Wood Science and Technology Centre

Quarterly Science and Innovation Trends

A quarterly update on value added wood products, green construction innovation, and non-timber forest bio products applied research and innovation in Atlantic Canada

Fall 2020

The team at the UNB Wood Science and Non-Timber Forest Bio Products research centre are proud to present our updates on innovation and focus research areas in this fall 2020 issue of our quarterly Science and Innovation Trends update. Our research centre works with industry, government and technology partners in eastern Canada to help bring innovation and application to research in wood products, mass timber, solid biofuels, and a variety of non-timber forest bio products including hemp and Christmas Trees. What is new in these areas and others? Read below to learn more about some of the innovation and industry support projects we focus on daily for companies in Eastern Canada.

Research Continues on the Impacts of Climate Change on the Christmas Tree Industry

On the morning of Monday June 4, 2018, eastern Canada experienced record low temperatures, some areas recording as low as minus 6 to minus 8 degrees C. This resulted in severe damage to expanding shoots of thousands of Christmas trees. Record high temperatures the preceding Thursday and Friday had further predisposed the trees to the frost/freeze event. Thousands of trees of marketable size were heavily damaged, many of which may never recover to reach the grade they had attained prior to this damage. The damage was extensive

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throughout much of Nova Scotia and south-east New Brunswick, and represents many tens of thousands of dollars in lost income to growers in the region. Balsam fir (*Abies balsamea*) is the backbone species for most of the Christmas tree and greenery industry in north-eastern North America.

This 2018 event is direct evidence of two notable aspects of climate change: warmer falls and severe late-spring freeze events. Warmer fall weather can delay the time at which trees become winter-hardy, which in turn affects how well trees will retain their needles after harvest. Late spring freeze events can cause severe damage in both plantations and wild stands.

In early 2020 Dr. Ron Smith, a research scientist at UNB's Wood Science and Technology Center, submitted a funding proposal to the US Christmas Tree Promotion Board to support a research project addressing these damaging and expensive effects of climate change. The project's official name is ***Quantifying Genetic Variation in Needle Retention and Timing of Bud Flush in Balsam Fir Christmas Trees for Improved Performance under Climate Change in the Northeast***. The main objective of the project is to identify balsam fir trees that, in addition to being phenotypically 'good Christmas trees' have the growth characteristics (flush late in the spring and harden off early in the fall) needed to perform well under climate change. The first step in achieving this goal is to determine the level of genetic control of both timing of bud flush and needle retention after harvesting. This has not been determined for balsam fir in the north-east growing zone.

The project plan proposes to have partners from New Brunswick, Nova Scotia and Quebec collaborate for the benefit of all growers in the region. Superior clones identified in this program will be grafted into orchards and evaluated in all three provinces to ensure that the next generation of Christmas trees produced in each region will be well adapted to local climate conditions. The ultimate purpose of this proposed research is to provide seedlings to Christmas tree growers that are adapted for climate change with provenance consideration for the various growing zones across the membership area. Specific sub-objectives are:

Objective 1: Optimize needle retention testing methodologies by screening a total of sixty trees (twenty from each province) at specified locations and times;

Objective 2: Determine the degree of correlation between the time of bud flush and the time of the onset of frost hardiness

Objective 3: Determine the effects of rootstock and tree age on timing of bud flush and needle keepability.

Participating growers are committed to and/or actively engaged in selecting candidate trees; collecting branches and monitoring bud and shoot development; identifying early and late-flushing trees; grafting scions from selected early and late-flushing trees, and providing suitable rootstock plants (both wild and plantation) for grafting.

In addition to producers, representatives from UNB's Wood Science and Technology Center and the Faculty of Forestry and Environmental Management, the NB Maple Producers Association, and tree improvement specialists from NB and NS have agreed to assist in developing and guiding the project. All of the aforementioned individuals and groups are members of the recently formed Northeast Christmas Tree Alliance. A funding contribution will be provided by the U.S. Christmas Tree Promotion Board. For information contact Jon Barteaux, UNB Wood Science and Technology Center, at 506-453-5004 or jon.barteaux@unb.ca

Development of Lighter-colored MDF Using Available Softwood Chips

Medium Density Fibreboard (MDF) is a type of non-structural panels made of wood fibers bound together with adhesives under heat and pressure. It has a substantially homogeneous consistency resulting from the uniform distribution of the wood fibers throughout the board. MDF has been as a main substitute for solid wood and plywood for furniture boards, millwork, and interior decorative applications. Figure 1 presents produced MDF boards and various indoor uses such as wall panels, mouldings, and furniture components.

Wood based composites plants prefer to use available hardwoods for the production of MDF products to meet marketing demands. These MDF products generally appear relatively dark-coloured surfaces due to the chemical and biological characteristics inherited from hardwood fibers. The "unpleasant" colour usually limits the application of such MDF products used as indoor decorative panels where light-coloured environment is required. To overcome this "defect", the most common solutions are the application of painting and overlaying on the surfaces of produced MDF to make the value-added MDF products. The re-producing processes can, however, result in relatively high costs in material supply and manufacturing energy in the production lines. This investigation aimed to the possibility of utilizing available softwood chips to produce MDF with naturally authentic lighter-colored appearance.

