INCISING/PRESERVATION

by

Paul Morris

I will begin this presentation by providing some background to the development of the two Forintek incisors, follow that by discussing some data on the treatability of SPF incised with our prototype high speed incisor, and then consider optimized processing and the potential for marketing a treated SPF product.

1. BACKGROUND

Incising wood to improve its permeability has been common practice for many years in the pressure treatment industry. The purpose of incising is to open a rapid pathway for a treatment solution to enter the wood and to allow it to spread out within the wood providing a solid zone of protection around the outside of the piece.

The original incisors had blunt teeth, that were spaced wide and had a detrimental effect on the surface appearance of the wood (Figure 1). These blunt tooth incisions were, however, spaced closely enough to produce a solid zone of treated wood in relatively permeable western hemlock (Figure 2). This was not always the case with our less permeable
species such as spruce. The lower piece of lumber in Figure 2 is a piece of treated lodgepole pine and, in contrast to the hemlock, the areas treated from each incision are not meeting up. The degree of treatment is quite variable over the whole surface. Taking a boring from this piece we might measure 10mm penetration if we hit close to an incision, but if we take a boring between incisions the piece would fail to meet the Canadian Standard which requires 10mm penetration in 80% of pieces sampled.

The problem then, in some of our less permeable species is the difficulty in joining the gaps in treatment that occur between the incisions. The incision spacing necessary to do this can be determined by measuring the area treated from one incision.

Using a single point incision or a needle, we find that typical treatment penetration in spruce and lodgepole pine is about 2mm laterally, either side of the incision and about 20mm longitudinal (Figure 3). Trying to put incisions this close together with the old fashion blunt type of incisor is likely to cause serious damage to the surface of the wood and a totally unacceptable appearance. The treated wood industry in general has therefore been moving towards sharper teeth, to give a better surface appearance. However, even sharp teeth when placed much closer together can pinch the wood and strip the surface off lumber. To combat this problem, the industry has developed cleaning rings (Figure 4). These are spacers which are placed in between the incisor rings and act to push off strips of wood that would otherwise clog up the teeth. The need to have

74
these spacer rings limits how close together we can put the tooth rings.

2. DOUBLE DENSITY INCISING

Forintek has developed a double head incisor system for commercial incisors to solve the spacing problem. This applies a second set of incisions immediately between the first set and gives us the very close spacing (12,000 incisions per square meter) that we need for spruce, pine and alpine fir (SPF). One obvious concern with using double the usual number of incisions is the potential for strength loss. Because of this concern we have done tests to compare incising lumber in the dry condition to incising it in the green condition. Figure 5 shows that when incising dry we get a punching effect, and we still see some surface damage even with thin sharp teeth. However, incising it in the green condition we get a slicing effect, and barely visible incisions. The treatment quality is equally good with green as with dry incising despite the reduced fibre damage. Furthermore we have demonstrated on small test beams that incising the lumber green gives us a negligible strength loss (around 5%). We now have an experiment underway in which we will be incising full length pieces, and a much larger number of them, to give us a reliable figure for the strength loss caused by thin teeth with this very high density of incisions.

If we move toward incising green lumber, than it should be done in the sawmill to avoid having to ship green lumber to a treater. By incising prior to drying, we might expect some improvements in the drying time, as
described by Graham Mackay, and possibly incur less degrade. This improvement will help the incisor to pay for itself, increasing the margin expected from selling incised lumber as an added value product. Two problems may arise with the double density incising machine which will be commercially available. One problem is feedspeed. The moving rings may generate a lot of friction if the machine is run at mill speeds. Commercial machines currently run at 350 or 450 feet a minute. We could probably push them up to around 600 feet a minute but in a mill you want to go for 1000 or 1400 feet a minute, and this machine may not be suitable for that production rate. The second problem is the stripping. Although these cleaning rings cope with it by pushing the strips off, that sort of damage to a significant percentage of lumber would be unacceptable to a sawmill.

3. HIGH SPEED INCISING

The need to run at higher speeds and to eliminate stripping lead to Don Walser's new incising head design. This design has reduced stripping to a negligible amount, it runs at 1000 feet a minute, leaves an excellent surface appearance (Figure 6), and it still allows us to get 12,000 incisions per square meter into each board.

This high speed incisor has been developed over the last few months, the drying work has been done over the last few weeks, and the treating work has been done over the last few days. Figure 7 shows cross sections of
SPF pressure treated with chromated copper arsenate (CCA). In the unincised boards, we have penetrations of around 1 or 2 mm. There are also odd areas of penetration in the pine typical of red heart. Similarly, there is some heartwood penetration of parts of the alpine fir, again maybe associated with some early decay. In general there is very poor penetration over most of the surface. When we apply the high density of incisions we see deep penetration that is more uniform around the piece with just a few gaps. However, this was high temperature dried material and we normally expect this process to have some adverse effects on treatability. Figure 8 shows SPF which was not kiln dried prior to treatment and here we see an even better treatment. The gaps are closed up and we have achieved an intact zone of treatment 8 mm deep all the way around the lumber. Consequently, if we were selling a specialized SPF product for treating we would want to dry it to a higher target moisture content, again achieving some savings in drying time.

4. RESULTS

Table 1 shows results of the penetration and the retention tests both in terms of the percent of samples which, when bored, showed over 10 mm penetration, and in terms of the amount of chemical retained in kilograms per cubic meter. The standard requirement is to get 80% of the samples to show over 10 mm penetration and a retention of 6.4 kilograms per cubic meter. Presently, our dry-sort results fell quite short of that, but we have a better performance in the wet-sort. We also have a much better
surface appearance in the wet-sort because the sharp teeth slice between
the fibers of the wetter lumber and do not cut them. So moisture sorting
proves useful in this context. The wet-sort had about 55% of samples over
10 mm and a further 35% of the samples had penetrations of 8 or 9 mm. We
were also very close to the amount of chemical specified in the Canadian
standard.

At the moment there are a number of standards in use. The American
standard, the Canadian standard and a Canadian Industry standard which has
just been introduced and has a 5 mm penetration requirement for above
ground residential construction. With this prototype high speed incisor
we are practically meeting all three standards on retention. We are
meeting the Canadian Industry standard on penetration, but not quite
meeting the Canadian and American Standards. However, with a slightly
deeper incision we should be able to meet all three standards.

5. THE POSITION OF INCISING IN THE SAWMILLING PROCESS

Now I would like to consider where we might place the incisor in the
sawmill process. Currently the mill is sawing, drying, planing and
shipping the lumber. The treater is then receiving it, incising it, and
treating it. However, he is receiving a product the mill has dried below
the optimum for treating, and he is also incising the lumber dry and
getting a poor surface appearance.
We might therefore look at some alternative processes. Firstly, moisture sorting to improve our drying, and also to give us a better surface appearance when we incise. We might consider deep incising, partial kiln drying, (getting some savings in the drying time,) planing off part of that incision then shipping the treater a treatable product. However, we do tend to loose a great depth of incision when we plane after incising and that may not be practical. Perhaps a better alternative for a specialized treatable product for the US market would include planing green, prior to incising, and then partial kiln drying prior to shipping. Obviously this is going to cause some problems in lumber sizing which would have to be resolved.

Perhaps the optimum process would include treating the product prior to shipping. Why send the lumber to a U.S. treater when we could maximize our added value on this side of the border and then ship it into the States or into other markets? That thought leads into the question of marketing a treated SPF product.

