Analyzing Wood Procurement Systems:
Supply Chain Management and its use by (some of) today’s forest products companies

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Outline

- Focus is mainly on Canada
- Some interest quotes to show the concept of SCM has been around for a long time
- General outline of SCM
- Outline wood procurement in regard to SCM
- Some recent developments in Canada
- Some case studies on economic impacts
- Summary
Some interesting quotes

1. “The question of the maintenance of the pulpwood supply of Canada continues [as] the outstanding problem affecting our industry.”
2. “The greatest variable encountered in any ______ mill is wood.”
3. “Because wood is becoming a scarcer and more expensive raw material, every possible means should be used to reduce wood preparation losses and still meet _____ standards.”
4. “Faced with a wood shortage, the mills are today accepting wood that yesterday they would have objected to very strenuously.”
5. “A study of pulp quality is like a study of philosophy: you find many systems of approach and many ideas to help you develop a viewpoint, and you usually end up by developing your own. The most important thing is to arrive at some guide to further your progress.”
6. “Shortages and high costs of ___ wood have made it highly desirable to utilize the highest possible percentage of all wood entering a ____ mill.”
Some interesting quotes


An interesting quote (46 years ago)

“In the future, simulation techniques will likely expand to model complete logging systems. Entire forest enterprises will be simulated to determine the order in which stands are to be felled, and the location of forest roads, processing units, skidders, and harvesting machines. Computers will be used increasingly for inventories; not only the traditional forest inventory, but also inventories of men, machines, felled wood, semi-processed wood, wood in transit to the mill, stockpiled wood and wood being converted to finished product – be it paper, lumber or plywood.”

An interesting quote (24 years ago)

“Forest operation managers are encountering a remarkably changed decision environment. Evolution and progress in the areas of organizational structures, problem complexities, responsibilities, data availability and information technology ensure that such changes will continue. There is evidence that the approaches taken in the past to introduce operations research into the managerial decision making culture have met with limited success. New approaches, based upon what has been learned from past mistakes and what can be expected from the future decision environment, must concentrate more on improving the entire decision process …”

Robak, T. 1990. OR in forest operations: new environments, tools and approaches. IUFRO, Proceedings of Div. 3., XIX World Congress. 9-19.
There is only so much that can be done working within the historical boundaries of wood procurement.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Public control</th>
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<tr>
<td>Strategy</td>
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<td>Monitoring &amp; control of operations</td>
<td>Orders &amp; instructions</td>
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<td>BUSINESS MANAGEMENT PLANNING &amp; BUDGETING</td>
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<tr>
<th>Payment systems</th>
<th>Work organization</th>
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<td>Harvesting methods &amp; systems</td>
<td>Work safety &amp; health systems</td>
<td>Insurance &amp; pension systems</td>
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Integration of operations is required between 

**Forest management & silviculture**

Wood procurement

**Mill handling & processing**

Right through to the customer
Supply Chain Management (SCM)

- as a concept it is not new and is closely allied with logistics
- as a business management approach it emerged about 40 years ago
- as a term, it was not used widely in the literature until the early 1990’s
Emphasis is on integration of business processes across all boundaries

- it is a decision-aiding approach where the organization as a whole is more important than individual parts (e.g., departments, divisions)
- within companies & organizations
- between companies & organizations
- along any supply chain, from raw materials to the market
Supply Chain Management (SCM)

- is being absorbed by the over-arching concept of value chain optimization (VCO)
- check-out the following sites:
  - http://www.fibrenetwork.org/
  - http://www.cirrelt.ca
  - http://www.forac.ca
  - https://www.fpinnovation.ca
## Presentation

Officially launched in February 2010, the NSERC Strategic Research Network on Value Chain Optimization (VCO) is in direct response to the Federal Budget 2008, in which NSERC was allocated new funds to support collaborative research that directly contributes to the knowledge and innovation needs of Canada’s forest industry. In its quest for increased competitiveness of the Canadian forest products industry, FPInnovations has identified VCO as a key part of its Transformative Technologies program.

