Collaboration Through the Wood Supply Chain. Canada’s Strategic Network on Value Chain Optimization (VCO).

Dr./Prof. Reino Pulkki
Faculty of Natural Resources Management
Lakehead University, Ontario, Canada
Outline

- Focus on Canada
- Motivation for establishing the VCO Network
- Outline of the VCO Network
- Review of some accomplishments and research projects
The Canadian forest industry

- has traditionally produced commodity products
- is facing challenges of:
  - increased production costs
  - shifting of input factors to other sectors of the economy
  - lack of coordinated and integrated supply chains
  - decline in capital available to improve existing facilities or build new ones
The Canadian forest industry

- has endured major restructuring with many mill closures and major job losses
- direct job loss 2005 to 2011 → 105,700 (NRCan) (339,600 down to 233,900)
- over 200 mill closures
Competitiveness in the New Bio-economy

- must maximize the value of timber harvested, minimize operating costs and improve supply chains
- variability in species, stem size and wood quality can produce a variety of products with a range of values
Competitiveness in the New Bio-economy

- some values given by Dr. Tom Browne of FPInnovations in regard to the petroleum industry:
  - 4% of product volume generates 42% of value
  - 70% of product volume generates 43% of value
Motivation

- Canadians are looking to the forests to provide innovative and renewable source of materials and energy that can be a fundamental strength of the modern Canadian bio-economy.
- The low cost commodity business model is not sustainable.
- The modern bio-economy recognizes that the task is to extract the maximum possible value from the forest and to do so in a manner that preserves the forest as a sustainable resource for future generations of Canadians.
Fragment Research Environment

Forest Sector Research pre-2007

Source: Schmidt, J. 2013
Rebuilding Canada’s Leadership

Knowledge & innovation

Transformed forest sector

Optimized forest sector

http://www.blueoceanstrategy.com/
NSERC Forest Sector Research and Development Initiative

There will be no further competitions for this initiative. Research in the forest sector will continue to be funded under NSERC’s regular Research Partnerships Programs—such as the Collaborative Research and Development Grants, Industrial Research Chairs, Strategic Projects Grants (forestry research is covered under the “Natural Resources and Energy” target area), Interaction Grants and Engage Grants.

Read more about the NSERC Forest Sector Research and Development (R&D) Initiative.

<table>
<thead>
<tr>
<th>Overview</th>
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<tbody>
<tr>
<td><strong>Duration</strong></td>
<td>Various, up to five years</td>
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<td><strong>Application Deadline</strong></td>
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</table>
NSERC Strategic Network on Value Chain Optimization (established 2010)

FOREST
(e.g. suppliers, entrepreneurs)

PRODUCTION & DISTRIBUTION
(e.g. mills, carriers, warehouses)

MARKET
(e.g. customers, builders, printers)

Coordination mechanisms

VALUE

CHAIN

OPTIMIZATION
Mission

- The **urgent** mission of the NSERC VCO Network is to improve the Canadian forest industry **competitiveness** through forest and business innovation by training the best **highly qualified personnel** in the emerging field of value chain modelling and by providing **analysis tools** and decision support for optimization of the modern forest bioeconomy networks.
Key objectives of the VCO (1/2):

- Support decision-makers in their effort to design new and optimized sustainable forest bio-economy networks
- Increase value gain from forest and asset utilization by developing decision support tools for integrating the entire value chain
- Improve competitiveness through a structured and coherent implementation of new and optimized value propositions and business models
Key objectives of the VCO (2/2):

- improve agile execution and value capture throughout the business networks
- develop a culture of analytical decision-making in the forest bio-economy.
Research focus (1/2):

- network researchers will contribute to science and engineering knowledge by developing advanced methods for designing and planning complex forest value chains
- designing resilient and sustainable forest value chains and business models
- planning large-scale, multi-objective and stochastic forest value chains
Research focus (2/2):

- planning distributed and collaborative forest value chains
- designing proactive and agile logistics and manufacturing systems for the forest value chains
- designing a knowledge-based framework for forest value chain integration (e.g., spatial, temporal, decisional)
Forest Products Value Chains

D’Amours, 2011
What is value chain optimisation?

