

IMPACT

2015-2016 REVIEW OF ACTIVITIES

ADVANCED
BUILDING SYSTEMS
**PUSHING
THE LIMITS
FURTHER**

LIGNIN: GETTING
BIG FROM SMALL

COPING WITH
COMPLEXITY ALONG
THE FOREST VALUE CHAIN

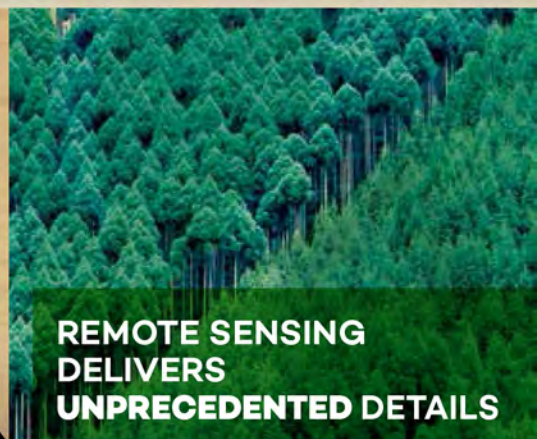
HELPING SMALL AND
MEDIUM ENTERPRISES
GROW BIGGER



**FUELLING
THE GROWING
BIOECONOMY**



**FPINNOVATIONS'
INDIGENOUS
FORESTRY PROGRAM**



**REMOTE SENSING
DELIVERS
UNPRECEDENTED DETAILS**



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EDITORIAL

COLLABORATION IS MUCH MORE THAN JUST A BUZZWORD. IT IS THE KEY INGREDIENT TO SUCCESSFUL RESEARCH OUTCOMES.

FPIInnovations is very pleased to present the 2nd edition of IMPACT, a review of some of our most exciting projects of the past year.

Your positive feedback for our inaugural issue encouraged us to continue with this format. I am confident you will be equally excited by the quality and incredible potential of the projects presented.

I think it is fair to say the forest sector is at a crossroads. Without abandoning its traditional product mix, it is reaching into market and product areas never before thought possible. The past year FPIInnovations signed agreements with the energy, natural food additive and genomics sectors, and we expect the list to continue growing as the world discovers the many advantages and possibilities of wood fibre and its derivatives.

A common thread found throughout all of these agreements is collaboration.

Collaboration is much more than just a buzzword. It is the key ingredient to successful research outcomes. Whether it is for global projects across industry sectors such as those described above, or a regional forestry project helping a single mill in a single community, collaboration among stakeholders results in better solutions faster.

There is no shortage of solutions during the past year that demonstrate the strength of this approach. In Nova Scotia we collaborated with Innovacorp, an early stage venture capital company, and government and industry partners to study the feasibility of a biorefinery in the province. We also worked with Laval University in Québec City to recreate a frozen Alberta pavement environment to determine more precise thresholds for Alberta's Winter Weight Premium program. In Ontario, our work with the Pikangikum First Nation, in collaboration with the Business Development Bank of Canada, and supported by our federal and provincial partners, continued to move that community toward successfully implementing a viable business in the forest economy. In Alberta, we worked with a member company



TERRY KNEE

Director, Communications FPIInnovations

and NORAM, a renowned engineering design firm, to produce commercial lignin from the black liquor stream of a pulp and paper mill. And in British Columbia, we launched the first-ever "ARCTIC Challenge" with the Foresight Cleantech Accelerator Centre to elicit proposals from cleantech innovators on solutions to current environmental challenges in the sector.

Collaboration is at the forefront of everything we do—it's in our DNA. And as our research team develops new ideas to expand the Canadian forest sector's reach into growing market areas, it is this sense of collaboration that will lead us and the industry to greater levels of success.

**IT IS THIS SENSE OF
COLLABORATION THAT
WILL LEAD US AND
THE INDUSTRY TO
GREATER LEVELS OF SUCCESS.**



BIOMASS

HELPING FUEL
**THE GROWING
BIOECONOMY**

Use of forest biomass has increased significantly in recent years, supporting the growing bioeconomy across Canada. Traditional forest products companies have invested in increased use of biomass for steam and energy generation, the pellet sector has grown significantly and some independent power producers use biomass as their feedstock.

FPIInnovations has helped drive this trend through long-standing research on technologies, equipment and harvesting systems. A key objective has been to improve the efficiency and bring down the cost of recovering biomass in the form of residual fibre that would otherwise be left behind in the forest or burned.

This has been an especially high priority in British Columbia, where there's strong motivation to tap into additional sources of fibre as the large supplies from mountain pine beetle-impacted areas decrease.

Over the past year, FPIInnovations was part of a group—consisting of the primary and secondary forest industries and other stakeholders—that aimed to increase access to residual fibre.

FPIInnovations helped facilitate recommendations to the B.C. government that resulted in a new provincial Fibre Action Plan released in September 2015.

Key among the identified actions is establishment of protocols and guidelines to ensure efficient removal and utilization of residual fibre. Operational guidelines that FPIInnovations has developed will be supplemented later this year with more detailed documentation to provide practical direction on integrated harvesting systems.

Gordon Murray, executive director of the Wood Pellet Association of Canada, says FPIInnovations' involvement was extremely helpful in facilitating the discussions that led to these guidelines. "They brought a lot of expertise and credibility, and were all about getting to a solution," he says. Cooperation between forest licence holders and residuals' users has improved, Gordon adds, resulting in more certainty for his members on the "paramount issue" of fibre supply.

Integrated harvesting systems involve planning the harvesting process to ensure residual fibre remains clean and dry, and is stacked in such a way that it can be efficiently collected on a subsequent pass, after which the residuals are commonly chipped on site using mobile equipment. Good communication between primary harvesters and secondary users helps maximize recovery efficiency and keep costs down.


FPIInnovations is also working with industry to find ways of bringing more fibre out of the forest to manufacturing facilities, such as leaving the tops on stems when this can feasibly be done.

The end result of all this will be better and more cost-effective fibre access for the varied operations that now rely on residuals. Additional benefits will include increased economic value generation from the same harvested area, fossil fuel displacement, and improved local air quality as slash burning is reduced.


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ENERGY PRODUCTION GETTING THE MOST FROM BIOMASS

In addition to working with stakeholders to help get more biomass out of the forest (see previous article), FPIInnovations also works with client companies to help them capture the full energy potential of biomass once it's in the mills.



The resulting reduction in natural gas use at this mill is estimated to represent an annual benefit of close to \$3 million.



The Process Engineering Group typically performs several projects each year to improve the efficiency and environmental performance of biomass boilers. The power produced in these complex combustion units is used at mills, reducing their fuel costs, and sometimes sold to provincial electricity utilities. Since biomass is a carbon-neutral energy source, the power generated can often be sold at a premium.

But use of biomass is a precise exercise, and companies are often challenged to achieve designed boiler firing rates and targeted energy production levels, while remaining within permitted limits for particulates and other emissions.

FPIInnovations has benchmark operational data, specialized instrumentation and equipment, and experience and expertise that can be deployed to identify key constraints such as fuel and air distribution in boilers. Each assignment it takes on is unique and effectively a research project unto itself, says Process Engineer Research Manager, Douglas Singbeil.

Resulting operational improvements are verified and typically substantial. One recent project involved challenges with a recovery boiler, in which power is produced using biomass by

products from the pulping process. The newly installed boiler was not firing at the designed rate and consistently required supplemental use of natural gas.

Analysis and mill trials conducted by FPIInnovations brought the root causes to light and improved the firing rate for the boiler by more than 30 per cent. The resulting reduction in natural gas use at this mill is estimated to represent an annual benefit of close to \$3 million.





REFINING A VISIONARY BUSINESS CASE IN **NOVA SCOTIA**

The idea of a major biorefinery in Nova Scotia is part of an ambitious vision for the future of the province and its natural resource sector. FPIInnovations, along with consulting firm BioApplied, is playing an important role in testing the viability of this prospect, as participants in the Nova Scotia Innovation Hub Initiative.

Key stakeholders involved in the initiative are the provincial government, Atlantic Canada Opportunities Agency and Innovacorp. These organizations bring a diversity of expertise and knowledge, yet they are united by a common goal of helping build a biorefining industry in Nova Scotia.

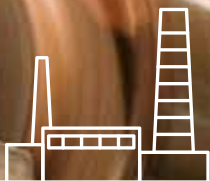
Year 1 program activity kicked off last July, focusing on answering the foundational question of what the value proposition for such a facility should be. It was important to carefully consider this question in order to chart a successful path forward for biorefining in Nova Scotia.

Numerous studies and other activities are being pursued to arrive at a well-supported answer, with FPIInnovations leading several of the major research projects. They include:

- ✦ an assessment of feedstock availability, both from forests and other sources;
- ✦ opportunities to improve capacity and output from the forestry supply chain;
- ✦ opportunities to transport raw materials more efficiently;
- ✦ opportunities for biofuel products to displace fossil fuels; and
- ✦ scenario-based modelling to determine fibre availability and best opportunities to optimize benefits along the forest value chain.

Depending on the findings coming out of the value proposition process—and early indications are promising—Year 2 program activities will involve more concrete efforts to develop a biorefinery business case and to begin to communicate it to potential investors.

The ideal outcome would be the construction of a biorefinery in Nova Scotia within the next few years. Such a facility would provide an important part of the foundation for a healthy, sustainable and prosperous provincial natural resource sector.



SMALL AND
MEDIUM ENTERPRISES

**HELPING SMALL
AND MEDIUM ENTERPRISES**

**GROW
BIGG**



NEW FPIINNOVATIONS ASSOCIATES PROGRAM

In November 2015, FPIInnovations launched the FPIInnovations Associates program, a new concept aimed to better serve small and medium-sized enterprises (SMEs). This program, a one-stop hub for wood products manufacturers, is designed to support SMEs by offering an affordable partnership option with FPIInnovations. The program is accessible to all companies from the wood products manufacturing sector that have less than 500 employees.

In 2015, there were approximately 9,000 SMEs in the Canadian secondary and tertiary manufacturing sectors, of which 80% have fewer than 10 employees. Although they represent a significant number, these businesses must deal with small budgets and capacity issues which make it difficult for them to get the support they need.

FPIInnovations Associates are offered networking events, training activities, strategic information, technical articles, information on funding, links to industry sites, webinars and workshops, as well as limited access to industry advisors. They also have access to a newsletter, reports and online publications targeted toward SMEs, all for an annual fee of \$500. For participants, the benefits are immediate! The program also recently launched a business benchmarking tool to help these companies identify areas for improvement to better position themselves within their sector.