The NSERC VCO research network is one of four new Strategic Networks supported by FPInnovations’ Flagship Innovation Program. The network serves to bring academic, government and industry researchers together to focus their efforts on priority areas of research. FPInnovations is involved in the planning and orientation of the network. It also plays a key role in transferring the research results to the industry and policy makers.
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

4.1 WP 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
Developing highly qualified people who are inspired to pursue careers and spur innovative solutions throughout the Canadian forest sector.

OUR MISSION

The voice for research focused on delivering value for forest product competitiveness and transformation to support Canada's national forest sector.

FIBRE (Forest Innovation by Research & Education) is the organization that builds synergies among eight forest R&D networks in support of the priorities of Canada’s vital forest sector innovation system. Each FIBRE network provides novel innovations to sustain and transform Canada’s forest sector.

FIBRE MEMBER NETWORKS

[Logos of member networks]
Introduction

Le CIRRELT est né en mai 2006 de la fusion du Centre de recherche sur les transports (CRT) de l’Université de Montréal (UdeM), l’École Polytechnique et HEC Montréal, du Centre de recherche sur les technologies de l’organisation réseau (CENTOR) de l’Université Laval et du groupe Polygistic de l’École Polytechnique, auxquels se sont joints les chercheurs de l’UQAM regroupés autour de la Chaire de recherche industrielle du CIRRELT en management logistique.

Activités scientifiques

10-06-2014
Université de Montréal
Séminaire de Mike Howitt à 11h
The Technician Routing Problem with Experience-Based Service Times

13-06-2014
Université de Montréal
Séminaire de Kerem Akartunali à 10h30
Optimization in Maritime Transportation: Two Applications
Consortium

FORAC Research Consortium is a centre of expertise for the advancement of the forest products industry. It regroups experts with competencies in forestry engineering, industrial engineering, mechanical engineering, management sciences such as operations management and strategic management, etc. The Consortium’s efforts are divided into two sectors: research and knowledge and technology transfer activities.

The multidisciplinary researchers at FORAC have international reputations in their respective domains and are actively developing concepts, business models and management tools that take advantage of the full potential of Internet technologies (see the RESEARCH section).

Using our research as a strong foundation, several transfer activities have been established, including an important program targeting SME (see the TRANSFER and TOOLS sections).

FORAC focuses on innovation to find creative solutions to complex problems.

Mission

FORAC research consortium, a strong partnership between forest products industry stakeholders (Université Laval, companies and governments), aims to be a Canadian and international standard recognized for its achievements and collaboration dynamics. In order...
Integrated Value Maximization: Value Chain Optimization

Forest Sector Value Chain

Forest Management and Planning
Intensive Silviculture, Breeding and Genetics
Harvesting and Log Merchandizing
Transportation
Solid Wood Products
Pulp & Paper
Secondary Manufacturing
Sales and Distribution
Market Requirements

Source: FPInnovations
Value Chain Optimization:
A market-driven, solutions-based approach

Think **market** before **product**

Market demanded attributes

Flexible Manufacturing Processes

Raw material attributes

Think **solutions** not **products**

Source: FPInnovations
The new pull supply mode (value-added markets)

- **GENOME**
  - Forest Management and Operations
  - Wood characterization
  - Fiber characterization

- **Chemicals Products**
  - Manufacturing Processes
  - Markets Diversification

- **Solid Wood Products**
  - Manufacturing Processes
  - Markets Diversification
  - Market Demanded attributes
Core Focus: Integration across entire value chain

Wood Supply chain

Forests → Sawmills → Kilns → Furniture mills → Warehouses → Retailers → Customers

Public forest → External sawmill

Private forest → External kiln

Dry wood supply

Ouhimmou et al. 2009
SCM helps develop

- intra- and inter-organizational co-operation and relationships
- better knowledge of the “process chain”

These in turn allow breakthroughs to occur, which may otherwise be difficult to attain.
These breakthroughs can be in

- process productivity improvement
- process yield improvement
- process cost reduction
- product quality improvement
- new products
Potential Benefits

- depending on business efficiency, typical improvements possible:
  - inventory reduction 15-60%
  - supply chain cost reduction of 20-30%
  - improved delivery performance 20-30%

Logging, transport and roads can account for ~65% of delivered wood cost

- preferably minimal volume and quality loss from the forest to the mill
- perhaps higher cost logging since overall product cost and quality must be the focus
- conversely, relaxing or changing mill specs could result in major wood supply cost savings
Need to ...