6. MARKETING TREATED SPF

We are looking not only at the potential for an added value product, but also at sending that product into a market which is much less dependent on housing starts. At the moment, 49% of the U.S. consumption of treated lumber is going into residential, remodelling and repair, not original construction. Furthermore, over the last 10 years the amount of treated
lumber used in the U.S. and Canada has been increasing at a rate of about 10-15% a year. It is not expected to continue at this rate, but may level off or slightly increase from the current level of around 6 to 7 billion board feet. Currently 85% of the treated lumber consumed in the U.S. is Southern Yellow Pine from the southern States. Table 2 shows production and consumption of treated lumber within the U.S. by region. The US south has a major surplus of treated lumber and that gets shipped north to the North Central, the North East and the Western regions. About 1.6 billion board feet of treated lumber is moving around the US per year. Canada should be able to get at least a portion of that market by shipping SPF down from the North.

SPF would already be preferred for residential, remodelling and repair because of its workability and its stability. However it has been kept out of that market for two reasons: its poor treatability and the fact that it is not in the US wood preservation standard. Its not in the US standard because up to now it has not been effectively treatable. If we can demonstrate the treatability of this material and if we can get it into the standard, it should be price competitive with Southern Yellow Pine.

Since 1978 the price ratio of SPF to Southern Pine has moved from close to 1 to 1, to a current level of about 0.8 to 1. We believe that a treated SPF product could probably undercut treated Southern Yellow Pine by a substantial margin, and there is no reason why that price differential should not continue. Currently Southern Yellow Pine
production is pegged at around 12 billion board feet a year and almost 50% of that is going into the treated wood market. It is a question of supply and demand. The price of Southern Yellow Pine is not likely to come down, but we may be able to bring the value of SPF up to its level.

7. SUMMARY

In summary, with a little further work we expect to be able to meet the Canadian and US treated wood standards with incised SPF. The product has a good surface appearance, the incisor can run at mill speeds, and there is a potential market for that lumber in the US.
<table>
<thead>
<tr>
<th></th>
<th>PENETRATION % over 10mm</th>
<th>RETENTION Kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Sort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(under 33% moisture content)</td>
<td>25</td>
<td>5.5</td>
</tr>
<tr>
<td>Wet Sort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(over 33% moisture content)</td>
<td>55</td>
<td>6.3</td>
</tr>
<tr>
<td>Standard Specification</td>
<td>80</td>
<td>6.4</td>
</tr>
</tbody>
</table>
TABLE 2

TREATED LUMBER PRODUCTION
CONSUMPTION AND SELF SUFFICIENCY IN THE U.S.
BY REGIONAL SHARES (%)

<table>
<thead>
<tr>
<th>REGION</th>
<th>PRODUCTION</th>
<th>CONSUMPTION</th>
<th>SURPLUS/ - DEFICIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. Central</td>
<td>9.9</td>
<td>28.5</td>
<td>-18.6 ( = 800 MMfbm)</td>
</tr>
<tr>
<td>N. East</td>
<td>6.1</td>
<td>21.1</td>
<td>-15.0 ( = 700 MMfbm)</td>
</tr>
<tr>
<td>South</td>
<td>74.0</td>
<td>37.9</td>
<td>+36.1 ( = 1700 MMfbm)</td>
</tr>
<tr>
<td>West</td>
<td>10.4</td>
<td>12.5</td>
<td>-2.1 ( = 100 MMfbm)</td>
</tr>
</tbody>
</table>

100%  100%

Sources: Walsh, 1985; RISI, 1988
FIGURE 1  Blunt tooth wide spaced incisor in operation.
FIGURE 2  Cross sections of hem-fir (top) and lodgepole pine (bottom) lumber incised and pressure treated with chromated copper arsenate (CCA) then sprayed with a reagent which shows up the treated areas as dark blue and the untreated areas as light orange.
FIGURE 3  Longitudinal and lateral penetration of CCA from a single needle incision in spruce.
FIGURE 4  Commercially available incisor head showing tooth rings and moveable spacer rings.
FIGURE 5  Surface appearance of double density dry incised (left) and green incised (right) SPF pressure treated with CCA.
FIGURE 6  Surface appearance of unincised and high-speed high-density incised SPF pressure treated with CCA.
FIGURE 7  Cross sections of high-speed incised and unincised high temperature dried pressure treated SPF.
FIGURE 8  Cross sections of high speed incised SPF which was not kiln
dried prior to pressure treatment.
TRAINING AND EDUCATION

By
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TRAINING AND EDUCATION

by

J.F.G. Mackay

Forintek, Western Laboratory and previously the Western Forest Products Laboratory, has traditionally provided support to the industry in the area of kiln operator training. In recent years this has become a more onerous task due to increasing numbers of applicants, considerably more than could be handled efficiently in a one-week course. A new type of training package has now been developed and it is the elements of this program that I will now describe.

The first thing we did was to reissue our Kiln Operator's Handbook. The previous edition had served its purpose very well, over 4000 copies having been distributed. It ran out of print about a year ago so this was a very good reason to do some upgrading and updating. Since the basics and principles of drying do not change, those sections of the books are similar. We have recognized technological changes and improvements that have occurred in the last 10-15 years including in-line moisture meters, green lumber moisture sorters and computerized kiln controls.

At the same time we have updated our Kiln Drying Correspondence Course. Since its inception in 1975, about 700 people have participated in this activity. Similar to the Handbook, the Course deals with basics and principles of moisture in wood as well as the technological aspects of
drying. The lessons have been increased from 10 to 12 to include advances in drying technology and statistical quality control. The written questions that accompany each lesson and the final written exam have been made more testing. It is expected that successful completion of this course will count towards accreditation in the Council of Forest Industries' Master Sawmiller program.

To supplement material that can only be read or written, we are developing other strategies that will further explain practical applications in kiln drying. A slide-based training video based on shots taken over the years in various mills with examples of both good and bad drying practices is being prepared. A soundtrack will explain the points being made. The video can be used as a supplement to the correspondence course, as part of in-mill training programs, as well as by ourselves as an introduction to regional workshops and seminars on drying.

We do recognize that some training should be done at the mills, so starting this fall and winter we are going to try to institute what we are calling regional workshops where one or more of the lumber drying group at Forintek will come out to specific areas where we have gathered together 15 or 20 people from a number of mills and sit down and look at some real world drying problems, and through the medium of group discussions try to work out how best to solve them. By its very nature, of course, this will be modified to recognize regional topics and we certainly anticipate and will require a significant input from the various industry associations in planning, organizing, and maintaining the industry focus of these
workshops.

In the course of putting together this training material on kiln drying, it became obvious that other areas where we have some expertise should also be included in a comprehensive wood products education program. Consequently, we will be preparing information packages on areas including moisture sorting, saws and saw maintenance, sawmill quality control and anti-sapstain protection.
CURVE SAWING, CANT OPTIMIZATION
AND LOG ROTATION

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Good afternoon! To complement John Hards' presentation, I will be covering three areas related to curve sawing. First, I would like to present the results of the lumber recovery and lumber size studies conducted jointly by Grande Cache Forest Products and Forintek at Grande Cache Forest Products' sawmill. Second, I would like to discuss the results of a sawmill simulation study that compare the performance of three ways of breaking down a cant. The three ways are the traditional manual linebar edging, computer optimized edging, and curve sawing. Third, I would like to discuss the impact of log rotation on the performance of the three cant breakdown methods.

2. CURVE SAWING PERFORMANCE EVALUATION

2.1 Lumber Recovery

A lumber recovery study was conducted four months after the implementation of curve sawing at Line 1 (small log line) of the mill. At this time, Line
2 had not been converted to do curve sawing. The studies were conducted for both lines. Since the two lines had the same kind of equipment, the results from Line 2 and Line 1 were assumed to represent the performance before and after curve sawing respectively.

The lumber recovery study began by selecting randomly 25 sixteen-foot debarked logs from normal production to fill each of three sort diameter classes for both lines. The sort diameter was defined as the diameter at one foot from the small end of the log. Selection of the logs was done on the same day for both lines to assure similar qualities. The logs were measured for top and butt diameters, maximum sweep, and length. Maximum sweep was defined as the maximum horizontal distance between the edge of the log and a string that was stretched along the edge of the log when the log was manually rotated to the horns sideways position.