FPIInnovations is very pleased with the positive response that the program received within the first few months of its launch. As for FPIInnovations Associates, they benefit from access to services that would otherwise be costly or difficult to source.

BUSINESS SKILLS WORKSHOPS FOR FOREST CONTRACTORS

For the past three years, FPIInnovations has been delivering a one-day workshop addressing a variety of formal business and operational skill sets required to run a successful logging business. The goal of this workshop is to introduce contractors to the Continuous Improvement (CI) process, and help them identify early opportunities for improvement within their operations.

Workshop participants are challenged to look at how they address such diverse issues as machine maintenance, financial management, machine utilization, fuel management and machine productivity. To achieve this complex task, they are introduced to DiagFor, a CI tool designed by FPIInnovations that helps simplify this analysis. As a backdrop to the process, they are shown methods, practices and concepts employed by top-performing contractors. In addition, participants are exposed to some of the latest research results pertinent to operating a logging business.

The workshop is quite popular among companies and entrepreneurs across Canada. Participants' comments, along with the fact that the post-workshop discussions often continue well past the scheduled end time, indicate contractors are both engaged and eager to learn—two key elements to making positive change. Frequently, participants go on to request a formal diagnostic and benchmarking analysis from FPIInnovations, thus obtaining an independent third-party assessment of their operations...but that's a whole other story.



HEALTH AND SAFETY PROGRAM SAVES MONEY

L & M Wood Products Limited, a Saskatchewan-based company with a sawmill, post plant, planer, firewood processor, and chromated copper arsenate (CCA) pressure treatment plant, offers a great example of a successful collaboration with FPIInnovations.

Over the last 18 months, the enterprise had asked FPIInnovations' industry advisors for help to implement an improved safety program for its employees to reduce claims related to injuries and incidents at work. According to Trinda Delainey, Office Manager at L & M, "FPIInnovations provided methods that helped us strategize against weaknesses, build confidence with our strengths and solve major problems."

With the help of the industry advisors who acted as facilitators, L & M noted a significant reduction of lost time and productivity from claims and incidents at work, which translated into cost savings of nearly \$35,000 over the last year. In addition, there was a 50% reduction in accidents, incidents and lost time. This reduction would not have been achievable without the help of FPIInnovations. "If left to reduce this on our own, we would have realized only a 20% reduction, which is in line with the industry standard. But, more importantly, we have positively affected our company safety culture by keeping employees engaged and sustaining the improvements realized to date. This is a win-win for the management and the employees of L & M," adds Delainey.



PROVIDING CONTINUOUS IMPROVEMENT TECHNIQUES TO INCREASE COMPETITIVENESS

During the year, many SMEs across Canada worked with FPIInnovations to focus on improving their business. Specifically, these wood products manufacturing companies focused on implementing new ways to transfer best practices in manufacturing to their employees as well as developing products for new markets.

While a large number of SMEs were already sold on the potential benefits offered by implementing Continuous Improvement (CI) initiatives in their operations, their enthusiasm dissipated as time progressed and new issues needed to be addressed. To support their efforts, FPIInnovations introduced a simple, structured approach to businesses to ensure their investments in CI initiatives do not get sidelined. The strategy serves as a roadmap to ensure that CI investments are directed effectively, that employees are engaged, and that companies move forward quickly and successfully. And it works: decreased lead times, improved margins and quality, less employee turnover, increased floor space, and improved inventory management are some of the benefits of using CI techniques.

A perfect example of successful CI implementation was given by STOR-X, a British Columbia-based company that produces organizing systems. With the help of FPIInnovations, STOR-X experienced a 50% reduction in lead times, greater than 50% increase in capacity, and improved quality and margins—all out of the same manufacturing space—by properly applying CI techniques. Employee engagement proved positive as many of them contributed to the process.

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INDIGENOUS

FPIINNOVATIONS' INDIGENOUS FORESTRY PROGRAM

SUPPORTING ECONOMIC GROWTH OF COMMUNITIES

In 2007, FPIInnovations launched a forest sector technical support program in British Columbia with the goal of enhancing economic conditions and employment opportunities in Indigenous communities. The program provides technical support for developing new, or enhancing existing, forestry and wood products businesses. FPIInnovations' advisors conduct on-site needs assessments within these communities and help the leaders develop a customized approach that will help them achieve their economic and social goals while maintaining alignment with their traditional and cultural values.

This year, FPIInnovations engaged with 44 Indigenous communities in British Columbia and Alberta. It contributed to the creation or enhancement of 17 businesses or programs that resulted in capital investments of \$680,000 and 62 employment opportunities for community members.

The successes of this program are numerous. An example of a major success in B.C. this past year is the "Opening Doors" program.

Since its launch in B.C., this program has supported Indigenous communities create or enhance 54 forestry-based businesses, resulting in over \$2.4 million in capital investment and contributing to the creation and maintenance of 220 direct and indirect jobs. In 2014, the program expanded to support Indigenous communities in Alberta. In recent years, FPIInnovations also provided services to Indigenous communities in Saskatchewan, Manitoba, Ontario, Yukon, and Northwest Territories.



MERGING INDIGENOUS ART FORMS, THE FOREST SECTOR AND ACADEMIA

The Opening Doors exhibition, presented last October in Vancouver, B.C., was the culmination of an innovative and inspiring project for a new generation of young Indigenous artists from 10 British Columbia coastal communities and one community in Yukon. The exhibition featured doors, skillfully carved, from B.C. western redcedar and yellow cedar that were harvested primarily from Indigenous lands. Designs were unique and embraced the culture and storytelling nature of their traditional art.

In collaboration with the Emily Carr University of Art and Design, the Centre for Advanced Wood Processing at the University of British Columbia, and the Freda Diesing School of Northwest Coast Art, the Opening Doors program focused on the artistry and design of traditional Northwest coastal art through the offering of a unique educational program and the promotion of Indigenous coastal communities and artistic talents.

During a four-week intensive program, Indigenous artists were offered instruction and mentorship on tool use, form line and design, scale-drawn design, and finishing techniques from senior carvers. They also had the opportunity to explore innovative ways of reproducing the door panels through the use of computer numerical control (CNC) technology. The hand-carved originals and the CNC-carved limited editions will be offered for sale domestically and internationally for high-end housing and commercial buildings.

Opening Doors provides a niche product and income to Indigenous artists. Beyond the economic impact, the program also exemplifies the potential of accelerating innovation and enabling partnerships among Indigenous communities, colleges and universities, governments, and industry. Currently, FPInnovations is working on the development of a detailed business plan for the artists and their communities, including initial marketing activities.

PILOT PROGRAM IN ALBERTA

A two-year pilot program in Alberta continued to provide examples of successful engagement with Indigenous communities.

FPInnovations engaged with 14 Indigenous communities. This engagement resulted in the development of 10 projects that provided technical advice and expertise.

A diverse range of projects was established with community leaders that focused on market analyses, economic feasibility analyses for bio-energy and log homes, operational and technical evaluations, resource assessments, skills development, and knowledge exchange. As a result of these efforts and the hard work of each of the communities, two sustainable businesses and programs were enhanced or developed last year that resulted in employment opportunities for 17 community members, capital investment by Indigenous communities of \$560,000, and economic benefits of \$235,000. In addition, two mutually beneficial working partnerships between established forestry companies and Alberta's Indigenous communities were fostered.

FPInnovations expects that these benefits will increase as Indigenous businesses and programs are established or modified based on the technical support provided.



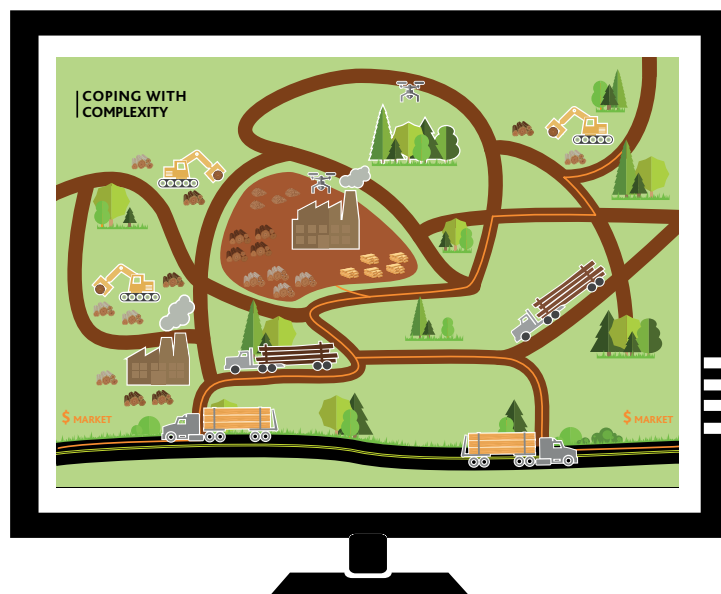
HIGH-TECH
SOLUTIONS

HIGH-TECH SOLUTIONS

The Modelling and Decision Support Group offers a more holistic approach aimed at improving the entire profitability of an industrial network, from forest to market.

HELPING MAKE CHALLENGING DECISIONS ALONG THE FOREST VALUE CHAIN

The value chain of the forest industry extends from the forest to the customer with many players involved, making it difficult to make clear decisions along the way. Fortunately, FPInnovations has numerous software solutions to help the stakeholders in the decision-making process by efficiently managing and optimizing activities.



IMPROVING WOOD YARD EFFICIENCY

The wood yard is the hub of the forest-to-sawmill process, but the many managerial aspects that need to be considered can make it difficult to efficiently operate.

FPInnovations is currently developing tools and services to cover operational aspects such as yard simulation, analysis and audit, machinery utilization, road engineering and surfaces, remote sensing, and moisture control. The scope is to provide efficient sorting and storage at the mill, reduce seasonal impacts, determine the type and quantity of mobile equipment to use and the appropriate wood yard design. Better integration of wood yard activities could lead to direct cost savings of up to \$200,000/year, with a reduction of over 15% of handling travel time.

POWERFUL SUITE OF TOOLS

Among the solutions offered to the forest sector, FPInnovations has developed a comprehensive suite of software and electronic tools capable of spatially analyzing many aspects of the value chain to improve forest operations' decisions with regard to transportation and transformation. This innovative approach links the market value of wood products to processing and forest operations' costs to allow spatial tactical planning decisions to be driven by value rather than cost.

FPInterface, Optitek, WoodValue, ForestPlan, and other customizable optimization tools are designed to assist planners make decisions such as determining which cutblocks to harvest, where to allocate logs based on supply and sawmill configurations, and the impact on the supply chain. They also provide the ability to run "what-if" scenarios to generate valuation information.