In this study, mixed softwood chips and hardwood chips were used because they are commercially available for producing the wood-based composites in East Canada. Wood fibers with moisture content of 5.5%, were mixed with urea formaldehyde resin and wax emulsion. The target boards with a thickness of 4.0 mm and a density of 870 kg/m^3 were produced in a continuous hot-pressing line at a temperature of 140 ºC and a speed of 36 m/min. All the produced panels were evaluated visually for the variety in appearance (darker or lighter), and then were tested to determine the physical and mechanical properties as follows: vertical density profiles, internal bond strength, modulus of elasticity, modulus of rapture, thickness swelling and water absorption, according to standard methods specified by ASTM D1037 "Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials". In addition, some MDF panels were tested to evaluate the value of formaldehyde emission based on the standard designed by Composite Panel Association.

The tested results showed that the MDF panels made with mixed softwoods appeared to be lighter-coloured surfaces in comparison with darker-coloured panels made from hardwoods. The values of formaldehyde emission from panels made with softwoods were lower than quality control limited index, indicating these MDF boards can be used for interior decorative materials with no potential harm to humans. In addition, all the physical and mechanical properties tested for panels made from softwoods were higher than required quality limited values, indicating they are qualified to meet marketing requirements. Therefore, this investigation demonstrates that the available softwood chips can be effectively utilized to produce environmentally friendly lighter-coloured MDF products for indoor uses, and this processing option can also reduce the potential processing costs used for applying painting or overlaying on dark-coloured MDF products.

For more information please contact Dr Chen Huang, UNB Wood Science and Technology Centre, at chen.huang@unb.ca.

Research in Cupping and Checking of Wood Decking Boards

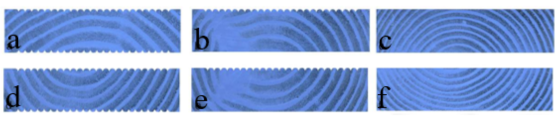
Wooden boards widely used for residential decking with a huge market valued at nearly $7 billion annually in the United States only. However, wooden decking boards are currently losing the market to wood-plastic composites because of the higher cost of maintaining and less weathering resistance as they could be distorted and discolored outdoor with more cupping, checks, and other physical defects due to surface stresses generated by moisture changing, swelling, and shrinkage. Different ways were recommended in previous studied such as saw kerfs or grooves machining of decking boards to minimize the defects in wooden decking boards. Surface profiling is another machining process using profiles with different geometries and designs to reduce cupping, checking, and other possible physical defects.

The main objective of this research was to find a practical solution to significantly reduce the cupping and checking of profiled decking boards using double-sided profiling. The effect of different profile type (Flat, single, and double-sided), wood species (Douglas fir, western hemlock, and white spruce), and growth ring orientation (concave and convex) tested on cupping and checking of ACQ treated decking boards. The results showed a significant difference in the cupping of profiled decking boards made of different wood species as Douglas fir showed less cupping than white spruce and western hemlock. Also, double sided profiled decking board with concave growth ring orientation showed less cupping and checking than convex growth ring orientation after 6 and 8 months of outdoor exposing at the FPInnovations test site in Vancouver, BC.

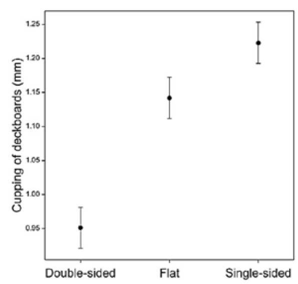
The effect of experimental variables on cupping of profiled decking boards during 1 to 6 months of drying and after treating board with ACQ and drying (8 months) presented in the following table.

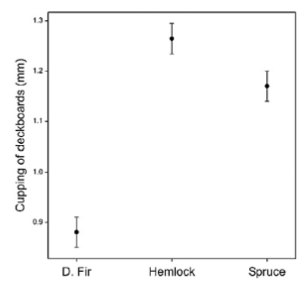
	Cup profile type (mm)			Cup species (mm)			Cup growth ring (mm)	
Time (months)	Double	Flat	Single	Douglas fir	Western hemlock	White spruce	Convex	Concave
1	0.42^a	0.41^a	0.57^b	0.56^a	0.403^b	0.442^b	0.48^a	0.46^a
6	1.40^a	1.41^a	1.58^b	1.44^a	1.46^a	1.50^b	1.48^a	1.45^b
8	1.50^a	1.61^b	1.72^c	1.61^a	1.58^a	1.64^a	1.59^a	1.63^a

Values within each factor that share the same superscripted letter are not significantly different ($p > 0.05$); values with different superscripted letters are significantly different according to Fisher's least significant difference test ($p < 0.05$).