- Business model
- Decision process
- Implementation and best practices
Benefits

• methods to identify **sustainable strategies for the transformation of Canadian forestry companies** to improved business models through a systematic analysis of value chains

• **highly qualified personnel** capable of supporting the transformative processes required today

• innovative decision support systems to **sustain a continuous re-engineering process**.
Strategic forest-industry planning: long term sustainable and competitive advantage

T1: Regional strategic analysis capacity: BC Coastal, Hardwood, Boreal Forest

T1: VC long term forest-Industry strategies: tenure, logistics systems, capacity, long term planning, capital, investment, disturbance and uncertainties, bioeconomy, ecosystems, economy of scales

Business models: creative, sustainable, agile, and demand driven

T3: Design of VC Vertically integrated, collaborative VC Flexibility, mass customization, intermodal infrastructure, holistic forest value chain model

T2: Planning of VC Value chain policies, Sales and operations, Differentiating forest products, community forestry, forest planning for multiple values

Integrated planning: new planning and control systems, methods and algorithms

T4: Logistics forest-to-mill: merchandizing yards, harvesting, truck movements

T4: Transportation: planning, intermodal

Real-time operations forest-to-market: hardware and software integration

T5: Integrated framework for VC modeling, knowledge sharing, Stochastic modeling, agent-based simulation, forest products information
Theme leaders

• **Theme 1. Integrated forest and industry strategies for the modern bioeconomy**
  – Eldon Gunn & David Martell
  – industrial engineering and forestry
  – Dalhousie University and University of Toronto

• **Theme 2 & 3. Integrated value chains**
  – Robert Kozak & Paul Stuart
  – wood science and chemical engineering
  – University of British Columbia and École Polytechnique

• **Theme 4. Optimized value chains**
  – Reino Pulkki & Bernard Gendron
  – forestry and operational research
  – Lakehead University and Université de Montréal

• **Theme 5. Knowledge modeling and sharing**
  – Sophie D’Amours
Forest, Industry, Energy and Environment Policies

Forest, Assets and Value Proposition Management

Operative Planning

Companies

Governments & Communities

Value Chain

Forest, Inbound, Mills, Outbound, Sales

operations, logistics, logistics, logistics, operations
Governance

- Board of Directors
- Steering Committee
- Scientific Committee
- 8 Theme leaders
- Scientific director and support team
- Network liaison manager
Four years later...

Forestry, Wood science, Forest operations, Chemical engineering, Industrial engineering Computer science and OR, and Business

FPInnovations, NRCan CFS, FPAC, Resolute Forest Products, Tembec, Domtar, Kruger, Western Forest Products, Catalyst Paper, Canfor Pulp, West Fraser, Maibec, Atikokan Generating Station, Environment Canada, Comet, Biorefining, CRIQ, WWF

Web-site, Intranet, Workshops, Webinairs Summer Schools, VCO book project
### Actual Research Program – to-date

<table>
<thead>
<tr>
<th>Theme I</th>
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## Update on Communication & Transfer Plan

### Accepted Transfer Projects Update Progress

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<th>Project Title</th>
<th>Investigator</th>
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<tbody>
<tr>
<td>TP01 Optimal Planning/Scheduling of Lumber Finishing Operations at Maibec</td>
<td>Jonathan Gaudreault</td>
<td>• Maibec • PMP Solutions</td>
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<td></td>
<td>Université Laval</td>
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<tr>
<td>TP02 Business Transformation Along the Value Chain</td>
<td>David Cohen</td>
<td>• Up to 30 European and North American companies and experts interviewed.</td>
<td>Completed/Report Submitted</td>
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<td>University of British Columbia</td>
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<td>TP03 Modeling Ideal Settling Schedule for Homogenizing Moisture Content of</td>
<td>Muhammad Afzal</td>
<td>• FPInnovations</td>
<td>In progress</td>
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<tr>
<td>Comminuted Biomass from Various Sources.</td>
<td>University of New Brunswick</td>
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<td>TP04 Analysis of Forest Biomass Supply Chains</td>
<td>Taraneh Sowlati</td>
<td>• FPInnovations • Potential Partners • Western Forest Products • BCTS • Ledcor</td>
<td>In progress</td>
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<td>University of British Columbia</td>
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<td>TP05 Optimal Procurement Strategy for the Transports of Logging Debris for</td>
<td>Gary Bull</td>
<td>• Ledcor</td>
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<td>Bioenergy Generation</td>
<td>University of British Columbia</td>
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<td>TP06 Real-time transportation and logistics systems planning and control</td>
<td>Bernard Gendron</td>
<td>• FPInnovations</td>
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<td>Université de Montréal</td>
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<td>TP07 A Strategic Planning Model for Environmental and Economic Outcomes</td>
<td>Eldon Gunn</td>
<td>• Nova Scotia Department of Natural Resources • Swedish University of Agricultural Sciences (SLU)</td>
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<tr>
<td></td>
<td>Dalhousie University</td>
<td></td>
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<td>TP08 Development of a user-friendly interface and practical application of a</td>
<td>Reino Puukki</td>
<td>• GreenForest Management Inc. • Central Computer Services Inc.</td>
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<td>DSS built for forest management and operations strategic, tactical and</td>
<td>Lakeshead University</td>
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<td>operational planning and control</td>
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<td></td>
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<tr>
<td>TP09 Development and implementation of an ABC method to support decision</td>
<td>Mikael Rönqvist</td>
<td>• Maibec</td>
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<td>making for planning operations</td>
<td>University of Laval</td>
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<td>TP10 Industry Workshop: Life Cycle Analysis for Forest Biorefinery Evaluation</td>
<td>Paul Stuart</td>
<td>Potential Partners • West Fraser • Alberta Innovates • Domtar</td>
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<td></td>
<td>École Polytechnique de Montréal</td>
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### Update on Communication & Transfer Plan