These tools can also help select the best harvesting sectors in a timber sale bidding process, determine improvement potential in transport and road networks, and react to broader issues like analyzing the impacts of natural disturbances over time to prioritize forest operations' activities. Tools such as ForestPlan can customize solutions based on processing capabilities to allocate the right wood to the right mill at the right time, therefore providing optimized solutions to increase the profit margins.



BIOPRODUCTS
WHEN
CHEMISTRY
BECOMES
GREEN!

The recent focus on the environment, sustainability and clean technology has led to an increased demand for products made from renewable and biodegradable biomass feedstocks—for which Canadian forests are an extremely abundant source. Through research and development, these products are increasingly being used as alternatives to traditional fossil fuel-based products such as fuel, plastics, solvents, automobile components, and food additives.

FPIInnovations quickly positioned itself as a global leader in the field with research programs aimed at maximizing the value of biomass in its many forms. It has worked closely with members on projects ranging from cellulose nanocrystals (CNC) to cellulose filaments (CF) to lignin production, resulting in the construction of pre-commercial demonstration plants and the development of new green products. From those platforms, FPIInnovations is looking to the future and pushing the envelope to develop the next exciting opportunities and further enhance the value of the work accomplished to date.

Through research and collaboration agreements, FPIInnovations is pursuing its primary objective to support members with cutting-edge innovations that lead to market applications and reduce environmental impacts.

OIL AND GAS AND FOOD INDUSTRIES COURT THE FOREST SECTOR

Bioproducts were at the centre of innovative collaboration agreements in 2015. Schlumberger, the world's leading provider of technology for drilling, production, and processing to the oil and gas industry and operating in more than 85 countries, invested in CelluForce in 2015 to explore the potential of wood-derived CNC for use in oil and gas well production. CelluForce, a joint venture between FPIInnovations and Domtar, operates the world's first large-scale CNC plant in Windsor, Quebec.

FPIInnovations also signed a strategic partnership with Naturex, a European company specializing in plant-based natural ingredients. The agreement provides for the development of active molecules derived from Canadian forest biomass for applications in the food and cosmetics industries. Development of successful applications will open entirely new markets for the Canadian forest sector.

DISPERSING AND DRYING OF CF

The innovative cellulose filaments (CF) are a revolutionary green material extracted from wood fibres that can dramatically improve pulps, papers, bioplastics and other composites. CF is produced and shipped to end users as a semi-dry product at consistencies of 30% or higher. To achieve full reinforcement potential and use by the client, the high-consistency wet CF must be dispersed by the end user, to the consistency required for each application. FPIInnovations developed methods to efficiently disperse CF and monitor the quality of the filaments in the dispersions. These methods were scaled-up by conducting over 20 industrial dispersion trials, and the technology was then transferred to interested member companies.

While shipping CF in a wet product is one way to transport it to the end client, it is not cost-effective since the weight of the wet product adds to the cost of shipping the CF. To alleviate this problem, FPIInnovations' researchers successfully developed processes to dry and fully re-disperse CF, thus opening the door to innovative applications in many industrial sectors. In fact, not just one, but two practical methods were developed to produce dry CF that can be re-dispersed in water. Patent applications have been filed for both of these processes.

IMPROVING STANDARDS OPENS NEW MARKETS

Experts from FPIInnovations took the lead in the development of new International Organization for Standardization (ISO) Standards this year that are expected to open opportunities for the paper and tissue industries. Included in the improvements is a new standard that will remove restrictions on lignin content. FPIInnovations is also very involved in the activities of ISO Technical Committee 6 - Paper, Board and Pulps and is working on developing standards for cellulose nanomaterials—in particular, the first international standard method for the characterization of sulphated CNC, such as the CNC produced by CelluForce—which was recently unanimously accepted as a new working item proposal.

Participation on these committees also enabled FPIInnovations' scientists to monitor and contribute to the development of new ISO standards for bioenergy and sustainability.

PULP AND PAPER

ENHANCING

PRODUCT

PERFORMANCE

TESTING CAPABILITIES FOR TISSUE AND TOWEL PRODUCTS

Worldwide demand for tissue products is growing and last year FPIInnovations launched a five-year tissue strategy, with an ambitious target to become the top tissue research and innovation center in the world by 2020.

As part of this strategy, FPIInnovations has developed a suite of tissue testing methods and tools to characterize tissue structure and evaluate key performance attributes such as softness, water absorption and uniformity, as well as linting and dusting. FPIInnovations' pulp, paper and tissue testing laboratory can also test the physical properties such as bulk, optical properties, wet and dry strength, and water absorption according to ISO standard methods. FPIInnovations has a full handfeel softness panel and tissue softness analyzer (TSA) and has done a large amount of work to assess their correlation which, is very useful for the mills that have purchased the TSA instruments. FPIInnovations can also provide other testing services including pulp quality and fibre morphology

evaluation, chemical analysis and microscopy/image analysis that can be used to help troubleshoot tissue operational problems and to support new product development and performance enhancement.

Some of the new testing tools have been installed in members' mills to support improvement of their manufacturing efficiency and enhance product performance. These tools have also proven to be invaluable to the mills in the development of new products. FPIInnovations has long-standing expertise and has developed tools for diagnosing and troubleshooting web defects for paper and board grades, which have now been adapted to help identify cost-effective solutions to efficiency issues in tissue manufacturing and converting. This is a critical area for tissue makers, as poor converting efficiency leads to a significant amount of rejects and waste (broke), going back to the paper making system, causing operation and product quality issues.

ENHANCING MACHINE EFFICIENCIES

Monitoring, controlling, and minimizing variations on pulp, paper or tissue machines can significantly improve machine efficiency, with little or no capital investment. For a typical machine (200,000 tons/year), a 1% increase in machine efficiency can bring up to \$1 million per year in savings. Reducing variations on the machine often results in a decrease in customer complaints and significant reductions in raw material and chemical usage that can amount to additional savings of several million dollars per year.

IMPROVING PAPER MACHINE EFFICIENCY FOR LIGHTWEIGHT GRADES

In the last several years, manufacturers of printing and writing papers, and packaging grades have tried to lower the basis weight of their products in an effort to decrease costs. They have found, however, that lower basis-weight papers tend to have lower average strength and exhibit more strength variations, leading to poor paper machine and pressroom efficiencies. The current industry solution to these problems is to add kraft or starch, which increases costs, and often has adverse effects on the papermaking process and on some key paper properties. In trials conducted this year, FPInnovations showed that a more efficient approach is to improve the uniformity of the web by reducing pulp quality variations. The research also demonstrated that adding a small quantity of CF in the furnish significantly increases the strength uniformity, leading to less web breaks on the paper machine and therefore better efficiency.

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REDUCING WEB BREAK FREQUENCY ON PULP MACHINES

Adopting chemistry developed by FPInnovations enabled a member mill to boost drainage and wet-web strength, thereby reducing web breaks and significantly increasing production by 20%.

This achievement was a follow up to a survey conducted by FPInnovations among several members producing kraft pulps, to determine their current and future needs in terms of pulp drying machine efficiencies. The main limiting issues were drying capacity and a high number of wet-end breaks caused by drainage variations, profile non-uniformity, and sheet crushing, especially during grade changes.

This led to laboratory work that identified the presence of shorter fibres and a higher amount of fines as the underlying cause of the drainage and dewatering issues. The results also showed that adding coagulants, a common practice used in the industry to address drainage problems, could worsen drainage and reduce wet-web strength. The elimination of the coagulant from the process along with the adoption of chemistry identified by FPInnovations to boost drainage and wet-end strength, allowed the mill to reduce breaks significantly—resulting in the 20% increase in production.

HELPING OUR MEMBERS

EFFICIENT ENERGY MANAGEMENT INCREASES SUSTAINABILITY OF PROCESS OPERATIONS

With climate change becoming an issue at the highest levels, industry, governments and communities are all making it a priority to “go green.” FPIInnovations has been helping member companies operate in an environmentally responsible and sustainable manner. In fact, FPIInnovations has helped mills save \$1 to \$4 million per year and decrease their environmental impact, through reduction in fossil fuel use and greenhouse gas emissions, and better utilization of plant assets.

Through collaboration with CanmetENERGY, FPIInnovations has developed a unique expertise that combines its deep knowledge of pulp and papermaking processes with novel energy efficiency approaches. Its unique approach towards process integration considers changes in operating conditions and configuration of the process, process variability, energy costs, and the complexity of the multiple system interactions that take place within the water, energy and utility network. As part of the approach, benchmarking is performed and a process and utilities’ simulation is developed. Studies performed at several member pulp and paper mills have identified significant energy and water recovery opportunities, many of which require minimal capital expenditure to implement.

NEAR-INFRARED SENSOR TECHNOLOGY MAY SAVE HIGH-YIELD PULP MILLS OVER \$1 PER TON

Optimizing production while maintaining product quality is a concern for all mills, given the increasingly competitive nature of the high-yield pulp market. Having access to continuous real-time data on pulp bale properties has the potential to enable mills to reach target specifications more quickly, reduce bleaching chemical costs, minimize re-pulping costs, improve troubleshooting of production issues, prioritize laboratory tests, and better segregate final products according to customer needs. In fact, savings for a line producing 350 tons of high-yield hardwood pulp per day have been estimated at about \$1.14 per ton.

Most high-yield pulp mills produce various grades of pulp and therefore experience frequent grade changes on their production lines. Current mill practices to verify product quality rely on the preparation and testing of handsheets. While the use of handsheets is well established, it introduces a significant time lag between the manufacturing and identification of off-grade products, which can result in significant amounts of material being downgraded or scrapped.

FPIInnovations has developed an on-line near-infrared sensor technology that can provide continuous measurement of properties such as bulk, tensile strength, brightness and oven-dry content, without requiring additional staff. The technology is non-destructive, requires no sample preparation, and is much faster than the current practice. Sixteen months of mill trials have been completed which confirmed that the system has the robustness and necessary safety and communications features to be operated in a mill environment.

OPTIMIZING BIOMASS BOILERS IS GOOD FOR THE ENVIRONMENT

The most cost-effective approach to maximizing boiler efficiency is to optimize the fuel and air distribution of the boiler to improve combustion. FPIInnovations’ team conducted trials at one mill and identified operating problems with one recovery boiler caused by excessively high black liquor firing temperature and a poor set-up of its tertiary air system. Results of the recovery boiler trials provided effective solutions to major issues that had remained unresolved for six months—equivalent to a benefit of up to \$13 million per year for the mill. A second mill benefited from FPIInnovations’ boiler expertise by evaluating its recovery boiler firing conditions for total reduced sulphur (TRS) control. The improvement of its boiler operation generated benefits that can amount to \$7 million per year for the mill.

