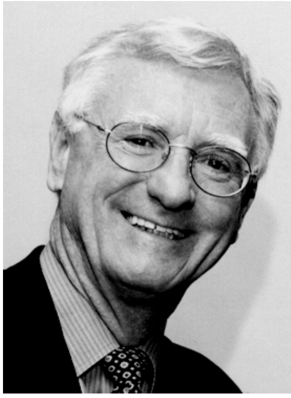

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Wood construction shows a new face in North America

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Wood construction shows a new face in North America

1 Introduction

The significant forest resources of North America and Canada in particular have served the residential construction market from early days of European settlement. However, until very recent years there has not been a great interest in advancing heavy timber construction into many large scale non-residential projects.

This paper will present an assessment of quite recent attitudes of North American designers to the use of wood in such projects, discuss some of the strategies that are effecting a change in these positions, and showcase some recent work that represents a change in the manner in which wood is being integrated into institutional and commercial projects across the continent.

2 Wood use in non-residential construction has been limited

The author showed in a 1999 study that glulam production on a per-capita basis in North America stood at only 31% of that in Scandinavia, and at 50% of Europe as a whole at that time.

The well-established steel and concrete industries have long held a hold on the majority of major construction projects, and designers continue to cite their unfamiliarity with wood as a major reason why they do not incorporate it into buildings, even though such construction might comply with the applicable building regulations and codes.

In 1995, the Canadian Wood Council prepared an internal study of a sample of Ottawa and Toronto area building permit applications and determined that from that sample a total of 52% of the non-residential work could have been constructed with wood structural components and satisfy all the requirements of the current building codes and other regulatory standards. The reality is that less than a third of that potential was so built.

The Markets and Economics Group of Forintek Canada Corporation completed a survey of architects and structural engineers across the US and Canada in 2000, and reported an interest in designing with wood in larger projects. However, although there have been some significant structures constructed in recent years, such work has come from a relatively small group of committed designers who have developed a competence in working with the material, and have promoted the opportunities to their clients. The larger community of designers has been slow to follow the approach, although an increasing awareness of such successful projects is being registered as showcased projects in industry-sponsored, high quality publications are being directed to that audience.

The Forintek study provided an overview of several aspects of the preferences designers have to the use of wood in non-residential construction. Figure 1 shows that respondents liked to design with wood, but steel is their favourite. Attitudes about the use of wood as shown in Figure 2 are represented as the favourability for the structural use of wood in various types of non-residential buildings. Responses in the centre of the graph varied somewhat by region, but the averages are plotted.

The majority of non-residential buildings in North America are low-rise. In this category, there is a favourability to use wood, but this consideration does not translate into larger structures and is shown in Figure 3. Similarly, the larger the building area, the less inclined designers were to favour wood as an option as seen in Figure 4.

