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FPInnovations' industry-driven R&D program in forest operations

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Presentation

- Overview of FPInnovations and program development approach
- Case studies of innovation project development & implementation
  - FPSuite™
  - Road Safety Inspections
- Exciting developments coming from the Forest Operations program

FPInnovations in Brief

Canada's forest sector research institute

500+ employees

Annual budget: $90 millions CAD

Research across the forest sector value chain

Expertise & innovation programs in

- Forest Resource Assessment
- Forest Operations
- Solid Wood Products
- Pulp, Paper and Bioproducts

100+ patented technologies and processes

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FPI - Member Supported Innovation

- A partnership between industry and federal & provincial governments
  - *Pooled investment creates critical mass*
  - *Shared priorities, technical risk and benefit*
- Members/Partners include:
  - *Over 300 forest companies*
  - *10 Provinces*
  - *Federal Government*
- Members set priorities, FPI delivers results
  - *ROI typically 3-7 times after-tax investment for industry member*

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Some Members of FPInnovations

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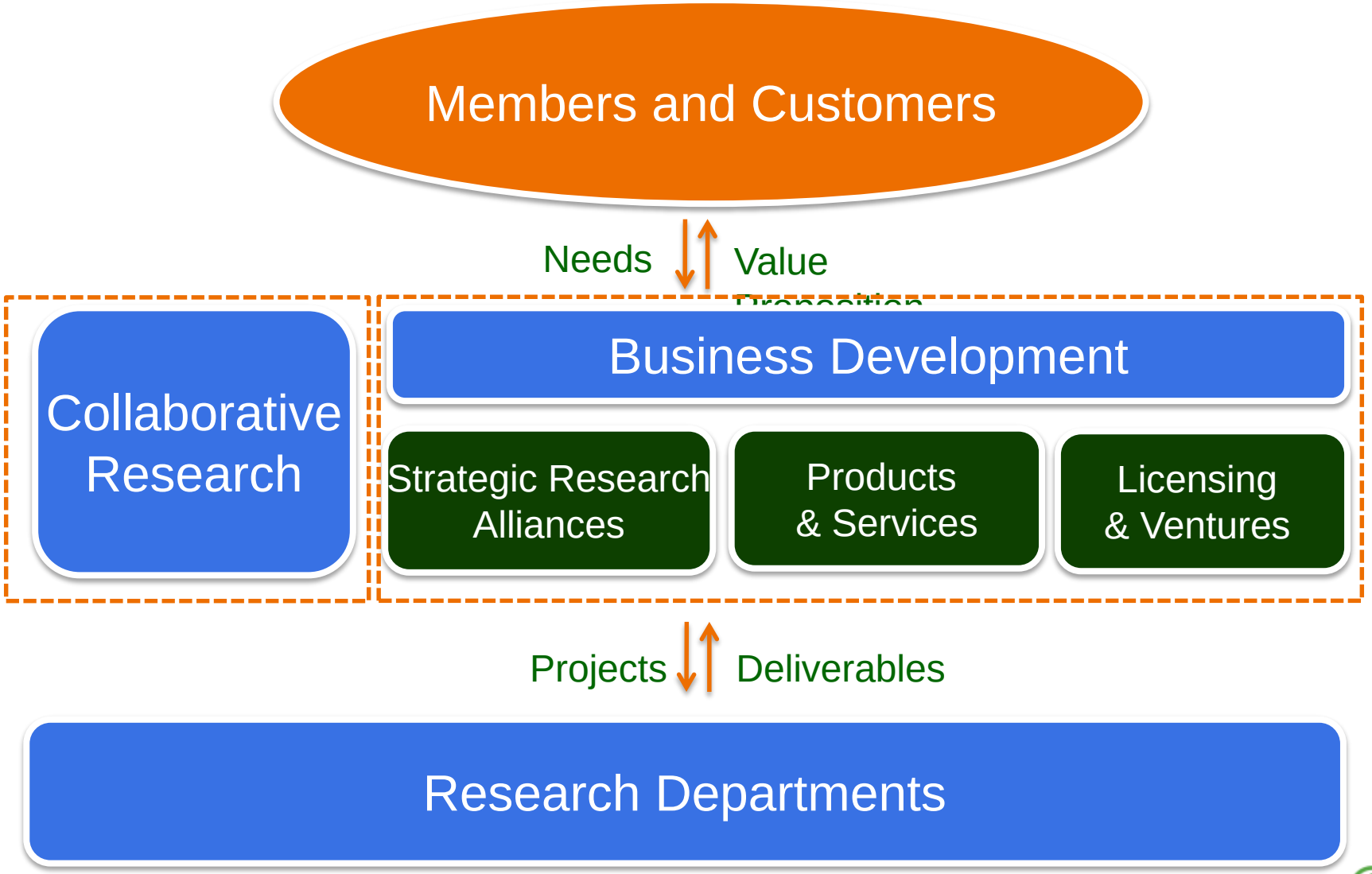
FPI Business Model