- have a clear understanding of all phases of production
  - forest management and silviculture
  - forest harvesting and wood transport/delivery
  - mill processes
  - value-adding
  - delivery to customers
  - markets
Need to ...

- make decisions based on total cost for product and product quality, not on sub-optimums (e.g., lowest roadside cost or millgate price)
It doesn’t need to be complicated

80,000 m³ excess

If 10,000 m³ safety buffer, reduction of 70,000 m³

@ $50.00/m³ millyard this would free up $3.5 M of capital
Sawmill chip loss example (sawmill log input 700 000 m$^3$)

- effect of chipper maintenance
- fines+pins content before screening 15%
- fines+pins content after screening 3.5%
- on an annual basis = 33 367 m$^3$ of fibre
- @ $35/m^3$ (chip price) = $\sim$1.17 million lost in potential chip sales annually
- some income for hog fuel sales possible but if going to landfill then more expense
Sawmill lumber loss example (sawmill log input 700 000 m³)

- shrinkage and sawing thickness variation
- planer trim loss ~8%, but can be higher with variation in log quality and sawing accuracy
- any volume saving in the planing mill is significant due to costs already incurred
Sawmill lumber loss example (sawmill log input 700 000 m$^3$)

- for similar mills sawing similar wood, consumption was 2.12 vs 2.29 m$^3$/m$^3$-lumber
- ~24 500 m$^3$ lumber recovery difference
- ~$4.9 million in lost lumber sales @ 200 $/m$^3$ lumber price
Logging System Comparison Illustration

Need to look at:
- operational costs
- wood yield of each phase
- wood quality after each phase

System 1 - FT-SW system
System 2 - FT-CH system
Compartment volume = $V = 150\, \text{m}^3/\text{ha}$

Full tree to roadside, shortwood to mill (FT-SW) system fibre balance

- Stumps: $2.1\% \times V$
- Sawhead felling kerf: $0.84\% \times V$
- Broken/lost pieces: $5.21\% \times V$
- Roadside delimber slash: $12.6\%$ of roadside $\text{m}^3$
- Slasher ends: $1.5\%$ of limbed $\text{m}^3$
- Slasher saw kerf: $0.47\%$ of limbed $\text{m}^3$

Fibre on truck: $118\, \text{m}^3/\text{ha}$ or $78.7\%$ of $150\, \text{m}^3/\text{ha}$ potential volume
How much are lower stumps and a thinner saw kerf worth?

~0.84% loss due to hot saw kerf

Hot-saw’s 5.5 cm saw kerf on 2 million m$^3$ = 16 800 m$^3$ or $840 000 (@$50/m^3$)
118 m³/ha or 78.7% of initial 150 m³/ha

Roundwood handling
Roundwood storage
Drum debarking
Chip storage
Chip screening

FT-SW mill fibre balance

Digester

Fibre to pulp

Bleaching

45.2 m³/ha or 30.1% of initial stand volume as product
Compartment volume = \( V = 150 \text{ m}^3/\text{ha} \)

- Stumps
- Sawhead felling kerf
- Broken/lost pieces
- CFDDC limbing and barking loss
- Loading loss

\[
\begin{align*}
2.1\% \times V \\
0.84\% \times V \\
5.21\% \times V \\
3.0\% \text{ of roadside m}^3 \\
0.5\% \text{ of roadside m}^3
\end{align*}
\]

Fibre on truck

133 m\(^3/\text{ha}\) or 88.7\% of 150 m\(^3/\text{ha}\) potential volume

Full tree to roadside, chip to mill (FT-CH) system fibre balance
FT-CH system, mill fibre balance