The two sets of sample logs selected were run through Line 2 and Line 1 respectively and the resulting lumber was pencil trimmed and pencil edged by a certified grader. Wane and thickness were the only criteria used for trimming and edging. Sufficient gap time was provided between consecutive logs to allow for pencil trimming and edging.

The results of the lumber recovery study are summarized in Table 1 which shows that curve sawing increased lumber recovery significantly. The increases were 16, 8, and 4 percent for the three diameter classes in ascending order, respectively. The percentage gain decreased with increasing log diameter, as generally expected. The declining trend
suggests that there is little advantage in curve sawing logs with sort
diameters greater than 10 inches. Furthermore, curve sawing 10-inch cants
with circular saws was found to be impractical from a saw maintenance
point of view.

2.2 Lumber Size

A lumber size study was conducted before curve sawing was implemented to
determine the lumber thickness variation produced by Line 1 machines (log
canter, cant canter, and gang edger). Lumber pieces produced from
twenty-seven 4-inch cants and 30 6-inch cants were measured for thickness.
A similar study was conducted three months after the implementation of
curve sawing at Line 1. Another lumber size study was conducted to
determine the sawing variation at the twin band. The Forintek baseline
lumber size study procedure was slightly modified for taking size
measurements (Wang 1986). Briefly, six size measurements (three on each
edge) were taken on the thickness of dimension lumber. When the ends were
not wany, the measurements at the leading and trailing ends were usually
taken at about one inch from the ends. When the ends were wany, the end
measurements were taken as close to the ends as possible. The size
measurements were analyzed using LUSI (Wang 1986).

The results of all lumber size analyses are summarized in Tables 2 and 3.
Table 2 shows that total sawing variation was reduced substantially by
curve sawing. Before curve sawing, the curved cants produced at the Line 1
cant canter were straight sawn by the downstream gang edger. If the curved
cant was fed into the gang edger with horns away from the linebar, the leading end of the lumber was usually too thin. If the curved cant was fed into the gang edger with horns against the linebar, the middle of the lumber was usually too thin. Therefore, very high total sawing variation was recorded. After curve sawing, these problems no longer existed, and a smaller total sawing variation was observed. The smaller sawing variation after curve sawing should not be interpreted as the saws were running better during curve sawing. In fact by analyzing the sizes of only the middle pieces from the 6-inch cants, we found that after curve sawing the total sawing variation was more than doubled (Table 2). The total sawing variation of the outside piece (away from the straight edge) remained essentially the same.

A total of 180 pieces of nominal 2-inch lumber (16 to 20 feet long) produced at the twin band from 60 nominal 6-inch cants were measured. The pieces were analyzed separately based on their sweep and positions in relation to the linebar of the twin band. The results (Table 3) indicate that regardless of sweep average lumber size varied by piece position, probably caused by improper setting of the twin band set works. The sawing variations of the second piece were small and were among the best in the lumber industry. The first and third pieces had much larger sawing variations, which could be attributed to the higher sawing variations at the cant cantor.

The sawing variations of the straight cants (sweep less than 0.6 inch) and those of the sweepy cants (sweep larger than 0.5 inch) statistically
different indicating that the twin band was doing a good job in curve sawing. If the twin band was not curve sawing well, the sawing variations of sweepy cants would have been much higher similar to those of the gang edger before curve sawing was implemented.

The fact that the twin band curve-sawed 4-sided cants well presents an opportunity for converting existing straight sawing band saw machines into curve sawing ones. Since the feeding system of the twin band consisted of vertical press rolls, horizontal feed rolls and the linebar, adoption of this feeding system to existing secondary band saw machines appears inexpensive and effective. The presence of knot stubs, however, should be dealt with if two sided cants are to be sawn successfully using the concept of curve sawing parallel to one side of the cant. Kenyon (1979) of South Africa patented feeding equipment to minimize the impact of knot stubs and other log surface irregularities on curve sawing.

2.3 Comparison of Three Cant Breakdown Methods

Three cant breakdown methods were compared using SAWSIM, a log bucking and sawing simulation program. Three dimension sawmill models (A,B,C) were used. All sawmill models had a "typical" reducer-twin primary breakdown to produce up to two side boards and a two-sided cant from a log. All side boards were edged with a board edger which positioned the board against a linebar for sawing. The two-sided cant was processed by a chipping-gang. All mills were equipped with an optimizer which selected the best cant width for each log.

101
The three mill models differed only in the breakdown of the two sided cant. The chipper-gang of Mill A had a shifting linebar infeed (complete with laser-line assist for the operator). The linebar could be shifted by 0.625 inch increments. The chipper-gang of Mill B was equipped with a cant optimizer. For maximum value, the optimizer considered three cant alignment angles: parallel to the least-squares line for one side of the cant, parallel to the least squares line for the other side of the cant, and parallel to a line mid-way between the above two lines. The optimization algorithm simulated that used in the cant optimizer developed by Applied Theory Inc\textsuperscript{1}. The cant in Mill C was processed with a curve sawing system which simulated the operation of the curve sawing system installed at Grande Cache Forest Products sawmill at Grande Cache, Alberta, by Ari Sawmill Equipment Ltd\textsuperscript{1}.

Two log mixes were used in the simulation. Log Mix 1 had 70 SPF logs from northern interior of British Columbia. The average top diameter, sweep, and taper were 6.49 inches, 1.36 inches, and 0.137 inches per foot respectively. Log Mix 2 had 179 primarily Lodgepole Pine logs from the Cariboo region of British Columbia. The average top diameter, sweep, and taper were 5.57 inches, 1.33 inches, and 0.100 inches per foot respectively. The simulation results from these two log mixes were weighted to represent a processing rate of 2800 logs per shift. The

\textsuperscript{1} Use of the suppliers' names does not constitute the endorsement of their products by the author.
weighted log distributions are summarized in Tables 4 and 5.

Simulation runs were designed to compare the efficiency of the three mill models. In these runs logs were assumed to be rotated to the horns down position at the primary breakdown. The results from Log Mix 2 were sorted by diameter, sweep, and taper to gain a better understanding of the differences among the three mill models.

The simulation results are summarized in Tables 6, 7, 8, and 9. For comparison purpose, the lumber and total product value recoveries of the linebar cant breakdown method were used as the basis for calculating the improvements due to cant optimization and curve sawing.

For both log mixes, both cant optimization and curve sawing improved lumber and (abbreviated as value from here on) value recoveries substantially (Table 6).

With Log Mix 1, cant optimization obtained higher lumber and value recoveries than curve sawing. With Log Mix 2, the reverse was true. The average lumber recovery due to curve sawing for the two log mixes was 5.7%, similar to the theoretical 6% found for a typical Swedish sawmill (Sederholm, 1982).

The value recovery increase due to curve sawing outpaced those due to cant optimization in all diameter classes (Table 7). Curve sawing was extremely effective in increasing lumber recovery for logs with top diameter less than 6 inches. The cant optimization alternative scored better than the
curve sawing alternative when the sweep of logs were less than one inch (Table 8). For logs with sweep more than 2 inches, curve sawing had 14.8% value recovery increase while cant optimization had only 0.6%. For logs with small taper, curve sawing was better than cant optimization (Table 9). For logs with higher taper, the reverse was true. The recovery improvement due to curve sawing decreased rapidly with increasing taper of the logs. When taper was greater than 0.15 inch per foot, the lumber recovery from curve sawing dropped below that from conventional linebar sawing, while value recovery maintained a small increase (0.5%).

2.4 Log Rotation

A mill study was conducted to determine the efficiency of manual log rotation. A simulation study, also using SAWSIM with the same three mill models described above, was conducted to see the impact of log rotation on lumber and value recovery. The results obtained from the mill study were used in the simulation study to determine lumber and value recovery losses due to poor log rotation. Only Log Mix 2 was used in this simulation study.