Managing Product Innovation

- Implemented 5 disciplines of innovations developed by SRI International
- Key elements for high impact research and development
- All projects undergo NABC evaluations

Important customer and market needs | Value creation | Innovation champions | Innovation teams | Organizational alignment

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The NABC – cornerstone of projects

Needs
- What issues/needs are we trying to address?
- Who is needs this?

Approach
- Is the approach technically sound?
- Risk & probability of success?

Benefits
- What will be the impact of the project ($)?
- How widely will the results be applicable?

Compe-tition
- Are there alternatives to achieve the same results?
- What is the impact of « not doing »

Ranking Criteria for projects

Criteria	Weight
Probability of Success (Risk)	
- Technical Risk	10
- Fit with skill set & competencies	10
- Implementation/capital Cost	10
Potential Reward	
- Potential Benefit	15
- Potential impact	15
Resources Required	15
Urgency	25
Total Points	**100**

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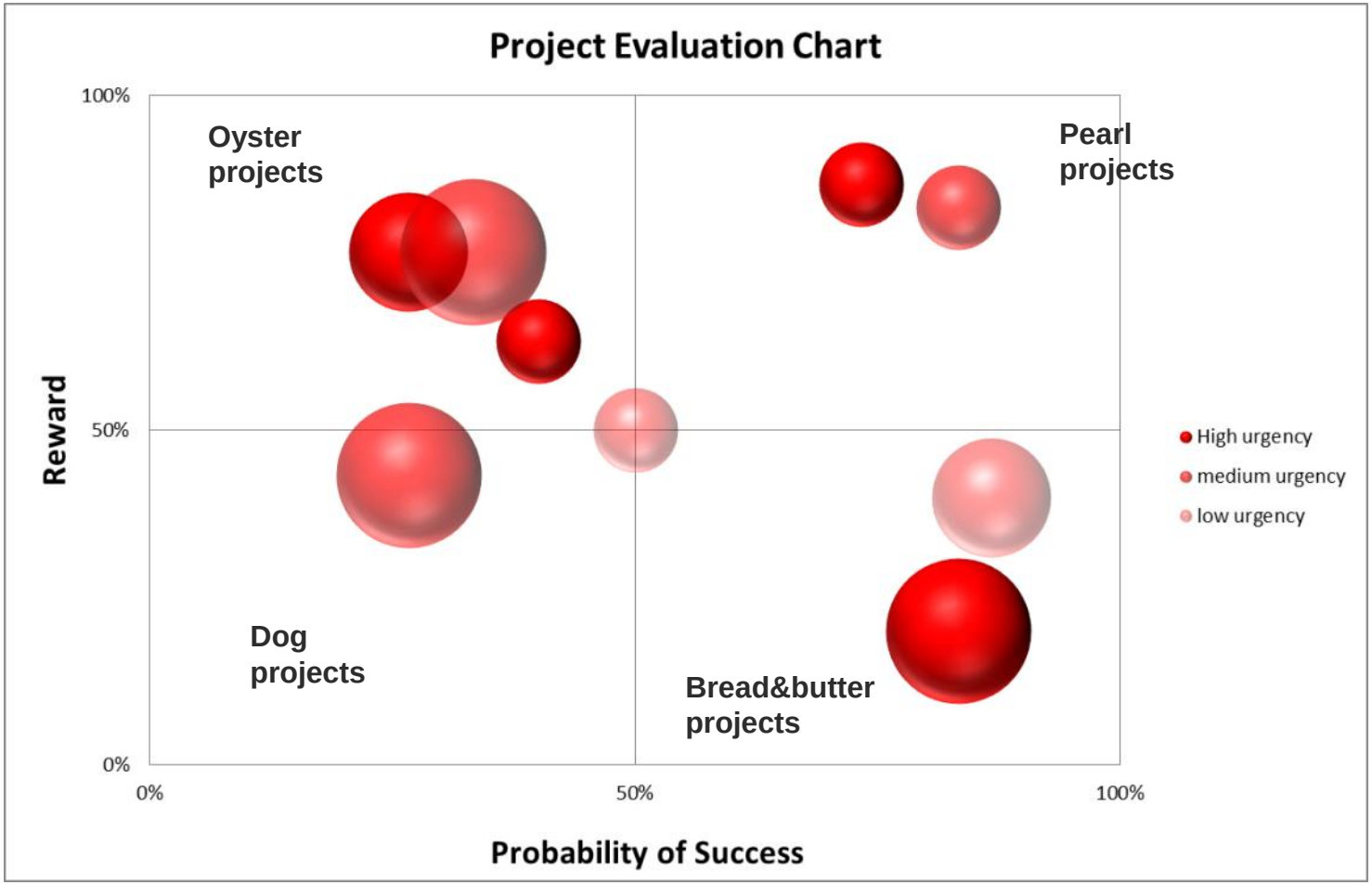
Project ranking - Visual Representation



