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Optimizing the Resource for Several Mills / Products.

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It's all in the logs

I am here today because Scott Jamieson of Canadian Forest Industries magazine visited Bryon Muhly, manager of resource optimization for Weldwood of Canada's Alberta operations. Scott subsequently wrote an excellent article entitled "Difficult Decisions", which appears in the April, 2001 issue of Canadian Forest Industries magazine. You will be able to view the article, until mid-June, on CFI's website at www.forestcommunications.com. In the article, Scott describes the Alberta fibre allocation project that Weldwood has undertaken, with HALCO's help. Scott also asked me to present this as a case study at this workshop. In additional to Bryon, we have been working closely with Paul Hostin at Hinton and Bob Held at Sunpine.

First, let me tell you a bit about myself, and the background to this project. When I graduated, I didn't know there was such a thing as a computer. I worked as a marine engineer, and as a process engineer for a time, and then joined IBM in the UK, where I learned how to program a computer. My first task was to write a program, called "SCRAM", that simulated the operation of Britain's first nuclear submarine reactor. Talk about being thrown in at the deep end! I then learned about linear programming, and was IBM's technical representative to the U.K. petroleum industry. Afterwards, I built and operated an LP model of a very large petrochemical complex in the U.K.

In 1968, I came to Canada, and started to apply my modeling skills to the harvesting and sawmilling side of forest industry. I set up couple of LP models, but it soon became clear to me that the industry wasn't ready for it. At that time, logs were cheap and plentiful, and all that mattered was to install capacity as quickly as possible, and to get it running. Nevertheless, I needed lumber yields from logs, and wrote a couple of programs to calculate these, assuming straight, uniformly-tapered logs. Early on I met a fellow named Doug Jones, of the J.Ernst Lumber Company in Quesnel, B.C., now part of Tolko Industries, and he taught me a large part of what I know about sawmilling. And one of the things he taught me was that "it's all in the logs". Together we wrote an article describing our work for J. Ernst that was published in CFI magazine at about that time.

Soon afterwards, I wrote the first version of the SAWSIM® Sawmill Simulation program, and people tell me it is still the industry standard. This time I was careful to allow the actual shape of logs to be described to the program, and also, all the possible ways of sawing them. SAWSIM® took on a life of its own. Subsequently, I, and the staff at HALCO, have developed models of peeling, plywood, OSB, LVL and I-joist operations, and, most importantly, the WOODSIM™ program, which simulates stem- and log-bucking operations, from the standing tree, though to log input to the mill. WOODSIM™ includes a model of the incidence of decay.

Note that so far I have said nothing about fibre allocation. It's my belief that to allocate fibre optimally, you have to have detailed models of the processes that manufacture and use the logs. Test results won't do, at least not by themselves. Test results are unreliable, usually inaccurate, and soon become out of date. And mill tests are expensive. You need to calibrate the detailed models against production records. It's the ability to predict actual productions under a variety of conditions that counts. Nevertheless you often need to make detailed measurements to get an understanding of what actually happens.

When you allocate logs, there are going to be winners and losers. If you don't have accurate models of the individual processes, both in the woods and in the mills, how are you going to persuade people to accept the results? How are you going to be sure that the winners can actually achieve the projected benefits, and that the losers are properly compensated?

With the detailed models of the operations in place, we developed the WOODMAN™ program, which uses the results from or embeds the detailed process models, sets up and solves a linear-programming matrix, and writes the results to a standard database. We can use MS Access, SQL Server or Oracle. We use XA to actually obtain the linear programming solution.

For descriptions of the programs I have referred to and more information about HALCO, see www.halcosoftware.com . I will also post a transcript of this talk on this website. My own email address is howardl@halcosoftware.com.

Previous HALCO projects

The Weldwood Alberta project was not our first. After some early LP models which had limited success, my first really successful LP model of a woodlands, sawmill and chip supply operation was of Procter & Gamble's (now Weyerhaeuser's) Grande Prairie, Alberta operations, in 1982. The woodlands department had warned that the logs were going to get smaller, and various schemes for dealing with this had been proposed. The folks in Cincinnati, being more familiar with toothpaste than sawmills, had become confused, and asked for a 10-year plan, year by year, assuming that no capital would be spent. They were smart. Each year it was necessary to balance the chip supply and demand, and without the necessary tools, this was difficult. I was asked to make the calculations, and persuaded the company that the only way I could do this within the allotted time (about 4 weeks) was to set up a linear program, and then solve it for 10 different sets of data. I was able to do this to the satisfaction of both the woodlands and sawmill departments. What it showed was that to accommodate the change in log size, it was not necessary to spend any capital at all.