In addition to a positive impact on the environment, the assistance provided by FPIInnovations to its members in optimizing the operation of their biomass boilers has helped them meet environmental regulations, produce more steam from biomass instead of fossil fuels and generate revenue from sales of green electricity.



CORROSION PUTS HOLES IN PLANT OPERATING BUDGETS

Kraft pulp mills are complex chemical plants that operate pressure vessels, tanks and pipes containing hot, corrosive process fluids and gases. Failures due to corrosion put employee safety at risk, and can have a significant negative impact on the mill's operation and profitability. FPIinnovations' Corrosion Group helps mills find solutions to corrosion problems and identify best industry practices for inspection and repair of critical equipment.

Direct assistance provided to the mills includes corrosion monitoring and failure analysis. In addition, extensive research is conducted in FPIinnovations' laboratories, which are equipped with state-of-the-art technology. This allows scientists to conduct electrochemistry experiments in mill-simulated aqueous conditions at high temperatures to identify corrosive elements, and to perform experiments related to gaseous chemical, molten metal and molten salt corrosion.

GROWTH NEEDS INNOVATION.



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GENOMICS FOR
MORE RESILIENT
FORESTS TO
TECHNOLOGIES
THAT IMPROVE
HARVEST
OPERATIONS,
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INTERNATIONAL COLLABORATIONS

INTERNATIONAL COLLABORATIONS FOR INNOVATION

Leaders and organizations acknowledge that advancing their shared objectives is the answer to today's complex and interconnected issues. It's called collaboration and it's a growing global trend.

At FPIInnovations, our vision of creating a world where sustainable forest products contribute to all aspects of daily life means our innovation process demands that our researchers and scientists have the intellectual space to explore ideas. We believe that being innovative involves engaging organizations beyond our own walls. Indeed, we're engaging with domestic and international companies and groups more than ever, both within the industry and across non-traditional markets. We have committed to engage with government, colleges and universities, research agencies and industry stakeholders to foster innovation.

To further this commitment, FPIInnovations has established research partnerships with firms in Europe to promote cooperative relationships and exchanges at the academic, scientific, technical and business levels. Establishing such links abroad helps our research make the leap from the laboratory to society, where it can benefit consumers.

One example is our collaboration with the French firm Naturex, a global leader in the specialty plant-based natural

ingredients sector. FPIInnovations and Naturex will combine their know-how to develop active molecules derived from Canadian forest biomass for food industry and cosmetic applications.

The potential of this disruptive innovation is very promising: with the combination of FPIInnovations' extensive knowledge of the forest industry and expertise in extractable wood derivatives, and Naturex's ability to identify and extract natural active ingredients, the potential of the biomass as a source of specialty plant-based ingredients for food processing and cosmetic applications is tremendous.

Another promising partnership is with the *Centre Technique du Papier (CTP)* in France. This alliance aims to pool the capabilities of both world-class research institutions to non-traditional market applications of cellulose bio-based materials.

FPIInnovations is always ready to explore emerging areas where there are opportunities for further investment and collaboration. This is the idea behind our partnership with

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the *Institut Technologique FCBA* in France, which is active in the forest, wood and furniture industries. Our memorandum of understanding details a framework for information exchange toward developing common research projects, creating synergy between the two institutes, stimulating open exchanges on mutual development and establishing collaborative projects in the interest of both organizations' members and respective forest industries. This alliance will pave the way for global innovations in the areas of tall buildings and end-of-life-management of wood buildings, among others.

Indeed, fostering cross-sector collaboration and bringing stakeholders to the table from outside the forest industry is something we firmly believe in. The agreement with Schlumberger, the world's leading supplier of technology, integrated project management and information solutions for the global oil and gas industry is a shining example. Schlumberger has invested in CelluForce, a joint venture between

FPIInnovations and Domtar that operates the world's first large-scale cellulose nanocrystals (CNC) plant. The partnership with Schlumberger focuses on research towards innovative CNC applications, resulting in game-changing applications that will contribute to every aspect of daily life, which of course includes the oil and gas sector.

Strong partnerships and strategic research alliances are necessary to achieve real solutions. More and more companies are embracing the culture of collaboration to foster global innovation, and this movement is yielding promising results.

Another example is post-tensioned-timber building systems. FPIInnovations signed an agreement with two New Zealand-based leaders in this technology. Under the agreements with Structural Timber Innovation Company and Prestressed Timber Ltd., FPIInnovations has obtained the rights to U.S. and Canada Patents related to development of post-tensioning technology



FPIInnovations has established research partnerships with firms in Europe to promote cooperative relationships and exchanges at the academic, scientific, technical and business levels.

and complete access to all knowledge, research data and reports, thereby placing FPIInnovations at the forefront of post-tensioned-timber systems in North America. This partnership not only accelerates North American adoption, but also promotes cooperative relations at the academic, scientific, technical and business levels, by adopting and adapting opportunities from international sources to support innovation in the global forest sector.

It is indeed very inspiring as what we're seeing worldwide is the coming together of non-traditional partners, and a willingness to embrace new ways of working together.



FPInnovates THINKING

OUTSIDE THE BOX

FPInnovates
Montréal
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2015

INNOVATION &
TECHNOLOGY
Conference

In November 2015, FPInnovations was proud to host the first edition of FPInnovates—a one-and-a-half-day conference that highlighted the importance of innovation in the workforce and the impact of new technologies. Held in Montréal, QC, the event attracted 200 delegates from across the country who were inspired by future change, informed by industry leaders, and educated and energized by innovators.

The conference offered participants the opportunity to hear from renowned speakers and leading international experts, as well as attend a panel discussion addressing important issues on the future of the forest industry. The event featured technical case studies, in addition to 50 posters highlighting the latest progress, successes, and technological advances by FPInnovations, college and university stakeholders, and other innovators.

This unique engaging, and thought-provoking event was aimed at encouraging participants to think outside the box and view the innovation process as a solution to the challenges they are facing.

We are currently planning the second edition of the conference, which will take place in Vancouver, B.C., and will focus on models of collaboration and research. Don't miss it!





Glenn Mason, Assistant Deputy Minister of Natural Resources Canada gave participants interesting food for thought with his presentation entitled **Is Canada's Forest Sector Innovation System Adapting to Global Trends?**

Eric Termuende, Co-Founder and Director at Gen Y Inc. and named one of the top 100 emerging innovators under 35 globally, discussed how the next generation thrives on innovation, change and disruptive ideas.



“INFORM, INSPIRE AND CHANGE THE WAY WE THINK ABOUT INNOVATION AND COLLABORATION IN THE FOREST SECTOR”

Panel discussion on **The Next Big Thing: Future Innovations for a Thriving Industry**, with moderator **Pierre Lapointe, CEO of FPIInnovations**, and participants Kevin

Edgson, President and CEO, EACOM Timber Corporation; David Lindsay, President and CEO, FPAC; Yvon Pelletier, President, Fortress Paper; Daniel Archambault, Executive Vice President, Kruger; and Mark Feldinger, Vice President, Canfor, and Chairman of the Board of Directors of FPIInnovations.



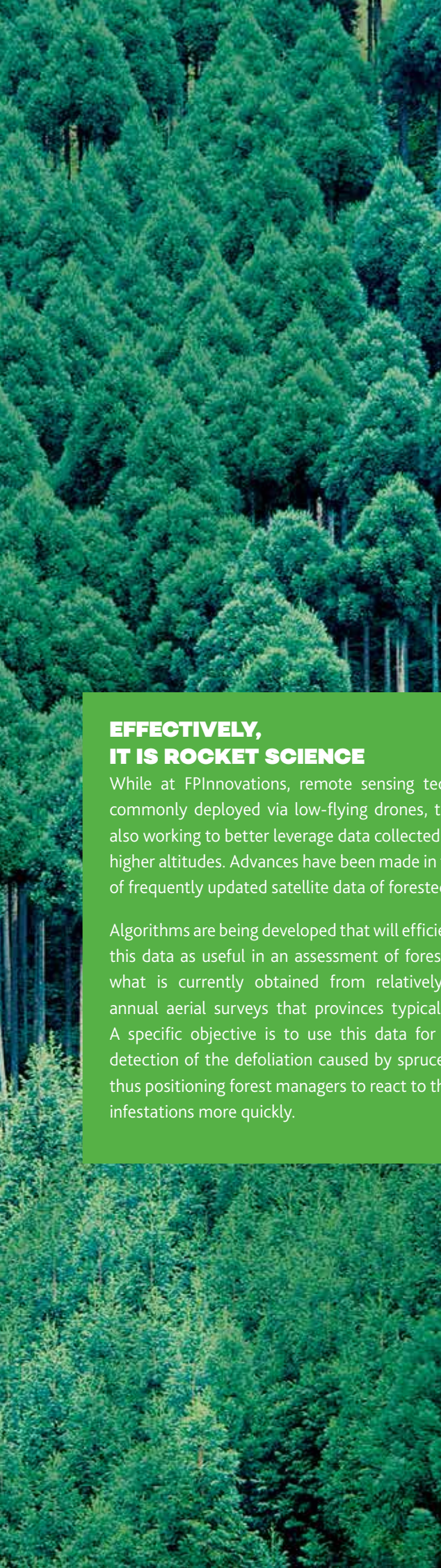


FOREST
OPERATIONS



CENSUS VS. SURVEY

REMOTE SENSING DELIVERS UNPRECEDENTED DETAILS



Seedling by seedling. That's the level of detail on the forest landscape that can now be captured with current remote sensing technology. FPIInnovations' work in this area is opening the door to more precise insights—effectively a census of forest attributes rather than a survey—and is making those insights much more easily and quickly available than in the past.

This work is being undertaken by a recently expanded Responsive Remote Sensing group, which is determining the best combinations of sensing technology and deployment platforms in order to deliver the data needed to meet specific forest management challenges.

Recent work has included continued trials of drones, or unmanned aerial vehicles (UAVs). They are proving adept at capturing data needed across diverse aspects of forest operations, including pre- and post-harvest stand surveys, manufacturing-related metrics such as volumetric mill inventories, and monitoring of hazards such as hot spots from forest fires. The group is also establishing operational guidelines such as optimal flying heights and degree of flight overlap.

EFFECTIVELY, IT IS ROCKET SCIENCE

While at FPIInnovations, remote sensing technology is commonly deployed via low-flying drones, the group is also working to better leverage data collected from much higher altitudes. Advances have been made in the analysis of frequently updated satellite data of forested areas.

Algorithms are being developed that will efficiently render this data as useful in an assessment of forest health, as what is currently obtained from relatively expensive annual aerial surveys that provinces typically conduct. A specific objective is to use this data for early-stage detection of the defoliation caused by spruce budworm, thus positioning forest managers to react to the spread of infestations more quickly.