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2 Case Studies

FPSuite™

Road Safety Inspections

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Case Study No. 1 - FPSuite

The Needs

- Lack of accurate, real-time operational data from forest operations for better process control
- Need to be able to send new work instructions to the job sites
- Poor wood flow tracking systems to facilitate planning and truck scheduling
- No cellular coverage (limited availability in Canada)

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FPSuite

The Approach

- Hardware/software development program started in 2009
  - Acquire data on the complete forest supply chain
  - Transmit data automatically to the office
  - Monitor production at different phases
  - Centralize information
  - Facilitate continuous improvement & efficiency gains

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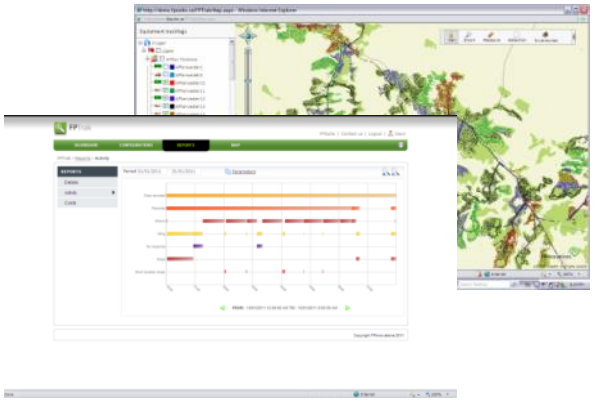
FPSuite™



FPDat™

- ✓ Data logger for heavy equipment
- ✓ High precision GPS specialized for forestry conditions
- ✓ GPS navigation and KPI display
- ✓ Activities & downtimes tracking
- ✓ Basic production tracking

FPCom™

- ✓ Automated data download & transfer
- ✓ Satellite option
- ✓ Cellular option
- ✓ Wi-Fi
- ✓ Track log exchange between machines

FPTrak™

- ✓ Web portal and data hosting service
- ✓ Tabular, chart & graph reports
- ✓ Drill-down capabilities
- ✓ Map display of operational progress
- ✓ Centralized platform

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FPSuite™

The Benefits

- Reported 5-10% efficiency gains
- Reductions in lay-out costs
- Elimination of tresspass incidents
- Facilitated planning
- Real-time tracking of operational progress (cut areas)
- Improved truck scheduling

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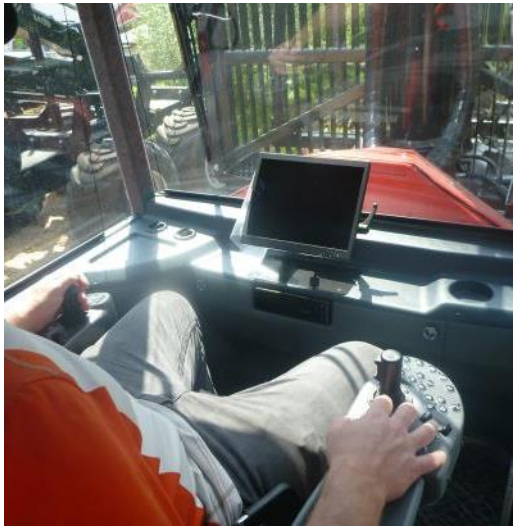
FPSuite™

The Competition

- OEM systems
  - Specific to brand
  - Mainly cellular-based
  - Variable definitions (PMH)
- Other commercial systems
  - Not specialized for forestry
  - Less functionalities



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FPSuite™ - Summary

- NABC highly effective to support this project
- Successful innovation with widespread implementation across Canada
- Nearly 500 systems in use, less than 2 years after introduction on the market
- Great feedback & testimonials from users
- Flagship product for FPInnovations

Case Study No. 2 – Road Safety Inspections (RSI)

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Road Safety Inspection

The Need

- Increasing collision frequency on resource roads causing serious or fatal injuries because of increased traffic (Forestry + Mining + Oil & Gas)
- Many roads are not designed for a desired travel speed or traffic flow
- Urgent need to assess and increase road safety by reducing accidents and collisions
- A systematic approach to assess road safety and prioritize upgrades and traffic control measures was needed

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Road Safety Inspection

The Approach (From R&D to full implementation)

2008

- Road scanning Pilot Project
- Sight distance calculation module prototyped in third party software (horizontal and vertical alignment, sight distance, running surface width and pullout locations, signage, etc.

