Operations Research
Recherche opérationnelle
(Org: **Bernard Gendron** (Montréal))

AMIRA DEMS, École polytechnique de Montréal.
SOLVING AN INTEGRATED MULTI-PERIOD WOOD PROCUREMENT PROBLEM.

The problem we consider is a practical annual forest harvesting planning problem from the perspective of Eastern Canadian context. Within this context, forest cutblocks are heterogeneous and have different sizes. The total planning horizon considered is one year, divided into 12 time periods (months). This forest management problem is difficult to solve since it integrates two inter-related problems: the forest bucking problem using a cut-to-length (CTL) bucking system and the multi-facility supply planning problem. In fact, the choice of areas to harvest in each period and how to harvest it affects the amount of different assortments provided to mills. The main decisions deal with which areas to harvest during each period so that orders from various wood-processing facilities, located in distant places are satisfied. Moreover, the model provides decision support with respect to how to harvest the different cut blocks according to the bucking priority list used, and in what quantities harvested logs from each block should be transported to sawmill. The problem includes overall decisions about transportation, storage in the forest and at the mill terminals. One considerable part of the harvesting cost is due to the productivity decrease with the number of harvested products per cutblock. There are also a number of restrictions to be considered during harvesting. In this paper, we develop a mixed integer linear model describing the problem. Then, we solve it directely using CPLEX. Computational results from an Eastern Canadian forest company are presented.

GÉRALDINE GEMIEUX, Université de Montréal/CIRRELT
A Column Generation Approach for Demand-Driven Harvest Scheduling

We consider the problem of assigning to each harvest team an annual schedule to meet the demands of the mills, while integrating inventory and transportation. We present MIP models used in a heuristic based on column generation, where columns represent harvest schedules. First computational results are in the context of eastern Canadian forests.

SANJAY DOMINIK JENA, CIRRELT, Université de Montréal
Modeling and Solving Location Problems for the Forestry Industry

We study a complex extension of a multi-period multi-commodity facility location problem appearing in the Forestry Industry. In this problem, workers have to be assigned to logging camps. Latter may have a very flexible structure. We focus on the modeling aspect and review methods to solve this problem.

DAVE LEPAGE, FPInnovations
Challenges and opportunities in forest transportation

Forest industries generate a large part of Canadians economic. Canada is a world leader to create value from its forests. Several members expressed their needs to get decision support systems able to plan better routes, review their transportation strategy, and to schedule trucks in real-time. Actually, high costs, environmental pressure and lack of human's resources are key issues in forest transportation sector. Behind those key issues, it is more complex today to adequately manage fibre inventories and to meet the customer's expectations along the value chain. Transport collaboration is not a new phenomenon, but it is not well accepted in the Canadian forest industry. Sharing information and transport network resources resulting in significant cost savings. In using common transport facilities, the collaborators will realize synergies, economies of scale, and cost savings in storage, staging, handling, and shipping the goods. Transport collaboration yields other benefits as well: more efficient inventory management, reduced transport costs, increased frequency of deliveries, economies of scale to small- and

medium-sized businesses and enhanced corporate responsibility by reducing carbon emissions. FPInnovations will present the challenges in forest transportation and will underline the importance of collaboration.

JOEL NEUHEIMER, Forest Products Association of Canada
Canadian Forest Products Industry's Transportation Challenges Moving Forward

With 19 member companies, with approximately 120 different mill operations scattered acrcoss Canada, the vast majority of which are in remote locations served by only one of the two major railways in Canada, FPAC will present the idea of enhancing rail freight service competition in Canada via the extension of existing interswitching provisions within the Canada Transportation Act (CTA). An Interchange exists when the line of one federal railway company intersects with the line of another federal company and track is available to store empty and loaded cars. Shippers within 30 kilometres of an interchange have access to the second carrier at a regulated Interswitching Rate that is set by the Canadian Transportation Agency (The regulated rate is currently set as the variable cost plus 7.5

