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Errata corrige
Nel numero 11-2023, nella didascalia di p. 72 compare erroneamente come immagine d'apertura Église du Sacré-Coeur, Brig, Atelier coopératif d'Architecture et d'Urbanisme (ACAU), 1970 (Nadine Iten), la didascalia corretta è: Église St-Nicolas d'Hérémence, Hérémence, Walter Förderer, 1967 (Michel Martinez), ce ne scusiamo con gli autori e i lettori / In No. 11-2023 issue of ArchAlp, the captions on pages 72 erroneously report as the opening image Église du Sacré-Coeur, Brig, Atelier coopératif d'Architecture et d'Urbanisme (ACAU), 1970 (Nadine Iten), the correct caption is Église St-Nicolas d'Hérémence, Hérémence, Walter Förderer, 1967 (Michel Martinez). We sincerely apologise to the authors and our readers.

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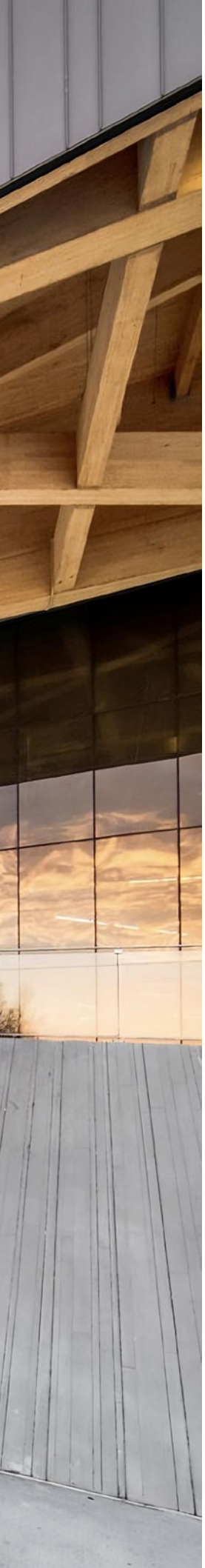

Evolving Perspectives: the resurgence of wood in Quebec architecture

Over the past two decades, Quebec has undergone a radical transformation in its approach to using wood in architecture, spurred by trade constraints on wood exports to the United States. This evolution is the outcome of synergistic efforts that have facilitated a transition resulting in significant technological and architectural advancements. Historically, Quebec's vast forest resources have played a pivotal role in the development of local timber construction, particularly through traditional timber frame techniques. However, the 19th century witnessed a shift towards light-frame construction methods like the Balloon Frame, driven by industrialisation and urbanisation. By the mid-20th century, concrete gained dominance, the fruit of prioritising aesthetics over ideology in architectural design, especially in Montreal, where concrete structures flourished. The 1980s trade dispute with the United States marked a turning point, fostering innovation and a paradigm shift in wood use.

Collaboration between industry and academia, exemplified by the Krüger Pavilion and the founding of FP Innovations, has propelled large-scale wood construction forward. Cecobois further supports this trend by facilitating access to technological innovations. This era of change highlights both the potential and limitations of wood in architecture, showcasing its role as a versatile and eco-friendly material that can enhance architectural design while facing technical challenges that sometimes limit its visibility and application.

Gianpiero Moretti

Since 2003 he has been a professor of Architectural and Urban Design at the School of Architecture of Laval University, in Canada. Between 2013 and 2017 he was director of the same faculty. Throughout his professional career, he has constantly combined creative research activities with the practice of architecture. This approach aims at a broad understanding of the built environment and the cultural practices that produce it. Through the establishment of a close link between research, teaching, and practice, possibilities for synthesis open up between theoretical knowledge from research and the conditions that determine the realisation of innovative built environments.

Keywords

Timber architecture, innovation, contemporary architecture, Canadian architecture.