2009-10

- Demonstrate the application of georeferenced videography and laser scanning
- Develop methods for analyzing the data and reporting
- Sight distance module programed in Trimble Trident Analyst

2011-12

- Full-scale implementation in actual resource road applications using a fee-for-service approach

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Road Safety Inspection

Mobile Mapping System (MMS) Technology

- One or Two laser scanners (LiDAR)
- Multiple or one 360 degree high definition video cameras

- High precision GPS
- Navigation: Inertial Measurement Unit (IMU)

- Distance Measurement Instrument (DMI)
- Data collected at speeds up to 50 km/h

- Live video feed for real time monitoring and calibration
- Frames captured at 5-6m intervals in .AVI or .JPG format

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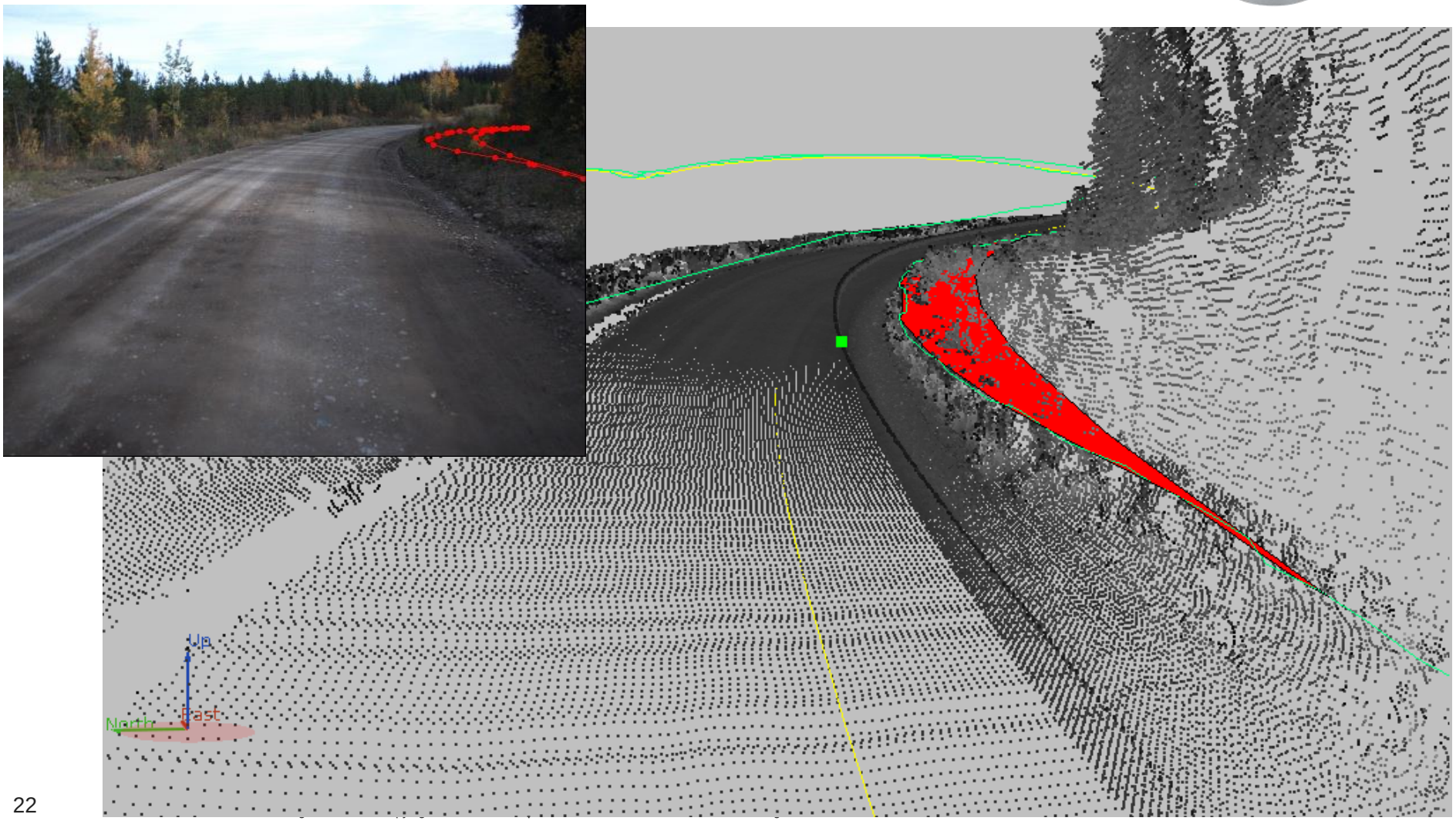
Road Safety Inspection



