

fall/winter 2018

IMPACT

MAGAZINE BY FPINNOVATIONS

**VIRTUAL
FOREST,
AUTONOMOUS
NAVIGATION,
and much more!**
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BUILDING THE
BIO-ECONOMY IN
**THUNDER
BAY**

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EXCLUSIVE!

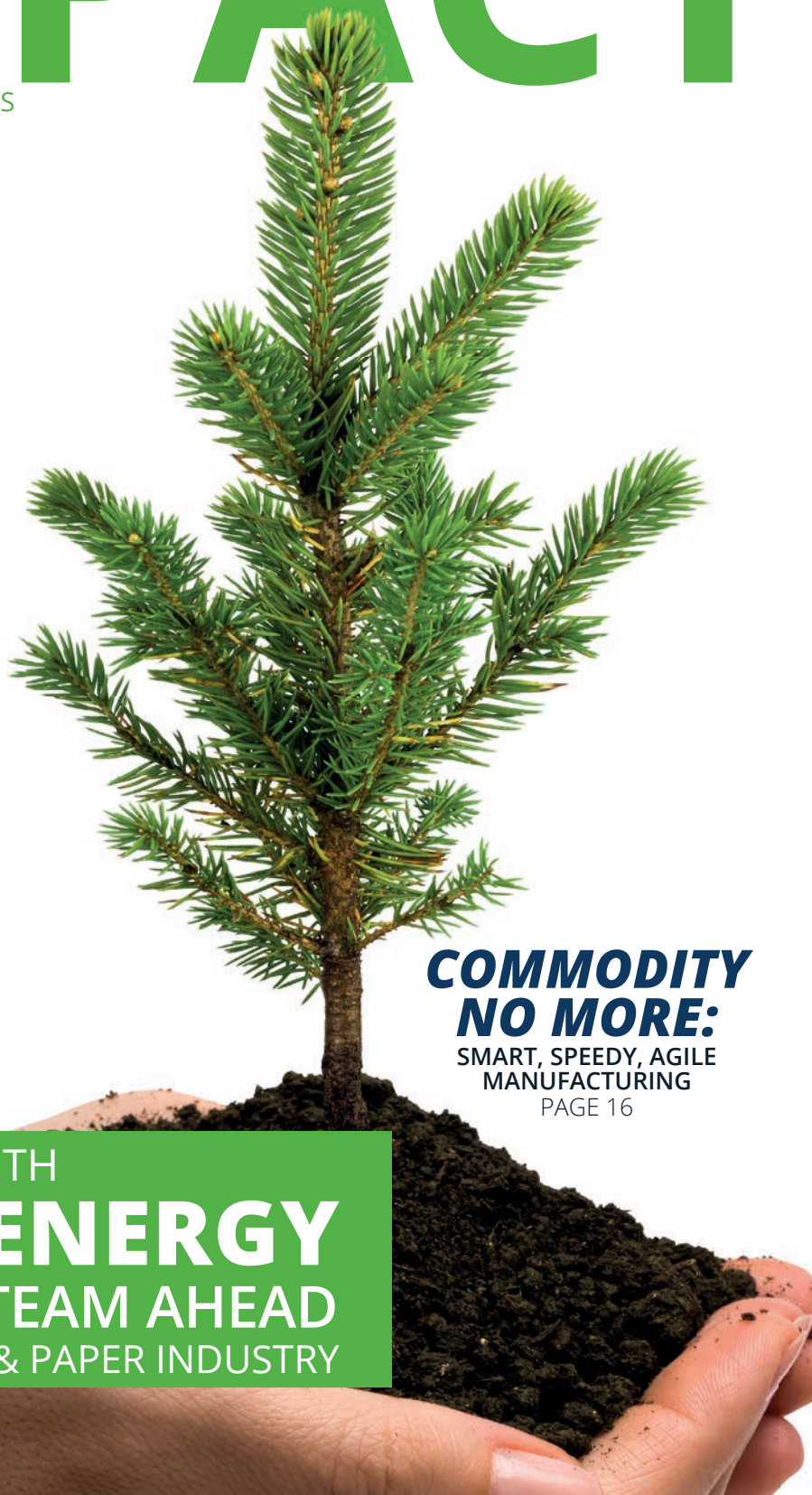
COLLABORATION WITH
CANMETENERGY
MOVES FULL STEAM AHEAD
TO TRANSFORM PULP & PAPER INDUSTRY

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**COMMODITY
NO MORE:**

SMART, SPEEDY, AGILE
MANUFACTURING

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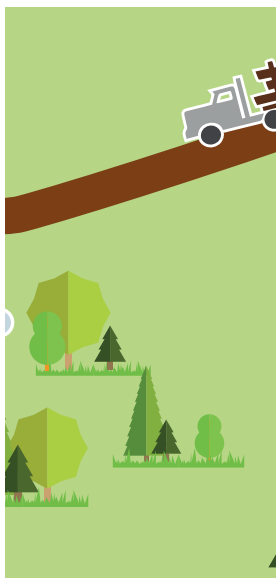
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MESSAGE FROM STÉPHANE RENOU

The true sign of intelligence is not knowledge, but imagination.

— Albert Einstein

Knowledge by itself is not enough. It is no longer enough. What we do with the knowledge and science that we develop and how we foresee using it matters as much as—if not more than—the knowledge itself. What good is knowledge without applications, without a purpose, without a dream?

Yes, FPInnovations is recognized worldwide. Yes, we are known to be an innovation catalyst for Canada's forest sector. And yes, we have a unique partnership model. But if we can't continue to metamorphose and adapt to society and its needs, then what good are we?

Change is the law of life

The forest sector is at a critical juncture: Now, more than ever, there's a thirst for accelerating the transformation and growth of the forest sector. The quest for speed and excellence calls upon us to join forces and work together to reach a common goal: a bright and sustainable future for all current and future stakeholders in the sector.

We knew we needed to re-centre FPInnovations' priorities to focus on our one and true mission: support the innovation, growth, and advancement of the forest industry. We also knew we cannot become what we want by remaining what we are. Something—or *some* things—had to change.

What changed?

Last year was a crucial year for FPInnovations as we focused on reassessing our business model and on increasing the efficiency of our organizational structure. Our objective was to reaffirm FPInnovations as the applied science and innovation leader for forest-based industries across Canada, and to perfectly align our priorities with the sector.

“

We are creating an environment that encourages and fosters collaboration, co-creation, and the birth and exploration of innovative ideas, within and outside of the industry.

”

Last year also witnessed major and fundamental changes to the organization. While striving for excellence in the way we operate, we further concentrated our efforts on creating and developing tangible solutions that directly address the forest industry's key issues. Facilitating the transformation of the industry and accelerating innovation are not just buzzwords here at



FPInnovations; they are part of our daily reality and our *raison d'être* because it is through them that we can bring tangible solutions to the forest industry.

What are we doing differently?

We are developing a unique innovation value proposition for forest-based industries that we hope will generate bottom-line impact and maximize economic impact to our members and partners.

We are identifying new technologies and opportunities to accelerate the development and deployment of innovations.

We are establishing new alliances, generating a pool of mass of minds, and opening new doors for product volume, through strategic partnerships with industry, academia, technology developers, end-users, and other innovation providers. By doing so, we are creating an environment that encourages and fosters collaboration, co-creation, and the birth and exploration of innovative ideas, within and outside of the industry. The

relationships we are building fit and integrate perfectly with our vision of a world where sustainable forest-derived products are part of all aspects of our daily lives.

Great things never came from comfort zones, and the changes we are bringing to FPInnovations are already felt and seen. I invite you to explore this edition of the now bi-annual Impact magazine, and read about our latest collaborations and innovations. This is our impact.

Happy reading!