The use of the technology has advanced so far as to be able to nearly fully replicate what can be collected through much more labourious and expensive ground-based surveys, with reporting on regeneration standards being one particularly promising application among others.

New workflows are being developed for automating data analysis as an alternative to visual interpretation. This is also helping to address challenges that include the inherent flight instability of small craft such as drones, and the need to filter out the "noise," such as slash or snow that obscures seedlings and that shows up when capturing such detailed data. Tree height and stocking levels can be also captured, and work continues to enable determination of species mix.

The robustness of the algorithms still needs to be validated across more diverse stand conditions. However, the potential benefits for a standardized approach are clear, particularly in the context of provincial regeneration reporting requirements.

Access via remote sensing to a detailed regeneration census—identifying issues such as gaps between or clumping of seedlings—will provide a more timely and cost-effective basis for reporting, as well as for subsequent management decisions and results monitoring.

ENHANCING WHAT WE KNOW ABOUT FOREST LANDSCAPES

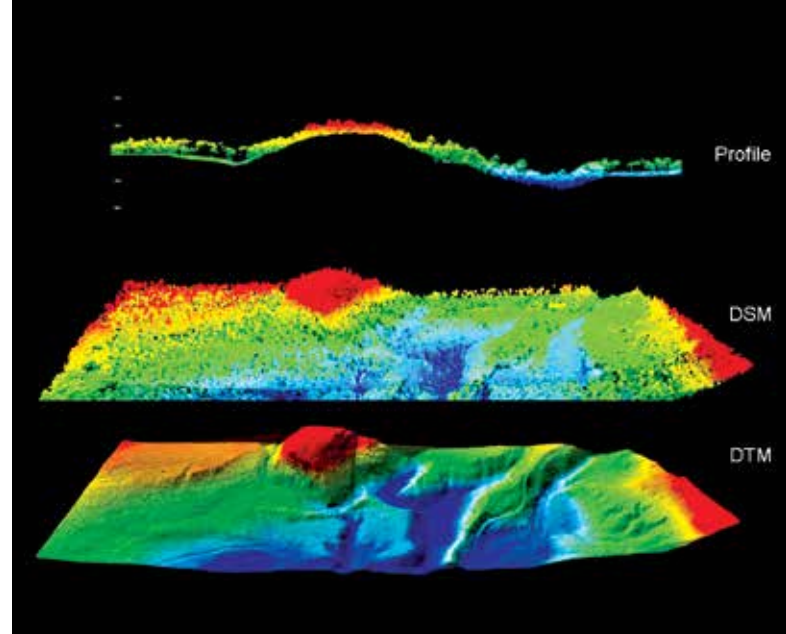
While FPInnovations is working to help industry get more from remote sensing technology (see previous article), existing aircraft-and laser-based surveying practices are already in wide use and expanding across Canada. When combined with ground plot data, they generate valuable enhanced forest inventories.

These inventories provide precise data on the forest landscape typically produced at 20-by-20 metre resolution. The aerial surveys, using LiDAR technology, substantially reduce the “boots on the ground” time associated with forest operations and planning.

The Canadian Wood Fibre Centre, a branch of the Canadian Forest Service, Natural Resources Canada, has been actively developing and promoting adoption of enhanced forest inventories, and Senior Research Scientist Doug Pitt says there’s been strong uptake on operational use of the resulting data and continued momentum towards greater utilization.

New Brunswick, for example, is now in the process of acquiring enhanced inventory data for its entire 6.1 million hectares of forest. Nationally, there has been full or partial implementation across 30 million hectares, with proposals or development work under way for another 50 million hectares.

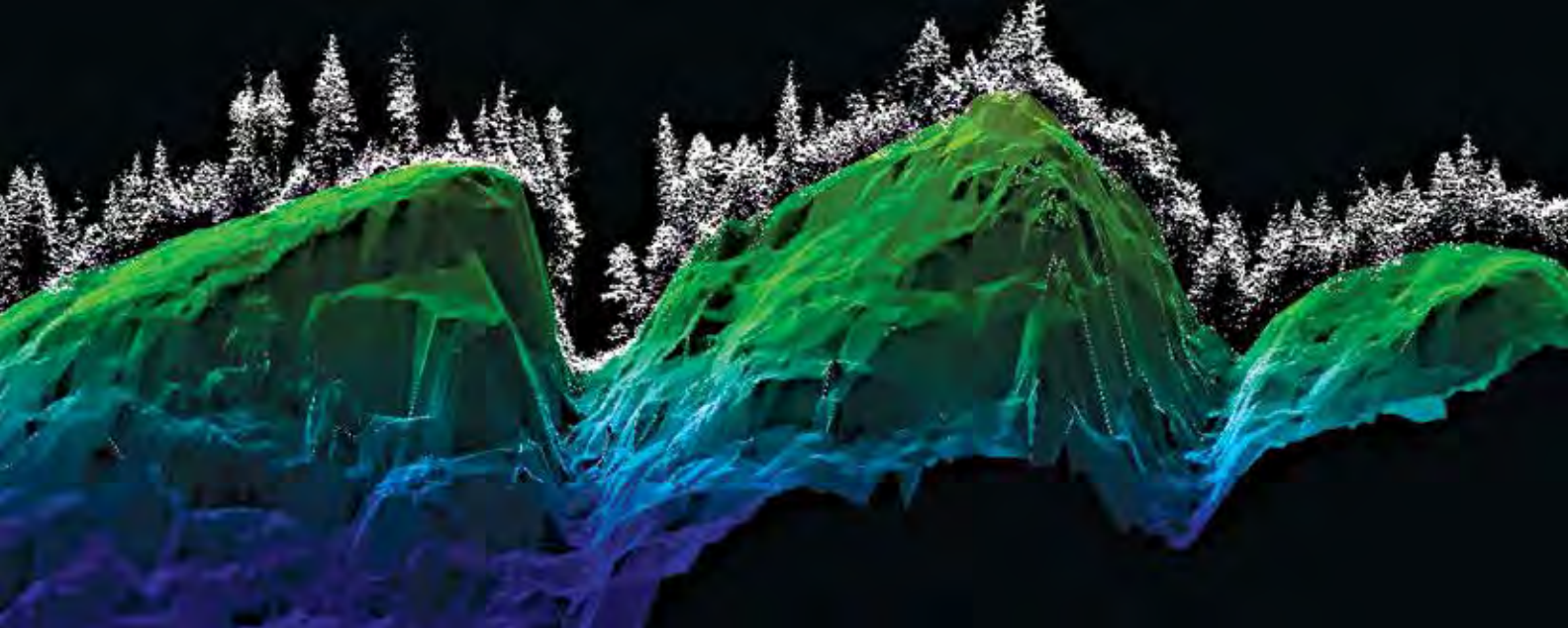
“Enhanced inventories are a game changer,” Dr. Pitt says. “This is not just an incremental improvement in the value of the inventories we have. It’s more like the difference between navigating by compass and navigating with GPS. It has a huge range of potential benefits. We find companies typically identify a couple of specific applications for enhanced inventory data when building their business case, but end up using the data for many more applications.”



Adam Dick, Acting Manager of the Inventory Development Section at New Brunswick’s Department of Natural Resources, says that industry and government are still only scratching the surface, and cites tree species recognition as one way in which enhanced inventories are likely to become even more useful. “As we get better at extracting information from LiDAR, we’ll be able to apply these gains to data already collected and project future conditions,” he says.

Enhanced inventories already provide improved data on characteristics such as terrain and forest structure, and even features of the standing timber such as piece size that inform how it can best be processed in mills. This detailed information supports better decisions on road and harvest planning, avoidance of wetlands and environmentally sensitive areas, and mapping of slopes that represent potential safety hazards, among other areas.

All of that can drive better management outcomes and reduce costs typically by about \$2 per cubic metre of harvested wood. As well, upfront costs of acquiring the necessary data are decreasing. “It’s clearly better and faster, and it’s rapidly becoming cheaper as well,” Dr. Pitt says—a combination that makes the case for adoption all the stronger.



A STEEP INCREASE IN SAFER, MECHANIZED HARVESTING

One of the biggest recent transformations in harvesting practices in B.C. is happening on some of the province's steepest slopes, and is driven in part by an ongoing FPInnovations project. The objective is to dramatically improve the safety of steep slope harvesting, and the solution is ground-based, winch-assisted felling machines which put workers under the protective cover of machine cabs.

While only two such machines were in use in B.C. and the adjacent U.S. Pacific Northwest as recently as early 2015, 100 are expected to be operating in the region by the end of 2016.

Vernon, B.C.-based Tolko Industries Ltd. purchased the first winch-assisted machine to be brought into North America in 2013—a machine that has since operated some 4,000 hours without safety incident. Area Supervisor Ryan Potter

describes this as the “way of the future,” as Tolko looks to maintain both safety and harvest levels while increasingly operating on steeper ground.

FPInnovations is working with industry and manufacturers to test and adapt mechanized steep slope harvesting machines and techniques for use in B.C., thus leveraging technology already developed in other jurisdictions with similar topography. FPInnovations is also collaborating with international partners to develop what may become broadly applicable equipment and safety standards.

Field demonstrations and information sharing through FPInnovations' Steep Slope Initiative website (<http://steepslopeinitiative.fpinnovations.ca>) are helping licensees and contractors build the business case for such equipment. Mechanized ground-based systems are proving efficient at dealing with smaller tree stem sizes, and are more cost-effective and better able to access smaller cutblocks than cable-based harvesting systems.

The Steep Slope Initiative, which was in year one of five in 2015-2016, is intended to achieve a 50% safety improvement, and sustainable access to two million more cubic metres of wood in B.C.



HELPING WESTERN REDCEDAR STAND

THE TEST OF TIME

Improving decay resistance and coating materials are the latest in long-standing efforts by FPInnovations to strengthen the market appeal of western redcedar secondary products. With a warm colour tone, this species is commonly used in siding, decking and other high-visibility exterior applications. It is naturally stable and durable, but when clear coatings are applied to this species it typically requires frequent refinishing.

Recent research is focused on the comparative performance of coating materials, and on the use of light-absorbing chemicals and other potential means of improving the effectiveness of environmentally friendly water-based coatings.

Further research has identified specific chemical attributes, or “extractives”, in western redcedar that create resistance to spore germination on wood products. This research is already being used by the B.C. Ministry of Forests, Lands and Natural Resource Operations to select parent trees for breeding programs, and should ultimately help fend off the major form of decay transmission before it can even establish a foothold.