Road Safety Inspection

The Benefits

- Can scan over 100 km per day
- Prioritization of upgrades
- Inventory of assets (signs, bridges, etc.) and LiDAR for other upgrades
- Represents a due diligence for safety and therefore reduces liability
- Methodology is safe with minimal impact on traffic

Before **After**

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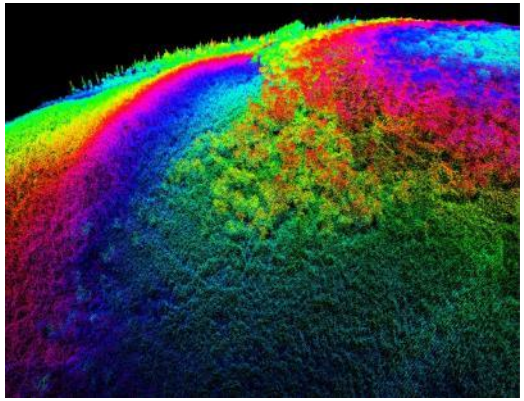
Road Safety Inspection

The Competition

- Old-fashioned surveys!
- Aerial LiDAR may provide adequate point cloud density at a much lower cost and wider land base cover.
- High resolution video cameras may also offer suitable data at a much lower cost than using LiDAR



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Road Safety Inspection - Summary

- Since 2008, FPI has performed over 1100 km of RSIs across Canada
- NABC approach provided strong business case for the project at the time (new technology may make obsolete today)
- Post upgrade assessment and interview with users revealed improved road safety
- Success has led to contract-revenue for RSI services

Key Learnings

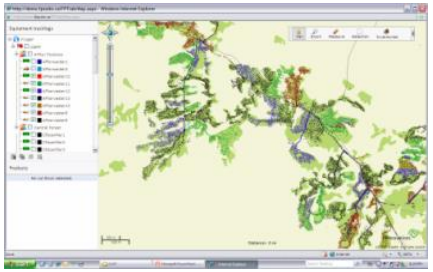
- The 2 case studies demonstrated the power of SRI's NABC approach + collaborative research model
- R&D projects that are driven by actual needs have the best chance at rapid implementation
- FPInnovations' needs-driven research has shown tangible uptake and value delivery with its members
- Does not preclude some "curiosity-based" research to increase the collective knowledge base of the scientific community and generate unplanned innovation
- Approach led to many innovation projects in FPI portfolio

Exciting developments coming from the Forest Operations program

Harvesting Operations

Road construction

Silvicultural Operations



Precision forestry

Transportation

Forest biomass

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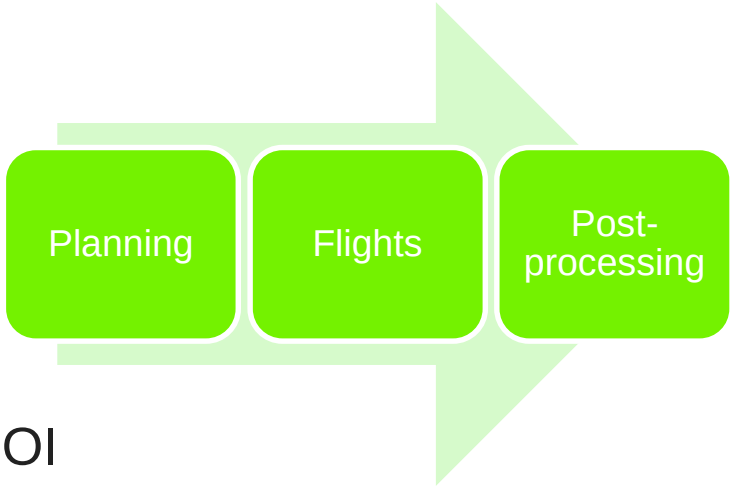
Unmanned Aerial Systems (UAS)
Potential applications

- Needs
  - Planning, prescriptions, layout, monitoring and compliance
  - Operational planning and reporting at the block level
  - Niches:
    - Timely, low cost info
    - Autonomy
    - Safety
- Approach
  - Validation based on total workflow
  - Identify best applications based on ROI



