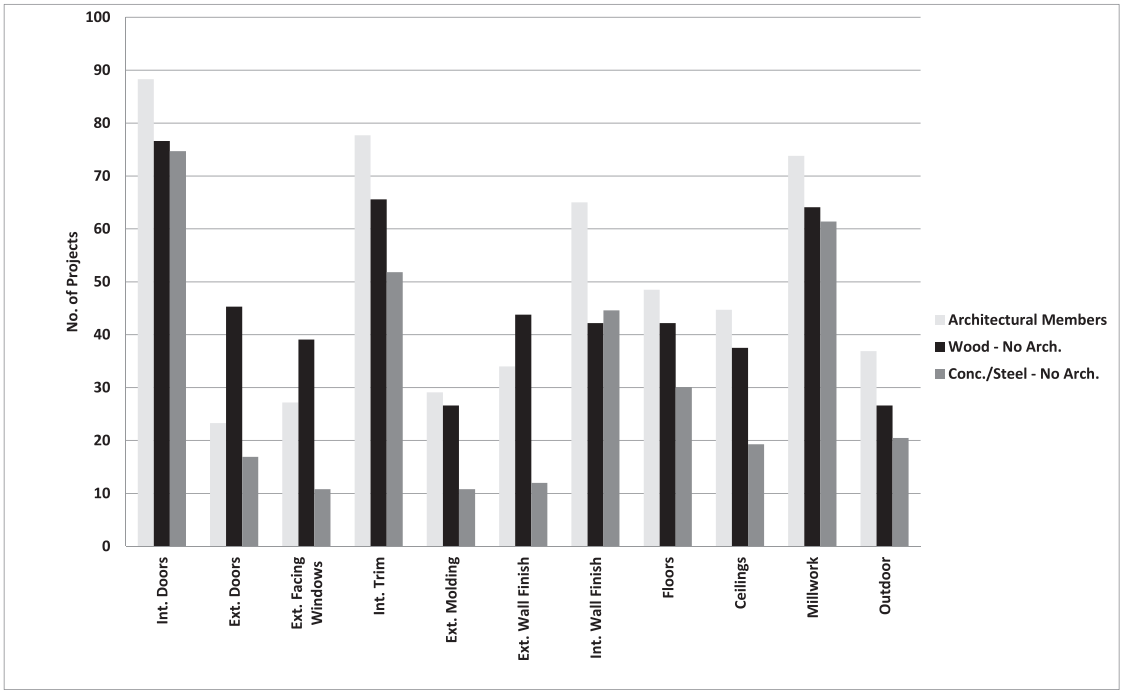

Figure 5.—North American architect survey; percentage of time wood is specified by interior finish type (by respondent category).