“This will result in planting trees that are as potentially durable as old growth, by selecting trees that have high extractive content for both standing trees and in wood products,” says John Russell, a research scientist with the ministry’s Tree Improvement Branch. “This will help sustain a \$1 billion industry as it moves from old to second growth.”

Western redcedar represents 30 per cent of the coastal harvest in B.C. And since these are the highest-value logs in the province, its presence often makes or breaks the economic viability of specific cutblocks.



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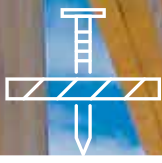


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WOOD CONSTRUCTION





ADVANCED BUILDING SYSTEMS **PUSHING THE LIMITS FURTHER**



It is becoming increasingly easy to notice the growing position occupied by wood in residential and commercial construction. The renaissance of wood construction seems to have taken off with both industry and the general public.

Over the last few years, FPInnovations has devoted significant efforts to facilitate the use of wood as a renewable construction material in larger buildings in terms of surface area and storey height, thereby expanding the share of wood products in the global market. The numerous publications released by FPInnovations from these efforts bring together the expertise of many specialists and collaborators to provide architects and designers with state-of-the-art information, and they are good examples of the many contributions of FPInnovations in the field of wood construction.

FPInnovations is continuing to work towards increasing the use of wood in construction. Participation of its many experts in a large number of international and national committees demonstrates the organization's expertise and involvement in this direction, and the many examples of state-of-the-art, innovative buildings being constructed across the country support this initiative.



TALL WOOD

CONSTRUCTION INITIATIVES

In 2014, FPInnovations launched a comprehensive guide to support tall wood construction, *Technical Guide for the Design and Construction of Tall Wood Buildings in Canada*. The aim of the guide, which was developed with the collaboration of many experts and research groups, was to help designers and builders master the major concepts required for the construction of tall wood buildings and to expand the presence of such buildings in the North American landscape. A few years earlier, this publication followed the launch of *Introduction to Cross-laminated Timber (CLT)*. CLT is a base element in solid wood construction, and a concept that was imported and adapted to Canadian and U.S. codes and standards by FPInnovations.

Interest from provincial governments in wood construction in their jurisdictions has been increasing over the past few years. Changes made to many of the provinces' building codes or regulations are now producing results.

For example, at the University of British Columbia in Vancouver, B.C., the construction of an 18-storey student residence building consisting of a mass timber superstructure atop a concrete base is under way. Tests conducted by FPInnovations on wood structural components contributed to the design of this unique construction.

Once completed, it will be among the world's tallest wood buildings. The Wood Innovation and Design Centre in Prince George, B.C., currently the tallest contemporary wood building in North America, is another good example of a

mass timber tall building built with CLT and based on FPInnovations expertise. FPInnovations research teams also gathered performance data on vibration and sound insulation during construction and after completion, and performed a whole building life cycle assessment for LEED accreditation purposes.

The Province of Quebec is also contributing to the growing list of tall wood buildings in Canada. Québec City's landscape will soon change with the construction of a 13-storey building, the structure of which is entirely made of mass timber, unlike other wood buildings that often include a concrete core. At about 40 metres in height, the building will become the tallest of its kind in North America. In Montréal, an investment of nearly \$130 million will lead to the construction of a huge complex which will become the largest solid wood housing project in the country. The three 8-storey buildings, with a total surface area of nearly 60,000 square metres, will be built with CLT and glulam, based on knowledge and technologies implemented by member companies through FPInnovations' science and research, and now being adopted by numerous manufacturers across the country.

**Helping designers and
builders master the major concepts**



FACILITATING THE CONSTRUCTION OF MID-RISE BUILDINGS

FPIinnovations' latest contribution to the design and construction industry is its *Mid-rise Wood-frame Construction Handbook* that was released in fall 2015. Prepared with the collaboration of over 40 experts in different fields, the handbook covers a broad spectrum of data and techniques to facilitate the construction of wood-frame buildings up to 6 storeys across Canada, as allowed in the 2015 edition of the National Building Code of Canada.

Many mid-rise buildings have been completed or are being built in numerous locations throughout the country. These projects have been facilitated by the changes announced to building codes in several Canadian provinces, thanks in part to FPIinnovations' work and the contribution of its many experts to codes and standards committees.

ENVIRONMENTAL PERFORMANCE OF WOOD CONSTRUCTION

The use of wood in construction is a sound strategy to address climate change as it can significantly help reduce the environmental footprint of construction. Over the years, numerous certification programs have been created to help builders and owners design high-performing buildings.

In response to these programs and in line with established guidelines, FPIinnovations has developed an ISO-compliant Environmental Product Declaration program to help its members in the forest products industry communicate environmental footprint data to clients and the general public. With this tool in hand, manufacturers can help make informed purchasing decisions and increase their competitiveness over other similar products.





IMPORTANT BREAKTHROUGH FOR MIDPLY™ SHEAR WALLS

The Midply shear wall system, jointly developed by FPInnovations and the University of British Columbia, was chosen in 2014 for the construction of a 5-storey elderly care facility in Tokyo, Japan. The system, composed of sandwiched wood-based panels placed between 2x4s, results in walls offering greater structural integrity and dissipation of seismic energy. With a superior resilience to severe earthquakes and extreme winds over standard shear walls used in construction, the wood-frame wall system is an effective solution in buildings where high-resistance walls are needed.

The integration of this wall system into the Japan building code follows several years of collaborative work by Canada Wood, the Council of Forest Industries (COFI) and FPInnovations. This breakthrough in the Japanese construction market provided an opportunity for British Columbia manufacturers to increase their market share in Japan—for example, 30 containers of wood products were shipped to Japan from British Columbia for the project. It is also paving the way for new market opportunities in regions around the world with high seismic activities and extreme winds.

It is estimated that wood-frame construction currently represents over 80% of the market share in North America for buildings up to 4 storeys. As it is rapidly gaining market share in 5- and 6-storey buildings, the Midply shear wall system can play an important part in maintaining and expanding the role that wood building systems play in new construction.

QUEBEC 12-STOREY MASS TIMBER BUILDINGS GUIDE

The recent introduction of innovative, wood-based products and systems allows for the construction of taller wood buildings, therefore expanding the market for this renewable material. From this perspective, the Quebec government published, in August 2015, *Mass Timber Buildings of Up to 12 Storeys – Directives and Explanatory Guide*, a technical guide developed by the Régie du Bâtiment du Québec (RBQ) in collaboration with FPInnovations' experts.

The impact of the guide was immediate: soon after its release, several high-rise mass timber projects were announced in the province of Quebec. According to Frédéric Verreault from Chantiers Chibougamau/Nordic Structures, the member company in charge of the Arbora project, "The guide is very forward-looking and has become a reference tool in numerous countries around the world." Chantiers Chibougamau/Nordic Structures, which introduced CLT products in the province, provided technical data to the writers of the guide.

ENGINEERED WOOD FLOORING: FOCUS ON SUBSTRATE DEVELOPMENT

In recent years, FPIInnovations' Engineered Wood Products Manufacturing team has focused on testing performance properties of substrates used in the manufacture of engineered wood flooring products. The annual Canadian production of engineered wood flooring is estimated at nearly 30 million square feet, while sales for all types of hardwood flooring in the United States totalled \$3.35 billion in 2014.

One of the team's goals was to study the mechanical properties of the different substrate products and to provide an accurate assessment of flooring manufacturing costs. By using FPIInnovations' research results, members were able to shorten the product development phase and make informed decisions to improve the competitiveness of their engineered flooring products.

The research focused on different types of substrates, including medium-density fibreboard, wood strips, oriented strandboard, aspen plywood and specialty substrates. The project also studied the incorporation of innovative sound-absorbing material in the substrate layers. This feature, in addition to reducing the impact sound transmission of installed flooring products, has the potential to shorten the installation time and cost of flooring material in condominiums or multi-storey apartment buildings where sound insulation is required.

Thanks to research performed by FPIInnovations, many of these products have already been commercialized by member companies as a result of the evaluations that were completed. It is also expected that other products will be launched in the near future.

found not to be responsible in these cases. In response to this issue, FPIInnovations developed, with funding from B.C. Housing's Homeowner Protection Office, new test methods capable of identifying several mould-resistant coatings that can provide adequate protection, even under conditions conducive to condensation.

The new test methods, although perhaps only an interim measure, are now being adopted for future building projects. They are helping member companies and stakeholders by supporting the continued use of wood products with increased performance—to provide safe and durable buildings until new moisture management approaches are developed to solve these problems.

WOOD-BASED SIDING: THE ARCHITECT'S PERSPECTIVE

Last year, researchers from FPIInnovations' Appearance Wood Products team, with the help of their colleagues from the Business Development group, conducted a comprehensive opinion survey of architects with respect to exterior wood-based siding. The approach consisted of organizing discussion groups followed by individual interviews to identify the most desirable attributes for such products.

This customer-oriented approach provided valuable information with respect to product performance, preferred sizes and shapes and maintenance requirements. Information was also gathered about consumers' preferences, market trends and the regulatory environment related to the specification of wood sidings. This collaborative work will allow better understanding of market needs and help manufacturers market the most suitable siding products.

Responses from architects were highly valuable to FPIInnovations for determining improvements necessary to meet specifiers' expectations and to better address performance-related code requirements. The architects surveyed also reported being very pleased with the approach as they felt it provided them with an opportunity to have a say in product improvements and new product developments.

MOULD-RESISTANT COATINGS AS A SOLUTION TO MOISTURE PROBLEMS

The durability and performance of materials is an important issue in construction. Therefore, the recent increased awareness of mould growth problems in attics of buildings in damp climates such as those in coastal British Columbia needed to be addressed to maintain consumers' confidence. These wood-frame residential buildings were constructed according to code requirements, and the typical causes of these problems—inadequate air sealing or ventilation—were

FPIINNOVATIONS EXPERTS CONTRIBUTE TO **CANADIAN STANDARDS ON WOOD PRESERVATION**

In Canada, use of treated wood is regulated by industry standards and building codes. The Canadian Standards Association (CSA) O80 series, through its wood preservation standards, supports an industry processing 1 billion board feet of lumber per year.

FPIinnovations' experts played a valuable role in the changes brought to the Canadian standards—a great recognition of their knowledge in the field of wood preservation.

The CSA O80 series has undergone several minor amendments since the 2008 edition, but most of the text remained unchanged. With considerable input from two FPIinnovations experts, three of these standards have been substantially updated and revised.

In 2015, the *General Requirements for Wood Preservation* and the *Procedure for Certification of Pressure-Treated Wood Materials for Use in Permanent Wood Foundations* standards were revised. Work included a complete re-write to eliminate all omissions, inaccuracies, inconsistencies and disjointedness among sections.