Combinations of profile type and growth ring orientations
(a) Double-sided profile, convex growth rings; (b) Single-sided profile, convex; (c) Flat profile, convex; (d) Double-sided profile, concave; (e) Single-sided profile, concave; (f) Flat profile, concave





In conclusion, profiling the underside of profiled decking boards could create a balanced double-sided board and significantly decrease the cupping of profiled decking boards with average of 1.5 mm ($p < 0.001$) after 8 months of weathering compared to flat and single-sided profiling with 1.61 and 1.72 mm, respectively. Double sided profiling could also control the developing of checks at the surface of boards and reduce the number of large checks in profiled deck boards that were mainly located in profile grooves and hard to see with naked eyes. The author suggests you read the full text of this research study to find more detailed information about the specified measuring process and further results.

This research was undertaken by UNB Master's student, Mr. Sina Heshmati (Sina.Heshmati@unb.ca), and his industry supporters under the supervision of Dr. Prof. Philip D. Evans. Sina was a then research assistant with the University of British Columbia.

Research at UNB the WSTC Life Cycle Analysis (LCA): A Tool to Address the Impact of Non-Residential Buildings on Climate Change

Buildings and construction account for 36% of the planet's total energy consumption and nearly 40% of direct and indirect CO2 emissions. Architects, engineers and builders are becoming increasingly aware that wood-based building materials such as mass timber products consume less energy and emit less greenhouse gases and pollutants over their life cycle than do other building materials such as steel and concrete.

The previous issue of this quarterly newsletter included a short article on a UNB WSTC research project that had just been awarded financial support by the New Brunswick Environmental Trust Fund (ETF) for 2020. The project is now underway, and it will focus on Life Cycle Analysis (LCA) as a tool to identify the impact of non-residential buildings on climate change, with the specific objective of generating first-hand data to address environmental issues from the perspective of building and construction.

The project will use an LCA software tool to *"… evaluate environmental impacts at all stages of the building process, from building material production to transportation, construction, to the end of building life, and to relate these with category indicators such as global warming potential, acidification potential, eutrophication potential, ozone depletion potential, fossil fuel consumption and other factors."* A two-phase work plan is proposed:

- Phase one focuses on compiling life-cycle inventories, collecting and synthesizing information on materials, energy, water use, etc. at various points in the building life cycle.
- Phase two will upload the information collected into **Athena Impact Estimator for Buildings** (IE4B), a Canadian open-source software tool that will be the project's

main research base. IE4B will enable the construction of a database of environmental footprint profiles of buildings throughout their life cycles (see www.athenasmi.org). IE4B is compatible with all major types of commercial construction and renovation technologies used in North America, and can model more than 1,200 structural and envelope assembly combinations, allowing for quick and easy comparisons of multiple design options.

Through the project, collaboration will be ongoing with UNB's Department of Facilities Management and Office of Sustainability. Direct communications will be maintained with the Athena Sustainable Materials Institute in Ottawa, which will provide expert technical input and support as required. Ongoing dialogue with the US Department of Agriculture Forest Products Laboratory (USDA-FPL) will be expanded and enhanced, and the UNB WSTC project team will work closely with the USDA's Economic Statistics and Life Cycle Assessment Unit.

The proposal defines the scope of this LCA as *"… an assessment of the material effects of structure, envelope, and interior partition assemblies and operating energy and water use during a 60-year period modeled by the Athena Impact Estimator for Buildings."* The project plan identifies five buildings on the UNB Fredericton campus as candidates for the LCA research: the IUC Forestry Building, the Forestry and Geology Building, the Richard J. Currie Center, the new Kinesiology Building and the Old Arts Building. The Old Arts Building (now officially named Sir Howard Douglas Hall) will present an interesting LCA challenge: it was built in 1829, with a third storey added in 1879; it is a National Historic Site, and the oldest university building still in use in Canada

Project activity is reported to be about 30% complete as of early November 2020. Virtual meetings have been held with USDA LCA researchers and specialists. Collection of energy and water use data on the five buildings is complete. Training sessions on using Athena IE4B software are ongoing, and life cycle inventory databases are under construction. Material take-offs on exterior walls, floor plans and rooftops are in progress, and architectural and structural drawings have been acquired for four of the buildings.

Sustainability has become an important factor in the commercial construction sector. With this increasing awareness, wood and wood-based building materials are poised to take market share from steel and concrete, but this will only happen if the appropriate information is communicated to construction industry decision-makers. One of the important outcomes of this project will be to provide UNB WSTC with a base level of experience and expertise with LCA issues and applications, transferrable knowledge which will benefit the architectural and commercial building sector in Atlantic Canada. This will enhance UNB WSTC's profile in promoting green building technologies and concepts generally.

Support for this project is provided by the NB Environmental Trust Fund. Project completion target date is March 1, 2021. For more information contact Ms. Wanrong (Amber) Zhu at 506-452-6132 or wzhu1@unb.ca.

The UNB Wood Science and Technology Centre is a self-sustaining applied research and development centre, under the administration of the UNB faculty of Forestry and Environmental Management, that services the value added wood products, wood construction innovation, and non-timber forest bio products industries in Atlantic Canada. For information about the testing and research services offered by the centre, visit us at www.unb.ca/wstc and see our twitter page @UNBWSTC and our LinkedIn page here: https://www.linkedin.com/company/unb-wood-science-and-technology-centre/