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Unmanned Aerial Systems (UAS)
Potential applications

Visual inspections

- Live image, photos and videos for control and planning

Area based assessments

- Ortho mosaic

3-D point cloud analysis

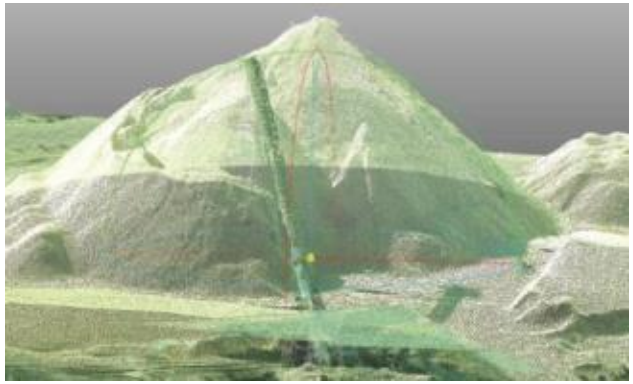
- Volumetric calculations

Multi / Hyper spectral

- Tree health / species

Hot spot detection (IR)

- Fire mop-up



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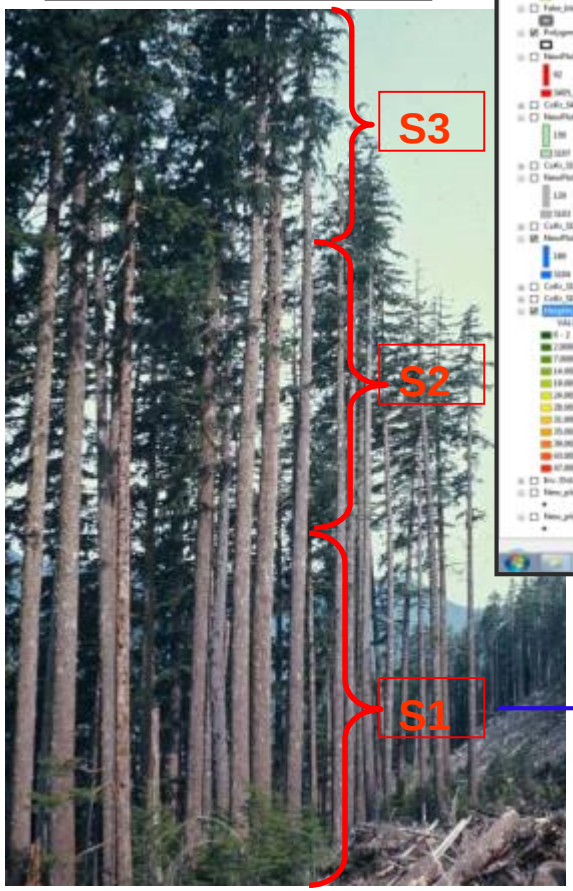
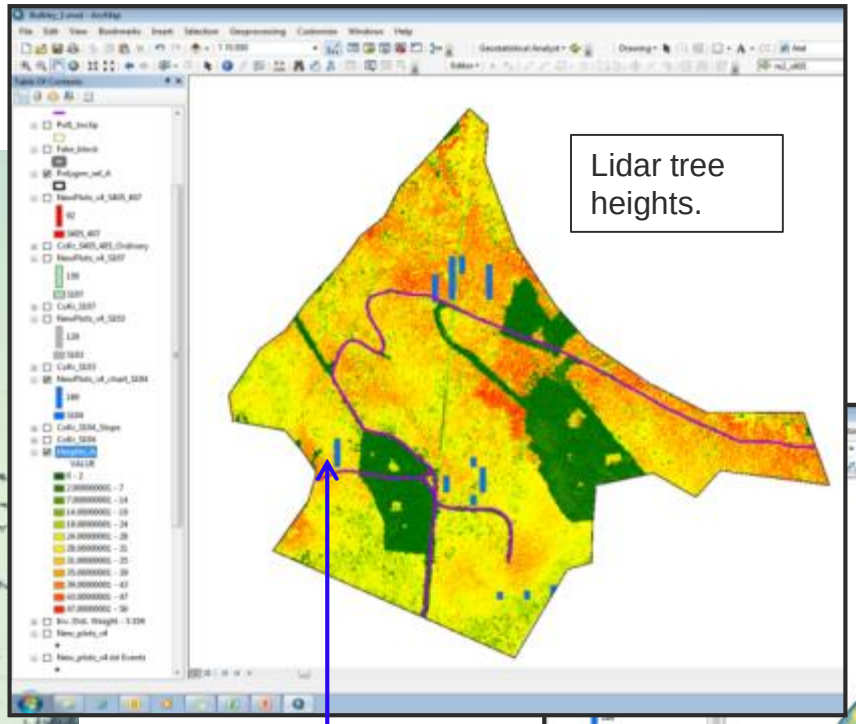
Mapping Stand Volume and Value: Enhanced Inventory by Log Sort