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Quebec, and Canada in general, possess a significant forest resource, representing 2.2% and 8.6% of the world's forests respectively (Government of Quebec, 2023). Historically, despite the vastness of the territory, access to this resource was facilitated by transportation along major rivers to processing sites near rapidly growing cities. This abundance of resources has played a crucial role in the establishment of local timber as a primary resource for direct building construction, primarily through the timber frame technique. From the 17th to the 19th century, solid timber was widely used in house construction. Notarial records demonstrate the diversity of methods used for timber construction and the various terms used to describe these building techniques. Structural elements of such houses were assembled both vertically and horizontally (Varin, 1992) (Figs. 1 and 2).

As in other parts of North America, the 19th century saw industrialisation and urban population growth contribute to the emergence of light-frame construction (Balloon Frame), a technique that allowed buildings to be constructed with an unskilled labour force, unlike the timber frame method. Additionally, for residential buildings, the small size and light weight of timber pieces allowed for a single worker to construct the frame, making the process highly cost-effective (Sprague, 1981).

In the 1950s, the widespread adoption of concrete followed advancements made during the war in large-scale prefabrication and post-tensioning techniques, which increased the material's strength by stressing the reinforcements. In the field of architecture, the focus shifted towards aesthetics rather than ideology, with more modern tastes taking precedence. Concrete became the preferred material for architects seeking greater expressiveness. During this period, Montreal was recognised as the North American city producing the most spectacular concrete structures, fully leveraging the material's potential, thanks in part to companies like Francon and the Canadian subsidiary of Schokbeton established in Saint-Eustache since 1962. This reputation was built on projects such as Habitat 67, Place Bonaventure, La tour de la Bourse, and the new Montreal metro stations (Van Laethem, 2014). During this period, wood was primarily used for small-scale residential construction. In response to this significant shift, players within the wood in-

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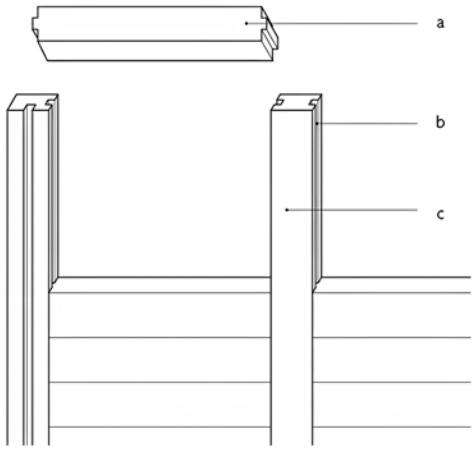

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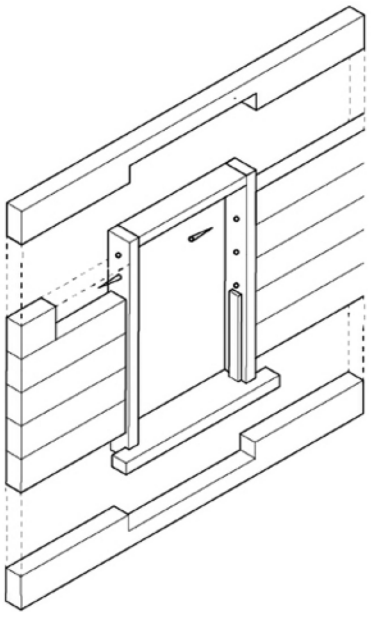

Opening picture
Stade de Soccer de Montréal, exterior view (photo Olivier Blouin).

Fig. 1
Sliding dovetail joint / a. Solid wood piece cut into a tenon, b. Groove, c. Post (Varin, 1992).

Fig. 2
Openings defined by door frame posts (Varin, 1992).

dustry banded together with the founding of the Canadian Wood Council in 1959. Representing hundreds of manufacturers across Canada, this organisation quickly became a key reference point for establishing codes and standards. The publication of a wood construction manual greatly facilitated the dissemination and implementation of techniques for various wood construction systems.