Very soon the model had quite an impact on log quality. The woodlands department's job was to deliver fibre to the pulpmill at minimum net cost. Lumber was, in effect, a by-product that was credited against the cost of logs. The sawmill had a poorly-designed slasher deck that didn't work very well, and it limited production. Once the woodlands department was able to see clearly what this bottleneck did to the net cost of producing chips (i.e log cost, less net income from lumber production), delimbing improved dramatically, and slasher-deck throughput went up. HALCO has now modeled the majority of Weyerhaeuser Canada's operations east of the Rockies.

The model we developed, and the successor to it has now been in regular use at Grande Prairie for nearly 20 years, and is embedded in the Company's standard management procedures. I am told that the benefits have amounted to many millions of dollars.

HALCO has also done two similar projects for Northwood in B.C. (four sawmills, a plywood plant, and associated log supply, now part of Canfor), a project for Fraser Papers in N.B., and modeled Weldwood's operations in the B.C. Cariboo region (two sawmills, two plywood plants, and associated log supply). We have also set up models of two very large plywood plants, and proposed OSB, LVL and I-joist operations in Texas for Champion International (now part of International Paper). We have now

set up the model of Weldwood's Alberta operations, and are currently completing models of two separate operations in the U.S. Pacific Northwest.
One of these operations has one sawmill, and the other has two. In one the emphasis is on how to buck in the woods for overall maximum net value to the company, taking the effect on mill productivity and product value into account. In the other the emphasis is on valuing stands for bidding purposes. For a given stand, we calculate the machine and department times that are required to process the stand, and of course, the product values and the projected net revenues. It doesn't require multiple mills to achieve substantial benefits.

Weldwood, Alberta

Weldwood has a kraft pulpmill at Hinton, Alberta, east of Edmonton, in the foothills of the Rocky Mountains, that produces some high-end grades, and the Hi-Atha sawmill nearby, which cuts dimension lumber, targeting Japanese and premium square-edge grades. In 1998, Weldwood acquired the Sunpine operations, consisting of a veneer and laminated veneer lumber operation at Strachan, about 125 miles southeast of Hinton, and the Sundre sawmill, post mill and treating facility, which are an additional 50 miles to the southeast. Both sawmills are modern two-line operations.

The annual capacities are (from www.weldwood.com):

Hinton pulp	425,000 tonnes of pulp
Hi-Atha	245 MMfbm of lumber
Strachan	1.5 MMcf of LVL and 172 MM3/8 of veneer
Sundre	190 MMfbm of lumber and 54 MMfbm of specialiies

The roundwood supplies to these mills come from the Hinton and Sunpine forest management areas (somewhat in excess of 2 MMm3/year from Hinton, and somewhat less than 1 MMm3/year from Sunpine). In addition, there are substantial log and chip purchases and trades.

The starting point for the fibre allocation is a predetermined harvest plan. It could be a set of alternative plans. HALCO is not in the business of developing software for harvesting plans as such. While in Fredericton, I have taken the opportunity to visit Remsoft (www.remsoft.com), who are in this business. Forest inventory data is essential, and we have had discussions with Timberline Forest Inventory Consultants (www.timberline.ca), who have developed some proprietary processes for generating stand tables from photo-interpreted inventory data. These are based on statistical relationships between forest inventory polygon labels and ground-based plot data. HALCO's role is to help convert harvest plans into optimized business plans for the harvesting and solid-wood manufacturing operations.

Weldwood has a well-established database of forest inventory data. They divided the available timber for 2001 into 59 compartments for the Hinton FMA, and 17 for the Sunpine FMA, made up of 70 different cover types. They supplied a stand table for each cover type, and "cookie" data derived from taper equations for each FMA.

The species are predominantly lodgepole pine, white and black spruce, and balsam fir.

Both tree-length and cut-to-length (shortwood) harvesting systems are used, and also some woods-chipping.

In the model, trees are topped, and long-butted if necessary. The resulting stems are bucked in the woods to logs, which may be hauled, or merchandised into other logs, and/or bucked into blocks (bolts). Blocks are the inputs to mills. So we have alternative stem- and log-bucking methods, and various combinations of the two. Logs and blocks are grouped into log and block sorts. Blocks are classified by species, top diameter, length, and quality class.