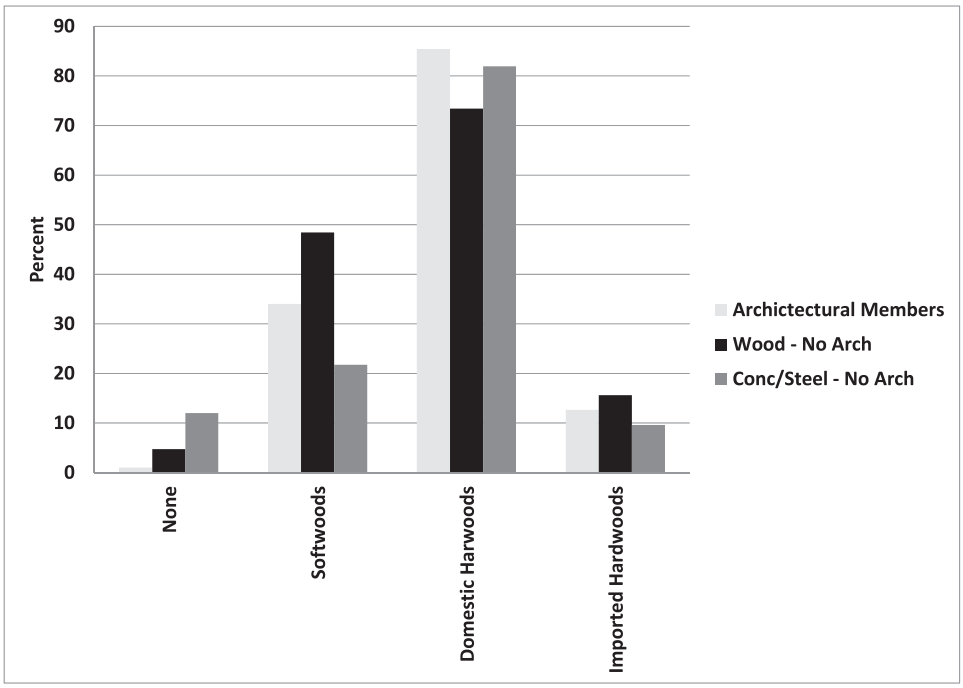

Figure 6.—North American architect survey; percentage of time species categories are specified (by respondent category).

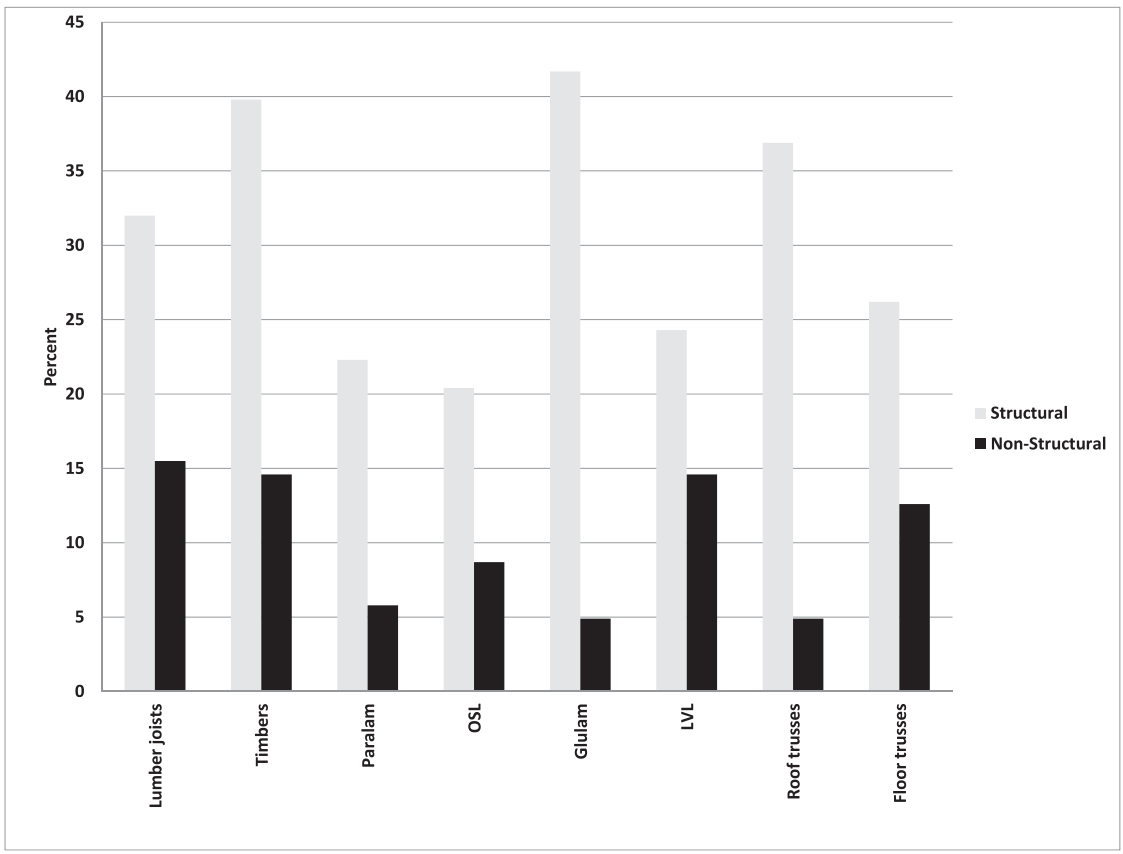

Figure 7.—North American architect survey; percentage of time architectural elements are structural versus nonstructural (product type; balance in each is "did not use"). OSL = oriented strand lumber; LVL = laminated veneer lumber.