#### Revision of the Transfer Project Proposals

| TP11  | Decision Support System for Annual Harvest Scheduling | Bernard Gendron  
Université de Montréal | • FPInnovations | Accepted |
|-------|------------------------------------------------------|------------------|----------|----------|
| TP12  | Evaluating a decision-making framework for the analysis of investments, production and supply strategies / Application d’un cadre décisionnel pour l’analyse d’investissements, de stratégie de production et d’approvisionnement | Jonathan Gaudreault  
Université Laval | • FPInnovations  
• Coopérative Forestière Ferland-Boilée  
• FORAC | Accepted |
| TP13  | Dock and Driver Scheduling in a Timber Transport Supply Chain | Louis-Martin Rousseau  
École Polytechnique de Montréal | • FPInnovations | Accepted |
## Update on Communication & Transfer Plan

### International/Inter-university Internships

<table>
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<tr>
<th>Project No.</th>
<th>Title</th>
<th>Student</th>
<th>Hosts (s)</th>
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<td>2-3.14</td>
<td>Transformation Along the Value Chain</td>
<td>William Nikolakis University of British Columbia</td>
<td>Up to 30 European and North American companies and experts interviewed.</td>
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<td>4.19AS</td>
<td>Integrating Annual Harvest Scheduling, Transportation and Inventory Management</td>
<td>Géraldine Gémieux Université de Montréal</td>
<td>Andrés Weintraub University of Chile, Chile.</td>
<td>Completed</td>
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<td>1.7</td>
<td>Heureka Development and Modelling</td>
<td>Andrew B. Martin Dalhousie University</td>
<td>Tomas Lamas Swedish University of Agricultural Sciences, Sweden.</td>
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<td>2-3.25AS</td>
<td>Impact of Climate Change Policy Scenarios as well as others Scenarios in the Selection of Sustainable Forest Biorefinery Strategies.</td>
<td>Dieudonné Romaric Batsy</td>
<td>Marilyn Brown School of Public Policy at Georgia Institute of Technology, USA.</td>
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## Update on the Communication & Transfer Plan

### Plan Update & KPI

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<th>November 25, 2013</th>
<th>April 16, 2014</th>
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### Scientific publications and communications

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<td>Nb of other communications</td>
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<td>Nb of communications during VCO scientific activities</td>
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### VCO Network’s community

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<td>Nb of Professors-researchers (International)</td>
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<td>Nb of Canadian universities</td>
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<td>Nb of Associate students</td>
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<tr>
<td>Nb of members on VCO LinkedIn group</td>
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<td>170</td>
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<tr>
<td>Percentage of LinkedIn-members ‘outside’ VCO Network</td>
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<td>40%</td>
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### Partnership

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<td>Percentage of project with partner(s)</td>
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<td>30%</td>
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<td>Percentage of project with an</td>
<td>74%</td>
<td>78%</td>
<td>72%</td>
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### FPInnovations’ contact

| In-kind contributions to the direct and indirect cost of research from the partners | $388,870 (on 2013/01) | TBD* | TBD* | $500,000 |

### VCO Scientific Activities

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*Legend: * = Management system in implementation
Overview of the Activities

Book

VCO BOOK PROJECT: Challenges in Optimizing the Forest Value Chains

Preface
Denis Ouellet (after completion of most chapters)