A pivotal moment in wood usage was undoubtedly the trade dispute between Canada and the United States that began in the 1980s and culminated in 2000 with the imposition of export duties on primary wood products to the United States. This crisis opened the door to a true paradigm shift as innovation became a fundamental element in exploring viable alternatives.

In Quebec, at Université Laval's Faculty of Forestry, Geography, and Geomatics, the Gene-H.-Kruger Building was constructed between 2003 and 2005 (Paul Gauthier + Gallienne Moisan Architectes / ABCP Architecture). This building served as a hub for a pan-Canadian consortium involving four universities: Laval University, University of British Columbia, University of Toronto, and University of New Brunswick, along with Forintek Canada, a private wood products research institute. Spanning two levels, the Kruger Pavilion houses conference and meeting rooms, teaching spaces, offices, and accommodates 18 laboratories (10 heavy-duty and 8 light-duty). The Kruger Pavilion is home to the Wood Research Centre, catering to graduate students in engineering and wood sciences across all three levels of study, as well as hosting the NSERC Industrial Research Chair in Structural and Appearance Engineered Wood. Notably, this facility represents the largest wood transformation research hub in Eastern Canada. Research topics covered range from wood anatomy to secondary processing and machining, encompassing analytical chemistry, polymer and adhesive chemistry, wood physics, timber processing, mechanical testing, composite panels, and wood drying.

At the time of its construction, this research centre served as a true manifesto for wooden construction. A range of bioclimatic strategies were integrated into the project to provide users with better control over their work environment and to reduce energy consumption. The building's orientation and layout were designed to optimise outdoor microclimates, natural lighting, passive cooling, and passive solar heating. The project was also optimised for sustainability through a collaboration with the GRAP (Groupe de Recherche en Ambiances Physiques) at the School of Architecture, Université Laval (Fortier, 2010).

The framework features exposed glued-laminated timber beams and columns in the public areas of the building, while traditional wood framing is used in other areas. Interior finishes include softwood decking and plywood, oriented strand board (OSB) panels, maple veneers, white pine wall protection strips, solid maple panels in the conference room, and hardwood floors in the offices. As for the exterior cladding, it consists of processed spruce boards stained grey (Fig. 3).

The push towards innovation also led to the reorganisation of various research entities in Canada. Forintek Canada Corporation (founded in 1918), the Pulp and Paper Research Institute of Canada (Paprican, founded in 1925), and the Forest En-

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Fig. 3
Project "Origine", Quebec City (photo Stéphane Groleau).

gineering Research Institute of Canada (FERIC, founded in 1975) merged to form FP Innovations in 2007. FP Innovations is a not-for-profit private R&D organization that conducts research in the pulp and paper industry, forest operations, wood products, and bio-sourced products. FP Innovations employs over 400 specialists across Canada and operates with an annual budget of $76 million. Its roster of members includes 180 industry companies, with its board of directors representing industry members as well as provincial and federal governments. The organisation's headquarters are in the Montreal region of Quebec, with main research centres in Vancouver, Quebec City, and Pointe-Claire, along with regional offices across Canada.

In 2008, following extensive consultations, the Government of Quebec launched a strategy to promote the use of wood in construction. This initiative aimed to encourage the use of wood as an eco-friendly and renewable construction material while boosting the province's forestry industry. The strategy included financial incentives to promote wood use in residential, commercial, and institutional construction projects. Additionally, awareness and training programs were implemented to educate architects, engineers, and builders about the environmental and technical benefits of wood (Government of Quebec, 2008).

In the same year, in Quebec, the establishment of Cecobois added another significant player in promoting the use of wood for the construction of large buildings. This organisation, formed through a collaboration among industry professionals, developers, engineers, and architects, aims to support Quebec stakeholders involved in commercial, institutional, industrial, and multi-residential wood construction projects. Cecobois provides them with various tools including technical guides, case studies, and advisors who can assist at every stage of the design process for buildings or structures using wood.