A related standard on *Specification of Permanent Wood Foundations for Housing and Small Buildings* was also updated and published in 2014. This updated standard allows permanent wood foundations, which are easier to transport to remote locations than concrete, to be used to construct northern and indigenous housing. In addition, wood foundations have a lower carbon footprint, are easier to insulate and can be constructed in cold weather that would preclude use of concrete.

FPIinnovations' experts played a valuable role in the changes brought to the Canadian standards—a great recognition of their knowledge in the field of wood preservation.



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AN EMERGING BIOPRODUCTS PLATFORM

Lignin is the second most abundant organic molecule on Earth and the most abundant natural aromatic compound. This polymer, which can be extracted from the residual pulping liquor (black liquor) at kraft pulp mills, acts as a natural, non-toxic binder of cellulose fibres. It provides physical strength to vascular plants such as trees while conferring other biologically important qualities to cell walls such as hydrophobicity—the property of being water-repellent—and resistance to ultraviolet light, insects and microbial attack.

Over the last few years, FPIinnovations has led several major research projects to facilitate the recovery of lignin from biomass or biomass-processing operations. FPIinnovations developed a novel technology to extract lignin from black liquor, and licensed it to NORAM Engineering which led to the development of the LignoForce System™—a process for the recovery of lignin from black liquor. FPIinnovations also conducted research relating to the development of several lignin applications that could benefit from the unique chemical and/or physical properties of this polymer. These efforts are now paying off!

FPIinnovations also conducted research relating to the development of several lignin applications that could benefit from the unique chemical and/or physical properties of this polymer.



START-UP OF HINTON MILL'S LIGNIN EXTRACTION PLANT

In 2015, FPInnovations was proud to partner with an Alberta-based member company mill to implement a commercial-scale lignin recovery plant. With investments announced in 2014, the pulp mill was to become the first in Canada capable of extracting lignin from its black liquor using the patented LignoForce System.

After months of intensive work, operations at this extraction plant started in March 2016. FPInnovations' experts took an active part throughout the entire process by participating in design and construction review meetings, developing validation measurements and onsite tests, assisting the mill in obtaining relevant permits, and supporting the start-up of the plant. With an expected annual production of up to 10,500 tonnes of commercial lignin, the LignoForce System will provide this mill with a new, high-value revenue stream.

Now in operation, the plant's LignoForce System will eventually produce 30 tonnes per day of lignin; ramping up to full production is expected to be completed in the second quarter of 2016. At today's price assumptions per tonne for lignin, the new system is expected to generate net profits of several million dollars per year for the mill.

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The background of the page features several chemical structures. On the left, there are structures of wood components with labels alpha, beta, and gamma. On the right, a large structure is labeled 'Lignin'. The main title is in a bold, sans-serif font.

SUCCESSFUL RESULTS IN PLYWOOD AND OSB MANUFACTURING

Under increasing environmental and regulatory pressure, the wood composites and engineered wood products industries have been looking for alternatives to current adhesive formulations—a key component in the manufacturing of their products. Historically, wood adhesives were mostly based on fossil resources including such toxic compounds as formaldehyde and phenol. Therefore, developing greener wood adhesives from renewable natural sources and reducing the environmental impact of volatile organic compound (VOC) emissions became an important goal.

To address these concerns, FPIInnovations' Engineered Wood Products Manufacturing team initiated a pilot project through its Green Chemistry program aimed at identifying formulations into which lignin could be added. The project specifically looked at using an Alberta mill's lignin product extracted from black liquor as a replacement for a portion of fossil fuel-based phenol formaldehyde adhesive resin in plywood and oriented strandboard (OSB) panels.

Tests were performed on panel samples manufactured using a PF resin containing one-third LignoForce softwood kraft lignin. OSB panels were manufactured using different dosages, then submitted to CSA standard tests for evaluation of their specific characteristics, namely the creep response of adhesives.

The trial demonstrated that it is feasible, under current commercial conditions, to use lignin to partially substitute phenol for synthesizing PF resin. The resulting resin can be applied in OSB manufacturing, with panels meeting OSB manufacturers' criteria. The successful integration of kraft lignin into resin formulations is expected to create significant market demand for a non-traditional and innovative use of forest resources. A 20% replacement of PF resin in plywood formulations could lead to savings of about \$700,000 per year in typical plywood mills, assuming a lignin price of \$1,000 per tonne (note: price used only to show the potential).

NEXT STEPS

Further investigation is required to clearly evaluate the benefits of lignin as a substitute for chemical derived from petroleum products. So far, lignin has shown its potential as a green substitute for phenol, plywood glue fillers, and PF resins, offering similar—if not enhanced—environmental performance for a fraction of the price. Many opportunities are still to be explored, and the forest sector can only come out as a winner.

THE MULTIPLE POSSIBILITIES OF LIGNIN

Lignin still holds a lot of great opportunities. For example, in collaboration with experienced industrial and academic partners, FPIInnovations demonstrated the technical feasibility of incorporating lignin into thermoplastic polymer blends used in the production of compostable plastic bags and utensils of a high recyclable content; rigid polyurethane foams used as partial replacement of petroleum-based polyols; and dispersants and flocculants used in the effluent treatment, textile, oil and mining industries.



TRANSPORT



EXTRA AXLE BOOSTS PAYLOAD AND FUEL EFFICIENCY

Nine-axle, tridem-drive logging trucks are now approved and in use on a key transportation route in the Vanderhoof area in north-central British Columbia, thanks to a research and approval process carefully navigated by FPInnovations and its industry partners.

The additional axle, in comparison to the standard eight approved across Canada, results in a payload increase of more than 15% and an energy intensity reduction between 5 and 10%. This represents significant cost and operational advantages for forest companies, as well as environmental benefits such as reduced greenhouse gases. Since larger trucks mean fewer trucks on the road, overall safety for the travelling public is also improved.

The additional axle, in comparison to the standard eight approved across Canada, results in a payload increase of more than 15% and an energy intensity reduction between 5 and 10%.

The approval was the culmination of a three-year effort, the earlier stages of which involved assessment of factors such as the dynamic stability and road impacts of the larger trailers. Those findings were then validated during a two-day road test in December 2015, involving close observation of factors such as how well the vehicle stayed within lanes on turns and its speed on hills.

The prototype trailer used for the test performed as expected and, most crucially, within all safety parameters. The resulting route-specific approval benefits multiple forest companies in the region, and the learnings from this process will have broader benefits.

The results were translated into a “roadmap” document—developed in cooperation with the B.C. Ministry of Transportation and Infrastructure and the Ministry of Forests, Lands and Natural Resource Operations—that is expected to ease the process of securing future route-specific approvals. A separate guide will also be developed to assist the industry with assessing the potential use of larger vehicles on private resource roads.

Broader use of 9-axle logging trucks in B.C. is estimated to have the potential to create \$36 million in annual savings for the industry. Work is continuing to get regulatory approval for other expanded truck configurations in the province, including a 10-axle chip van. Operational experience with these vehicles in B.C. may help pave the way for their approval in other jurisdictions in Canada and elsewhere.





IN FOR THE HEAVY HAUL IN ATLANTIC CANADA

The industry recently gained important additional transportation flexibility in New Brunswick. In this case it took the form of approval of specific heavy haul corridors around the province—aligning with key wood flows—on which forest companies can apply to operate a variety of larger truck configurations.

This regulatory change followed assessments conducted by FPInnovations of several of the specific truck configurations now permitted on the corridors to confirm that they could be used safely. The provincial government also assessed potential impacts on road infrastructure. The capacity increases vary from two to seven additional tonnes per payload, depending on the specific route and configuration.

As in the case of approval of larger logging trucks in B.C., greater capacity per vehicle improves the efficiency of fuel use, and reduces both costs and environmental impacts. The impact may be particularly significant in the southern part of the province, where regular weight restrictions are more stringent.

In Nova Scotia, FPInnovations recently began an assessment of alternative truck configurations, which currently involves cataloguing various options. It remains to be determined if and in what form allowance for heavier payloads will be made in that province.

KEEPING ROADS FROM CRACKING UP AT THE EDGES

A couple of stretches of the Campbell Highway north of Watson Lake, Yukon are now outfitted in textiles with the same properties many people look for in the clothes they wear to the gym. Wicking fabrics have the ability to move moisture away, and the test sites in Yukon will help determine if they can prevent moisture-related road deterioration and reduce maintenance requirements.

Northern roads like these are particularly susceptible to the development of cracking along their shoulders, known as edge cracking, during the spring thaw, and usually within just a couple years of being built. Edge cracking results from the combination of various mechanisms such as moisture build-up and differential frost heave.

The test installations were made in the summer of 2015 by FPInnovations working with the Yukon Department of Highways and Public Works and with funding from Transport Canada. This involved digging up 45-metre sections of roadbed to install geotextiles under the surface. The geotextiles extend into the road ditch, where different configurations of drainage systems have also been constructed. The test sites have moisture sensors and thermistors, and results are expected for analysis in 2016.

“We hope these materials will help drain the roadbed, and also reinforce it so we get less frost heaving and other movement,” explains Glen Légère, Research Leader, Roads and Infrastructure. “If it’s effective, there would potentially be wide applications on roads and other paved areas, especially in areas with a high water table.”

While geotextiles have been installed in roadbeds before, the wicking properties of the particular type being tested here are unique. It also has superior strength and reinforcement properties.

If effective, this geotextile could become a cost-effective approach to ensuring good lateral drainage in mill yards, and to reinforcing moisture-prone logging roads. Return on the investment would be in the form of improved transportation productivity and reduced long-term maintenance costs.



TESTING ALBERTA PAVEMENTS... IN QUEBEC

A research facility at Laval University in Québec City contains a precisely reconstructed segment of frozen Alberta pavement, and FPIInnovations is involved in the important testing to which it is being subjected. The outcome will be more precise thresholds for the western province's Winter Weight Premium (WWP) program.

This program, variations of which exist in several other Canadian jurisdictions, allows the forest industry to haul heavier loads on roads once a specified frost depth is reached—typically about a 10% greater payload. In Alberta, the frost threshold is currently set at a conservative one metre. But earlier modelling by FPIInnovations suggests it could likely be shallower without causing damage to roads.

For example, if a frost depth of 0.80 metre is found to be supportable, industry could take advantage of improved transportation efficiency approximately two weeks earlier at the start of winter, and a week later at the end of winter.

That's where Laval University's unique-in-Canada pavement simulator comes into play. The mobile trailer-like structure allows for precise reproduction not just of pavement characteristics but of weather conditions, and it is set up with wheels that accurately simulate the passage of heavy loads over long periods of time. Full-scale testing under precisely recreated Alberta winter conditions is under way in 2016.