Quality class is a catch-all for all the properties that affect product volume and grade recoveries, that are not accounted for by species, top diameter and length. These typically include taper, crook and sweep, fibre strength, knottyness, decay, and general degree of roughness. For instance, in B.C. we have dry-belt and wet-belt Douglas fir, which are the same species, but dry-belt fir tends to be a lot rougher. Similarly we might classify both black and white spruce as spruce, but assign them to different quality classes.

For tree-length operations, peeler-sawlog combinations are hauled to the LVL mill, where they are merchandised to peeler- and sawmill-blocks. The sawmill-blocks are then hauled to the Sundre sawmill, 50 miles away. Sawlogs may be hauled direct to Hi-Atha or Sundre. Sawlog-pulplog combinations may be hauled to the Hi-Atha sawmill, from which pulplogs are transferred to the woodroom at the Hinton pulpmill. And oversize logs have to be dealt with.

Cut-to-length operations may produce peeler multiples that go to Strachan, sawmill blocks that go to Hi-Atha, Sundre or log trades, and pulplogs that go th Hinton. Cut-to-length systems may be more expensive, but with peeler, sawlog and pulplog sorts going to four or more different places, cut-to-length operations make it easier to get the right log to the right place.

A key issue for an LVL mill is fibre strength. White spruce veneer is not strong enough, and only lodgepole pine is peeled for LVL. Fibre strength depends on the growing site and the position of the fibre in the tree. So fibre strength is an important aspect of log quality. The same applies to logs that are used to manufacture machine stress rated (MSR) lumber. And fibre-strength is an important property of the chips.

A very important function of the model is to strike a balance between internally-produced and purchased chips. For many years, having dealt mainly with sawmills, chips were, to me, just chips. However I have discovered that chips to a pulpmiller, particularly one making high-grade pulp, are like snow to an Inuit. There are many different kinds. In the model, we distinguish between roundwood-, sawmill-, veneer-, purchased- and woods-chip types, and also between pine, spruce-pine and balsam-fir chips. We also distinguish between high-strength and low-strength chip-fibre types, and the user must specify yields of each from each species and chip type.

Residues and co-gen requirements are also taken into account.

WOODMAN™

So we have a business model, with a variety of forest compartments at varying distances from the mills, and log sorts, block sorts, and chips, going to different mills and end-uses. These are to be delivered in such a way that all the constraints are met, and net operating income is maximized. The key fibre-allocation variables are the stem- and log-bucking methods and harvesting systems to be used for each forest compartment and species, the butt- and top-diameter breaks between the sorts, and which sorts go to which mills. There are a lot of possible combinations.

We use the WOODSIM™ program to calculate the yields of log sorts, block sorts, and block-classes, for each combination of forest compartment and the fibre-allocation variables that makes any sense. These results are saved in a database.

We use SAWSIM® to calculate the rough green lumber recoveries by product group, size, length and “rough-lumber grade”, and sawmill machine-time requirements for each sawmill, species and block class. These results are saved in databases also.

We enter a large amount of other data, including harvesting and hauling costs, manufacturing costs and capacities, lumber finishing and sales data, veneer and LVL model and sales data into the WOODMAN™ input database. For more details, please refer to the WOODMAN™ description at www.halcosoftware.com.

We then run the WOODMAN™ program that makes the optimization calculations and writes the results and much of the input data to another database, from which summary and detailed reports are generated.

Usually management wants to see the summaries, but an important part of the reporting is a detailed and complete fibre balance across every part of the operation, an accounting of all the revenues and expenses, a record of which constraints are limiting, and the shadow prices. If you can't check it, don't believe it!

Benefits

Setting up, validating and operating the Alberta Business Model required a major commitment of time, both by Weldwood and HALCO. There will be corresponding benefits:

- The first is the obvious one – from optimization. The net operating income associated with the Alberta operations is many millions of dollars per year. Even if the benefits resulting from use of the model prove to be relatively small on a percentage basis, the impact on profitability will still be very large. On the other hand, the changes may prove to be quite large, with a corresponding impact on profit.

- Planning and forecasting for existing operations has become much easier, and faster. Many more alternative operating strategies can be evaluated, and potential operating problems avoided. Often the main operating variables for each case are pre-determined. The model then takes care of the "number crunching" details and the reporting.

- The process of using the model to evaluate alternative potential capital investments has already started. It will be possible to evaluate many more alternatives than would otherwise have been the case.

- The model can be used to evaluate log purchases and trades. The benefits of accurate evaluations that consider all the variables can be substantial.

- A model can vastly improve communications between departments. Many changes, particularly in harvesting operations, have effects that are far-reaching. When all concerned can view the results of model runs, it becomes easier for everyone to work towards a common goal.