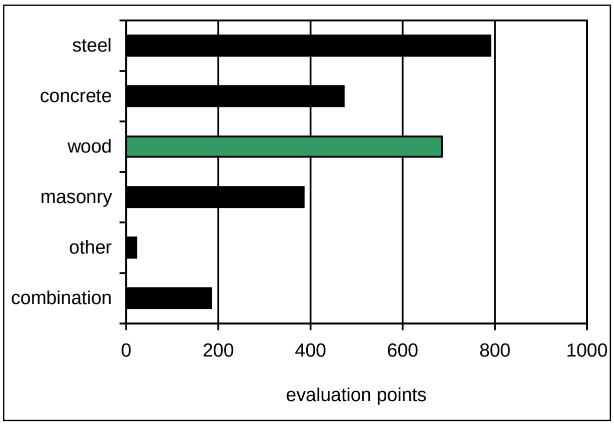

Figure 1: Material preferences for non-residential buildings

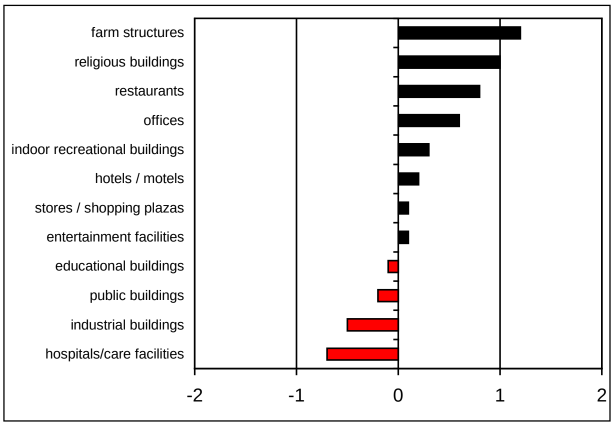

Figure 2: Favourability to the structural use of wood in various uses of non-residential buildings.

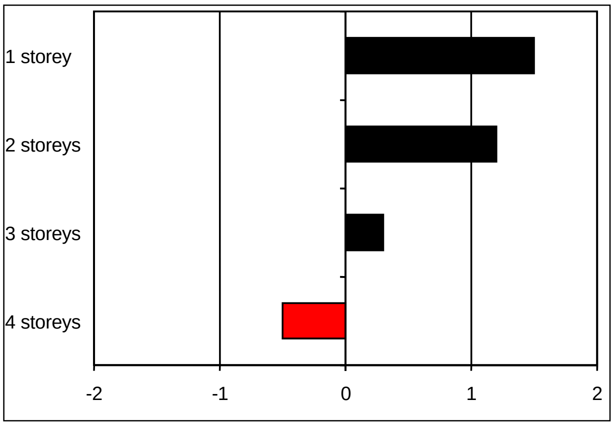

Figure 3: Favourability to structural use of wood in non-residential buildings, by height.

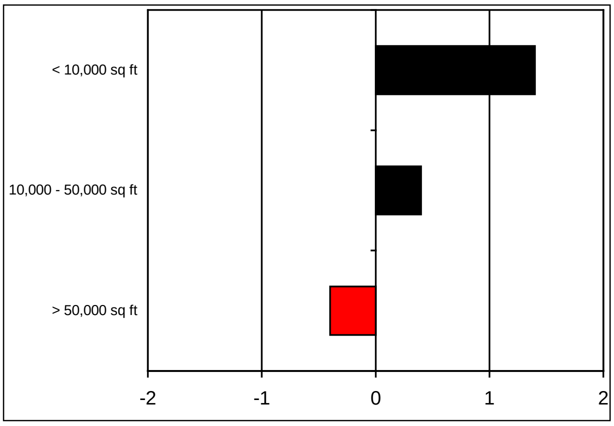

Figure 4: Favourability to structural use of wood in non-residential buildings, by area

Architects and engineers held generally similar opinions on the advantages of using wood as structure as represented in Figure 5. A lack of familiarity with wood design and applications has been regularly cited as one of the main hurdles to advancing the use of the material into larger projects. Figure 6 indicates that 75% of respondents reported an inadequate understanding of wood as a structural material in their schooling.

The afore-referenced survey also indicated that designers are generally favourable to the use of wood in small non-residential buildings. However, at this time only about 15% on these buildings are believed to be constructed of wood.

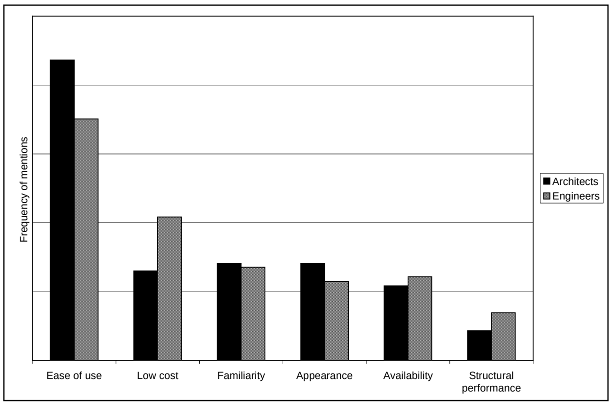

Figure 5: Perceived advantages of using wood as structure in non-residential buildings.