1. Introduction
Book Editors (after completion of most chapters)

2. Framework for integrated decision making in value chain planning
Sophie D’Amours, Eldon Gunn, Reino Pulkkki and Marc-André Carle (in redaction)

3. Strategic transformation of the forest industry value chain
Paul Stuart et al. (in redaction)

4. Scenario planning tools for forest, industry, markets and trade
Cristian Palma, Gary Bull, Andrew Goodison and Steven Northway (CANCELLED SINCE AUTHORS HAVE DECLINED TO DO THE REVISION)

5. Defining decision support needs for strategic planning of the forest value chain in a Canadian context
Eldon Gunn and David Martell (ACCEPTABLE AFTER MINOR REVISIONS)

6. The meaning and means of environmental sustainability: Forestry in a more responsible world
Justin G. Bull and Robert Kozak (READY FOR PUBLICATION)

7. A survey of methods for agile manufacturing systems
Jean-Marc Frayret and Nathalie Perrier (MAJOR REVISION NEEDED)

8. Key aspects of woody biomass flows within the Canadian forest value chain
Luc Lebel, Reino Pulkkki, Riadh Azouzi and Denis Cormier (READY FOR PUBLICATION)

9. Standards for information and knowledge sharing in the collaborative design of planning systems within the forest products industry: A survey and roadmap
Riadh Azouzi and Sophie D’Amours (REVISION NEEDED)

10. Transport and logistics
Bernard Gendron, Reino Pulkkki and Marius Posta (in redaction)

11. What does VCO matters for government and industry?
Jean Favreau and Catalin Histea (draft reviewed, in revision)

PUBLISHER: A contract has been signed with the publisher CRC Press/Taylor & Francis.
Overview of the Activities
VCO Summer School 2014

4th VCO Summer School 2014,
Defining a Service Offer in Value Chain Optimization (TBC):
• June 11 to 13, 2014
• Hosted by Eldon Gunn, Dalhousie University, Halifax, Canada.
Overview of the Activities
Workshops

Forthcoming Workshops:

«Challenges and Experiences in Implementing OR to solve Industrial Problems in Forest Value Chain», by Professor Mikael Rönnqvist and Jean-François Audy, to be hold during the 56th CORS Annual Conference, May 26-28, Ottawa.

Within the full program (36 regular talks) of the OR in forestry cluster, the VCO workshop host:

• Finalists presentation of the David Martell Student Prize are Rezvan Rafiei, Gregory Paradis and Sanjay Dominik Jena.

• A tutorial give by Dr. Mikael Frisk and three additional speakers which are Catalin Ristea, Dirk Kloss, Mikael Rönnqvist, on the challenges and experiences in implementing OR to solve industrial problems in forest value chain.

«Workshop on Strategic Assessment in Forest Management and Industrial Capacity», by Professors Eldon Gunn and David Martell, in preparation for Fall 2014 Session.
### Overview of the Activities

#### VCO Webinars - Winter 2014 Session

| JANUARY | Wednesday January 22, 2014  
1:30 – 2:00 P.M. EASTERN TIME ZONE | "Production Planning and Control Optimization in Demand Driven Wood Remanufacturing Industry"  
By Rezvan Rafiei, Ph.D. Student, Université Laval. |
|---|---|---|
| FEBRUARY | Tuesday February 18, 2014  
1:30 – 2:00 P.M. EASTERN TIME ZONE | "A Linear Programming Framework for Models of Forest Management Strategy"  
By Andrew B. Martin, M.Sc. Student, Dalhousie University. |
| MARCH | Wednesday March 5, 2014  
1:30 – 2:00 P.M. EASTERN TIME ZONE | "Matching Market Signals to Canadian VCO: A Disaggregated Trade Flow Analysis"  
By Wei-Yew Chang, PDF student, University of British Columbia and  
Professor Chris Gaston, University of British Columbia. |
| | Tuesday March 18, 2014  
1:30 – 2:00 P.M. EASTERN TIME ZONE | "Demonstrating the Importance of Demand-Driven Modeling Using the Wood Pellet Supply Chain and Value Chain: A Case Study"  
By Natalie Hughes, M.Sc. Student, Lakehead University and  
Professor Chander Shahi, Lakehead University. |
| APRIL | Wednesday April 23, 2014  
1:30 – 2:00 P.M. EASTERN TIME ZONE | "How to Calculate Biomass Feedstock Costs From Forest to Mill Gate"  
By José Méndez, Ph.D. Student, École Polytechnique de Montréal and  
Professor Paul Stuart, École Polytechnique de Montréal. |
Overview of the Activities
Executive Summary – Winter 2014 Session

- Issue 10 – January 2014

- Issue 11 – February 2014

- Issue 12 – March 2014
  *Modeling Uncertain Demand in Wood Pellet Supply Chains: A Case Study from Northern Ontario*, by Natalie Hughes, Chander Shahi and Reino Pulkki.