New Compilation and Cruising (NCCruise) model

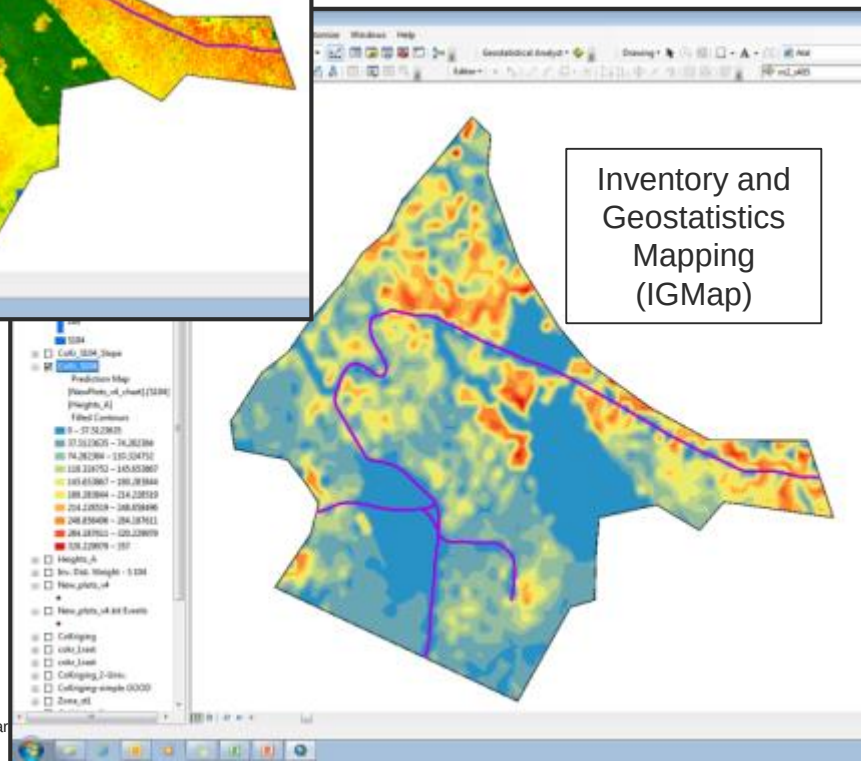




Lidar tree heights.

Volume (m3/ha) of **Sort x** over the entire area.

Volume (m3/ha) of Sort x at each plot (blue bars).



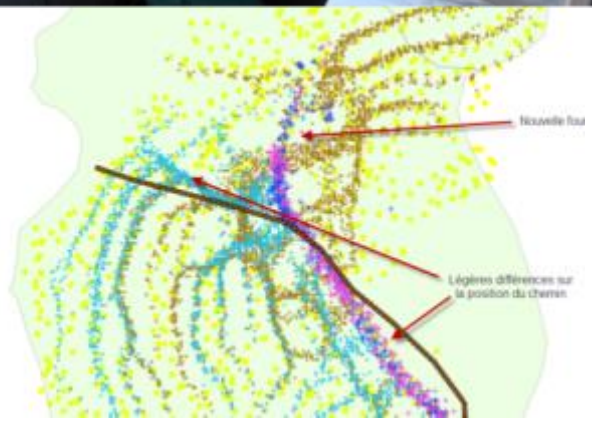
Inventory and Geostatistics Mapping (IGMap)

Tool for assessing forest net worth

- New & simple tool for assessing net value of forest blocks
- Integrates results from FPInterface/Optitek to assess the net values
- Could be used for bidding on timber sales
- Will provides many KPIs to decide to bid (or not)
- Currently in testing mode

The Power of On-Board Computers

- Use harvester OBCs to easily get quality data for:
  - Managing harvested volumes by product
  - Analyzing costs relative to forest conditions
  - Better planning
- Use with FPSuite to manage harvesting systems bottlenecks



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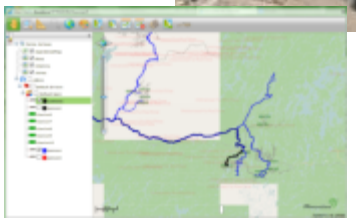
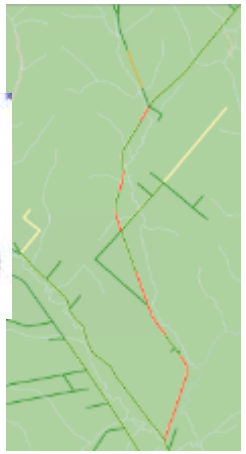
What's next?
The Full supply chain