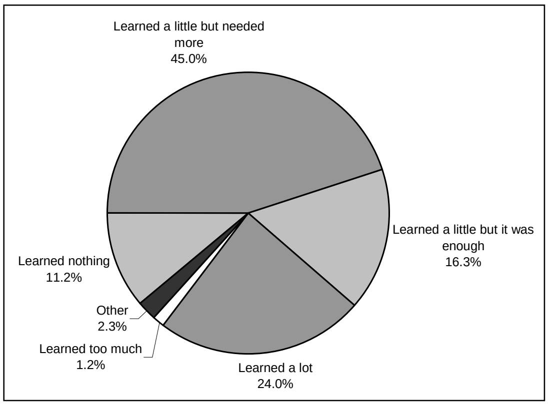

Figure 6: Amount learned about wood as a structural material in school.

2.1 Limitations to realizing opportunities

There is optimism on the part of industry for expanded heavy timber construction in both Canada and the United States, but there is work to do to pave the way for advancing the cause. Some of the issues to deal with are:

- Only a small number of companies are able to provide design-to-construct services for even basic primary skeletal framing in wood.

- As larger projects begin to integrate major wood components, the Contract Manager or General Contractor is now tending to be one of the large, mainstream constructors, often bound by union agreements. Within the unionised carpentry world, there are few carpenters who have the wood framing skills that are required to install the larger, more complicated wood assemblies. Further, the nature of this larger work often involves assembly at heights that are more often the purview of structural steel riggers. Traditional carpentry forces are often not prepared to work at these heights.

- The relatively small number of wood technology graduates at either master's, graduate, or technical college level who have a ready-to-work wood technology background. Even more importantly, a small number of undergraduates see the wood industry as a challenging or rewarding career opportunity.

2.2 Opportunities lie ahead

Expectations of increased opportunities for wood construction volume in the Canadian market as a result of new code provisions now in place are for a doubling of present levels. For example, changes to fire codes allow larger floor areas that can now be built with wood.

A study by the American Forest and Paper Association (AFPA) indicated that present United States code provisions offer the potential for 2.76 Billion US dollars of wood products in non-residential construction. Current experience is 0.88 Billion US dollars. Pending changes in the building codes will see that potential market rise to 4.9 Billion US dollars.

A major challenge for industry is to increase the confidence on the part of designers and regulators to use wood to take advantage of the opportunities that lie ahead.

A number of initiatives in Canada, in the main sponsored by the Canadian Wood Council (CWC), have proven to be effective in raising the awareness of the potential of wood in construction of non-residential projects. Over the last 10 years, 50 Wood Solutions Fairs have been held across the country. This project, conceived by the author, brings an average of 1000 architects, engineers and constructors together for a day-long series of concurrent seminars, exhibitor displays and a no-charge lunch.

The CWC has sponsored a number of professors' conferences to assist in focusing the needs of practicing designers who plan to work with wood buildings, and to lend support in developing course materials.

Project successes have been quite widely showcased in literature and seminars such as mentioned above, and this paper will later describe some recent examples.

3 Engineered Wood Products are becoming more available

Some of the circumstances that have permitted wood to be seen to have the potential to efficiently contribute to and meet the requirements of building designers and building codes include the following:

- **The introduction of the Wood I-Joist**

  In the author's view, the mass production of the Wood I-joist in the early 1980's was the most significant development in providing a product to open new doors to the categories of projects that now integrate wood as structure.

  The wood I-joist is manufactured to close tolerances, provides low variability of performance, opportunities for though-web penetrations of services, and span capabilities of in the order of nine metres. Greater depths and larger flange products are produced on special order to attend to spans that may extend to about 13 metres. The steadily increasing number of North American wood I-joist manufacturers and the ready availability of product though lumber yard distribution channels have served to bring the I-joist into the realm of commodity products.