The WWP program is widely used by Alberta's forest industry, and creates significant cost efficiencies by allowing for larger loads and fewer trips. FPIInnovations has begun similar theoretical threshold analysis relative to the equivalent program in New Brunswick.



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PIT GROUP EXPANDS ACROSS THE BORDER

The opening of a PIT Group office in Atlanta, Georgia, last fall represents a significant international expansion for FPIInnovations. This group has long-standing relationships with U.S.-based green technology suppliers, and saw the opportunity to make its unique service offering directly available to U.S. truck fleets.

PIT Group provides unbiased testing services to help technology suppliers evaluate and refine prototypes, and to help trucking fleet managers select the ones that will best reduce their costs and environmental impacts. Testing is done on a fleet's own vehicles and with the involvement of its own personnel.

With trucking companies increasingly active on both sides of the border, a continental service offering makes great sense. It also better positions PIT Group to be on top of key regulatory and technological developments in the U.S.

PIT Group's U.S. efforts have initially focused on the highly popular Energotest road laboratory. In an upcoming "special edition" of this service in the U.S., the usual requirement to be a PIT Group member will be waived for trucking fleets with specific technologies they want tested, and who bring along technology suppliers who will pay for the service.

As of this spring, PIT Group's momentum was building, with large new fleets being brought on board and growing interest from U.S. clients.






WOOD
PRODUCTS



REFINING ACCURACY OF **WOOD PRODUCTS MANUFACTURING**



Over the past several years, FPIInnovations' experts have been very involved in developing and improving sawmill automatization and optimization technologies and methods to make advancements in the sector.

ADAPTING KILN DRYING TO REGIONAL ISSUES

Nature can sometimes be a threat to forests, as is the case with wildfire and pest infestations, and Canada is not immune to such disturbances.

This is particularly evident when there are significant changes in the characteristics of the fibre, as was the case with the lodgepole pine attacked by the mountain pine beetle (MPB) in B.C. and Alberta in the last decade. FPIinnovations successfully responded to the call for help from its member companies for solutions to minimize the loss of wood and ligneous materials observed during the drying of MPB-attacked lumber. Now that a large proportion of the lodgepole pine has been harvested, the industry in the interior of B.C. will be producing substantially larger volumes of subalpine fir to replace equivalent volumes of lodgepole pine. FPIinnovations' researchers are now working on several strategies, including longer drying times and lower-grade recovery, to minimize the impact of drying associated with the wet pockets commonly present in subalpine fir.

In Eastern Canada, FPIinnovations' expertise was also requested as the forests faced an outbreak of wood pests, including the emerald ash borer. As the ash tree is an important component of Canadian hardwood lumber production, FPIinnovations' researchers have helped industry adopt phytosanitary programs that are based on kiln drying schedules meeting stringent requirements to comply with international standards for various Canadian wood species.



LOG ROTATION VERIFICATION IN SAWMILLS ACROSS CANADA

Each year, rotation inaccuracies of canter log turners cause sawmills to experience huge financial losses that can be mitigated by fine-tuning the machines. The causes of these losses vary, and can include wear, insufficient maintenance, miscalibrated or blocked scanners, incorrect optimizer settings and unexpected log motion during scanning.

To help its member companies, FPIinnovations developed the Log Turner and Double Length Infeed (DLI) Operation Verification software, a tool that measures log rotation errors and identifies issues with scanning, mechanical adjustments and wear, and wood control and computer

control parameters. The DLI system uses log images from existing scanners and does not interfere with production. A less sophisticated measurement tool was also developed to analyze rotation errors for Single Length Infeed (SLI) systems.

Over 30 installations of FPIinnovations' log rotation verification system have been completed across Canada since its development. The system checks, verifies and recommends improvements for a wide variety of the factors that affect the performance of primary log breakdown systems. Most of the changes have no cost, yet the industrial impact of these applications is estimated at over \$20 million per year.



ENABLING SAWMILLS' FLEXIBILITY TO INCREASE EFFICIENCY

Species separation is another important issue for sawmills, and FPInnovations has been working hard at developing and improving species separation systems that result in increased flexibility for sawmills.

Research first led to the development of SapTek, a system now under licence with AUTOLOG. SapTek enables sawmills to run different species at the same time, with the ability to separate them automatically at the green sorter—based mostly on wood species but also on wood moisture content. It is the only known

system offering a high degree of reliability in both frozen and unfrozen green lumber. After a reaction solution is sprayed at the end of a wood piece, SapTek uses a vision system to determine whether the wood should go through a longer or shorter

drying time. The system is now widely used in Eastern Canada for sorting spruce, fir and even jack pine. The overall benefit across a sawmill using SapTek can be as high as \$750,000/year.

FPInnovations has recently developed a new near-infrared (NIR)-based automated system for species sorting. This new application has already been tested on many species in rough green and dry planed boards, and a demonstration system has been installed in a member's sawmill in B.C.

The online industrial demonstration confirmed that separation can be achieved at typical planer speeds of 1400 to 2000 fpm; in mill tests, an accuracy of 95% or better for separating spruce-pine-fir (SPF) from Douglas-fir species was obtained. Estimated benefits include the reduction of log sorting costs by \$0.50/m³ and annual mill sorting costs by \$100,000 per shift.

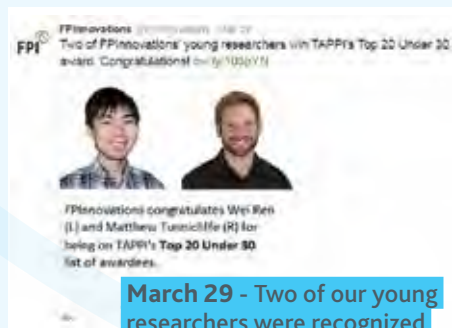
Even when log turners appeared to be operating well, investigation proved that adjustments were required, leading to improved accuracy and annual benefits of \$150,000 to \$500,000 per mill.





RETROSPECTIVE 2015-2016

Year on TWITTER



March 29 - Two of our young researchers were recognized for their great achievements!



March 17 - The Opening Doors program featuring Indigenous art was featured on CTV National News.



March 16 - Ontario's Minister of Natural Resources and Forestry talked natural resources and forestry with our Ontarian researchers.



March 10 - We celebrated International Women's Day with the wonder women of science and technology.



March 3 - Canada's Governor General visited the Opening Doors project in Vancouver, BC.



February 12 - Several mayors from Ontario donned 3D glasses to see our innovative presentation.

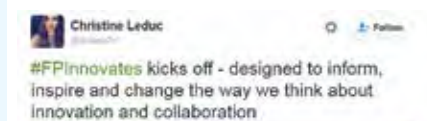


January 29 - Ontario's Minister of Northern Development & Mines visited our researchers in Thunder Bay.

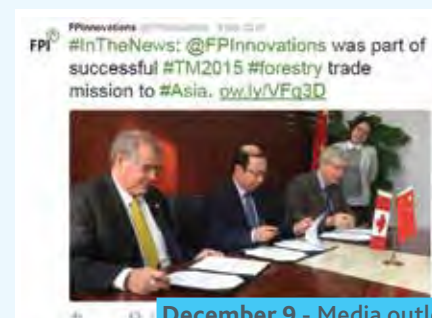


January 18 - The BC Premier visited our display at the biggest tech event in BC history, and talked to our CEO about our innovations.

Let's revisit the moments that made this year memorable!



November 25 - The hashtag #FPIinnovates trended on Twitter as attendees, government, and industry players tweeted, retweeted our inaugural conference on innovation and technology.



December 9 - Media outlets highlighted FPIinnovations' part in the successful 2015 Forestry Trade Mission to Asia.



RETROSPECTIVE 2015-2016



October 21 - Our PIT Group opened an office in the US.



October 22 - The Canadian Embassy in Finland tweeted about our researchers attending a conference in Helsinki.



October 19 - Our CEO joined the mayors of two world-class Canadian cities at a foreign relations event in Montréal.



October 7 - We were honoured with three prestigious awards from well-respected industry organizations.



September 21 - Yet another of our researchers was given an accolade by an esteemed professional organization.

FPI® FPinnovations
 MT @LaRBQ: Stéphane Labrie, Serge Simard, @phcouillard, @SamHamad, Pierre Lapointe of FPI at launch of #wood guide



1 3
 13.8k likes · 18 Aug 2015

August 18 - The Quebec Premier helped us launch our Mid-rise Wood Frame Construction Handbook.

FPinnovations @FPInnovations · 18 Aug 2015
 FPI® #Wood takes the centre stage @ Montreal Fashion & Design Festival along with art & models! #FMD15 @sensationmode



40 12 1 110

August 18 - Wood took the spotlight at the Montréal Fashion & Design Festival, along with models and art works!

FPI® FPinnovations
 Quebec government launches 12-storey #wood #building #construction guide; FPinnovations acts as scientific advisors ow.ly/R0Ktt

10 7
 44 likes · 17 Aug 2015

August 17 - The Quebec government launched a guide based on the scientific expertise of our world-class researchers.

WD Canada @WD_Canada · 15 Jul 2015

Minister @MichelleRempel announces funding for @FPInnovations #forestry #industry



1 10
 JULY 15 - The Canadian Minister of State for Western Economic Diversification tweeted about funding some of our programs in Western Canada.

FPI® FPinnovations
 FPinnovations is @ the National #Forest #Innovation Summit in Kenora. Visit us @ the Forest #Science Interactive Fair



12 1 1 110

July 9 - FPinnovations joined Canadian ministers at a national summit on innovative forestry.

Sooke VOICE News @sookevoice - 2 Jul 2015
 @fpinnovations gets grant of \$25K from BC Govt for a study on remedial treatment solutions for mold in ventilated attics in coastal climate

July 2 - The BC media tweeted about one of our novel studies and the support by the BC Government.

FPI® FPinnovations
 .@FPInnovations will be there! Canadian #forestry summit set to begin in #Kenora and Thunder Bay.

FPI® FPinnovations
 FPinnovations' Dr. Paleologou receives two R&D awards ow.ly/LmDQm @apothivets



April 8 - Another of our esteemed scientists received two awards.

FPI® FPinnovations
 FPI's Bruce Allison won APacWest's Best Supplier Paper Award for "A Kinetic-Dynamic Model of the Causilizing Process Suitable for Control"

1 1 1 110

June 15 - Our scientist won best supplier paper award.

OUR VISION

**A WORLD
WHERE
PRODUCTS
FROM
SUSTAINABLE
FORESTS
CONTRIBUTE
TO EVERY
ASPECT OF
DAILY LIFE**