133 m³/ha or 88.7% of initial 150 m³/ha

58.8 m³/ha or 39.2% of initial 150 m³/ha as final product

Chip storage
Chip screening

Digester

Fibre to pulp

Bleaching

0.5% of input
2.5% of input
52% of input
5% of input
<table>
<thead>
<tr>
<th>LOGGING COST ($/m3)</th>
<th>FT-SW</th>
<th>FT-CH</th>
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<tbody>
<tr>
<td>- cutting</td>
<td></td>
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</tr>
<tr>
<td>- felling</td>
<td>4.00</td>
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<tr>
<td>- stump area delimming</td>
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<tr>
<td>- stump area bucking/slashing</td>
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<td>- primary transport</td>
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<td>- roadside delimming</td>
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<td>- roadside slashing</td>
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<td>- roadside limbing/barking/chipping</td>
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<td>6.90</td>
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<td>- scaling</td>
<td>0.50</td>
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<tr>
<td>- roads and landings</td>
<td>3.05</td>
<td>2.71</td>
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<td>- set-up &amp; take-down</td>
<td>0.85</td>
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<td>- planning and supervision</td>
<td>2.54</td>
<td>2.26</td>
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<td>- contractor profit</td>
<td>2.34</td>
<td>2.80</td>
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<tr>
<td>- stumpage (no charge for better utilization)</td>
<td>7.50</td>
<td>6.66</td>
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<tr>
<td>- woodlands overheads &amp; forestry</td>
<td>4.24</td>
<td>3.76</td>
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<td>ROADSIDE COST($/m3)</td>
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<td>TRANSPORT COSTS ($/m3)</td>
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<tr>
<td>- loading</td>
<td>1.75</td>
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<td>- secondary transport (100 km)</td>
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<td></td>
<td>8.50</td>
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<tr>
<td>- millyard scaling &amp; handling</td>
<td>1.75</td>
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<td>0.50</td>
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<td>MILLYARD COST ***($/m3)</td>
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<th>WOODROOM PROCESSING ($/m3)</th>
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<td>- transport to woodroom</td>
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<tr>
<td>- debarking</td>
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<tr>
<td>- chipping</td>
<td>0.35</td>
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<tr>
<td>- transport to chip pile</td>
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<td>- energy compensation</td>
<td>-0.52</td>
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<tr>
<th>COST AT CHIP PILE***($/m3)</th>
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<td>CHIP RECLAIMING ($/m³)</td>
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<td>--------------------------------------------</td>
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<tr>
<td>- reclaim chips</td>
<td>0.25</td>
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<tr>
<td>- screening</td>
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<tr>
<td>- energy compensation</td>
<td>-0.65</td>
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<td></td>
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<tr>
<td>COST AT DIGESTER*** ($/m³)</td>
<td>54.27</td>
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<tr>
<td>BLEACHED PULP YIELD ON WOOD (%)</td>
<td>43.70</td>
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<tr>
<td>WOOD CONSUMPTION (m³/ADt pulp)</td>
<td>5.02</td>
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<tr>
<td>DIRECT PROCESSING COSTS, $/ADt pulp</td>
<td></td>
</tr>
<tr>
<td>- wood cost</td>
<td>272.58</td>
</tr>
<tr>
<td>- digester chemicals</td>
<td>14.80</td>
</tr>
<tr>
<td>- bleaching chemicals</td>
<td>50.00</td>
</tr>
<tr>
<td>- other processing costs</td>
<td>31.00</td>
</tr>
<tr>
<td>- net processing energy</td>
<td>-1.00</td>
</tr>
<tr>
<td></td>
<td>-------</td>
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<tr>
<td>TOTAL VARIABLE COST*** ($/ADt)</td>
<td>367.38</td>
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***Cost includes wood loss effect
## Summary table for NBSK pulpmill example (350 000 ADt/yr)