In the mill study, a total of 127 logs were selected from normal production to fill 4 sort diameter classes. Log length varied from 14 to 20 feet. Seventeen of the logs had distinctively two-axis sweep and the other 125 logs had predominately one-axis sweep. The logs were laid on skids in the log yard and visually rotated to the horns down position, which was identified with the letter "T" using spray paint. The logs were also numbered using a different color of paint.
The logs were run through Line 1 at normal operating speed. The log numbers were manually recorded and the logs were video-taped (using two portable video cameras) as they were leaving the two canters. The video tapes were later viewed to measure angle of rotation from the horns down position in degrees.

The measured rotation angles of logs with primarily one-axis sweep are displayed in Figures 1 and 2. Thirty-six percent of the time, the operator was able to turn the logs to within 15 degrees of the horns down position (Figure 1). Forty-three percent of the time, the rotation angle was greater than 30 degrees.

Analysis of variance of the rotation angles showed that rotation angle was negatively related to sweep (Figure 2), but not related to log diameter. In other words, as the sweep of logs increased, the operator became more efficient in turning the logs to the horns down position. This implies that unless log rotation efficiency can be improved, little recovery increase can be expected from curve sawing straight logs (sweep less than 1 inch) and large recovery increase can be expected from curve sawing sweepy logs (sweep more than 2 inches).

The simulation study found that lumber and value recoveries decreased steadily with increasing rotation error (Table 10). If the rotation error was within 15 degrees from the horns down position, less than 1% loss in lumber or value recovery was estimated. If the rotation error was 90
degrees, almost 9% of value recovery was lost.

The lumber or value recovery decreased by 4% for curve sawing (Table 11), when manual log rotation angles (Figure 1) were simulated in sawing Log Mix 2. Smaller decreases were found for cant optimization and linebar sawing. These estimates were, however, subject to errors. First, in the simulation, rotation errors in both clockwise and anticlockwise directions from the horns down position were treated equally. Second, SAWSIM curve sawed logs with same efficiency whether logs were rotated with horns up or down. For example, rotation angles of 30, 60 and 90 degrees had the same effect as 120, 150 and 180 degrees respectively.

3. CONCLUSIONS AND RECOMMENDATIONS

The lumber recovery study found that curve sawing with single arbour circular gang edgers increased lumber recovery by 4 to 16 percent for logs with top diameter from 4 to 8 inches at Grande Cache Forest Products sawmill. A lumber size study confirmed observations that the twin band curve-sawed effectively.

The simulation study found that curve sawing two-sided cants produced the higher lumber and value recoveries for two interior log mixes, when compared to cant optimization and conventional linebar edging. Curve sawing excelled when logs were small (top diameter less than 9 inches),
with less than 0.15 inch/foot taper, and with more than 1 inch of sweep.

Log rotation was found to play an extremely important role in curve sawing. The value loss was almost 9% when rotation angle was off by 90 degrees from the horns down position. Manual log rotation was found to cause a 4 percent lumber recovery loss for one interior log mix.

Canadian mills that have a substantial amount of small sweepy logs, should consider implementing curve sawing not only with infeed systems specifically designed for curve sawing, but also with twin band feeding systems.

To maximize the benefits from curve sawing, log rotation efficiency should be improved.

4. REFERENCES


### TABLE 1

**Before and After Curve Sawing**
**Lumber Recovery Comparison**

<table>
<thead>
<tr>
<th>Sort Diameter (in.)</th>
<th>Lumber Recovery Increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3 - 4.8</td>
<td>16</td>
</tr>
<tr>
<td>4.8 - 6.3</td>
<td>8</td>
</tr>
<tr>
<td>6.3 - 8.2</td>
<td>4</td>
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</tbody>
</table>

### TABLE 2

**Before and After Curve Sawing**
**Size Variation Comparison**

<table>
<thead>
<tr>
<th>Nominal Size (in.)</th>
<th>Before</th>
<th>After</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No. of Pieces</td>
<td>St (in.)</td>
</tr>
<tr>
<td>2 X 4</td>
<td>54</td>
<td>0.099</td>
</tr>
<tr>
<td>2 X 6</td>
<td>60</td>
<td>0.061</td>
</tr>
<tr>
<td>2 X 6¹</td>
<td>20</td>
<td>0.013</td>
</tr>
<tr>
<td>2 X 6²</td>
<td>20</td>
<td>0.034</td>
</tr>
</tbody>
</table>

Only the centre pieces were included in the analysis.

Only the outside (third) pieces from the linebar were included.
### TABLE 3

Comparison of Size Variation of 2 X 6's by Position from the Linebar of the Twin Band

<table>
<thead>
<tr>
<th>Sweep (in.)</th>
<th>Factor</th>
<th>Piece Number from Linebar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First</td>
</tr>
<tr>
<td>&lt;0.6</td>
<td>Number of Pieces</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Sawing Variation, (in.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Within-Board</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>Between-Board</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.038</td>
</tr>
<tr>
<td>&gt;0.6</td>
<td>Number of Pieces</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Sawing Variation, (in.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Within-Board</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>Between-Board</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.040</td>
</tr>
</tbody>
</table>
### TABLE 4

**Distribution of Log Mix 1 by Diameter and Length**

<table>
<thead>
<tr>
<th>Small End Diameter (in.)</th>
<th>Average Sweep (in.)</th>
<th>Log Lengths (ft.)</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00-4.99</td>
<td>1.4</td>
<td>80</td>
<td>120</td>
<td>40</td>
<td>120</td>
<td>160</td>
<td>240</td>
<td>760</td>
<td></td>
<td>27.1</td>
<td></td>
</tr>
<tr>
<td>5.00-5.99</td>
<td>1.5</td>
<td>160</td>
<td>40</td>
<td>240</td>
<td>320</td>
<td>120</td>
<td>480</td>
<td></td>
<td>22.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.00-6.99</td>
<td>1.3</td>
<td>40</td>
<td>160</td>
<td>40</td>
<td>80</td>
<td>320</td>
<td></td>
<td>17.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00-7.99</td>
<td>1.3</td>
<td>40</td>
<td>160</td>
<td>40</td>
<td>80</td>
<td></td>
<td>11.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00-8.99</td>
<td>1.1</td>
<td>160</td>
<td>40</td>
<td>40</td>
<td>240</td>
<td></td>
<td>8.6</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9.00-9.99</td>
<td>1.0</td>
<td>120</td>
<td>40</td>
<td>40</td>
<td></td>
<td>160</td>
<td>5.7</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>10.00-10.99</td>
<td>1.6</td>
<td>40</td>
<td>40</td>
<td></td>
<td>120</td>
<td></td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.00-11.99</td>
<td>1.2</td>
<td>80</td>
<td></td>
<td></td>
<td>80</td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>80</td>
<td>120</td>
<td>280</td>
<td>80</td>
<td>1240</td>
<td>440</td>
<td>560</td>
<td>2800</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Percent</strong></td>
<td></td>
<td>2.9</td>
<td>4.3</td>
<td>10.0</td>
<td>2.9</td>
<td>44.3</td>
<td>15.7</td>
<td>20.0</td>
<td>100.0</td>
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<td></td>
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</tbody>
</table>