Stéphane Renou
President & CEO

FORESTRY 4.0

FIND OUT
MORE ABOUT
**ROBOTICS
IN
FORESTRY**

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Trial timeline 2018–2019

Fall 2018
Advanced vehicles

Spring 2019
**Off-the-grid
communications**

Fall 2019
**Autonomous
navigation**



Current focus areas

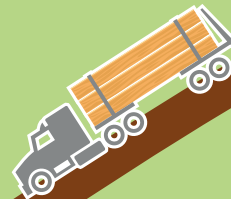
**SLAM
(simultaneous
localization and
mapping)**

Critical path to
autonomous navigation



FPSilvi-β

Toolbox for automated
regeneration survey



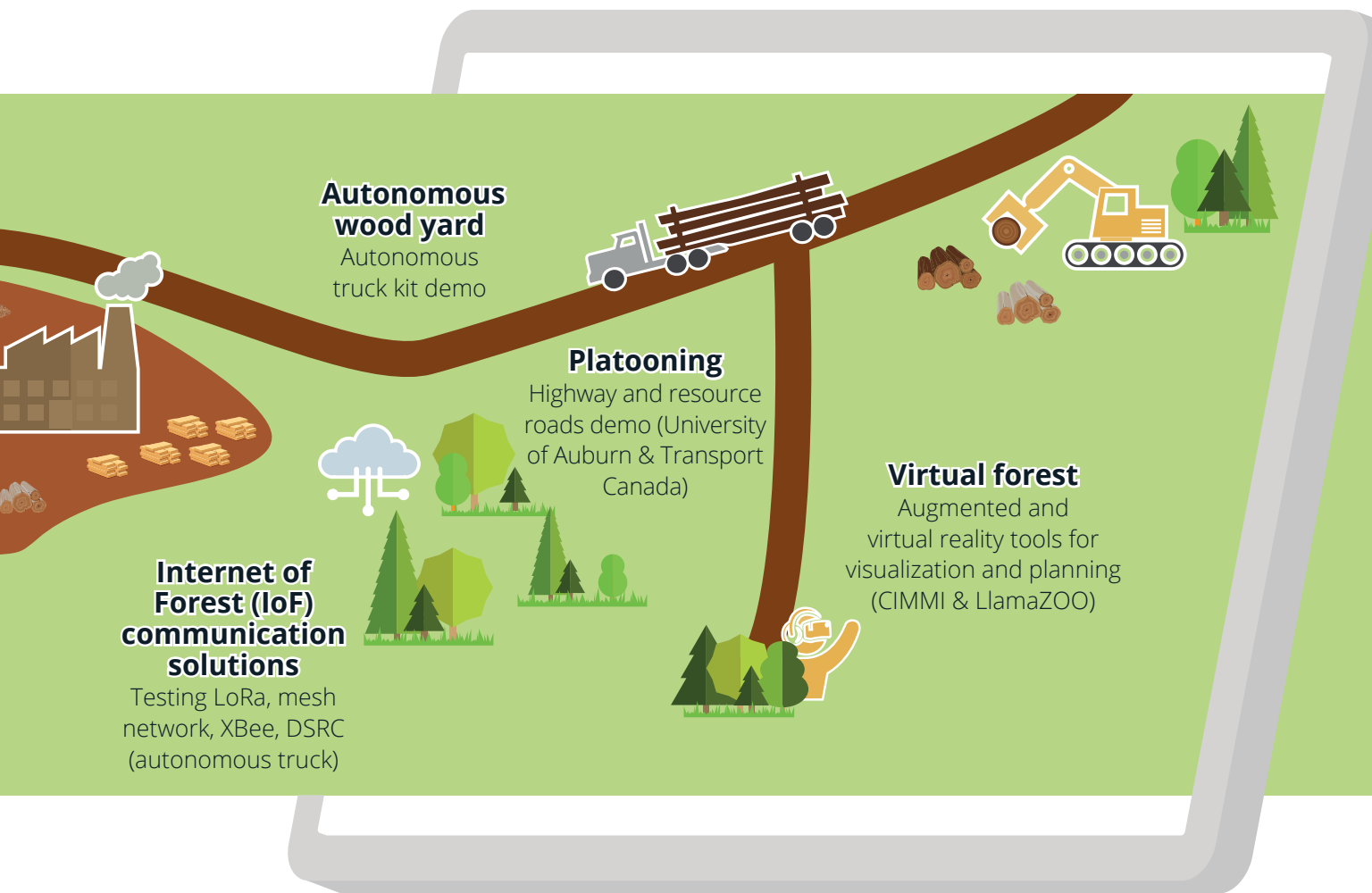
**Sensor on tree-
length system**

Feller-buncher stem
counter, OBC automated
data extraction

FPIInnovations' Forestry 4.0 initiative enables the upstream part of the forest value chain to fully leverage the agility and power of the 4th industrial revolution. Here are the highlights, one year later.

COLLABORATION AND TECHNOLOGIES ARE OUR BEST ASSETS TO INCREASE OUR EFFICIENCY.

Francis Charette, Lead Researcher, Forestry 4.0



NEW TOOLS SECURE ACCESS TO QUALITY FOREST FEEDSTOCKS

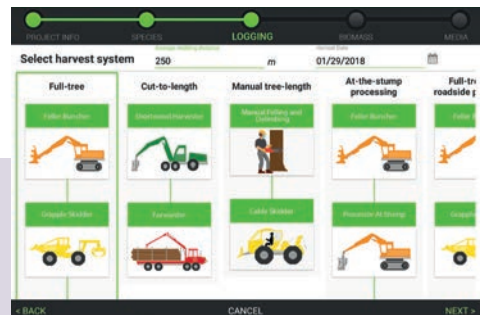
Logistics of supply, storage, and the variety of forest feedstocks is complex, and innovative solutions are required to improve feedstock quality for the bioenergy industry.

FPIInnovations published the **Best Management Practices Guide for Access to Quality Forest Feedstocks** which assesses the economic benefits of best management practices on feedstock quality and process improvement. The guide proposes opportunities to create value from biomass with innovative recovery and storage techniques. Case studies for roundwood and bark storage help demonstrate

benefits of good management practices.

As a companion tool to the guide, FPIInnovations recently launched the **BIOS** mobile app, a free and easy-to-use tool that can estimate roadside biomass volumes and potential greenhouse gas emissions of the supply chain. This app is a key part of a larger initiative within the Ministry of Forests, Lands, Natural Resource Operations and Rural Development aiming to develop a map of British Columbia's forest bioeconomy.

The guide and app are available on our website!



STEEP GRADE DESCENT GUIDELINES APP RELEASED FOR ANDROID PHONES

FPIInnovations' Steep Slope Initiative researchers have released a new Android app to meet the demands of forestry operation planners in determining appropriate payloads and descent speeds for loaded log-hauling trucks travelling on slopes with curves, as well as on inclines greater than 18%.

The Steep Grade Descent (SGD) Guidelines app is based on a spreadsheet tool and allows the user

to input various road parameters such as grade, length, the presence of a switchback, and traction level. The app predicts safe loads and operating speeds for specific road conditions, which are also entered into the app.

"We took the cue from our members working on logging sites who told us they needed increased mobility to do their jobs efficiently," said principal researcher, Seamus Parker. "The app can be used on phones and other mobile devices, and the response from forestry operators has been positive."

The SGD Guidelines app is available to all through the Google Play store, and FPIInnovations is working on an iOS version, which will be released in the upcoming year.

NINE AXLES GET THE GO-AHEAD ON MORE B.C. ROADS

Starting with a single line on the map in the Vanderhoof area a couple of years ago, a large network of highway and forest-service routes now criss-crosses the northern and central interior of British Columbia, on which forest companies are authorized to haul logs with trucks using nine-axle B-train trailers. The additional axle increases payload capacity by about 17 per cent.

FPIInnovations did the safety and stability assessments that proved the viability of this configuration in B.C., and remains active in

a government–industry working group that shepherds route-by-route approvals through a provincial process. FPIInnovations developed guidelines, which have also proven useful to the two B.C. manufacturers that currently supply the bulk of the new nine-axle trailers being used in the province.

“The units are performing as expected,” says James Sinnett, Manager, Transportation. “Drivers are telling us they really like how the larger trailers feel and handle on the road, and that they find them very stable.”

Sinnett says the provincial government has been supportive in making timely approvals and creating the critical mass of routes needed to justify vehicle purchases. The benefits of the growing nine-axle network are significant, and include more efficient log transport—particularly as logs have to be hauled over longer distances, less wear and tear on pavements, reduced greenhouse gases, and even an easing of the constant challenge of finding sufficient numbers of professional drivers to meet industry needs.



Facilitating Change in Remote Communities



An estimated 290 off-the-grid remote communities in Canada are the focus of a project to implement biomass small-scale combined heat and power (CHP) systems. By significantly reducing fossil fuel consumption, these efforts will aid in decreasing greenhouse gas emissions, while addressing important health, safety, and economic concerns of these communities. In remote British Columbian regions alone, a successful implementation could reduce the annual greenhouse gas emissions by approximately 215,000 tonnes of CO₂ equivalent, save 80 million litres of diesel, and create up to 260 new jobs.

Biomass CHP system facility

In 2016, a team composed of FPIInnovations, the National Research Council of Canada, the University of British Columbia, and with the support of Natural Resources Canada, embarked on a journey to develop the first CHP demonstration and training facility in North America. The facility will include a biomass CHP system as well as other micro-grid components to test and improve their integration in remote Canadian regions.