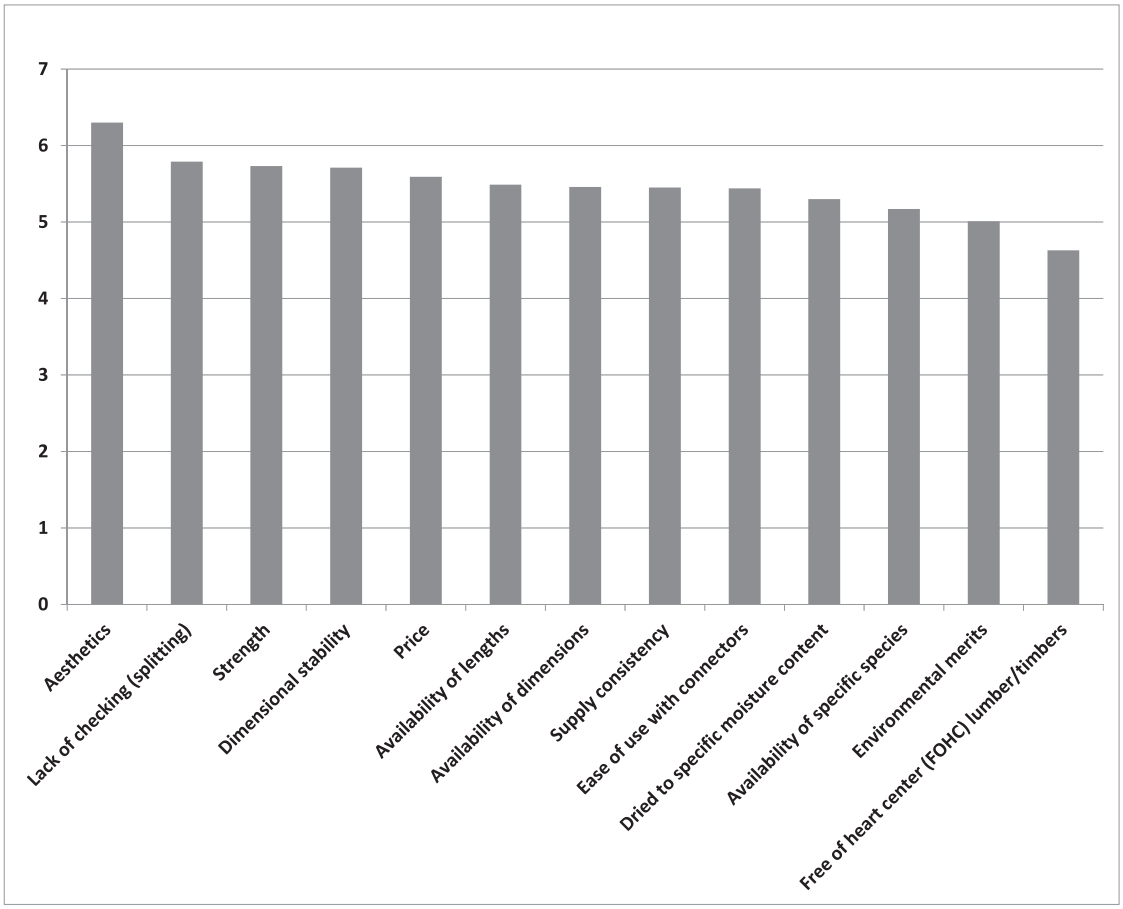

Figure 8.—North American architect survey; importance of attributes for wood architectural elements (1 = not at all important to 7 = very important).

the basis of their red tones, or staining a white wood for color and/or character matching, could work.