- **Additional beam products**

  Beam and header products which include glued-laminated timber (glulam), laminated veneer lumber (LVL), and parallel strand lumber (PSL), have also become much more generally available though lumber yard distribution, although pre-framed glulam (custom cut, notched and drilled for example) is still most often provided directly from the manufacturer or a dedicated distributor network.

  A number of primary wood producers have established LVL manufacturing facilities to respond to product demand. Production of LVL has also increased dramatically. Approximately 50% of current production is used as flange material for wood I-joists; the other half is manufactured into beams and headers

The manufacturers of standard light gauge hangers for the various wood products are now producing custom manufactured hangers to specific project requirements. This source of supply supplements the more traditional manufacturing sequence which engages miscellaneous steel suppliers to fabricate weldments and assemblies which have been designed and drawn by either the project consultants, or the structural wood supplier.

- **Changes in market approaches by the Light Metal Plate Connected Wood Truss industry**

The light wood truss industry is well established in the residential market sector. Whilst it is has been very conservative in terms of product applications, the recognition of new market opportunities, computerisation of design sequences and the increasing level of sophistication and automation of manufacturing have allowed a more adventurous approach reaching beyond the unusual framing applications.

- **Competitive wood pricing compared to structural steel**

Although at the time of writing of this paper wood costs are at an almost historical high in North America, comparatively greater increases in steel costs are providing opportunities for wood solutions to be advanced on a very competitive basis.

- **3-D modelling and CNC framing equipment are becoming more common**

Major Canadian glulam manufacturers and their support infrastructure have, within the last few years embraced a number of European drawing and framing tools to enhance the production of more intricate framing and connection systems.

- **New education initiatives are underway**

In an effort to provide industry with more capable graduates, new teaching positions in advanced wood design and construction are currently being proposed at major Universities in Canada.

3.1 Some attitudes are changing, and significant projects are currently being constructed in wood

Recent experience which post-dates the referenced Forintek study is of a significant change in the zeal of designers to work with wood as measured by the increase in the number of significant projects that are being presented to the major glulam suppliers for assessment and budgeting.

The principal of a major international architectural firm based in Toronto recently expressed to the author his new awareness of the manner in which wood was being used in major works in North America as represented in the various publications discussed earlier, and felt that his firm should be turning their attention to such designs. As a result, a six storey wood framed office building has been proposed by his design team. Similarly, the principal of an equally significant engineering firm confirmed to the author his broadening interest in realising the opportunities for wood structure in major buildings as the reason for their very recent extensive use of glulam and LVL in quite large and elaborate projects in Canada.

It seems success in expanding the use of wood as structure in North America will be as a result of example, and the growing number of landmark projects will serve as references and inspiration for future applications.

The 2010 Winter Olympic games which are to be hosted in Vancouver and Whistler, British Columbia are providing the opportunity for wood in a number of facilities, and the Provincial government has announced that it will be a “Wood Olympics”. The industry is now marshalling efforts to support this goal, and to facilitate such construction.

Two recent Canadian applications of wood structure in institutional projects have been championed by Toronto architect Tye Farrow of Salter Farrow Pilon Architects, and now Farrow Partnership architects are the Thunder Bay hospital in Thunder Bay, Ontario, and the Credit Valley Hospital in Toronto, Ontario. Both projects required special review by fire regulators, and in each case unique solutions for fire suppression were integrated into the design. In the case of the Credit Valley Hospital, a high pressure Marioff Hi-Fog system injects a fine mist into the enclosure once triggered by infra-red sensors. This approach provides a number of advantages over the deluge sprinkler technique in that the many shielded surfaces are quickly wetted, and any fire is deprived of oxygen by the misted space.

3.2 Thunder Bay Hospital, Thunder Bay, Ontario
(Constructed by Western Archrib, Edmonton, Alberta, Canada)

This 375-bed, 63,000 square metre facility opened in 2004 replaces three regional hospitals. The three-storey main public corridor is curved to follow the path of the sun and allow deep penetration of light into the space. Figures 7 and 8 provide views of the work.