- Trucking phase: **FPDat Transport**
  - Key features: cycle time, geozones, e-logbooks
- Road maintenance: **FPDat Grader**
  - Blade sensor
  - Grading instructions sent to operator by satellite modem
- Leveraging existing onboard computer files with FPDat
  - FPTrak for centralized monitoring





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Performance tracking device for manual operations

- Inspired by health/performance devices to monitor personal progress
- GPS position, heart rate, sound level and time tracking
- Treatment specific algorithm development to produce reports on area covered, productivity, work effort and calorie management

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Steep Slopes Initiative (Safety/Productivity)

- Mechanize – get workers off the hillside and into protected cabs
- Stability testing to develop a machine rating system for due diligence
- Winch-Assist equipment to permit operations up to 100% slope
- Grapple systems, small mobile yarders, cameras, gps

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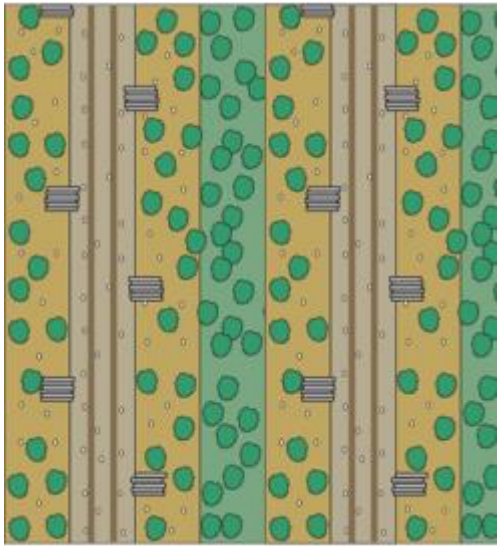
Innovative Partial Cutting Applications

- Operator-friendly 123 method
- Multi-treatment in heterogeneous stands
- LiDAR maps to help prescription
- Thinning in Ungulate Winter Range



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Improved Environmental Performance of Resource Roads

- Wetland road best practices
  - Develop and monitor road designs for bearing and cross-road drainage
  - Develop national BMP guide (2016)
- Practical operations training
  - Erosion & sediment control
  - Water crossing installations
- Supporting members in maintaining SFI/ SFC certification

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Infrastructure Analysis for Increased Payloads

- Advanced pavement modeling for winter weights
- Review of winter weight bridge load ratings.
- Extended haul season in NS, ON, MB, BC with TPCS.
- Infrastructure impact analyses for new truck configuration applications.

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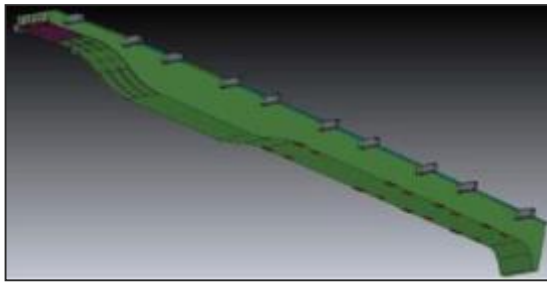
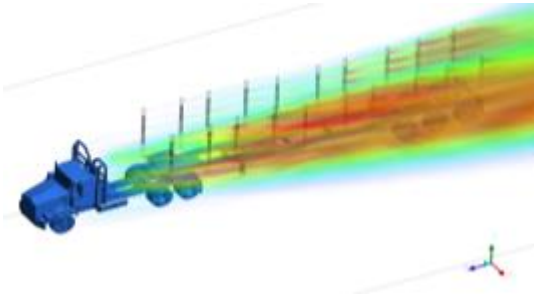
New innovations for truck-trailer design

- Innovative use of advance materials to reduce tare weights:
  - Composite Stakes & Bunks
  - Composite panels for chip trailers
  - Composite panel cab protector
- Lightweight trailer of the future
  - Replace standard frame with monocoque composite materials design: 1.5 t reduction
- Advanced Aerodynamics
  - Use CFD analysis, wind tunnel testing and track test to optimize aerodynamic design of truck and trailer components





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Innovative tools and methods to improve feedstock quality

- Biomass drying methodologies
- Moisture meter implementation
- Log yard biomass reclamation
- Hog fuel classification
- Biomass sampling guidelines

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Thank you!

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