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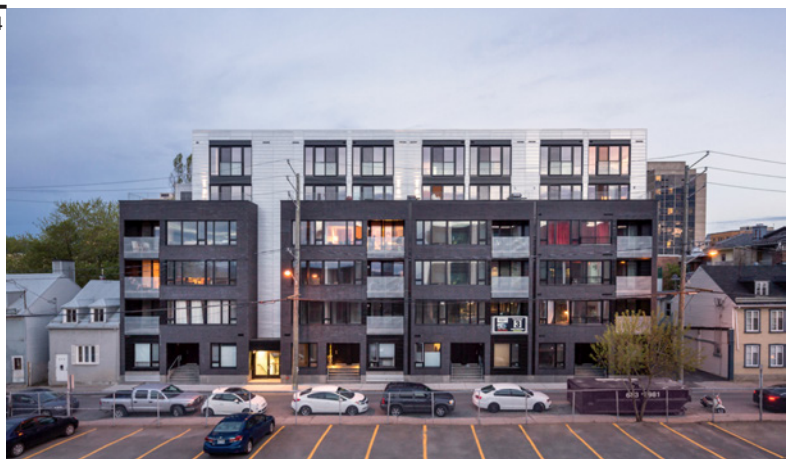

A fertile ground for architectural exploration

The political commitment and establishment of research and dissemination organisations in the early 2000s have facilitated the implementation of many innovative architectural projects.

In 2014, the residential project "District 03" (Éric Pelletier Architecte / Lemay) (Fig. 4), a 6-story build-

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ing constructed with mass timber panels, was completed in Quebec, marking a first in North America. Spanning a total area of 5,010 m^2, the development comprises 53 units and features massive cross-laminated timber panels, with some left exposed. Initially, the plans called for exposed concrete interiors for both phases of the building. However, an analysis suggested that the soil would not support this without significant piling operations. This led the architects to revise their plans to incorporate wood, which required no piling for the foundations. Despite equivalent structural capacity and volume, the weight of wood is only 20% of that of concrete.

Another challenge of this project involved maximising the exposed surfaces of the wood structure. 50% of the ceilings and 20% of the walls are left exposed, accounting for 40% of the project's total surfaces. The prevailing building code at the time would have only allowed 10% of surfaces to be exposed wood. However, laboratory tests demonstrated that fire resistance requirements were met, making the approach institutionally acceptable. This transformation enabled the integration of wood as a defining architectural element of District 03, harnessing its positive carbon footprint (Cecobois, 2015).

In a more complex scenario, for the "Origine" project (2017), a 12-story residential building constructed in Quebec City, professionals had to demonstrate that a wooden structure of such scale could meet the prescriptive requirements of the Quebec Building Code for performance and safety. In 2014, during the early stages of the project, the acceptable solutions under the prevailing Quebec Building Code stipulated that a building exceeding four stories must be of non-combustible construction, thereby excluding wood.

To increase the number of wooden floors, designers had to submit a request for equivalent measures to the Régie du bâtiment du Québec (RBQ) and demonstrate that these measures align with the performance objectives and functional statements of the Code. Through the Tall Wood Building Demonstration Initiative launched in 2011 by Natural Resources Canada and the Canadian Wood Council, designers developed construction solutions that were tested in laboratories at FP Innovations and the National Research Council of Canada to prove that the 12-story wooden structure would be as effective and safe as a non-combustible building designed according to the Code's acceptable solutions (Construire en Bois, 2018). The RBQ accepted the request for equivalent measures and incorporated them into a guide entitled "Mass Timber Buildings of up to 12 Storeys", serving as a pre-approved equivalent solution and providing guidelines for constructing wooden buildings compliant with the Quebec Building Code.