Sourcing quality biomass

A key challenge with implementing biomass CHP systems in these locations is sourcing quality biomass. The team is concentrating on designing economically viable and simple supply-chain technologies that can easily be introduced into remote communities. With mostly small-sized and fairly uniform chips with low fines and moisture contents required as the biomass fuel, crucial components of the system also include size reduction and sieving equipment in addition to biomass dryers.

**THE TEAM IS
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INTO REMOTE COMMUNITIES.**

Biomass dryer solution

When Christoph Schilling, Researcher in the Fibre Supply Group at FPInnovations, and colleague Marian Marinescu began investigating commercial biomass dryers, a system by Lauber GmbH caught their interest. "Compared with other solutions for small systems, Lauber's was the least complicated," explained Christoph. "Simplicity is vital to the remote locations we are targeting." With consultation from Lauber, FPInnovations designed a sturdy cross-laminated timber panelled structure that could be prefabricated and then assembled at remote sites within a few days.



The cross-laminated timber panels serve as the main structural component. A doubled floor is integrated into the shed to evenly distribute the hot air beneath the biomass. Hot air supplied by a Lauber make-up air unit takes warm water generated by the CHP systems and converts it into usable drying air. Perforated metal tiles allow the air to stream through the biomass and dry up to 50 m³ within three days.

Supporting First Nations communities

It's anticipated the facility will be operational for demonstrations and training in 2019, increasing awareness around the benefits of biomass CHP systems and potentially triggering ten installations within the next three years. "Canada's First Nations communities are our main focus for this project, not only from a climate change perspective, but also to help these communities grow in the forestry and wood products sectors," said Christoph Schilling. "Through the Indigenous Forestry Program, FPInnovations' aim is to support their economic development, create employment opportunities, and instill a sense of excitement into younger generations."

REVISED WINTER WEIGHT PREMIUM SAVES THE INDUSTRY \$2 MILLION

A recent winter weight premium (WWP) policy change in Alberta, following recommendations from FPIInnovations' collaborative research, is saving the forest sector more than \$2.0 million annually. The WWP allows premium weights for log hauling and equipment transport during the winter. The revised WWP season will begin at a frost depth of 0.750 m instead of 1.0 m, extending the estimated average season by eight days.

FPIInnovations teamed up with Laval University's industrial NSERC chair on the interaction between climate, pavements, and loads, led by Professor Guy Doré, to simulate wheel loads on a replicated Alberta pavement. Pavement responses at different frost depths corroborated with preliminary findings from FPIInnovations' advanced modelling.

This win-win policy change is a result of several years of research and collaboration where the key ingredients were the identification of a true industry need and collaboration between all parties towards a science-based outcome with tangible benefits to our members and the forest sector.



NETWORKING LEADS TO NEW RESEARCH ON STEEP SLOPE HARVESTING

Networking is an investment in business development and a recently published paper on tensile force monitoring in steep slope harvesting, jointly written by FPIInnovations' Steep Slope Initiative (SSI) scientists and researchers at an Italian university, exemplifies that golden rule.

The seed for the collaboration was planted at a Forestry Mechanization (FORMEC) conference, held annually in Europe. Initial discussions at the conference began in 2015 and ultimately resulted in the publication of a research paper in the *Croatian Journal of Forest Engineering* this year titled, "Tensile Force Monitoring on Large Winch-Assist Forwarders Operating in British Columbia," co-authored by University of Padova Ph.D. candidate, Omar Mologni; FPIInnovations researchers Peter Dyson and Dzhamal Amishev; and Italian scientists Andrea Rosario Proto, Giuseppe Zimbalatti, Raffaele Cavalli, and Stefano Grigolato.



"Networking opportunities at FORMEC were pivotal in getting this joint project underway," said Amishev. "This research is part of a collaborative process that will make steep slope harvesting safer for workers around the world."

Key outcomes of the study include the improved understanding of tensile forces reached during winch-assist operations of large-scale forwarders in British Columbia. The trails, slope, travel direction, and distance of the machines from the anchor were statistically significant and able to account for 49% of tensile force variability. However, in the same conditions, the operator settings accounted for 77% of the tensile force variability, suggesting the human factor is the main variable of cable tensile force behaviour during winch-assist operations.

FPIInnovations hosted Mologni, from Padua, Italy, for three months in 2017 and organized the logistics of field visits in the B.C. Interior. "Having the opportunity to work with FPIInnovations on this new and developing harvesting technology improved my understanding of forest harvesting practices and gave me an appreciation of how diverse those approaches and equipment can be around the world," said Mologni.

FPIInnovations is currently working on a subsequent collaborative journal publication with faculty members of the University of Padova.

PIT Group celebrates its 10th anniversary



In 2007, due to numerous requests from members in the road transport and forest industry sectors, FPInnovations starts working on improving technologies in fuel efficiency, and the Transport group sets up the first Energotest campaign.

2008

PIT Group is born

In response to the success of the initial Energotest trials, FPInnovations launches its PIT (Performance Innovation Transport) Group. Municipal and public sectors quickly join PIT Group, as the demand for fuel efficiency grows.



2009

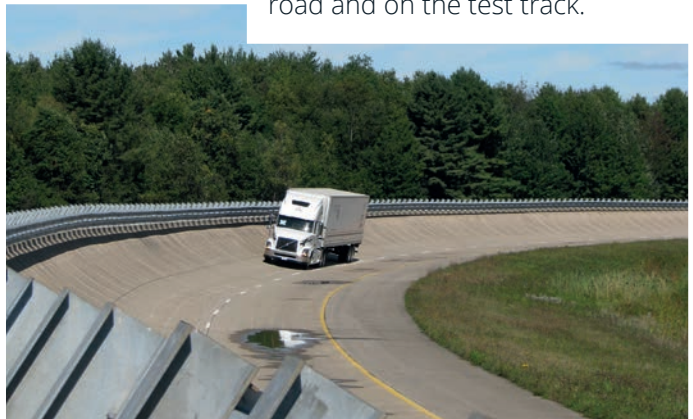
Doubles trials

To meet industry demands, PIT Group runs two Energotest trials; in spring and in fall.

2010

New tests

PIT Group develops new test protocols, conducts stop-and-go tests on various duty cycles, as well as evaluates hybrid trucks on the road and on the test track.



2011

Widens its scope

PIT Group diversifies its testing portfolio and acquires new test equipment: refrigeration units for an environmental chamber, emission testing with PEMS, and onboard test equipment for measuring exhaust emission under real-world conditions.

2012

Sets the standard

PIT Group joins the Environmental Technology Verification (ETV) program of Environment Canada, as well as develops a Canadian standard for the use of onboard recorders. PIT Group also conducts its first evaluation of electric cars.

2013

Creates strategic partnerships

Rarely granted to an outside laboratory, the Standards Council of Canada (SCC) grants the ISO/IEC 17025:2005 (CAN-P-4E) accreditation for tests conducted by PIT Group and a new test using a towing dynamometer to simulate various load and road conditions is developed.



2014

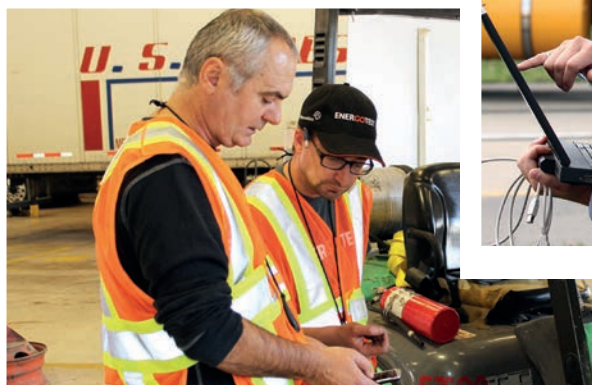
The rise of PIT Power

PIT Group creates the PIT Power certification program for fuel economy value rankings that fleets can use to quickly identify the fuel efficiency value of a technology and organizes its first conference on emerging technologies.

2015

American presence

PIT Group opens an office in Atlanta, Georgia.



2016

Year of firsts

The year marks the first platooning test with Transport Canada, the first delivery of electric passenger shuttles for Calgary International Airport, and the first in-service fuel testing in the United States.

2017

New projects

PIT Group and partners announce a collaboration to design an electric autonomous shuttle adapted to Canadian winter conditions, as well as launches an ELD third-party verification program.