### TABLE 5

**Distribution of Log Mix 2 by Diameter and Length**

<table>
<thead>
<tr>
<th>Small End Diameter (in.)</th>
<th>Average Sweep (in.)</th>
<th>Log Lengths (ft.)</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00-3.99</td>
<td>1.2</td>
<td>45</td>
<td>123</td>
<td>74</td>
<td>38</td>
<td>53</td>
<td>332</td>
<td></td>
<td>11.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.00-4.99</td>
<td>1.5</td>
<td>12</td>
<td>76</td>
<td>113</td>
<td>308</td>
<td>53</td>
<td>285</td>
<td>846</td>
<td></td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td>5.00-5.99</td>
<td>1.3</td>
<td>9</td>
<td>63</td>
<td>79</td>
<td>436</td>
<td>20</td>
<td>147</td>
<td>754</td>
<td></td>
<td>26.9</td>
<td></td>
</tr>
<tr>
<td>6.00-6.99</td>
<td>1.5</td>
<td>29</td>
<td>89</td>
<td>225</td>
<td>91</td>
<td>433</td>
<td></td>
<td>15.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00-7.99</td>
<td>1.0</td>
<td>32</td>
<td>90</td>
<td>18</td>
<td>41</td>
<td>181</td>
<td></td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00-8.99</td>
<td>1.3</td>
<td>25</td>
<td>12</td>
<td>61</td>
<td>41</td>
<td>139</td>
<td></td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.00-9.99</td>
<td>1.2</td>
<td>17</td>
<td>35</td>
<td>29</td>
<td>80</td>
<td></td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00-10.99</td>
<td>1.7</td>
<td>16</td>
<td>9</td>
<td></td>
<td>9</td>
<td>25</td>
<td></td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.00-11.99</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td>9</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>66</td>
<td>347</td>
<td>383</td>
<td>1208</td>
<td>91</td>
<td>704</td>
<td>2800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Percent</strong></td>
<td></td>
<td>2.4</td>
<td>12.4</td>
<td>13.7</td>
<td>43.1</td>
<td>3.3</td>
<td>25.1</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

111
TABLE 6

Improvements in Lumber and Value Recoveries by Cant Optimization and Curve Sawing

<table>
<thead>
<tr>
<th>Log Mix</th>
<th>Increase in L. R.</th>
<th>Increase in V. R.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>5.7</td>
<td>4.2</td>
</tr>
<tr>
<td>2</td>
<td>5.2</td>
<td>7.2</td>
</tr>
</tbody>
</table>

* L.R. = lumber recovery
V.R. = value recovery

TABLE 7

Effect of Diameter on Improvements in Lumber and Value Recoveries Due to Cant Optimization and Curve Sawing

<table>
<thead>
<tr>
<th>Dia. Class (in.)</th>
<th>Increase in L. R.</th>
<th>Increase in V. R.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>&lt;6.0</td>
<td>6.6</td>
<td>10.0</td>
</tr>
<tr>
<td>6.0-8.9</td>
<td>4.0</td>
<td>5.4</td>
</tr>
<tr>
<td>9.0-12</td>
<td>4.2</td>
<td>4.2</td>
</tr>
</tbody>
</table>

* L.R. = lumber recovery
V.R. = value recovery
TABLE 8

Effect of Sweep on Improvements in Lumber and Value Recoveries due to Cant Optimization and Curve Sawing

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>&lt;1.0</td>
<td>6.8</td>
<td>3.5</td>
<td>4.5</td>
<td>2.7</td>
</tr>
<tr>
<td>1.0-1.5</td>
<td>5.0</td>
<td>5.9</td>
<td>5.3</td>
<td>6.2</td>
</tr>
<tr>
<td>2.0-2.9</td>
<td>1.7</td>
<td>20.6</td>
<td>0.6</td>
<td>14.8</td>
</tr>
</tbody>
</table>

* L.R. = lumber recovery
V.R. = value recovery

TABLE 9

Effect of Taper on Improvements in Lumber and Value Recoveries due to Cant Optimization and Curve Sawing

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>&lt;0.085</td>
<td>7.7</td>
<td>11.0</td>
<td>5.7</td>
<td>9.0</td>
</tr>
<tr>
<td>0.085-1.499</td>
<td>4.2</td>
<td>6.6</td>
<td>3.3</td>
<td>4.9</td>
</tr>
<tr>
<td>1.50 +</td>
<td>0.9</td>
<td>(4.2)</td>
<td>2.7</td>
<td>0.5</td>
</tr>
</tbody>
</table>

* ( ) = decrease
L.R. = lumber recovery
V.R. = value recovery
### TABLE 10

**Effect of Log Rotation Angle on Curve Sawing Performance**

<table>
<thead>
<tr>
<th>Rotation Angle from Horns Down (degrees)</th>
<th>Lumber Recovery</th>
<th>Value Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>30</td>
<td>3.7</td>
<td>3.5</td>
</tr>
<tr>
<td>45</td>
<td>5.3</td>
<td>5.6</td>
</tr>
<tr>
<td>60</td>
<td>7.6</td>
<td>7.4</td>
</tr>
<tr>
<td>90</td>
<td>8.4</td>
<td>8.9</td>
</tr>
</tbody>
</table>

### TABLE 11

**Effects of Log Rotation on Lumber and Value Recoveries for Three Mill Alternatives**

<table>
<thead>
<tr>
<th>Mill</th>
<th>Lumber Recovery (Value Rec.)</th>
<th>Loss from Horns Down Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horns Down Manual Log Rotation</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>237.2 (56.0) 232.5 (55.4)</td>
<td>2.0 (1.1)</td>
</tr>
<tr>
<td>B</td>
<td>249.5 (58.4) 241.5 (57.1)</td>
<td>3.3 (2.3)</td>
</tr>
<tr>
<td>C</td>
<td>254.3 (59.4) 244.5 (57.4)</td>
<td>4.0 (3.5)</td>
</tr>
</tbody>
</table>
FIGURE 1 Distribution of manually controlled rotation angles for logs with primarily one-axis sweep
FIGURE 2  Correlation between the amount of sweep and manually controlled rotation angles for logs with primarily one-axis sweep
CURVE SAWING

By

John Hards

Manager, Technical Development
Fletcher Challenge Canada Ltd.
700 West Georgia Street
Vancouver, B.C.
CURVE SAWING
by
John Hards

I want to start with a little about the history of the Grande Cache sawmill, because with the log quality we obtain from the forest in the region you might wonder why anybody would build a sawmill there. Some of you probably remember there was a competition at that time for the Berland forest. A sawmill was part of the ticket of getting this forest, which was large enough to support a large pulp mill. The Alberta Government wanted to have a sawmill in Grande Cache because they had a mine there, a new instant town, somewhat similar to Mackenzie in northern B.C., and a commitment to a lot of people. They wanted to spread the employment base so that the town would survive when the coal market went down.

The management of British Columbia Forest Products agreed to build a sawmill in Grande Cache in return for getting the Berland tract which they required to supply a pulp mill proposed for Whitecourt. The sawmill was built, but unfortunately the recession came and B.C.F.P. was unable to build the pulp mill. After a few years and quite a few studies B.C.F.P. allowed their cutting option to lapse and the timber reverted to the Alberta Government. B.C.F.P. was allocated enough timber to run the sawmill, but the timber turned out to be some of the poorer quality in the
foothills. It is very sweepy and crooked, and presents a difficult conversion problem. Had the pulp mill been built the sawmill might have been alright as it was originally designed because we would have been able to switch logs back and forth and chip the pulp wood, and we would have had reasonably good quality sawlogs to put in the sawmill. Having to process the entire log mix made the mill a marginal operation.

Faced with the situation as it developed, B.C.F.P. started looking at alternatives that might make the mill profitable. They seriously considered converting it into a stud mill, but turning a dimension mill into a stud mill results in an inefficient operation unless you start all over again. The Alberta Government had an interest in the mill's survival, but suggested that a study of alternatives be undertaken prior to any further investment. The study was done by Carroll Hatch using SAWSIM, a sawmill computer simulation program. They measured a sample of trees in detail for sweep, crook, diameter, taper and length, and used this information to characterize the forest inventory. The study showed that with the price of studs at that time we would probably lose more money if we converted to a stud mill. SAWSIM was then used to investigate alternatives. It indicated that by cutting longer lengths, producing MSR, improving machining capabilities in the mill, and installing optimizers recovery and value yields could be improved enough to make the mill profitable.

