FOREST HARVESTING TRENDS & NEW TECHNOLOGIES

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FPInnovations is a not-for-profit world leader that specializes in the creation of scientific solutions in support of the forest sector’s global competitiveness.
FPINNOVATIONS

OUR NETWORK

347 M ha of worldwide forest managed

10% growing stock

47,320 M m³

> 60 B$ in revenue

200,000 + employees

125 M m³ annual harvest

37% of the world’s certified forests
Joint Venture FPInnovations, Domtar, Fibria, Schlumberger

- CelluForce is the world leader in the development and production of Cellulose NanoCrystals (CNC)
- The company operates the world’s largest CNC plant (300 t/year)
- $45 M

Development and Implementation of Electric Shuttle

- From initial concept to commercial product
- 20 vehicles in operation at Calgary Airport
- Stepping stone to autonomous electric shuttles
Trends & New Technologies
CHALLENGES AND TRENDS

- Fibre Costs & Value
- People & Safety
- Sustainability
- Fibre Supply
TRENDS AND NEW TECHNOLOGIES

CHALLENGES AND TRENDS

**Fibre Costs & Value**
- Sub-optimal equipment productivity and utilization
- The high cost of transportation
- Inadequate forest inventory information impending full value recovery decisions

**People & Safety**
- Aging operator and financial vulnerability of contractors
- Significant labor shortages
- High-risk conditions of forest operations

**Sustainability**

**Fibre Supply**
CHALLENGES AND TRENDS

**Sustainability**
- More demanding certification standards, government policies, and public expectations
- Pressure to reduce the carbon footprint of forest operations
- Adapt and better predict vulnerability of operations to climate change

**Fibre Costs & Value**

**People & Safety**
- Availability of fibre is shrinking
- The quality of the resource is decreasing
- Lack of fibre predictability

**Fibre Supply**

TRENDS AND NEW TECHNOLOGIES
THE KEY:
Advanced Technologies

“The future of timber harvesting systems will certainly be robotic. The question is, how to get there!”

Ren Visser, University of Canterbury
TRENDS AND NEW TECHNOLOGIES

OUR APPROACH – FORESTRY 4.0.

- Communication
- Harvesting
- Transport
Transportation

PLATOONING
AUTONOMOUS TRUCKS
OPPORTUNITIES IN TRANSPORTATION

Platooning

• Convoy of autonomous trailers

Autonomous Trucks

• Modular load (wood, chips, hog...)
• All wheels can turn
FREEWAY TRANSPORTATION

- Fuel Savings and reduced CO₂ emissions
  - Trucks connect together (different brand, owner, ...)
  - Coordinate speeds in order to safely reduce the gap between leading and following vehicles
  - 7.25% fuel saving and CO₂ emission reduction

- Reduced congestion, improved safety

FOREST OPERATIONS

- Reduce the impacts of driver shortage
  - 2-3 trucks, always connected (one contractor)
  - Only one driver for the convoy (lead truck)

- Safety
RADAR: DETECTION OF DISTANT OBJECTS AND MEASURE THE DISTANCE WITH THE TRUCK IN FRONT OF IT

DSRC COMMUNICATION: SHARE THE INFORMATION WITH THE OTHER VEHICLE IN THE CONVOY

GPS: MONITOR TRUCK’S TRAJECTORY

CONTROL OF ACCELERATION AND BRAKING
COMMUNICATION

V2V  Vehicle to Vehicle
V2I  Vehicle to Infrastructure
V2N  Vehicle to Network
V2E  Vehicle to Enforcement
V2X

Standard V2V may not be adapted to forest environment. V2V radios crucial for vehicle autonomy.

Test various radio frequencies to determine best suited for forest environment.
Platooning Demonstration project by FPInnovations

November 2018, Quebec, Canada

Click this link to see the video
FPINNOVATIONS’ AGENDA TO AUTONOMOUS TRUCK

CONTROLLED ENVIRONMENT

OPEN ROAD

AFTER-MARKET AUTONOMOUS KIT (AK)

OEM AUTONOMOUS TRUCK

Source: Volvo
OTHER SECTORS

TRANSPORTATION

Source: ASI Robotics

Source: Perrone Robotics
AUTONOMOUS TRUCKS

- **GPS**
  - Position

- **CONNECTIVITY**
  - VtoV, VtoI, VtoN, VtoE

- **LIDAR**
  - Vision capability of the system in conjunction with the cameras

- **CAMERA**
  - Remote supervision by a human

- **RADAR**
  - Detecting metal and high water material (and people)

- **COMPUTER**
  - Compute the data, take decision and transfer the command to the system (DBW)
ROADMAP TO AUTONOMY