- Issue 13 – April 2014
  *Optimization-Based Formulations for Operability Analysis of ProVess Supply Chains*, by Richard Mastragostino and Christopher Swartz.

Next issues will be broadcast during Fall 2014 Session!
82 VCO Projects completed or in progress over past 4 years

1.1WP VCO-03 - Analysis Capabilities for Strategic Forest Management for a Sustainable Value Chain

1.1WP VCO-04 - The Need for Spatial Detail in Strategic Forest Management Planning

1.2 VCO-07 - Policy and legislation to facilitate development of Canada’s forest-based bioeconomy

1.3 VCO-13 - Competitive Analysis for Economically Sustainable Value Chains Resulting from Transformative Business Strategies

1.4 VCO-56 - Optimal Facility Location and Supply Chain Design for the BC Coastal Forest Sector using Agent-Based Integrated Production Modeling

1.7 - Determining an Effective Computational Environment to combine forest treatments, CCFM C&I and the Value Chain

1.8 - Design of advanced strategic optimization tools for very large-scale joint optimization of forest treatment, landscape management and markets

1.13 - What is the Consequence of Natural Disturbance on the Design of the Forest Industry in a Particular Region? How should natural disturbance affect industry design?

1.14 - The Effect of Management Intensity Zoning on Forest Value Chains

1.17 - What are the Benefits and Risks Associated with Tightly Integrated Industry Structure. What can one do in the design of the industry to mitigate the risk of uncorrelated final product markets?

1.20 - Strategic Management of Flammable Boreal Forest Landscape that are Subject to Storm Damage

1.21 - Robust Network Design for Forest Biorefinery Value Chain – decisions support systems for the transformation of the Canadian forest industry

1.22 - How do we reconcile sustainable forest management of the boreal forest with the logistics and transportation considerations necessary for sustainable forest industry?
1.23 - Sustainable forest management of the Acadian/ St. Lawrence/ Great Lakes Forest and the supply chain in the forest bioeconomy.

1.2AS - Policy and Legislation to Facilitate Development of the Forest-Based Bioeconomy in Canada

1.24AS - Synchronizing long- and short-term forest management planning processes

1.25AS - Socio-Economic Impacts of Woody Biomass Based Bioenergy Development at the Atikokan Power Generating Station: Local Perceptions and Public Opinions

1.26AS - Biomass for bioenergy from managed forests through the value chain: Modelling availability as a function of ecological and industrial drivers

2-3.1WP VCO-21 - Rethinking Sustainable Supply Chains: A Case Study of Paper and Digital Media

2-3.2WP VCO-57 - Manufacturing and logistics agility: a review of concepts and current research topics

2-3.1 VCO-14 - Supply Chain Design and Management for Economically Sustainable Value Chains resulting from Transformative Business Strategies

2-3.2 VCO-15-16 - Wood Fibre and Merchandizing Yard: how to ensure collaboration when partners compete for the same resource?

2-3.3 VCO-21 - Rethinking Sustainable Supply Chains: a case study of paper and digital media

2-3.4 VCO-23 - Operability Considerations in Manufacturing and Supply Chain Design for Forest Industry Transformation

2-3.5 VCO-24 - Agile Manufacturing Strategies for Hardwood First Transformation

2-3.6 VCO-28 - Identifying the Relationship Between Inventory Levels and Functional Performance in the Forest Value Chain

2-3.7 VCO-32 - Developing Forest Collaborative Planning Systems for Community Forestry

2-3.8 - Analyzing the impact of open innovation in University-industry collaborations

2-3.10 - Optimizing the Biomass Procurement Supply Chain for the Biorefinery Value Chain.
2-3.11 - Sorting and Grading Issues within the Forest Supply Chain.

2-3.12 - Evaluating potential partnership in forest products value chains.

2-3.13a - Strategic, Tactical and Operational Supply Chain Policies for the Forest Biorefinery.