We had to start looking at what we had there. Optimizers are relatively straightforward. You heard about optimizing the log deck this morning,
and edger and trimmer optimizers are other applications. However, we had
canter lines that were a difficult problem. The lines each have a log
canter followed in line by a cant cantor. These canters have vertical
belts that are mechanically centred and the log is fed in between the
belts. The canter is set and it chips out a full face on each side of the
log. Because of the way they are made neither the log cantor nor the cant
cantor do a very good job of positioning the log. They were designed so
that the log would come out of the first cantor, be turned 90 degrees,
have the two flat faces on the rolls, go in between the second set of
belts, be squeezed, go through the second cantor and leave you with a
four-sided cant. The cant would go further down stream and directly into
a gang edger with guided saws. The system actually worked quite well from
the point of view of production. You could put a lot of wood through, but
the lumber recovery was terrible because these belts just don't do any
positioning.

we had to decide what we were going to do with this part of the mill
because it is the key to recovery. When Forintek made us aware of curved
sawing, and Ari's representative described their product, it looked like
something that might fit. We went on a trip to Sweden and saw that the
curve sawing certainly works over there. Their logs are what we would
consider straight but they still achieve an improvement in recovery from
curve sawing.

Figure 1 shows an obvious reason for curve sawing. It shows a sweepy log
for which it is claimed curve sawing provides an improvement of 43% to 58% in recovery because you are able to take advantage of the actual size of the log, rather than reducing its effective diameter as you do when you try to cut a straight cant. In our Grande Cache sawmill the improvement on some logs could be much more than that. If you put this sweepy log against a straight edge and the straight edge is designed with the saws at 1 3/4", then for a 4" diameter log you might recover nothing from it, but with the curved sawing technique you may recover two full length 2x4's.

There are a couple of keys to curve sawing. The first key is the log canter which chips the first two faces. The log has to go in, with the correct rotation, which is controlled by the operator. If he doesn’t rotate it correctly curved sawing doesn’t work correctly. It is very difficult for the operator to judge the correct rotation because he first has to detect the sweep and then he has to turn the log horns up or horns down to place the sweep in the vertical plane. Most of the time he can do it. The cant is then turned 90 degrees, placing all the sweep in the horizontal plane and the second, or cant canter, can chip along the curve.

The way that curve sawing is accomplished in Sweden was really interesting, but we learned that it is not the only way to do it. They use a diablo roller, which we call an hour glass roll. This works by putting pressure on the cant. In our Grand Cache mill this roller is above, and it pushes down on the cant. The idea is that knots, or poor quality limbing will have very little effect on the rolls. It does have some centering action, and in the cant canter the chipping action comes right
after these rollers, and chips the log on the centre line. That actually works very well, but there is a little problem which I will explain in a minute. Further downstream you have the four-sided cant that was actually straight cut on the log canter, turned 90 degrees then chipped along the curve on the cant canter. On the gang saw, there is a very short straight edge close to the saws and the previous long straight edge is moved back out of the way. A holdover roll keeps the cant tight against the short straight edge. All you are doing is working on a very short part of the curve of each piece, and in a way the saws are really seeing a straight cant. It’s almost like feeding the table saws at home where you can actually cut a curve and it works very effectively. This is the same machinery they use in Sweden, however they very often have a saw in the centre. They make a different cutting pattern and have the curved length forced to the centre. They simply take small side boards which we don’t want. All we want is 2-inch dimension lumber.

Now the little problem comes in. What we have done in effect is half taper chipping on the log canter and on the cant canter but we are doing full taper sawing on the gang edger. So we are losing some recovery. You have to make a long full face on the cant to make it work properly at the gang saw and you end up chipping a little bit more off than the theoretical ideal. We have some ideas to fix that.

A question that always comes up is what do we tell sawfilers about curve sawing. Ari has a theory that the arc of the curve fits into the clearance between the teeth and the saw blade (Figure 2), and I am sure
this theory is correct. However, we did not change our saws for curve sawing. Ari wanted to put a splitter on to prevent the wood binding at the back end of the saws. We did not do this and I do not feel there have been any related problems but there is a problem of saw binding and it relates to the distance from the infeed holdover rolls to the saws. This distance is very short, about 1", and the cant is moving very fast, probably 350 feet a minute, and you must have the sequencing done so that the leading end of the piece is properly held by the rolls before the cant enters the saws.

Sequencing of the rolls is a very critical timing problem, and occasionally a piece will get into the saws the holdover rolls push it over and put pressure on the sides of the saws which are in the guides and this stretches the leading edge of the saws. That's something that really needs to be watched in future installations.

Ari explained to us that it is very important that the positioning of the log is absolutely correct on the log canter where you are making the first two straight cuts. If the face on one side is larger than the face on the other, meaning the log isn't centered properly, on the infeed chain, you are going to have a lot more wane than you want. This is very exaggerated (Figure 3), but it happens in our mill. You can very often have sides (R and L) of different size. This produces a terrific amount of wane on the top, and no wane on the bottom, and you have to trim the pieces. This should not happen if the log canter does its job properly.
We knew that centering the log on the first canter was critical, and we bought a scanning system that looks at where the log is on the chain, and moves the cutting heads very slightly in increments of 10 thousands of an inch. Because of log movement that occurs on the chain from where it is scanned to where it enters the canter we were not able to make that work effectively. We have done away with it for now, and are mechanically centering the log, and log rotation is the key. If the log is not rotated properly, then the tail end is somewhat to one side and causes problems.

Ari claims that 50% better centering and primary breakdown can improve recovery by more than 5%. However, recovery drops if the log is not properly centered. If it is off-centre by 5 millimeters it goes down to 47%, 20 millimeters off centre reduces it to 43%. So curve sawing is an art, and it is critical that the machinery is carefully designed and that everybody who works in the mill really understands what they are trying to achieve.

We have a centering system in front of the cant canter similar to that in front of the log canter, but this second centering system centers the cant, then lets it go. Then the infeed rolls come down on top of it, holding it in place while feeding into the chipping heads. In our mill, because of the original design, we run logs butt first. We didn't want to change that because it meant restructuring the log crane and the log decks, but we should have made the changes because it is extremely difficult to center the log fed butt first.
We learned the answers to two questions – one was which way should you turn the horns, horns down; and the other was should logs be fed top first or butt first, and the answer is top first.
FIGURE 1 Improvement in lumber yield from curve sawing
By utilizing the difference between kerf and plate, "The Curve" can pass the saw.

FIGURE 2 Basic curve sawing technique used by ARI
C = CENTERING FAULT
F = FACE WIDTH DIFFERENCE
H = HEIGHT OF CANT
L = LEFT FACE WIDTH
R = RIGHT FACE WIDTH

\[ C = \frac{L^2 - R^2}{8 \times H} \quad F = L - R \]

The face width difference "F" is more than four times the log centering fault "C"

FIGURE 3 Consequence of a log being positioned somewhat off center
TESTING A NEW CIRCULAR SAW GUIDE SYSTEM
IN A LARGE PRODUCTION SAWMILL

By
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TESTING A NEW CIRCULAR SAW GUIDE SYSTEM IN A LARGE PRODUCTION SAWMILL

by

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1. INTRODUCTION

The cutting performance of circular saws has improved substantially in recent years due to splined arbors, reduced wear of saw teeth, optimised tooth geometry, improved grinding techniques, and most importantly, improved guiding. On the average, kerf reductions of more than 0.070 inches have been achieved in many B.C. sawmills. Further kerf reductions of at least 0.020 inches are possible by improved saw guide technology. This represents a potential increase in lumber yield of 2 per cent.