TRANSPORTATION

**CONTROL**
Move vehicle robotically

**SENSE**
Perceive world: tasks and rules to follow

**ACT / INTEGRATE**
Custom actions + test/tune standard maneuvers

**TRIALS**
Field tests

**DEPLOY**
Single site
4

Harvesting
CHALLENGES IN HARVESTING

Tree Harvesting

- Random tree position and odd shape of trees
- Navigation on uneven ground with obstacles
- High dynamic forces
- Harsh environment

Log Extraction

- Uneven pile shape and position
- Navigation – routing on uneven ground
- Avoiding rutting and sinkage in soft ground
- Multiple log products
Logging Equipment Manufacturers

• Business case for investing in automated / autonomous equipment
  • Required investments
  • Lack of large scale market

Opportunity to leverage development done in other sectors

• Mining, Military, Ports, Agriculture
• Sectors with large scale markets and that have benefited from important investments and R&D
OPPORTUNITIES IN HARVESTING

Teleoperation

Automated Functions

Autonomous Machines

Source: ARA

Source: Ola Ringdhal

Source: John Deere

Source: Scion
Teleoperation

- Dangerous terrain (steep slopes, dangerous sites), limited to specific actions (skidders), stationary.
- Challenges are real-time communication and sensors
- Applied Research Associates (ARA)
  - Develop a teleoperated CAT 521B Feller Buncher
  - Clear approximately 2,000 acres of wooded target ranges at Ft. Bragg
  - Operators were sitting in a trailer far from the dangers
  - 25% slower than traditional cutting

Automated Functions

- Some tasks are performed by humans, while some are performed by the machines
- Automation introduced to reduce workload and improve productivity
  - Tree processing
  - Intelligent boom Control (John Deere)
- Semi-autonomous system: Konrad Pully
  - Runs along a wire
  - Loaded by the harvester and unloaded by a loader

Source: Elmia
Source: Konrad
ENABLING TECHNOLOGIES
AUTOMATED AND AUTONOMOUS MACHINE

COMMUNICATION
Share information
• Machine to Machine
• Machine to Network
• Machine to Infrastructure

NAVIGATION
Move in the environment
• Localization
• Identify obstacles
• Find the best route
• Decision making

OBJECT RECOGNITION
& MANIPULATION
Make required tasks
• Identified trees
• Manipulations
• Processing
• Decision making
COMMUNICATION

Challenges

• Need to develop and implement communication systems in resource operations to enable Industry 4.0 concepts
• Desire for real-time or near real-time data communications
• Desire to use smartphones from operations
• Need V2X systems adapted to forest environment to enable modern vehicle safety and higher level autonomy
COMMUNICATION

Solutions for operations that are very remote

- Working with wireless technology provider that specializes in implementing local cell networks for remote areas
- Pilot project to be implemented in Haute-Mauricie region of Quebec, to be implemented in 2 or 3 harvest crews
- Microwave system for backhaul to network
Solutions for operations that are near networks

TECHNOLOGY DEVELOPMENT

*Boosted cellular system with local WiFi access point*

CONNECTED CUTBLOCK

*Wireless Internet connectivity for mobile devices within the cutblocks*
1. Forest inventory and hazard map
   - EFI at the stem level
   - DTM (highlighting hazard area)
   - Predefine route

2. Real time sensing and processing (SLAM)
   - As the machine travel in the block, sensor perceive the environment and computer process data

3. Decision making
   - Based on all data available algorithm calculate the optimal path for the mission

4. System control
   - Transfer decision into mechanical action
Example - Forwarder

- Detects logs on the ground using LIDAR
- Position the log vs the equipment
- Identify the best approach to grasp the logs
- Load the logs in the basket
Closing Remarks

We will get there!
We live in a world of bytes!

Source: Visual Capitalist
ACCELERATING TECHNOLOGICAL PROGRESS

Major Forces Shaping the Global Economy

Speed of change getting faster

Source: Forrester
But, markets are able to adopt new technologies faster.
Major Forces Shaping the Global Economy

FORESTRY 4.0. - OUR OBJECTIVES

In 2025, Forestry 4.0 will be...

25

**MILLION M³,** harvested by automated forest machines!

15% annual harvesting in Canada

**MILLION KM,** driven on forest roads by autonomous forestry trucks!

15% annual harvesting in Canada

**MILLION $/WEEK,** in additional value created by only cutting trees needed to satisfy a customer!

15% annual harvesting in Canada
**CLOSING REMARKS**

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<th>TECHNOLOGIES</th>
<th>WHAT &amp; WHEN</th>
<th>OTHER CONSIDERATIONS</th>
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<td>• Hardware already exists</td>
<td><strong>ECONOMICS WILL BE THE MAIN ADOPTION DRIVER</strong></td>
<td>• Safety</td>
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<td>• Software needs to be adapted and/or developed in most cases</td>
<td>• Short term</td>
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<td>• Leverage development done in similar sectors</td>
<td>• Platooning</td>
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