Respondents were equality split on whether more solid wood timbers would be specified if they had a recognized strength rating value such as that available for glue-laminated timbers and other engineered wood products (Fig. 10).

Finally, respondents were asked if they were using less, more, or the same number of architectural elements today than they did 5 years ago, and how many they expect to use 5 years from now. Compared with 5 years ago, 39 percent of respondents stated that they use more, and 52 percent use about the same. Thirty-two percent of respondents expect to use more architectural elements 5 years from now, and 62 percent expect to use about the same.

Summary

The results of the exploratory in-person and Web surveys presented in this report are positive for the prospect of increasing the use of wood for visual applications in North American nonresidential construction. This was reinforced for interior finish and architectural elements, the latter including solid, glue-laminated, and other engineered timbers.

Architectural elements were used with most building types, particularly in public and educational buildings. They were equally popular for nonresidential buildings that used wood and with steel/concrete as the primary structural material. Individual architectural element products included (in order of use) glulam, timbers, lumber joists, roof trusses, floor trusses, LVL, parallel strand lumber, and oriented strand lumber. There was significant incidence of nonstructural uses for all of these products.

Aesthetics were stated to be the most important attribute of architectural elements, followed by lack of splitting, strength, and dimensional stability. There was a noted link between architectural elements and interior finish. Both have a high incidence of domestic hardwoods use, followed by individual domestic softwoods.

It was noted that an increased use of solid timbers was likely if they had an accepted strength rating in place, much as that which presently exists for glulam.

Combined with advances in structural engineered products and building systems, improved engineering and architectural training in wood, and continued efforts to expand the allowance for wood solutions in the building codes, the future use of wood products is positive in nonresidential construction, both nonstructurally and structurally.

Results of this exploratory work indicate that a more in-depth survey producing results that can be statistically inferred to the population is recommended.