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<th>FT-SW</th>
<th>FT-CH</th>
<th>Difference</th>
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<tr>
<td>Initial stand m$^3$</td>
<td>2 541 443</td>
<td>1 952 155</td>
<td>589 289</td>
</tr>
<tr>
<td>required</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest area, ha/year</td>
<td>16 943</td>
<td>13 014</td>
<td>3 929</td>
</tr>
<tr>
<td>m$^3$ delivered</td>
<td>2 000 000</td>
<td>1 730 297</td>
<td>269 703</td>
</tr>
<tr>
<td>Opportunity cost of wood yield difference</td>
<td>=319 586 m$^3$*50 CAD/m$^3$</td>
<td>CAD 16.0 million/year</td>
<td></td>
</tr>
<tr>
<td>Production cost difference based on average wood cost</td>
<td>CAD 21.3 million/year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Marginal Cost Analysis

- when making decision on use of logging systems must also look at marginal costs
- marginal cost in this case refers to the cost of obtaining the last $m^3$
- cost is higher because the wood is of poorer quality, more distant and/or from more difficult logging sites
Marginal Cost Effect

![Graph showing Marginal Cost Effect with an average cost of CAD 50/m³.](image)

- **Average cost** = CAD 50/m³

- The graph illustrates the cumulative m³ on the x-axis and CAD/m³ on the y-axis.
Marginal Cost Effect

- Average cost = CAD 46.33/m³
- Savings are CAD 6.4 million/year more when marginal cost used instead of average cost
An example from South Africa

Jaco-Pierre van der Merwe
2014, MScF
Stellenbosch University
Log surface damage
(Jaco-Pierre van der Merwe 2014)
Typical chip size specifications
(Jaco-Pierre van der Merwe 2014)

<table>
<thead>
<tr>
<th>Material</th>
<th>Fines</th>
<th>Pins</th>
<th>Accepts</th>
<th>Over-thick</th>
<th>Oversize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawdust &lt; 1/8 &quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines &lt; 1/4 &quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pins &lt; 1/2 &quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overs &gt;11/4&quot; rh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;8mm slot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relative pulp yield values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fines</th>
<th>Pins</th>
<th>Accepts</th>
<th>Over-thick</th>
<th>Oversize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulp Yield % for <em>E. grandis × urophylla</em> (9 years)</td>
<td>0.25</td>
<td>0.50</td>
<td>1.00</td>
<td>0.94</td>
<td>0.92</td>
</tr>
</tbody>
</table>

(True, 2006; McEwan, 2004)
Economic analysis (van der Merwe 2014)

- Value of recoverable pulp: debarking technique
  - manual vs 3-pass $\rightarrow$ -R50.90/t
  - 3-pass vs 5-pass $\rightarrow$ -R9.64/t
- Value of recoverable pulp: drying period
  - 1-week vs 2 week $\rightarrow$ +R137.90/t
- Value of wood fibre lost: debarking treatment (10 trees)
  - 3-pass vs 4-pass $\rightarrow$ -R3.32/10-trees
- Value of wood fibre lost: debarking treatment (1600 trees)
  - 3-pass vs 4-pass $\rightarrow$ -R132.90/ha
An example business model in Finland – full SCM control

Source: Metsälitto – FinnForest – Ole Salvén
1/3 of turn-over from sawmilling
2/3 from other areas of solid wood business
- Construction
- Transportation
- Carpentry
- Mouldings/trimmings/engineered products
- Wholesale/sales
- Design and engineering
- Turn-key projects

Sell a total product with design, engineering and installation along with wood components

Wood ~350 €/m$^3$, but total selling price 1000 €/m$^3$
Summary

- It’s these types of potential opportunities that justify investments in SCM research and its implementation.
- Over the past years Canada has invested heavily in SCM and VCO for the transformation of the forest industry.
- As we move toward value-adding and highly specialized forest products for building, papers, chemicals, energy, etc., SCM and VCO will become more important.
- It has been claimed that in the future it will be supply chains and not firms that compete.
Take home message - decision-making focus

Tree improvement
For. man. planning
Silviculture
Roads
Cutting & extraction
Transport
Mill processing
Transport/Inventory
Customer

Forest resources

Wood/fibre yield
Wood/fibre quality
Production costs

Maximum value/benefit from our forest resources