2-3.13b - Design for flexibility in the forest biorefinery supply chain

2-3.14 - Forest Sector Business Transformation Impacts Along the Value Chain

2-3.18 - Economic Assessment of Forestry Biomass Storage and its Link in Designing a Sustainable Supply Chain for Biorefinery


2-3.20 - Bio-Economy supply chains suited to the interests of small forest dependent communities and First Nations

2-3.21 - Context of "Re-Engineering the Forest Products Industry"

2-3.22 - Supply Chain Optimization for the Delivery of Large Volumes of Biomass for Biofuel and/or Biocommodity Chemical Production

2-3.24 - Economic, social and environmental optimization of a forest biomass supply chain

2-3.25 - The Selection of Harvest Areas and Wood Allocation Problem – Multiobjective Optimization and Collaborative Approaches

2-3.26 - Matching Market Signals to the Canadian Wood Products Value Chain: A Disaggregated Trade-Model Approach

2-3.27 - Matching Market Signals to the Canadian Wood Products Value Chain: A Disaggregated Trade-Model Approach


2-3.29 - A Practical Methodology for Biorefinery Product Chain Environmental Analysis Using Life Cycle Assessment
2-3.31 - Operability Considerations in Manufacturing and Supply Chain Design for Forest Industry Transformation

2-3.6AS VCO-28 - Identifying the Relationship Between Inventory Levels and Functional Performance in the Forest Value Chain

2-3.23AS - Value Chain Planning in the Forest Biorefinery - a Margins-Based Approach

2-3.24AS - Analysis of forest biomass supply chains

2-3.25AS - Impact of Climate Change Policy Scenarios as well as other Scenarios in the Selection of Sustainable Forest Biorefinery Strategies

4.1WP VCO-37b - Integrating Transportation Planning, Inventory, and Loader Scheduling

4.1 VCO-31 - Manufacturing Control Methods and Order Promising Methods at Sawmills

4.3 VCO-47 - A Distributed Reactive Planning Approach in the Forest Supply Chain under Uncertainty

4.4 VCO-50 - Wood Biomass Procurement for Bio-energy – a Decision Support System

4.5 VCO-53 - Assessing the Impact of Advanced Forest Inventory Data on Merchandizing Yard Costs

4.6 VCO-55 - Exploring Alternative Production Strategies for the British Columbia Coastal Forest Supply Chain

4.7 - Modeling of the Market-Driven, Real-Time Production Planning and Management of Wood Pellets: A Case Study

4.8 - A Simulation Environment for Real-Time Sawmill Control

4.9 - Real Time Transportation and Logistics Systems Planning and Control.

4.10 - Optimization of Transport Route Including Rail in the Forestry Sector

4.11 - Real-Time Planning and Management of Materials and Information Flow (Quality, Yields, Costs) Starting from the Markets/Demand, and Tracing Back Up the Supply Chain through all Distribution Channels, Manufacturing/Processing and Raw Material Procurement
4.13 - Optimization Modeling of the Log Merchandising and Sort-Yard Location Problem (part 1)
4.14 - Optimization Modeling of the Log Merchandising and Sort-Yard Location Problem (part 2)
4.15 - Real Time Transportation and Logistics Systems Planning and Control
4.16 - Intermodal Transportation Benefits, Planning and Control
4.17 - The Three-Dimensional Truck Loading Problem with Routing Constraints – Application to the Lumber Wood and Moulding Industry
4.18AS - Truck scheduling and dispatching for woodchips delivery from multiple sawmills to a pulp mill
4.19AS - Integrating annual harvest scheduling, transportation and inventory management
4.20AS - Transportation-Driven Optimization in Tactical Wood Procurement Planning
4.21AS - Effects of Different Cut-To-Length Harvesting Structures on the Economic Value of a Wood Procurement Planning Problem & Solving an Integrated Multi-Period Wood Procurement Problem
4.22AS - Location Problems in the Forestry Industry
4.23AS - Optimal Procurement Strategy for the Transport of Logging Debris for Bioenergy Generation
4.24AS - Logistics and operations simulation of logging debris supply for bioenergy production
5.1WP VCO-33 - Working Paper: The Use of Agent-Based Modeling to Support Collaborative Design of Planning Systems within the Forest Products Industry
5.2 WP (Old 1.2WP) VCO-05 - Scenario Planning Tools for Forest, Industry, Markets and Trade
5.1 - The development of a metamodel for supporting collaborative engineering of decision support systems within the Canadian forest value
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