REINO PULKKI, Lakehead University, Faculty of Natural Resources Management
Modeling forest products supply chain by integrating enhanced forest inventories and merchandizing yard operations

Enhanced forest inventories and merchandizing yards can play a vital role in the ability to fulfill promised orders, while minimizing inventories of different log assortments. This study develops a supply chain optimization model, integrating enhanced forest inventories and merchandizing yard operations, to determine the economic impact of better forest information. Keywords: Enhanced forest inventory; merchandizing yard; optimization model; value chains

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GREGORY RIX, Ecole Polytechnique de Montreal
A Tactical Transportation-Driven Harvest Planning Problem

We present here a problem that arises in the Canadian forestry industry in tactical (annual) planning. Given a set of mill demands of multiple log assortments over this planning horizon and a forest management area of multiple sites available for harvest, the decisions commonly made at this level of planning are the schedules of harvest teams, storage decisions, and the allocation each month of volume from forest to mill while minimizing storage and transportation costs.

However, a critical component of operations of Canadian forestry companies is to guarantee a variety of different driver schedules to their trucking contractors throughout the year in order to ensure that they have a reliable source of permanent drivers, and we generalize the problem to take this into account as routing decisions. Additionally, the heterogeneity of the truck fleet necessitates further decisions to be made in harvest planning in the form of the length of cut timber.

This problem is modeled as a mixed integer program, with the objective function set to minimize storage and transportation costs, while also maximizing the workload of higher priority harvest teams and trucking contractors. This facilitates the use of a branch-and-price heuristic to solve the problem with columns, representing daily driver shifts, generated via a shortest path problem with resource contraints. Results are given on several case studies provided by industrial partners.

SINA SAADATYAR, Dalhousie University
Sawmill Campaign Generator as a Basis for Planning and Control

Sawmills are automated processing facilities where logs are scanned and cutting decisions made automatically based on optimization of lumber yields. Attempts to plan or control a sawmill need to deal with this fundamental fact. The campaign concept is a class of logs processed under a given price list to produce a set of lumber outputs. Log classes are defined in terms of species, small end diameter, taper and length distributions. Differing ways of sorting logs, different log classes and different price lists create different campaigns. In a subsequent talk, we discuss how one can control the mill via controlling campaigns. We have created a software allows us to generate campaigns. The starting point is a pattern generator which generates a large class of patterns (6000+). The second step is a yield calculator that gives the number of pieces by width, thicknesses and length if this pattern is applied to a given log. We consider a substantial sample of logs from the given log class, and for

each log in the sample evaluate all possible patterns against all the price lists. We thus arrive at an optimal breakdown for each log and the product outputs for all price lists. Cumulating the product outputs for all the logs in the sample we arrive at representative product output proportions. The model, coded in Python, is quite efficient. Source code for the model can be made available to all participants in the VCO.

PEGA SOHRABI, Dalhousie University

Using Campaigns to Control and Plan Sawmill Production

Sawmills are capacity limited process industries with divergent production processes in which a single log is turned into a large number of output products. The concept of campaigns facilitates various approaches to control of sawmill production. We look at two of these in reasonably complex settings with more than 70 final products and more than 100 potential campaigns. The first approach generalizes the concept of economic lot sizing. In the classical setting, the economic lot size takes into account holding costs and setup times to find a production strategy that minimizes inventory will respecting capacity constraints. We use a powers of two approach implemented as an MIP, but instead of focussing on product lot sizes, we focus on campaign lot sizes. For constant deterministic demand, this gives the minimum possible inventory levels achievable given the demand and capacity. We use a simulation environment to understand how these campaign lot sizes can be used in a stochastic environment. The other approach is a rolling planing approach where the production decisions each period are in terms of campaigns and markets for products are multiple tier with the possibility of disposal at low prices for excess production. An MIP approach makes it possible to account for production and setup times for the campaigns. Depending on what aspects of setup cost we wish to address, various formulations are possible. The MIP's aren't easy to solve but solutions within 6