2018

New partnerships

Auburn University and PIT Group combine their expertise to conduct independent and certified Energotest road tests on U.S. soil. PIT Group also partners with the Technology and Maintenance Council (TMC) in field testing and truck engineering projects.

... the best is yet to come!



Re-inventing Solid Wood Production for a Smarter Future

Imagine a future customer order to a mill. It's for a niche solid-wood product with highly tailored specifications. Using smart machines, advanced technology, and optimized processes, the mill sets out to meet the specifications while also maximizing the recovery from the small-diameter logs that make up most of its fibre supply. Scanning and log-turning capabilities provide precise insights and immediate responses to the characteristics of each log. With oversight from skilled operators, and full process integration, deviations from either product specifications or log optimization are quickly and continuously corrected by the smart machines. The customized product—one of a large number the mill is capable of making—rolls out at an even higher production rate than the commodity products of the past. Meanwhile, the modest volumes of chips and other by-products are also directed to more specialized and higher-return uses.

This, in fact, matches the current reality in other types of industrial production. FPInnovations' Smart Manufacturing² Initiative, or SM², is designed to accelerate the progress towards that future on behalf of Canadian solid wood processors.

“
**WE'RE STARTING WITH A
VISION OF WHAT WOULD
REALLY BE A RE-INVENTION OF
SOLID-WOOD MANUFACTURING**
”

The five-year project, with funding support currently secured from the Province of Quebec and the federal government, will extend into 2022.

Among the challenges it will address is changing log characteristics—including attributes such as species mix and size—and rising manufacturing costs. Key among the opportunities it will help

a 30% increase in lumber recovery, while at the same time bringing production costs down.

To achieve that, the SM² team and industry participants are targeting the development, and cost and engineering verification, of manufacturing innovations that will be well-suited to the current and anticipated characteristics of the log supply in key Canadian forest regions.

Five to seven specific technologies, intended in part to bring agility and flexibility and to facilitate product diversification, will also be taken through to pilot testing. Potential technologies include automated species identification, internal defect recognition, and ultrafast lumber drying, among others. This may involve a re-consideration of mill functions

that, to a large degree, are still conducted using decades-old approaches.

“Solid-wood mills need to maintain speed and agility of production, while greatly increasing the flexibility of processes and outputs and tapping into new markets,” says Constantineau. “The technology is there to achieve this, and through SM² we are working with our members to find the smartest ways of deploying it.”

capture is more differentiated and market-responsive production, with a greater proportion of fibre ending up in solid wood applications and less as sawmill by-products.

New product focal points are likely to include niche structural, engineered, and value-added uses for solid wood, as well as higher-value end uses such as non-structural panels for chips.

“We’re starting with a vision of what would really be a re-invention of solid-wood manufacturing,” says SM² Initiative Manager Serge Constantineau. “A vision to move more definitively past the commodity-based production approaches that were the norm up until fairly recently.”

SM² will be driven by ambitious goals, including



A CHINESE MARKET DISRUPTION MAY SIGNAL CANADIAN OPPORTUNITY

Recent FPInnovations market analyses indicate that a major shift in construction methods in China could provide a new opening for Canadian wood products. As part of its current and 13th national five-year plan, China is making an unprecedented shift away from on-site construction, and targeting 30% prefabricated construction by 2025. Benefits will include construction quality and efficiency, and cleaner and less disruptive on-site work.

Wood accounts for a relatively modest share of construction in China, but adoption could increase with the shift to

prefabricated construction, particularly at low- and mid-rise heights. A similar but smaller-scale shift to prefabrication in the United Kingdom, for example, drove a major increase in the share of construction using wood.

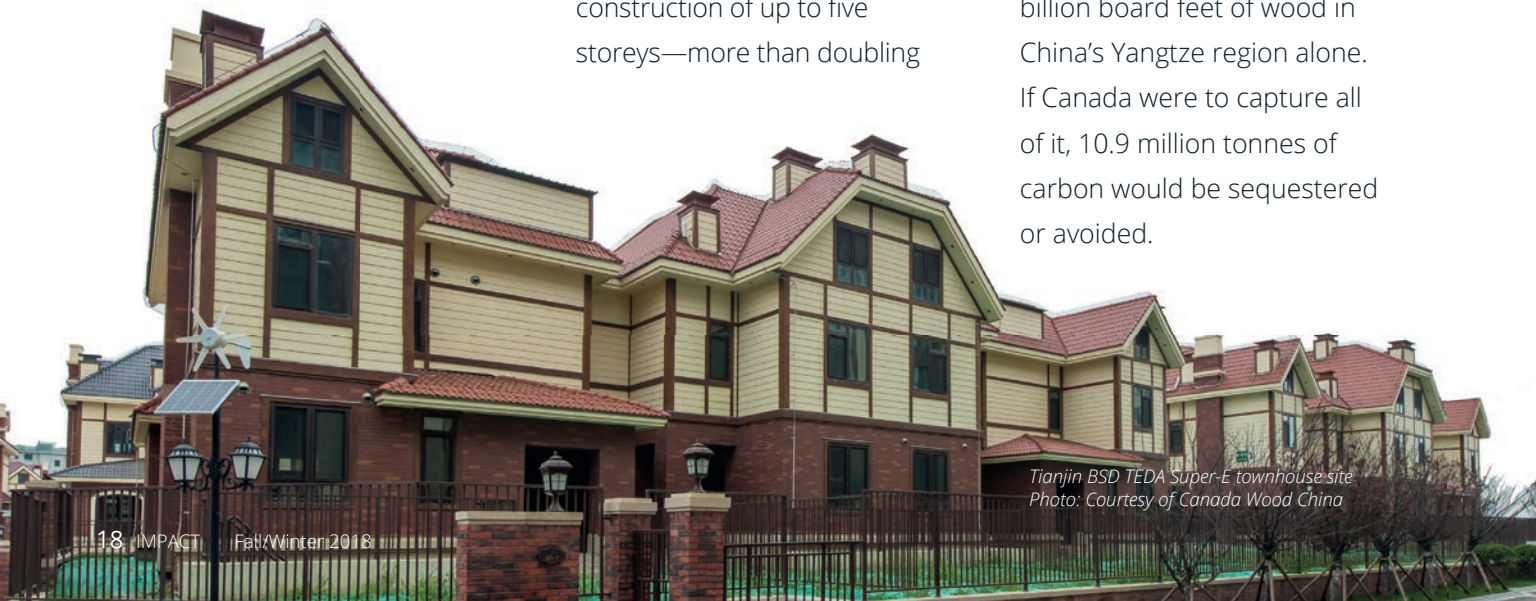
“In China, it would just take one major integrated builder to make the shift to wood and things could really start to move, because the builders are so massive,” says FPInnovations’ Lead Market Analyst David Fell.

The outlook has also been strengthened by recent code changes allowing for full wood construction of up to five storeys—more than doubling

potential wood construction volumes by floor area.

Another helpful factor is the growing Chinese determination to address climate change. FPInnovations recently added carbon sequestration and avoidance figures to its global market database for China and other Asian countries. Fell says this has proven to be of strong interest to the Chinese government agencies with which it has been shared.

Thanks to the increased height allowance, there’s a potential one- to five-storey residential construction market for 2.5 billion board feet of wood in China’s Yangtze region alone. If Canada were to capture all of it, 10.9 million tonnes of carbon would be sequestered or avoided.



*Tianjin BSD TEDA Super-E townhouse site
Photo: Courtesy of Canada Wood China*

Wood Construction Rises High; Building Bridges to New Opportunities

Tall wood buildings have started to dot the skylines in several Canadian cities in recent years: the 18-storey Brock Commons Tallwood House at the University of British Columbia in Vancouver, the 8-storey Arbora residential complex in Montréal, and the 13-storey Origine residential development in Quebec City.

These buildings are important showcases of the efficiency, sustainability, and aesthetic appeal of tall wood construction. FPInnovations has been working to verify and document their performance, and to help develop the specifications and guidance that will make wider adoption possible.

This has included measurements of several key attributes at all three buildings: building vibration during windy conditions, floor vibration as occupants move

around, and acoustics, explains Steven Kuan, Manager, Building Systems. These attributes have a bearing on structural integrity and safety, as well as on occupant comfort and considerations such as noise transfer between floors and between rooms.

The buildings, Kuan says, are performing within expected parameters, and the data collected are proving useful in the further refinement of design specifications for future tall wood construction.

Researchers have also been able to identify new moisture-management practices for use during construction.