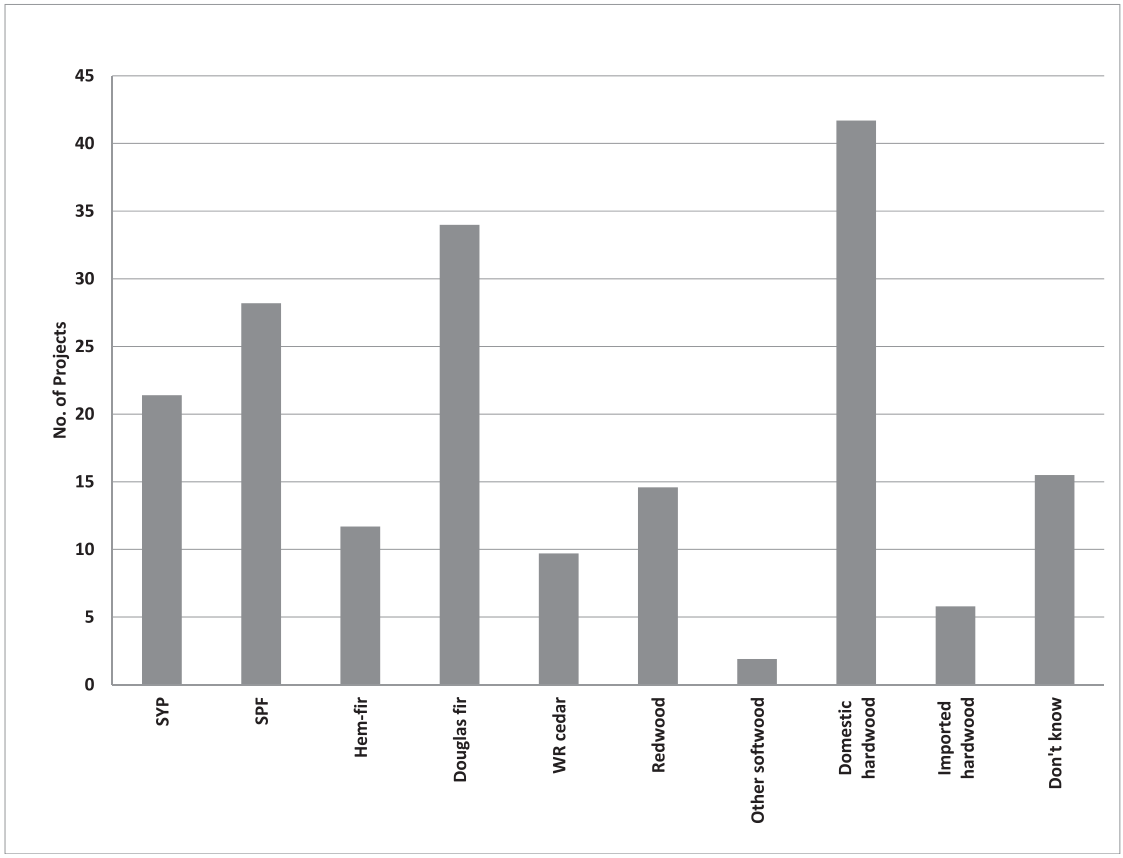

Figure 9.—North American architect survey; incidence of architectural element use by species. SYP = Southern yellow pine; SPF = spruce-pine-fir; WR = western red.

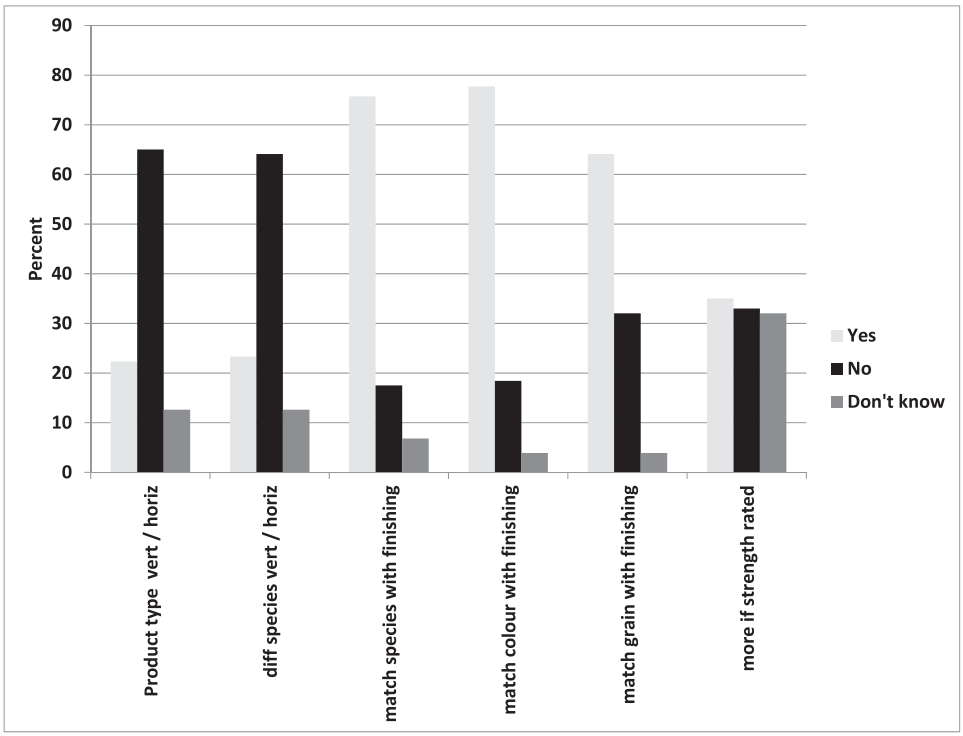

Figure 10.—North American architect survey; importance of product types and species between vertical and horizontal members, importance of batch species and grain between architectural elements and wood finish, and importance of strength rated solid timbers.

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