The innovative feature of the "Origine" (Yvan Blouin Architecte) project lies in its lateral resistance system against wind and seismic loads, entirely supported by mass timber instead of relying on reinforced concrete elements like other tall wooden buildings. With both the lateral and gravity load-re-

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Fig. 4
Project "District 03", Quebec City, exterior (photo Stéphane Groleau).

Fig. 5
Project "Origine", Quebec City (photo Stéphane Groleau).

Fig. 6
Stade de Soccer de Montréal, interior view (photo Olivier Blouin).

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sisting systems made of wood, this innovation made the building the tallest structure with a 100% wood structural system at the time of construction. Unfortunately, due to the complexity of construction and the necessity to meet fire resistance requirements, the magnificent wood elements are largely concealed behind non-combustible cladding, significantly limiting their visibility (Fig. 5).

This endeavour of experimentation and dissemination has certainly contributed to the increasing use of wood in larger public buildings. This is exemplified by the Montreal Soccer Stadium (2015) (Lam, 2016) (Fig. 6), designed by the firm Saucier + Perrotte in close collaboration with the engineers at Nordic Structures. The integrated design resulted in a structural grid that optimises the sizing of structural elements. This structure is composed of cross-laminated timber (CLT), using primarily local black spruce. The main roof is supported by thirteen glulam and CLT box beams, each measuring 69 metres long. The flexibility of the structure allows for the integration of mechanical systems due to the varying heights of the elements, providing space for ventilation. In this case, wood becomes a defining architectural element while also resolving the structural challenges of large spans.

Furthermore, wood is now being creatively used even in industrial buildings, as seen in the case of the Smart Mill headquarters (2021) (Atelier Guy Architectes). This building serves as a technological showcase highlighting the use of wood. Designed with a glulam structure and Eastern cedar cladding, the building houses both offices and a production space. The production area, a large open volume with significant height, is completely unobstructed and covered by prefabricated arch-shaped trusses spanning 22 metres. As for the administrative section, it spans two levels and surrounds an interior courtyard. The regularly spaced wooden columns serve a dual function: supporting the roof and anchoring the glass panels of the facade. In this project, wood is fully exposed and serves as the defining architectural element (Figs. 7 and 8).

Figs. 7-8
Smart Mill Factory, Lévis, exterior and interior views (photo Atelier Guy).

Innovation: Balancing Necessity and the Desire to Showcase Wood in Architecture

Since the early 2000s, a radical transformation has been underway regarding the use of wood in architecture in Quebec. Triggered by constraints related to tariffs imposed on wood exports to the United States, this transformation is the result of several synergistic actions that have facilitated this transition and led to remarkable outcomes, both technologically and architecturally.

Firstly, the synergy between industry and academia (Krüger and Université Laval) paved the way for the construction of the Krüger Pavilion, a facility equipped with state-of-the-art resources that catalysed wood research and technological innovation in Quebec, and more broadly in Canada. This in-

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itiative was undoubtedly supported by the political will expressed in Quebec's strategy for wood use in construction, implemented in 2008.

In the same spirit of collaboration between research and industry, the establishment of FP Innovation has played a crucial role in advancing the use of wood in large-scale buildings in recent years. As an applied research centre with advanced laboratories and many researchers, FP Innovation has made it possible to test innovative solutions, as seen in the "Origine" project, contributing to feasibility verification and updates to construction codes. This step remains fundamental for promoting wood use in large-scale construction.

Additionally, Cecobois, by supporting designers through publications, training, and specific consultations, has facilitated access to technological innovation and contributed to its application in large-scale architectural projects. This significant network is reflected in numerous projects that have contributed to a paradigm shift in wood use, placing it at the forefront of technological and aesthetic considerations.

This period of change and innovation prompts new reflections on the potential and limitations of using this eco-friendly material in architectural projects. In some cases, when pushed to the extreme, wood can achieve a balancing act that enhances architectural design. In other cases, technical challenges may lead to wood fading from architectural language, relegating it to a role as a lightweight and eco-friendly structural component. ■

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