FPInnovations has also done extensive testing on the fire performance of the engineered wood products used. Evaluating adhesives with rigorous test methods suitably adapted for cross-laminated

The data collected are proving useful in the further refinement of design specifications for future tall wood construction.

timber (CLT), for example, has been found to significantly reduce the risk of “de-lamination” during a fire. This will create added reassurance on the part of designers, regulators, and firefighters.

The test methods developed have been incorporated into the revised 2018 edition of the North American manufacturing standard for CLT panels (ANSI/APA PRG 320). FPInnovations research will also lead to a second edition of its widely used Canadian CLT Handbook, to be released in early 2019. These are key tools in making this exciting building form a more common feature of our cityscapes.

The resource road opportunity

Steel and concrete are the predominant construction materials used for resource road bridges today, but FPInnovations is working with the B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development to once again make wood a viable construction option for this application as well.

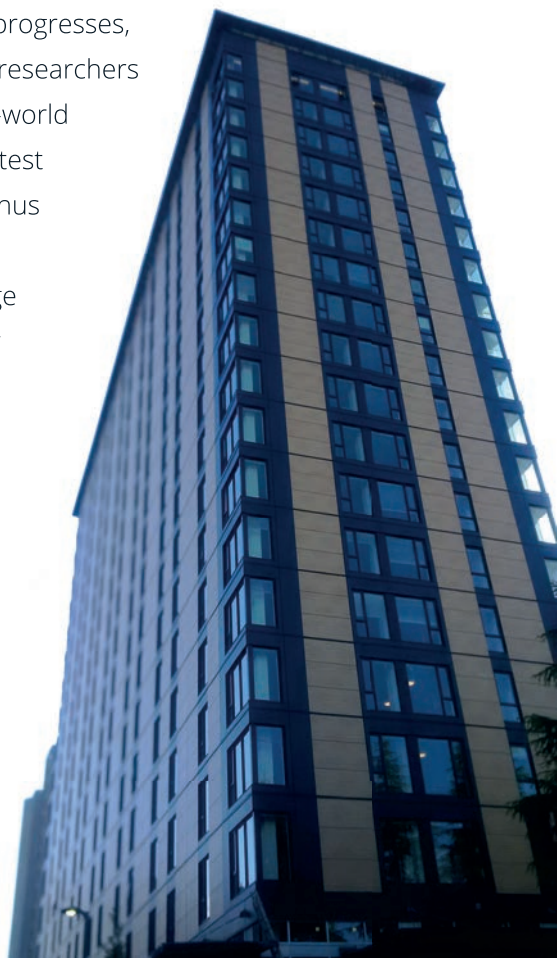
A new bridge deck system—combining side-by-side pieces of large dimensional lumber with steel truss plates and a top layer of reinforced concrete—has been developed. Load and fatigue testing of prototypes is ongoing, to develop a deck system that adequately combines strength with cost efficiency and ease of construction.

An all-timber bridge is also being fabricated for installation later in the fall of 2018 in the Kamloops area. It will be the first all-timber industrial forest bridge in B.C. in several decades. This project



involves using fibre reinforcement to improve the strength of glue-laminated timber bridge beams.

During the fabrication phase of this demonstration project, FPInnovations is assisting with a review of technical engineering challenges, and with a quality assurance review of bridge components. As the project progresses, engineers and researchers will have a real-world opportunity to test performance, thus furthering the all-timber bridge opportunity for resource roads and beyond.





FIRE TESTS LED BY FPINNOVATIONS INITIATE CODE CHANGES

In 2015, the National Building Code of Canada introduced prescriptive provisions to allow combustible construction materials for mid-rise buildings, while still ensuring the safety of occupants and firefighters in the event of a fire. However, Ontario and Quebec building and construction codes opted to require exit stair shafts to be built using noncombustible construction.

FPInnovations conducted a research project in 2017 that included a large-scale fire experiment, reaffirming that a mass timber exit stair wall is a suitable method of construction for exits, can perform well in a fire, and can meet all code objectives and functional requirements.

This research was used as supporting data in a Quebec code change request to allow exit shafts in mid-rise wood buildings to be built using encapsulated mass timber (combustible) construction with a 1-hour fire resistance rating. The proposal was received favourably by the Régie du bâtiment du Québec; implementation and construction details are currently under review.



SAVE THE DATE!
SEPT 30–OCT 3, 2019

A UNIQUE INTERNATIONAL
EVENT ON MID- AND
HIGH-RISE BUILDINGS
NOT TO BE MISSED!



WOODRISE2019
QUEBEC CITY, CANADA

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CO-ORGANIZERS



EXPANDING RESEARCH CAPACITY FOR INNOVATION

Extending the service life of wood products has become a focus of scientist Angela Dale and the Sustainable Construction – New Construction Materials team at FPInnovations. Understanding wood biodegradation and preservative detoxification by microorganisms aids in the development of innovations that prolong the life of wood products, while increasing their market competitiveness.

The team has been utilizing genomics to investigate the community of fungi and bacteria associated with treated wood. Recent work with metabarcoding, a method to rapidly screen the DNA of all organisms in a sample, piqued their interest in bacteria's role in detoxifying wood preservatives. Many of the bacteria found on the preservative-treated wood were classified as Risk Group 2 (RG2), necessitating a Containment Level 2 (CL2) designation for their laboratories in order to work with those species.

Angela Dale spearheaded the expansion of their laboratory capacities, ensuring their facilities met the specified design criteria and developing biosafety and biosecurity corporate policies



and procedures as well as a training program. Angela explained, "With a CL2-designated facility and a licence to work with RG2 organisms, we have been able to expand our research to test different products and extracts for their efficacy against bacteria."

FPInnovations' ability to work with RG2 bacteria will continue to support the development of improved and new wood protection formulations, while also opening the door to projects in other areas of research at FPInnovations.

WOODVALUE: EXTRACTING MORE VALUE FROM THE FOREST

As sawmills and log purchasers seek additional volume, they are challenged with the complexity of identifying and evaluating the most suitable and profitable forest areas. FPIInnovations' latest technology, WoodValue, is an advanced decision support tool that arms forest companies with quality information to maximize their output and revenue. "This tool identifies unrealized or missed opportunities in a way that is difficult to do with existing methods," says Catalin Ristea, Manager of Advanced Decision Making, Smart Manufacturing. "Industry members participating in the WoodValue prototype trial are already extracting more value from the same investment."