The Flexo guide is a new guide system developed at Forintek Canada Corp. to achieve kerf reduction. Also, it will reduce surface roughness of cut lumber by dampening saw blade vibration which causes back cutting of the saw blade. Most importantly, the new system will allow many sawmill operations to cut with single arbor instead of with double arbors. The use of single arbor machines, eliminates the mismatch line of double arbor cut lumber, which is one of the most serious problems the Canadian sawmill industry presently faces in manufacturing rough lumber for foreign markets. Replacing double arbor with single arbor machines will also substantially reduce saw and saw maintenance costs by reducing the number
of saws by half.

Essentially all circular saw guide systems operated in Canadian sawmills involve only one pair of guide blocks. Only two sawmills use double guide systems, one system has been developed by a Canadian equipment manufacturer and the other system is a foreign development. But these systems provide only marginal improvements in saw performance. One system involves stationary and rigid mounting of the guide blocks which requires very precise alignment of the two guide pairs. Since this alignment precision is not easily achieved in sawmill operations, this double guide system has not substantially improved the cutting performance of gang edgers. The other system involves a floating guide pair which is somewhat more effective than the rigid double guide.

The floating guide system consists of a standard guide pair which is stationary and positions the saw blade on the arbor and a freely floating guide pair on the back side of the saw blade below the work piece. Since both guide pads of the floating guide section are rigidly connected with each other and are mounted on a floating support, this guide system acts primarily as a vibration dampener and less as a reducer of sawing deviation.

The Flexo double guide system has substantial advantages over the other systems. Whereas the system with the floating guide pair reduces sawing deviation by less than half, the Flexo double guide has been found in laboratory experiments to reduce sawing variation by four to six times on
average. Also the new system effectively reduces saw blade vibration and in turn surface roughness of cut lumber.

The Flexo guide system consists of a stationary standard guide pair for positioning the saw blade, and a novel flexible second guide pair which is located above or on the back side of the cut. Figure 1 shows schematically the arrangement of the main and the flexible guide pairs. The flexible guide pair consists of two independently operating guide pads which are spring loaded, preferably by air pressure. A critical feature of the new guide system is the pad mounting which prevents the flexible pads from exceeding the zero line of the running saw when the saw blade tends to deflect against the other guide pad. This is extremely important for thin-kernel saws in cutting knots. The flexible guide pads provide a spring-like support to the saw which reduces the formation of lumps in cutting knots. Lumps, which are non-flat spots in the overall flat blade, are detrimental to the cutting performance of circular saws.

The Flexo flexible guide has been successfully tested in the laboratory. Further work with mill testing is required to introduce it into Canadian sawmills.

Based on laboratory cutting tests, the Flexo guide system has the potential to reduce kerf by 0.015 to 0.050 inches, improve sawing accuracy by 0.010 to 0.030 inches, to significantly increase feed speed and to replace double arbor with single arbor sawing which will eliminate mismatch. Poor sawing accuracy and mismatch are two of the most serious
problems encountered by sawmills in selling lumber to overseas markets. The indicated improvements in sawing performance achieved with the new guide system provides sawmills in B.C. with a potential revenue of up to $4,000 daily.

2. OBJECTIVE

The objective of the project is to design a commercial prototype, and test and optimize it in typical sawmill conditions. The mill test is designed to confirm the laboratory results, to allow for testing of alternate guide configurations, and at the same time, to operate the new guide system on a commercial machine which is one of the most productive and efficient gang edger operations in the Canadian sawmill industry. This commercial gang edger is part of the log break down process at Weldwood of Canada's Flavelle Cedar Sawmill in Port Moody.

3.1 Guide Design

The Flexo guide system was designed to be installed in a production edger equipped with a multiple saw set. The guide pads and their housing were reduced to a size which allows the Flexo guide to be used between saws spaced 1.5 inches apart.

A completely new guide arm was designed to mount the guide on a bar. The mounting allows the guide to be moved on the bar and be locked when it is
in alignment with the standard guide. This guide bar was built to fit into the gang edger. The new guide leads the saw into the cut with the saw rotating against the direction of feed. The guide arms were designed for maximum stiffness to prevent bending. Air supply hoses which provide the air pressure to the pistons carrying the guide pads were machined into the guide arms to avoid damage by fractured wood.

The first sawmill prototype of the Flexo guide was identical to the one built and tested in the laboratory. After the second test in the mill, the guide was modified to apply water lubrication which produces a bearing effect between saw blade and guide. For this, special channels were drilled into the guide arm to conduct water to an outlet located directly in front of the guide pads.

After a third test run, a new mounting device for the Flexo guide was designed to allow more accurate alignment of the double guide system.

3.2 Mill Test Set-Up

The guide system was tested in a high production circular saw gang edger operated with 20 saws mounted on a bottom arbor. The saws were rotated against the feed which is commonly known as counter cutting. The machine cut 6 inch Western red cedar cant's at a feed speed of 150 fpm.

The test saws measured 30 inches in diameter, 0.085 inches in blade
thickenss and cut a kerf of 0.125 inches. The rotational speed of the arbor was 1800 rpm.

4. RESULTS AND DISCUSSION

Three test runs were performed. In the first test, the guided saws initially performed accurate cuts. However, with time, the cutting accuracy deteriorated and the test had to be terminated to avoid damage to the saws and the guide system. The cause of deteriorating cutting accuracy was analysed and it was concluded that poor alignment and possibly insufficient lubrication accounted for the deteriorating performance.

Alignment between the main guide and the Flexo guide was found to deteriorate significantly when the main guide and the saws were rotated after and not before installing the Flexo guide. In multiple saw operations with a large number of saws, the position of the main guide appears to shift when the saws start to rotate. This shifting can be partly attributed to traces of sawdust between the guide blocks.

In the second test, the Flexo guide blocks were operated with water lubrication. In contrast to the first test, the saws rotated for approximately one minute before the Flexo guide was installed and aligned to the stationery saws. Special care was taken to align the saws accurately by using shims. The saws cut for approximately 20 minutes
before one of the three guided saws hit a rock which caused bending of all test saws. Guided saws respond sensitively to tooth damage since damaged teeth cause excessive saw blade deflection which disturbs the lubrication flow in the guide and therefore the support of the saw blade. Also, the guide pads showed wear and required replacement.

The lumber cut before the problem occurred was very smooth in surface texture. No individual tooth marks could be identified. This implies that the new guide system effectively dampened the vibration of the saw blade. Coupled saw blade and tooth vibration is the major factor causing surface roughness of cut lumber when cutting is performed with sharp saws.

After repairing the guide pads and levelling and tensioning the saws, a third test was carried out. Again the individual Flexo guides were aligned as accurately as possible. Initially, the saws cut accurately but once more began to loose accuracy and the test had to be terminated.

Again, various guiding and sawing parameters were checked to determine the reason for the loss in cutting accuracy. It became evident that the setting of the main guide as practiced by the mill did not provide the necessary tight guiding of the saw blade. Also, the water lubrication of this guide appeared insufficient to obtain a uniform bearing effect. Guiding and lubrication was improved by using slightly thicker saws, which reduced the gap between saw blade and guide pads, and by increasing the water supply to maximize bearing effect between saw blade and main guide. As a result the sawing accuracy improved by 0.020 inches.
Wear on the Flexo guide pads indicated that the accurate initial alignment between main and Flexo guide deteriorated when the saw was rotating. This can be explained by the fact that the stationary saw is never entirely flat due to tensioning or pre-stressing of the saw, but the centrifugal forces flatten the saw when the saw is rotating. This changes the position of the saw blade in the Flexo guide and bends the blade slightly.

This observation suggested a new mounting design for the Flexo guide which has now been developed and will be tested shortly. In essence, the new mounting aligns the Flexo guide while the saw is rotating at its full operational speed and not when the saw is stationary. The mounting also provides other significant advantages. Whereas the alignment of the Flexo guide as performed in the test runs described above took 25 to 30 minutes, the alignment involving the new mounting system requires only seconds and is independent of the number of saws in the sawing machine. Moreover, the new system appears to be readily applicable to shifting edgers where double guiding appeared to be extremely difficult.