Figure 7: Interior glulam corridor

Figure 8: Exterior entrance glulam framing

3.3 Carlo Fidani Peel Regional Cancer Treatment Facility, Credit Valley Hospital, Toronto, Ontario (Constructed by Timber Systems Limited, Markham, Ontario, Canada)

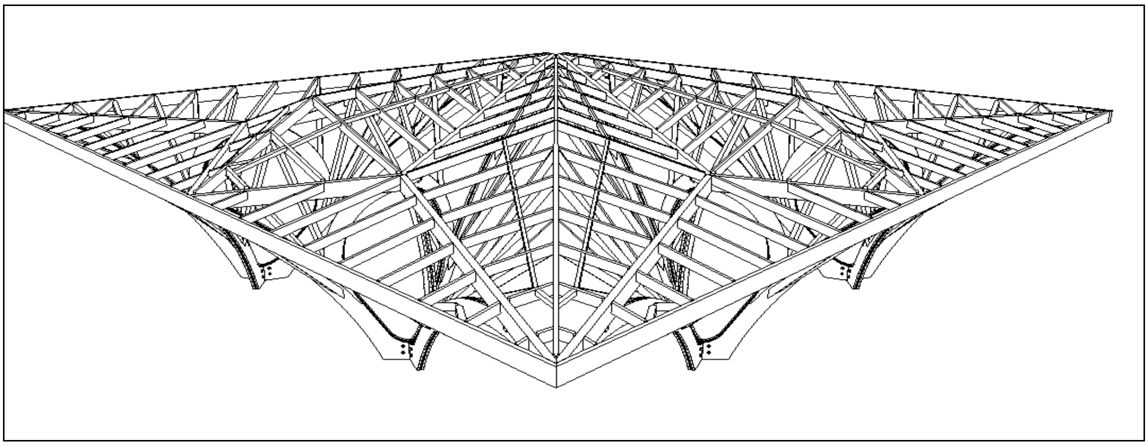

Figure 9: Perspective of Atrium glulam framing

Figure 10: View of partially installed glulam atrium framing

This new 85 million (Canadian) dollar, 30,000 square metre expansion will be completed in May of 2005. The facility features an intricate array of 14 metre high Douglas fir glulam “trees” in the atrium space and similar “lanterns” at the radiation treatment area. Twelve truckloads of glulam were engaged in the construction of these frames. Dowelled steel connection elements were concealed within the wood members. The wood structure was roofed with acoustic steel deck. Glazing panels spanned from the floor to the eaves level to allow light to flood the space.

Installation of the wood structure continued throughout the winter of 2003-2004, and was phased to co-ordinate with the construction of adjacent spaces to permit appropriate access and lay-down areas for the on-site assembly of the three elements that made up each of the 24 frames.

The structural analysis of the framing system was prepared by the consulting engineering company, and data provided to the manufacturer to develop connection concepts and details. As a consequence, a high level of interaction between the architect, engineer, and supplier was engaged to ensure that aesthetic, structural and constructability issues were properly attended to. The success of the unorthodox (at least for North American practice) arrangement was demonstrated by the fact that there were no changes at all to the work proposed, and no extra costs were applied beyond the tendered amount.

Figure 9 is a 3-D view of the model used to further develop member details. The curved glulam “trees” and the associated “branches” are seen in Figure 10.

4 Summary

Although some of the commentary of increasing interest in and construction of wood buildings in circumstances where steel and concrete would be more usual in the North American market is somewhat anecdotal, the reality is that current experience reflects a significant increase in heavy timber projects as reflected on orders to the major glulam manufacturers.

There are a number major projects in advanced stages of design and tendering, and although this specialised market is a small percentage of total wood construction, it is held that once a choice has been made to construct the major framing of a structure of wood, many of the secondary framing, sheathing and cladding components are more likely to be of wood as well.

As a result of the recognised potential of such scenarios, there has been considerable support from the wood industry as a whole to promote the use of wood in high profile projects with a view to capturing the attention of designers as to the feasibility of such construction, and hopefully increase the utilisation of a larger range of wood products as a whole.