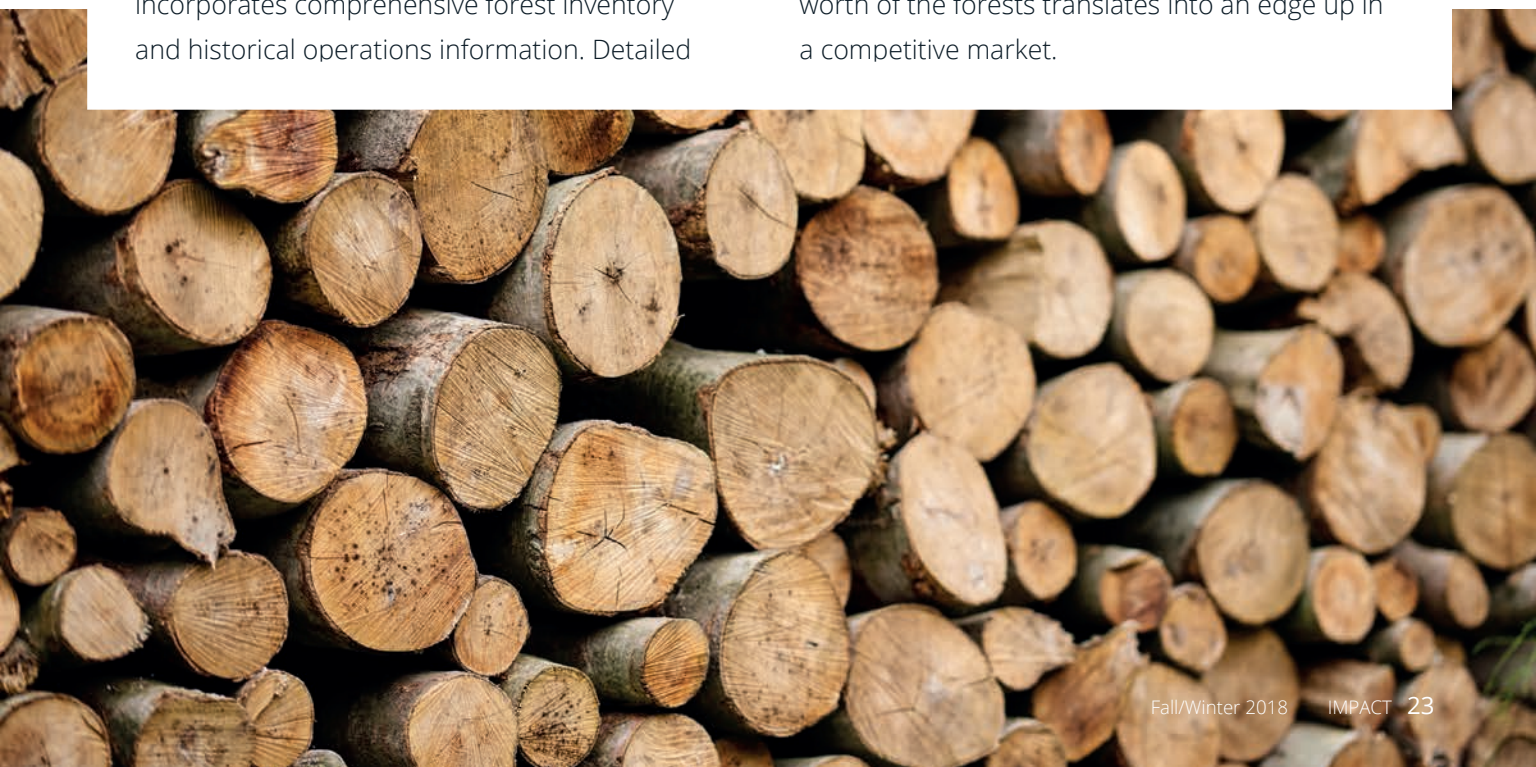
Customized approach

WoodValue is customized to each mill and incorporates comprehensive forest inventory and historical operations information. Detailed

analyses of the data make it an accurate and robust approach for predicting potential log sorts best suited for that sawmill and the desired finished lumber grades. Production costs also factor into the estimated net revenue. WoodValue only requires a few mouse clicks to generate three comparative scenarios for a single cutblock.

Bridging the gap

Mills have been encouraging their log buyers to adopt WoodValue in an attempt to move towards standardization and more objective decision-making. WoodValue provides more downstream market need and raw material availability information for improved guidance on the production of lumber products. With better bids and better blocks, understanding the real worth of the forests translates into an edge up in a competitive market.



**IN JUST FIVE YEARS,
THE PARTNERSHIP
HAS IDENTIFIED
\$55 MILLION
IN POTENTIAL ENERGY
SAVINGS AND ADDED
ENERGY-
GENERATING
OPPORTUNITIES
IN 15 PULP AND
PAPER MILLS IN
SEVEN PROVINCES.**



Pulp and paper mills have been a fundamental part of Canada's economy since the 1800s. Entire towns and communities have been built around them. The rise of digital technology, combined with industry challenges such as new pulp and paper grades, integrating clean technologies, carbon taxes, and switching fuels, has seen pulp and paper mills struggle to remain competitive, yet the challenges have also given rise to many new opportunities. FPInnovations' partnership

REVITALIZING THE **PULP AND PAPER INDUSTRY** ONE MILL AT A TIME



with Natural Resources Canada's CanmetENERGY is turning the tide for mills by collaborating on integrated energy optimization studies to maximize efficiency, increase the sale of green power, and reduce greenhouse gases (GHG). The results have been incredible.

In just five years, the partnership has identified \$55 million in potential energy savings and added energy-generating opportunities in 15 pulp and paper mills in seven provinces. How

was that achieved? CanmetENERGY's team and their catalogue of tools, such as advanced data analytics and proprietary software, are matched with FPIInnovations' team of scientists and pulp and paper experts to analyze and model how energy is used and produced throughout the mill, and to look for opportunities to recover and better use heat throughout the plant as well as reduce the need for purchased fuel. In turn, the steam saved can be used to produce electricity for sale to the grid.



"Our work with CanmetENERGY on integrated energy optimization is an industry collaboration game changer," says Jean Hamel, Vice President, Industry and Member Relations of FPIInnovations. "At the heart of the effort is the additional income gained through increased production of electricity from pulp and paper mills." Additional benefits arising from the reduction of fossil fuel use and overall mill optimization include lower plant GHG emissions, supporting a transition towards a low-carbon economy.

"Strengthening the Canadian pulp and paper industry is a priority for Natural Resources Canada," says Eric

Soucy, Director, Industrial Systems Optimization for CanmetENERGY.

"Teaming with FPIInnovations as a strategic partner to achieve major energy gains and related GHG emission reductions while improving productivity, is at the centre of positioning mills as part of a bioeconomy."

"Our work with CanmetENERGY on integrated energy optimization is an industry game changer."

In the project execution phase, site visits are an essential aspect of analyzing each mill's unique operating practices and allows FPIInnovations to tailor a one-of-a-kind action plan for each and every client, which takes into consideration whole energy systems rather than individual components.

"A key part of the approach is to engage with the partner mills very closely and frequently throughout the process, so that we deliver what they want," says Douglas Singbeil, FPIInnovations Sector Leader, Bioproducts. "We don't just do a study and deliver a final report to the mill. We

draw a roadmap for mills to follow in the implementation process of our recommendations and continue to

touch base with them and provide additional direction as they implement projects."

The distinctive approach of this method allows FPIInnovations to work in a holistic manner



involving all mill departments in the process, including accounting, so that financial benefits can be identified and then captured on the mill balance sheet, giving management realistic expectations. Working directly with mill operations staff to train

them to recognize and implement cost-saving and income-generating opportunities is another of the program's signature attributes.

The diversification of mill revenue in the mills' new role as providers of renewable clean energy, in addition to moving towards a low-emission industry, changes the traditional perception of the pulp and paper industry for the better. Facilitating the mills' transition to a bioindustry is an FPInnovations and CanmetENERGY hallmark that will help ensure the prosperity of pulp and paper mills for generations to come.



NEW INTERNATIONAL STANDARD (ISO 20494) ON PAPER STABILITY

Until recently, ISO 9706 was the only international standard that specified requirements for paper permanence. However, this excluded mechanical and high-yield pulp products and most recycled pulps.

In response to market demand, Canada, via FPInnovations, has taken the initiative to develop a new ISO standard specifying paper stability requirements for general graphic applications. An international round-robin study involving the accelerated ageing of paper indicated that neither mechanical nor optical properties of paper were significantly impaired during long-term storage, which is consistent with research findings spanning 20 years.

The new standard was published in December 2017 as ISO 20494: Paper – Requirements for Stability for General Graphic Applications.

ISO 20494 will open up opportunities for mechanical and high-yield pulp producers and paper manufacturers worldwide to develop and market a wide range of paper products containing mechanical and recycled fibre. The benefits: improved paper performance, lower production costs, higher sustainability, and a greatly reduced environmental footprint.

CAPTURING GROWING DEMAND FOR COST-COMPETITIVE, SUSTAINABLE PACKAGING PRODUCTS

One significant challenge our members are facing is how to utilize thermomechanical pulp (TMP) in the manufacture of paper grades that have a growing demand and higher value. The brown-bag grades used for food packaging represent the perfect opportunity to use TMP since brown bags are traditionally made from either unbleached kraft or recycled fibres. The knowledge and technologies developed by FPIInnovations on pulp refining were applied to enhance the strength properties of TMP.

“The research activities initiated by FPIInnovations in consultation with its member companies to develop packaging papers based on improved TMP is creating a unique opportunity to capture the growing demand for cost-competitive, sustainable packaging products”, said Balázs Tolnai, Paper, Packaging, and Consumer Products PAC Chair, and General Manager of Technology, Kruger Inc. “This will also help support the transformation of our members’ businesses.”

Through mill trials, FPIInnovations is demonstrating to its members the production of such new packaging grades, and is conducting conversion trials to add high-barrier performance and other functionalities to the papers by laminating them with aluminum foils and plastic films. FPIInnovations is also developing technologies to produce mechanical pulp fibres with strength properties approaching those of kraft fibres.

CHIPS TO BALE: OPTIMIZING THE FIBRELINE

FPIInnovations’ Chemical Pulping group has been closely collaborating with the pulp and paper industry for 25 years, cultivating a full scope of expertise, technologies, and tools. Today, they are uniquely armed to optimize mills’ fibre line processes and reduce production costs.

Fibreline audits analyze the entire pulp manufacturing process and are often the first step in identifying possible challenges impacting productivity, costs, and quality. “The goal is to ensure mills’ pulping processes are running at peak efficiency, thereby maximizing their operating capability and product quality,” says Theodore Radiotis, Lead Scientist – Fibre Production, Smart

Manufacturing. Optimizing “pulpability” requires a holistic approach including ideal wood and chip quality, delignification rates, use of additives, unbleached pulp yield, strength, and bleachability.