Since the gang edger used for these mill tests does not allow cuts to 12 inches in depth, an additional series of cutting tests were carried out to obtain information on the lowest kerf which can be possibly cut in processing 12 inch cants with a single saw. This information is of utmost importance to most Canadian sawmills which sell rough-cut lumber to overseas markets. Overseas customers are extremely reluctant to buy double-arbor cut lumber which as a rule shows mismatch. Presence of
mismatch is considered an indication of poor sawing accuracy. Because of this situation, many sawmills are considering replacing double with single arbor sawing machines. But single arbor machines involving standard guide systems cut extremely heavy kerf when cants of 12 inches are cut. When hemlock cants of 12 inches are sawn with single guided, single arbor saws, for example, the saws normally have kerfs of more than 0.240 inches. With the addition of the Flexo guide, the kerf can be drastically reduced. In cutting unfrozen and unseasoned western hemlock cants of 12 inches in thickness, the Flexo guide allowed a kerf as low as 0.136 inches. Without the Flexo guide and cutting the same kerf, the saw was able to cut only 6 inch cants.

To the author’s knowledge, a kerf of 0.136 inches has never been achieved in sawing 12 inch cants with a single circular saw. This kerf is normally considered excellent in cutting 6 inch thick cants with a single saw supported with standard guides. In cutting 12 inch cants with double arbor sawing machines, the kerf is commonly in the range from 0.150 to 0.250 inches with the majority of kerfs being over 0.200 inches.

What is even more impressive for the cutting performance of the Flexo-guided saw is the fact that the kerf of 0.136 inches was cut with a sawing variation of less than 0.010 inches. This is an extremely high accuracy for industry standards. Industrial operations normally have a sawing accuracy of 0.020 to 0.030 inches.

Furthermore, in cutting 6 inch cants with and without the Flexo guide, the
cuts differed widely in cutting accuracy. Whereas the Flexo guided saw showed a cutting accuracy of only 0.002 inches and less, the standard guided saw cut at an accuracy of 0.025 inches (Figure 2).

The excellent sawing results obtained with the Flexo guide used as a second guide support will provide major economic advantages. First, kerf is reduced substantially. Assuming that it is 0.025 inches lower, a mill using the guide increases its recovery by 2%. In a mill producing 500 M fbm per day, this amounts to $2000 per day. Second, a double guided single saw eliminates the mismatch problem which as discussed earlier constitutes a major problem in marketing Canadian lumber in Japan and Europe. Third, double guiding reduces saw costs since only half the number of saws are used in comparison to a double arbor gang edger.

5. CONCLUSIONS

The tests of the new guide system demonstrated that the Flexo guide has to be accurately aligned with the main guide. Accurate alignment was found to be extremely difficult to obtain in the gang edger with the saws in the stationary state. A new guide mounting system which aligns the guides while the saws are rotating at operational speeds without cutting is being developed to obtain the necessary accuracy with a very short period of time for alignment.
The Flexo guide can be operated without water lubrication since the water applied by the main guide is sufficient.

Additional laboratory cutting tests have shown that the Flexo guide has the potential to replace double arbor with single arbor sawing at acceptable kerf. Single arbor sawing eliminates the problem of saw mismatch.

6. RECOMMENDATIONS

Based on the results of this study, the following recommendations are made:

1. Further tests have to be conducted to evaluate the effectiveness of the new self-alignment system for the Flexo guide.

2. The new self-aligning system should be tested for its suitability for guiding shifting edger saws.

3. The potential of the new guide system for converting double arbor into single arbor machines (to eliminate the mismatch problem), should be demonstrated by installing the Flexo guide in a double arbor machine and operating this machine with one arbor only.
FIGURE 1  Main (stationary) and Flexo (flexible) guide arrangements and cross-sections of main and Flexo guide pairs
FIGURE 2  Difference in cutting accuracy observed with and without Flexo guide in cutting 6 inch unseasoned hemlock stock.
A SAW CONTROL SYSTEM

By
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A SAW CONTROL SYSTEM

by

Sita Warren

The problems encountered in setting up any type of sensor for monitoring sawing deviations are:

(1) very little room to build any type of holder to accommodate the sensor,

(2) sensors are extremely fragile, therefore, noise and vibration will result in damage.

In order to overcome these difficulties Forintek designed a holder to house the probe and locate it directly on the saw guide.

The sensor used in the application is a Kaman transducer which works on the magnetic principle. This displacement probe has a range of 0 to 0.240 inches. The probe is 50 to 270 thousandth of an inch from the saw blade and 17 thousandth of an inch from the plastic holder. The brass insert in which the probe is mounted is easily removable (Figure 1).

The probe was directly interfaced to an IBM computer which calculated the sawing deviations at various intervals. A light bulb was used to alert the sawyer when the sawing target was exceeded so that corrective action
could be taken. For example, the feed speed could be slowed down. The computer system continually stores data which provide management with the sawing deviations over an 8 hour shift. This is an important factor in ascertaining when the sawing deviations are the greatest.

A mill trial is in progress at the present time at International Forest Products and Dave Fisher has provided the economic benefits he has calculated for his mill (Appendix).
FIGURE 1 Saw deviation sensor holder
APPENDIX
May 2, 1989

Ms. Sita Warren  
Research Scientist  
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Dear Sita:

SUBJECT: ECONOMIC IMPACT OF SAW MONITORING PROBE ON TWIN

Sawing variations on our twin horizontal resaw have a very significant impact on the lumber recovery of our mill. We presently produce many two and three piece multiples at our headrig for final breakdown at the twin. If we are able to reduce sawing variation at the twin, we can significantly reduce target sizes for these multiples made at the headrig. In addition, an improvement in recovery will also be realized from the slabs being processed.

Reducing the target size that slabs are processed to will improve the recovery in width and length for the resulting pieces.

ECONOMICS

I anticipate a quick reduction in sawing variation from an average of .045" STANDARD DEVIATION to .030". This improvement will impact our lumber recovery such that we will realize a lumber pickup of 311,850 FBM and a value realization of $187,110 per annum.

Once the operators have developed an understanding of the relationships between feed speeds, quality of material being processed, and sawing variations as recorded and indicated by the probe; I believe a sawing variation of .020" STANDARD DEVIATION is achievable and maintainable.

This further improves our recovery by 207,900 FBM and $124,740 per annum.
Letter to: Sita Warren Cont’d.

Total realizable value from this project, applied to only one machine centre, is $311,850 per annum.

Our intent is to install a comparable system on the headrig as soon as possible. Other machine centres will be considered once the headrig project is complete.

Sita, I hope this information satisfies your requirements in determining a project value for our operation. I have included a list of assumptions used in determining these values.

Yours truly,

Dave Fisher
Production Manager

DF/jn
Encl.
ECONOMIC IMPACT OF SAW MONITORING PROBE

ASSUMPTIONS

- TWIN PROCESSED 1400 PIECES/SHIFT

- 75% OF RECOVERED WOOD FIBRE IS REALIZABLE IN LUMBER FORM

- $600/MBM LUMBER VALUE (CONSERVATIVE AS HIGH PERCENTAGE OF PRODUCTS AT THIS MACHINE CENTRE ARE IN THE UPPER GRADES)

- 495 SHIFTS/YEAR

- TARGET SIZE IS DETERMINED BY:
  MINIMUM ACCEPTABLE SIZE & (SAWING VARIATION x 3)

- AVERAGE SIZE PIECES AT TWIN = 10" WIDE x 16' LONG

NOTE: THE VALUE OF INCREASED RECOVERY OF CHIPS VS. SHAVINGS WAS NOT CONSIDERED IN THIS CALCULATION