The Quebec-based pilot and laboratory facilities simulate pulping operations to pinpoint issues and develop optimal operating conditions. Combined with its patented technologies, Near-Neutral Brightening and Paprilox™, FPIInnovations can support mills with full-scale implementations, helping to achieve annual savings ranging from \$0.5 million to over \$1 million.



HELPING PAPER MILLS ROLL SMOOTHLY

In 2002, FPIInnovations opened the doors to its Roll Testing Facility (RTF) in Pointe-Claire to troubleshoot paper producers' roll performance issues. Almost 16 years and 3,000 rolls later, RTF is now able to test any flexible web materials, from linerboard to tissue and even aluminum foil.

Roll structure defects can seriously hamper a producer's efficiency, customer satisfaction, and bottom line. Through a complete analysis of web uniformity and roll structure, RTF can identify sources of web-related issues on the printing press and converting line. "RTF provides

a unique set of services and tools to troubleshoot complex and long-standing issues and determine the root cause of the problem," explains Frédéric Parent, Research Leader, Web Performance Group. Pinpointing problematic areas and providing recommendations for corrective actions help mills address complaints and costly claims from end users.

The only facility of its kind in North America, RTF services mills from Canada, the U.S., Asia, and Europe. "Regardless of the customer, it comes down to three essential ingredients for producers: a high-quality

product, minimum rejects, and a uniform web, all of which RTF can help achieve," explains Frédéric. "Depending on the issue, the savings realized from improved efficiency can be in the order of millions of dollars per year for a typical paper machine." Roll upon roll, RTF has improved mills' bottom lines through enhanced efficiency, fewer paper breaks, and increased sales.



Thunder Bay Biorefinery Now Under Construction

The emerging and much-talked-about bioeconomy is taking shape at a mill site in Thunder Bay. In September 2018, construction began on a large-scale pilot biorefinery plant, which will become a focal point for the further development and commercialization of biobased products made from wood.

This is a key milestone in the advancement of FPIInnovations' patented TMP-Bio technology. It was made possible by a partnership with Resolute Forest Products, the member at whose mill the biorefinery plant is being built.

TMP-Bio is a means of converting wood into a wide range of new and potentially high-value products, based on a modification of the widely used (chemi-) thermomechanical pulping processes. It combines a mild chemical treatment with low-temperature mechanical refining, explains Dr. Zhirun Yuan, Senior Manager, Industrial Technology Integration.

An existing building on the Resolute mill site, where recovered paper used to be de-inked, is being retrofitted to house the biorefinery. The

project team anticipates that commissioning of the new facility will begin in the first quarter of 2019, and once in full operation it will have the capacity to process 100 tonnes per year of hardwood chips.

The process will produce two basic product lines: cellulosic or 2G sugars, and a high-quality form of lignin referred to as H-lignin.

Small-scale test production of sugars has already been achieved at FPIInnovations' Pointe-Claire facility, and the market for this product line is well established and demand is high.

After conversion into intermediate or "platform" chemicals, cellulosic sugars become a basis for diverse products including paints, plastics, textiles, and cosmetics. These end products are derived from a sustainable source, rather than from the alternatives of fossil fuels or sources such as corn and beets that can instead be used as food.

H-lignin, in contrast, is a new product, and development of market opportunities is underway. It can, however, serve directly as a biomaterial,

TMP-Bio is a means of converting wood into a wide range of new and potentially high-value products



without the need for an intermediate conversion step, with a wide variety of potential applications including animal feed, plastics, and components of manufactured wood products. It also has the potential to replace fossil fuel-based alternatives.

Ongoing refinement of the technology that will be used in Thunder Bay remains underway, says Dr. Yuan.

"What we're doing at Thunder Bay is a great model of how we see the bioeconomy working," he says. "We're applying new technology, getting better utilization of an existing facility, and using a raw material that we've got a surplus of to make higher-value products with a low environmental footprint."

The project will better demonstrate the potential for larger-scale commercial production, as well as provide a larger stream of product samples for end users, and thereby help build markets. The full annual market opportunity for the product lines has been estimated at more than \$1.5 billion.

With the award of the construction contract to Venshore Mechanical Ltd. of Thunder Bay—a local company that already completed related demolition work on the site—the project has started to deliver local economic benefits. Once its full potential is realized, it could provide a template for better resource use and economic diversification in northern Ontario and beyond.

Renewable Diesel from Wood:

Putting Together the Pieces



Various processes to convert low-value woody biomass into renewable diesel have been proven to work at a laboratory scale and some have been tested at a pilot scale. However, no one has yet been able to put them all together into a full-scale production process with demonstrated financial viability. That remains a big unclaimed prize in the field of climate-change solutions, particularly since sustainably sourced feedstocks for biodiesel are in limited supply.

FPIInnovations has been part of a collective effort to claim that prize for more than two years now—the Bioénergie La Tuque (BELT) initiative. The hoped-for outcome is construction of a commercial renewable diesel refinery in the north-central Quebec city of La Tuque, fuelled by low-value leftover wood from the region's existing forest industry.

Construction of a wood-fuelled refinery remains several years off, but the recent progress towards it has been steady, if painstaking, says Doug Singbeil, FPIInnovations' Industrial Sector Leader for Bioproducts. It has involved extensive technical and economic reviews of processes and performance

data, and simulations of numerous technologies and conversion pathways. The options have coalesced into three preferred pathways. With the preliminary work wrapping up, the BELT project will move into 18 to 24 months of actual demo-scale trials with preferred partners that will be conducted at biomass conversion facilities around the world.

"The key is the yield," says Singbeil. "How much energy in the form of final liquid product can you get from a given amount of biomass, operating under as close to real-world conditions as possible? Where are the opportunities to reduce the losses and produce a final product with the lowest possible carbon intensity?" The objective, he says, is to come out of the trials with sufficient insights to help determine the feasibility of a facility like the one foreseen for La Tuque. "It's very much an engineering task," he says.

Neste Corporation, a Finnish-based global leader in renewable fuels, is a partner in the BELT initiative, and will be among the stakeholders with a keen interest in the findings.

Forest biomass is an attractive feedstock for renewable diesel, particularly in regions where it is in ample supply as a by-product of sustainable harvesting, with few if any alternative uses. Building a potential basis for economic diversification is a key objective of the project.

“IF WE CAN PUT THE TECHNICAL PIECES TOGETHER IN A FINANCIALLY VIABLE WAY, IT COULD REPRESENT A MAJOR OPPORTUNITY IN LA MAURICIE AND OTHER REGIONS LIKE IT”

“If we can put the technical pieces together in a financially viable way, it could represent a major opportunity in La Mauricie and other regions like it across Canada,” says Singbeil. He adds that as part of the BELT initiative, the

integration of a renewable diesel refinery into the regional ecosystem will also be assessed, from the standpoint not just of biomass, but also of electricity, water utilization, and other resource needs.

Renewable diesel fuel is chemically indistinguishable from the petroleum-based product and can be blended into the consumer supply chain without issue at any blending level. Biodiesel, in contrast, is produced from waste fats and oils and differs in important ways from fossil-based diesel fuel.

BELT participants are targeting eventual production of 210 million litres of renewable diesel fuel at La Tuque annually—representing about 5% of total diesel consumption in Quebec—which, from initial calculations, would reduce CO₂ greenhouse gas emissions by 575,000 tonnes annually. Such a facility would also create roughly 500 direct and indirect jobs in the local area.



SOUND ADVICE HELPS GET THE MOST FROM NEW KILNS



Following a multi-million dollar upgrade to Lavern Heideman and Sons' operations in Eganville, two new kilns were not meeting performance expectations. Fortunately, the company had an obvious place to turn for help, since John Pineau—who works with a team of FPInnovations industry advisors regionally dispersed across Ontario—had already checked in on how the project was unfolding.

"This is exactly the sort of challenge the industry advisor program is set up to handle," says Pineau.

"We help small and medium enterprises like Heideman with a process challenge or product development, and make practical, results-oriented recommendations."

Industry advisors can assemble top-notch and often difficult-to-access expertise, from both within and outside FPInnovations. In the case of Heideman, a methodical audit identified stacking, product scheduling, and other operational and equipment adjustments that got the kilns operating as they should.

"It worked very smoothly," says Vice President Kris Heideman, of the process of engaging the

FPInnovations team.

"They laid out a very detailed project plan and set goals, and it was tracked well.

The report at the end was excellent—it achieved what we

set out to do." The solutions provided, he adds, were very well tailored to Heideman's fibre supply and other specific circumstances.

As a result, Heideman has improved product quality, reduced moisture variability, and increased utilization of its white and red pine fibre. It also was motivated to become an FPInnovations member.

The industry advisors, Pineau says, are really "eyes and ears on the ground," each with a detailed understanding of member and industry needs in their regions. They continually look for opportunities to make value-added linkages and to put the research, market, and innovation capacities that reside within FPInnovations to practical use for companies such as Heideman.



Shining a light on awards and recognition at FPInnovations!



Lin Hu, Senior Scientist

2017 ISO Excellence Award and 2018 Wood Engineering Achievement Award: Engineering Innovation, for her contributions in the area of floor vibrations



Javad Saberian, Senior Scientist

Jasper Mardon Memorial Prize for Best Paper Contributing to the Advancement of Papermaking and runner-up at PACWEST 2018 conference for his paper, "Improving Runnability of Pulp Drying Machines"



Wadood Hamad, Principal Scientist and Research Leader

Fellowship of the Royal Society of Chemistry (FRSC) conferred by the Royal Society of Chemistry in the UK as well as FIMMM, and 2018 TAPPI Nanotechnology Division Technical Award



Talat Mahmood, Research Leader and Allan Elliott, Scientist

Douglas Jones Environmental Award, for their paper "Novel Approach to Recover Products from Ash"



Erol Karacabeyli, Principal Researcher

Recognized for his contributions to the Canadian Lumber Standards Accreditation Board (CLSAB)

Helping Indigenous Communities Grow Their Own Opportunities

Since 2016, FPInnovations has worked with the Toosey First Nation located in Risky Creek (near Williams Lake, B.C.) on several big projects, including providing support and advice on portable sawmill purchases, the feasibility of a firewood machine and associated business, housing needs, best practices for building Indigenous homes, bioenergy projects, and bridge panels.

The Toosey First Nation now owns three portable sawmills, a twin blade edger, and a moulder/planer. It is in the process of installing a kiln to dry its products.



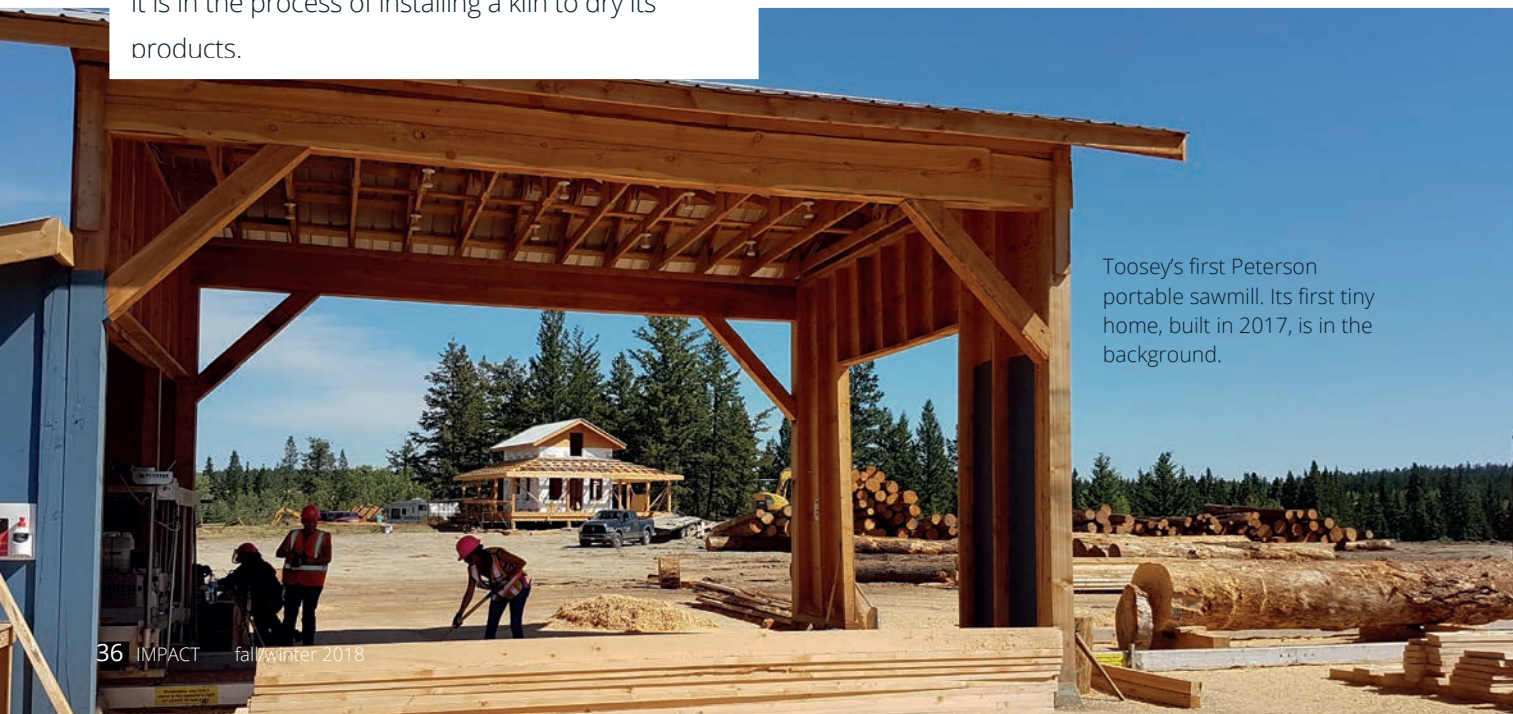
Bridge deck components being assembled by Toosey crew.

“

***IT IS A PRIVILEGE TO WORK
WITH THE TOOSEY FIRST
NATION IN THE DEVELOPMENT
OF THIS DIVERSIFIED ARRAY OF
PRODUCTS AND SERVICES.***

”

*Dave McRae,
FPInnovations National Indigenous Lead*



Toosey's first Peterson portable sawmill. Its first tiny home, built in 2017, is in the background.



FPIInnovations President and Chief Executive Officer, Stéphane Renou and Chief Francis Laceese during a visit held on August 15, 2018.



Mark Anson (FPIInnovations) is demonstrating the fire face equipment to Toosey First Nation staff.



“

**ALL OF THE STUDIES AND
ADVICE PROVIDED BY
FPIINNOVATIONS HAVE HELPED
US GROW AND GENERATE
SUCCESSFUL BUSINESSES.”**

”

Chief Francis Laceese, Toosey Indian Band



Mark Anson (FPIInnovations) is holding one of the Fire Faces.

Fire Faces

Thanks to financial support from the 2015 FPIInnovations Discovery Fund and the FPIInnovations Indigenous Forestry Program, a team of researchers and innovation support specialists from FPIInnovations developed and tested, with the Toosey First Nation, a specialized firewood product called Fire Faces. This innovative

approach enables the transformation of logging residual wastes that are difficult to dispose of, such as non-merchantable birch logs, into a commercial product.

From left to right: Jean-Pierre Martel (FPIInnovations), Darryl Fincham (Toosey First Nation), Chief Francis Laceese (Toosey First Nation), Dave McRae (FPIInnovations), Stéphane Renou (FPIInnovations), and Craig Kennedy (Toosey First Nation) during a visit held on August 15, 2018.

FORESTRY: A NEW FRONTIER FOR ROBOTICS DEPLOYMENT

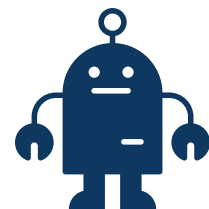
Robotics and forestry: It's an unfamiliar and exotic-sounding combination, and one that's currently getting very little research attention. FPIInnovations hopes its participation in the recently announced NSERC Canadian Robotics Network will change that.



Forestry is an especially challenging industry to introduce robotics into; much more so than agriculture or mining, for example, given issues such as difficult terrain, constantly shifting location of operations, and lack of internet connectivity. However, there are also potentially significant payoffs, including improved efficiency and safety.

As one of a number of industry partners in the new network, which includes a variety of industries and researchers from several leading universities, FPIInnovations hopes to engage more doctoral students and other leading minds in addressing the distinct challenges at the robotics and forestry interface.

Autonomous trucking is among the more promising applications that will be explored in the near term, while in the longer term there is potential for at least partial automation of harvesting equipment such as feller bunchers. Given existing labour shortages, robotics in forestry is more likely to help fill gaps—a significant further benefit—rather than result in job losses.





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